CAMECO CORPORATION

B-ZONE WASTE ROCK PILE

UTILIZATION OF WETLANDS
FOR
REMOVAL OF ARSENIC AND NICKEL

July, 1998

SUMMARY

In planning the activities for decommissiong the B-zone waste rock pile, research on the use of the wetlands in the vicinity as natural treatment systems for toe seepages was also undertaken. The 1996 final report, "Decommissioning of the B-Zone waste rock pile", summarized the information generated on the waste rock characteristics: hydrology, geochemistry, contaminant generation and removal rates. This work made clear that the B-zone waste rock pile and the surrounding wetlands lend themselves to a self-sustaining decommissiong approach.

The mechanisms that remove As and Ni from toe seepage water to sediments in the muskeg ponds were identified by work in both the field and the laboratory. The contaminants are adsorbed in the water columns to particulate matter, and in the deeper portions of the sediment, microbial activity stabilizes them. When design criteria for the use of the wetlands were defined, it became clear that sufficient space is available and that the proposed mechanism of contaminant removal is already taking place naturally. It is possible that the occasional input of organic matter would further stimulate microbial activity.

The proposal to use the muskeg as a self-sustaining system was challenged by work carried out in 1997. If contaminant removal and biomineralisation occur naturally, then evidence of these processes should be found in the conditions of the wetlands themselves. Periodically, some muskeg areas receive run-off and seepage from the ore/waste rock pile, and dust material transported aerially would likely accumulate in the vicinity of the piles. In order to provide this evidence, data on the chemical/physical characteristics of pond sediments and muskeg vegetation were analysed empirically. The solid-sample collection accumulated since 1992 was supplemented with samples of sediments and muskeg vegetation submitted for chemical analysis in 1997. This data interpretation lead to the following conclusions:

- Comparison of the distribution of As and Ni, on a kg/ha basis, in the vicinity of the B-Zone waste rock pile in muskeg pond sediment and water confirmed that pond sediments are the most effective accumulators of contaminants.

- The total mass of As and Ni that accumulated in the sediment was higher for muskeg areas receiving periodic contaminated seepage than in hydrologically-isolated muskeg areas.

- Although mining activity increases the extent of aerial transport of contaminants, the concentration ranges that were determined fall within those reported in the literature for mineralized areas.

- The differences in the ratios of As and Ni in waste rock samples to those in pond sediment suggests that biomineralisation has altered the form of the contaminants in the latter.

- Concentrations of As and Ni are higher in surface strata (25 cm) than in the deeper strata, suggesting aerial transport and deposition.

- Quantiication of the physical characteristics of the solid material served to reinforce the inference that microbial activity takes place. The findings of experimental field and laboratory work were consistent, in that both determined that As and Ni are adsorbed to organics and particulates in the water column and then transported to the sediment. Nickel **is** transformed into nickel sulphides and carbonates, while arsenic is associated with iron.

- The contaminant removal processes require the presence of pond sediments, which are limited on the lvison Bay side. Shallow ground water characteristics in the vicinity of the waste rock pile were described, with particular emphasis on the migration of contaminants towards lvison Bay. Monitoring data on toe seepages from the waste rock pile have been summarized to facilitate the estimation of contaminant loadings from the pile for decommissioning.

A further objective of the 1997 work was to determine whether the contaminants are indeed retained in the muskeg/ponded sediments, rather than being redissolved by run-off events if a diffusion gradient occurs between sediment pore water and pond water. This question was addressed by quantifying the easily extractable As and Ni from solid samples with distilled water.

- The easily exchangeable fraction of the contaminants is not related to the total concentrations of As and Ni in the solid material indicating that, in the sediments, the contaminants do not accumulate by adsorption alone. They are present in solid forms more resistant to leaching than easily exchangeable forms. Solid material with low concentrations release higher fractions *of* contaminants. Therefore, As or Ni total concentration gradients between the sediment and overlying water phases will not result in contaminant re-release from the sediment.

A final objective of the work carried out in 1997 was to explore the level of stability with which secondary precipitates and evaporates, which form in association with the waste rock, release contaminants.

- It was determined that precipitates/evaporates release more contaminants than waste rock, but leachability is affected by the ratio of water to solids and the contaminant type.

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1.0 INTRODUCTION

With the completion of the B-Zone waste rock pile in 1991, field and laboratory investigations were initiated in 1992 to evaluate whether the existing wetlands surrounding the pile could be used effectively in the decommissioning process. The wetlands and their ponds could, potentially, serve as natural retention areas for the contaminants in toe seepages from the waste rock pile. The major contaminants in the seepages are arsenic and nickel, whose entrance into the surrounding environment will not be entirely eliminated through re-contouring of the waste rock pile surface.

A primary aim of decommissioning the 6-Zone waste rock pile **is** to develop an environmentally sustainable system, one which ideally contains the option of a zero-maintenance solution. In such a scenario, retaining structures for seepage collection is undesirable, since ditches require continued maintenance. A final decommissioning design which allows the un-contained flow of residual seepages into the surrounding wetlands would represent a desirable amendment to the decommissioning scenario.

The use of wetlands as contaminant removal systems, although widely discussed, is frequently poorly applied when put into practice. The most important component of a wetlands' ability to facilitate contaminant removal, lies in the capacity of its sediment to support the microbial activity which lead to biomineralization, rendering metals to stable non-toxic forms. The sediment component of the wetland design is often ignored, which results in the failure of the wetlands to perform their desired function.

The capacity of wetlands to serve as permanent sinks for contaminants is of the utmost importance when wetlands are incorporated into the design of a decommissioning process. In the case of the muskeg and wetland areas surrounding the B-Zone waste rock pile, however, biomineralization processes in the sediments have been defined in detail. The characteristics of the wetlands in the B-Zone area, specifically the sediments in the ponds and their ability to serve as contaminant removal systems, were summarized in the 1996 report entitled "Collins Bay Decommissioning B-Zone Waste Rock Pile: 1996 Final

Report". The evaluation of these characteristics represented five years of laboratory and field work.

The mechanisms responsible for transferring contaminants from the water to the sediments appear to be similar for both Ni and As. The contaminants are adsorbed to particulate matter - a combination of organic matter generated by biological activity, iron hydroxides and inorganic suspended matter. The processes which lead to biomineralization in the sediment, however, are different for the two contaminants. Laboratory reactor experiments carried out with pond sediment and seepage from the collection ditch, indicate that nickel in the sediment is associated with carbonates and sulphides, whereas arsenic is associated with both the organic matter and iron hydroxide phases of the sediments. In the wetland ponds (near BT-2 Stn 250), enclosures were charged with seepage from the collection ditches several times over a period of four years. **As** and Ni were removed to the sediments in the enclosures at rates (**As,** 0.076 $g\cdot m^{-2}\cdot d^{-1}$: Ni, 0.078 $g\cdot m^{-2}\cdot d^{-1}$) similar to those recorded in the laboratory reactors (**As, 0.10** $g\cdot m^{-2}\cdot d^{-1}$: Ni, **0.1** $g\cdot m^{-2}\cdot d^{-1}$). Several publications have summarized the details of these experiments.
The publications are included in the Appendices of the **1996** final report and in Appendix **4** of the current report.

Contaminant loads from the seepages of the waste rock pile were estimated from the pumping records of the seepage collection ditch (Stations **6.11** and **6.11 SE),** taking hydrological considerations into account. The expected contaminant load from the toe seepages of the waste rock pile are such, that the removal capacities of As and Ni of the sediment can balance the input from the waste rock pile. Sufficient pond sediment area is available to provide the desired contaminant sink. When the decommissioning approach is considering healthy growing muskeg as part of its design component, the long term stability of the contaminants in the sediments is assured due to the biomineralization processes , which immobilize both **As** and Ni in the sediments.

Due to the physical conditions of the roads adjacent to the ore stockpile and the waste rock pile, some seepage and run-off from the waste rock pile does enter the BT-2 area periodically. This provided an opportunity to assess the field conditions through a sampling program of wetland sediments and determine if the characteristics of the samples reflect the results obtained from the field and laboratory experiments. Through evaluating the surface areas of both muskeg and sediments in the wetland ponds it should be possible to empirically infer the proposed contaminant removal processes for the wetlands.

A primary objective of the 1997 work was to estimate the existing mass of iron, sulphate and organic carbon - the three major compounds involved in the removal processes. These compounds should be present in abundant quantities, since they are the components of the sediment which enable it to function as a permanent sink for As and Ni.

Since it is proposed that these removal processes should occur naturally, they should operate without amendments, such as the organic carbon additions made to the field enclosures, even though higher removal rates would be anticipated with sediment amendment. As expected, the control enclosure (with no amendment) demonstrated moderate contaminant removal, with rates somewhat lower than if they had been amended.

In addition to substantiating the natural contaminant removal capacity of sediments, a base loading of contaminant for the area surrounding the B-Zone waste rock pile will be established through estimates of the mass of As and Ni in the areas surrounding the waste rock pile.

2.0 METHODS AND MATERIALS

2.1 Sample Summary

The B-Zone waste rock pile (WRP) was constructed between 1984 and 1991. The first samples of sediments from the ponds and muskeg were collected in the following year, i.e., in June of 1992. Muskeg material consists of several components. The uppermost vegetation cover is that which is growing, partly submerged in water. Below this layer, generally a layer of decaying vegetation is found. Due to the nature of the muskeg this layer is consisting of recalcitrant (hardly decaying woody, leathery vegetation parts) vegetation components. Below this layer a peaty layer forms, which depending on the topography converts very slowly to gyttja or ' loonshit'.

In Table 1, an overview is given of all the sampling episodes, the results of which are used in this report to assess the wetlands and its ponds. The locations of the samples are shown in Map 1. In red letters, the areas represented by the sample type are given referred to on page **14** of this report for loading calculations. Pond sediment (3 locations) and peripheral muskeg (2 locations) samples were collected and described as part of the initial survey of the B-Zone WRP wetlands, and were presented in the 1992 B-Zone Final Report, Boojum Research Limited. Sequential extractions on sediments from the enclosures, where 6.11 seepage water was added, to determine the fate of As and Ni in the sediments through biomineralization were carried out in 1993. This work was summarized in 1994 as a CANMET report (Arsenic and Nickel removal from waste rock seepages using muskeg sediment; Final report Contract No 23440-3-9275/01, Energy Mines and Resources Canada). These sediments do not represent natural transport mechanisms of the contaminants from the source through the muskeg environment as the seepage was loaded from the surface and sludge/ precipitates formed in the toe seepages was added to test re-solubilisation/ fixation of either Ni or As in the sediments.

Two cores were collected in 1992. The first was collected from BT-1 Stn 300, and consists of a muskeg core collected as a top sample from 0 to **25** cm depth, and a bottom

Table 1: Solids Sampling Locations, 1992, 1993 and 1997
Muskeg and Wetlands B-Zone

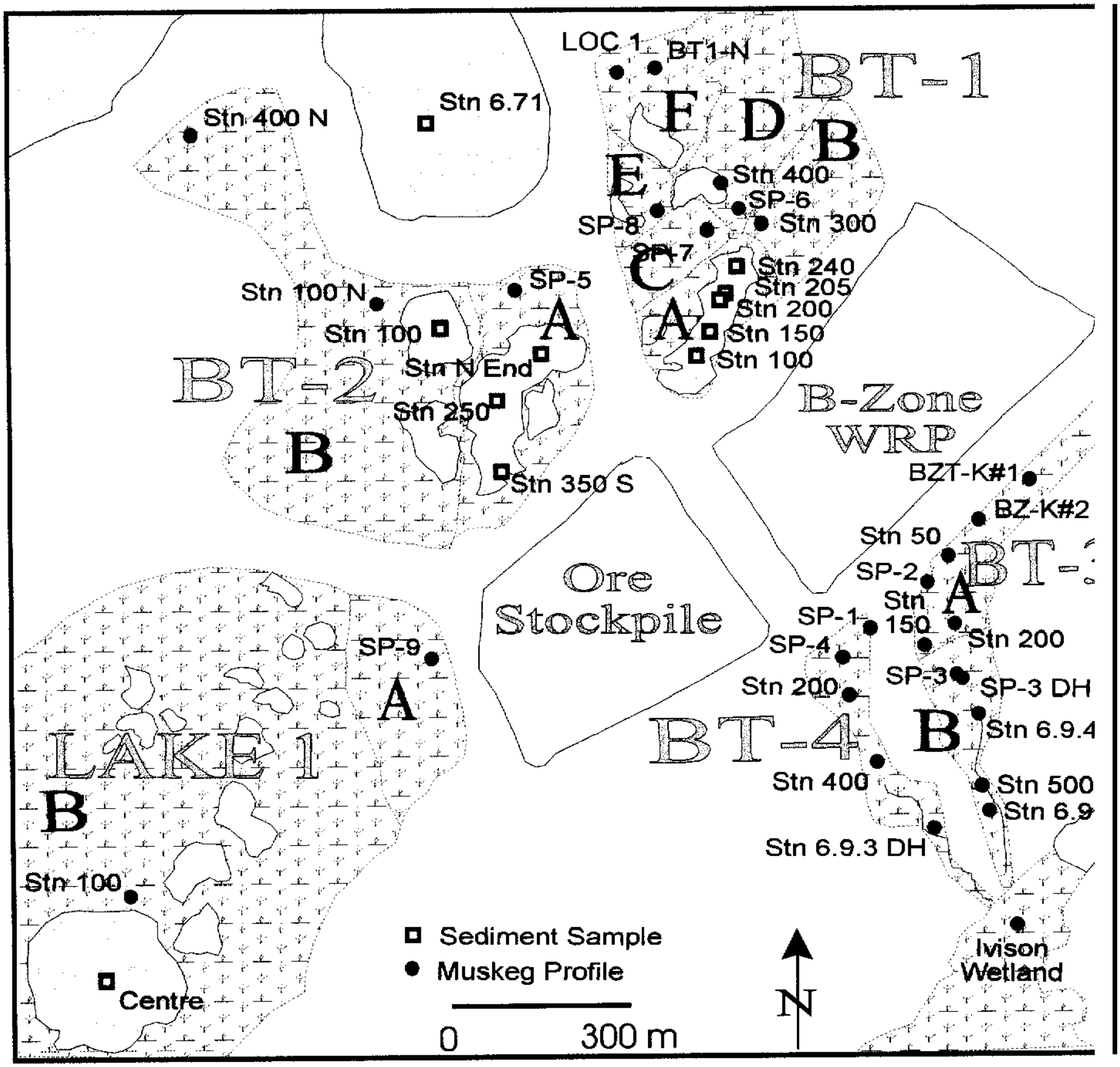
Year Collected	LOCATION									
	BT-1		BT-2		BT-3		BT-4		LAKE 1	
					SEDIMENT					
1992	Stn 200	E	Stn 100	E					Centre	E
1993	ENCLOSURES ONLY									
1997	Stn 100 Stn 150 Stn 205 Stn 240	E E E E	Stn 100 Stn **250** Stn 350 S BT-2 N End	E E E E	Stn 150	G				
					MUSKEG					
1992	Stn 300	K							Stn 100	**K**
1993	SP6 SP7 SP8 LOCI	C C C C	SP5	C	SP-2 SP-3	C C	SP-1 SP-4	C C	SP-9	C
1997	BT-1 N	C	Stn 100N Stn 400 N	C C	BZT-K#1 Stn 50 Stn 200 Stn 500 SP-3DH	**G** C C C C	Stn 200 Stn 400 Stn 6.9 3 DH	C C C		

E - Ekman C - Cutting G - **Grab** **K** - Core

sample covering a depth from 25 to 50 cm. The second core was collected from the shore at Lake 1 Stn 100 (a control lake), where four 20 cm thick consecutive samples could be obtained, covering the profile to a depth of 80 cm.

In June 1993, substrates from ten (10) muskeg profile sampling locations were collected during the process of installing shallow piezometers (SP-1 to SP-9, LOC 1). These samples were stored frozen (-20°C). No pond sediment samples were collected in 1993, but major strata were determined in the field. In 1993 sampling of the muskeg, the uppermost strata (e.g. 0 - 25 cm) was not specifically sampled (as was the case in 1997) unless an identifiable surface stratum, other than live vegetation, was present.

Map 1: B-Zone Sediment and Muskeg Profile
Sampling Stations, 1992-97.



In August 1997, muskeg samples were collected at eleven (11) locations, either where substrate profiles were examined previously, or where additional samples would complement information from previously established transects in the respective wetland areas. At these locations, samples were typically collected from specific depths where possible, 0-25 cm, 25-50 cm, 50-75cm and 75-100 cm, using the soil sampling auger.

2.2 Field sampling methods

In Table 1, the sample types obtained to describe the surface and subsurface material are designated by E for Ekman, C for cuttings from the soil auger, G for grab and K for cores collected by removing intact profiles using a shovel. Whenever the consistency of the material allowed, the top 0.2 m of the sediments were sampled using an Ekrnan dredge. A grab sample was obtained with a shovel when the Ekman dredge could not be operated. Muskeg samples were collected with a soil auger, and all major strata were identified in the field. Similarly, all samples were described in the field, then stored frozen (-20°C) until laboratory processing. When sufficient water was present, field measurements of pH, conductivity and Eh were carried out. These samples were stored in plastic bags.

In addition to the muskeg samples, precipitate / evaporate samples were collected from the B-Zone waste rock pile surface, the toe seeps and the collection ditches. The sample selection was guided by the frequent visual appearances of colouring on rock surfaces on the waste rock lifts. This sample type is referred to as the As/Ni oxidized material. In acidic toe seeps solid precipitate accumulates regularly which had previously been analysed, reporting high concentrations of As and Ni. This sample type is referred to as WRP- P sludge. On the perimeter ditch, a floating solid foam forms after precipitation events, which was considered part of mobile solid or TSS fraction originating from the waste rock pile, described as ditch foam. As a comparison to these precipitates, rock samples representative of the main rock mass, graphitic coarse gneiss , heamatized sandstone and clean sandstone was selected for the batch leaching experiment (Section 2.3.6).

2.3 Laboratory Methods

For the current study, the samples that were previously collected in 1992, 1993 and 1997 were re-described with respect to their texture and composition, and compared to the field descriptions that were originally made. This confirmed the identity of the samples and generated a consistent data set for the physical parameters of the material. Sub-samples were taken several times, in order to determine the wet density, moisture content and % Loss On Ignition (%L.O.I., 480° C for one hour on air dried material). A dried and ground sample was then prepared for chemical analysis. Some sub-samples were subjected to slurry tests, to determine water extractable As and Ni.

On June 13, 1997, the previously collected samples were thawed, re-described and processed in the laboratory. All 1992 and 1993 samples were oven dried at 70°C and ground in a Wiley mill. One (1) g samples of the material were digested (nitric-HCI-perchloric) and assayed for several elements, including As, Ni, Fe and S. Selected samples were subjected to multi-elemental analysis with ICAP.

For 1997 sediment samples, the Total Organic Carbon (TOC) concentrations were also determined using a Leco apparatus, to ascertain the relationship of organic carbon and % L.O.I. Since the relationship between these two parameters, in areas with similar productivity and decomposition rates, is expected to be constant, it can be used to reliably evaluate the organic carbon content of the sediment.

2.3.1 Sample Description

Samples were described according to their texture, colour, smell, and qualitative moisture content. The types of samples vary from organic (i.e. peat) to rocky/sandy (inorganic). The descriptions for all these samples are presented in Appendix 1, Table 1, which provides the comparison of the field and laboratory descriptions. In general, the qualitative description of a sample included the following parameters: excess water - moist or dry ; type of matter - rocks, sandy, organic, inorganic, sediment / peat; colour; odour - smell of

H_2S ; and the presence of roots and other intact vegetation parts. These observations may be used as semi-quantitative indicators to characterize the distribution of the elements derived from the chemical analysis, should further investigation be required.

2.3.2 Sample Preparation

From each sample, 60 mL (wet volume) was taken and put in a volumetric beaker, which generally produced a wet weight of around 49 g to 200 g. The remainder of the sample materials were re- frozen.

From the entire data set, only two of the eleven locations sampled produced material which was dry representative of terrestrial or only temporarily submerged (of a silty/sandy texture). Seventeen (17) samples contained excess water (described as very wet) and the rest were moist. With the exception of the two dry samples, no water had to be added in order to determine the pH, Eh and electrical conductivity. Details are given in Appendix 1, Table 2. For the samples which produced excess water from the sample bag, this water was separated from the sample and measured separately.

2.3.3 Moisture Content

The wet weight was recorded, and the sample was air-dried then oven-dried at 70°C for twenty-four hours. Moisture content was calculated as follows:

$$\text{Moisture content} = \frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \times 100\%$$

2.3.4 Wet Densitv Determination

A wet volume of 60 mL of each sample was the starting point, and a wet weight for this volume was obtained. The wet weight, in grams, divided by the wet volume, in mL, gives the wet density, in $g{\cdot}mL^{-1}$. It should be noted that this wet density determination performed on sampled materials in the laboratory, follows loosening of the materials, particularly muskeg samples, during field sampling. It is likely, therefore, that the reported wet density values underestimate the actual wet densities in the field. The measurement of wet density is obtained to estimate a pore water volume in the wetland substrates.

2.3.5 Distilled Water Extraction of Arsenic and Nickel

The objective of this procedure was to determine the mass of arsenic and nickel which could be mobilized from the samples when distilled water, to simulate fresh water recharge, was added. Fresh water additions will produce a concentration gradient for the sediment pore waters, which can result in mobilisation of elements by diffusion. This As and Ni may represent the very easily exchangeable fractions, if the contaminants are deposited only on the surface material, rather than adsorbed and integrated into the sediment.

The extraction procedure used a 120 mL sample of distilled water, added to a second sub-sample of 60 mL wet volume. The solid/water mixture was slurried and placed in a refrigerator for one week to equilibrate at a low temperature, simulating sediment conditions. The pH, conductivity and temperature of the supernatant were measured after one week of equilibration. After measurement of pH and conductivity a supernatant was obtained from the solid/water mixture. In order to test for arsenic, a sediment-free water sample (supernatant) was required. To obtain the supernatant, approximately 40 mL of water, containing as little sediment as possible, was poured off, and a centrifuge was used for 10 minutes at a setting equivalent to 1500 rpm, in order to separate water from solid.

A semi-quantitative test kit (E. Merck EM Quant) was used as a screening test to determine if any contaminants had been mobilized by the leach test. A test strip was placed in a test tube after zinc dust and hydrochloric acid (32%) were used to convert the arsenic compounds in solution to arsine, which reacts with the test strip. The colour which formed on the test strip was then compared to a colour scale (between 0 and 3 mg/L), in order to estimate the amount of arsenic present in the sample.

Screening level nickel determinations using a spectrophotometer were not possible, as the muskeg colouration interfered with the absorption used in the Hach determinations . As the As and Ni screening tests revealed potential release, the leachates were filtered (0.45 µm), acidified (1% HNO_3) and submitted to an analytical laboratory to accurately determine the As and Ni concentrations. The measures of moisture content, density and the associated raw data are presented in Appendix 1, Table 3. Detailed results of the leaching experiments and the concentrations reported in the leachate are given in Appendix 1, Table 4. The excess pore water characteristics and the As and Ni concentrations for those samples which contained excess water, are given in Appendix 1, Table 5.

2.3.6 Batch leaching of precipitates/evaporates on waste rock pile

Supernatant preparation for wet sample 'as received': From each sample bag, 60 mL of wet sample was weighed to obtain wet weight. To this volume, 120 mL of distilled water was added and stirred 1 minute on a magnetic stirrer. The obtained wet volume to water volume ratio was 1:2. The sample slurry was allowed to settle for 1 hour and the following measurements were obtained: pH (Corning M103 pH metre), Conductivity (Orion Conductivity, Salinity Metre, Model 140), Em (Corning M103 pH Metre, VWR Scientific 34105-023 probe) (Table 2). The measurement for distilled water was: pH = 6.76, Em = 301 mV, Conductivity = 36 µS/cm. The slurries were then dried at 60 °C until no further water loss occurred to obtain a dry weight equivalent to an air dried sample and moisture content was determined.

The samples had a wet density (g/mL) ranging between 1.25 to 1.4 with the exception of the NW ditch foam which had a density of **0.49 g/ml** (Table 2). Table 2 also **lists** the total Ni and As concentration of the six solids.

Table 2: Qualitative Description and Chemistry for Waste Rock Pile Solids

Sample Location	Qualitative Description	pH	Em (mv)	Cond. (us/cm)	Total Ni (mg/kg)	Total As (mg/kg)	Density (g/mL)
NW Ditch Foam	foam,yellowish brown,extremily wet	5.08	252	376	2100	3300	0.49
BZWR-7 Graphitic Gneiss	slate,coarse	3.89	322	250	480	380	1.36
BZWR-6 Hematizxed	reddish brown,sand strone,coarse	3.7	211	341	1300	2000	1.31
BZWR-6 As/Ni Oxidized	green,grey with yellow pebbles,clay	3.45	233	1712	176000	150000	1.25
BZWR-6 SS Area	light,grey,sand stone,coarse	3.98	245	221	320	230	1.41
WRP-P Sludge	sludge,light brown,extremely wet	2.77	373	2130	740	65600	1.25

Supernatant preparation from **dry** sample material: After the supernatant was prepared on the wet 'as received' samples, the entire sample was dried to obtain dry weight. This dried material was then used in batch leach tests. To 1 g air dried sample, 100 mL of distilled water was added resulting in a ratio was 100:1. The slurry was stirred for 1 minute, allowed to settle for 1 hour and then centrifuged the slurries at 800 RPM (HN-S Centrifuge) for 10 minutes prior to obtaining the pH and nickel measurements reported in Table 2. Ni was determined colorimetrically (EM Science 14785-2 Spectroquant Nickel, Spectronic 70 Metre at **445** nm).

Cumulative supernatant preparation: The Ni leached during the batch leach test, covering a period of 427.5 h included the As/Ni oxidized sample **(BZWR-6)** which had high As and Ni concentrations. In the first round of slurries, only Ni concentrations determined. As the results from the chemical analysis indicated that both metals are high in some of these solids, the batch leach test included monitoring of As concentration in supernatant was added to the experiment.

The supernatant was decanted, after regular contact time, and a fresh 100 mL distilled water to the solids after centrifuging. The new slurry was stirred for 1 minute, allowed to settle for *1* hour, followed by centrifugation again prior *to* the measurement *of* pH, conductivity, Em, Ni and As (decant cycle 1). The measurements of pH , Eh and electrical conductivity were carried out on the decanted supernatant and the sample was stored without water in the refrigerator.

The experiment was carried out over 10 days from April 14th to April 23rd, 1998. The next decant cycle started with adding the next volume of 100 mL distilled water to the solids which was treated in the same fashion as before. For the first 8 decant cycles 100 mL of distilled water was added, followed by 200 mL for decant cycle 9 to **13.**

2.4 Calculations of the Mass of As, Ni, Fe, S and LOI.

In Appendix 1, the results of the elemental analysis of the sediment samples (dry weight basis) are presented in Tables 6a and 6b. A summary of As, Ni, Fe, S, TOC and LOI converted to $g \cdot m^{-3}$ or % used in the calculations is given in Appendix 1, Table 7 .

Estimates of the mass of As, Ni, Fe, S and Total Organic Carbon (TOC) in the top 25 cm of muskeg and sediments were derived in the following manner.

For muskeg areas, the results of elemental analysis of the most shallow samples collected in 1992 and 1993, and the top 25 cm samples collected in 1997 were used. For pond sediments, the Ekman or grab sample concentrations were used. As the elemental concentrations are performed on a dry weight basis, the elements' concentration in wet sample volumes were back-calculated, using the moisture content and sample density data obtained from the laboratory measurements. These calculations yielded concentrations in units of $g \cdot m^{-3}$ wet substrate, according to the relationship:

$$[\ ]_{dw/wv,\ g.m\text{-}3} = [\ ]_{dw,\ g.t\text{-}1\ (=ug.g\text{-}1)} * \text{density}_{ww/wv\ t.m\text{-}3} * (1 - \text{Moisture Content}_{\%})$$

The concentrations of elements in wet solids, in $g \cdot m^{-3}$, were multiplied by 0.25 m to yield mass per m^2 to a 0.25 m depth. The mass per m^2 was then multiplied by the area of the muskeg or pond sediment, which was derived from aerial photographs.

Estimates of the mass of elements in pond water were made by using the pond water concentration data in $mg \cdot L^{-1}$ and calculating the volume of the pond by assuming an average depth of 0.5 m. This average depth is based on field observations and considered a reasonable estimate. Depending on the annual precipitation, the water depth in the pond can vary, but usually it is by less than 0.5 m. In zones where samples were collected from more than one location, the mass per m^2 data were averaged, then multiplied by the area of the zone. In Appendix 1, the data used for the compilation of the mass estimates are given in Tables 8a to 8f.

2.5 Estimation of Easily Exchangeable As and Ni in Muskeg and Wetland Solids

Easily exchangeable (EE) As and Ni is expressed in units of weight of **As** or Ni per unit volume of muskeg or sediment in, for example, $g \cdot m^{-3}$. The following calculation was performed using the laboratory moisture content determinations and the dissolved As and Ni concentrations following extraction with distilled water:

$$EE_{As,\,Ni} = \frac{V_p + V_e}{V_s} \quad C_{diss\ As\ or\ Ni}$$

where:

$EE_{As,\ Ni}$	Easily Exchangeable As or Ni, in $g \cdot m^{-3}$ (= $mg \cdot L^{-1}$)
V_p	Volume (in L) of original pore water in 0.06 L wet sample.
V_e	Volume of extract ($D\text{-}H_2O$); 0.12 L used.
$C_{diss\ As\ or\ Ni}$	Concentration of dissolved As or Ni in filtered supernatant, in $mg \cdot L^{-1}$
V_s	Volume of wet sample; all samples had original volume of 0.06 L.

The $EE_{As\ or\ Ni}$, in $g \cdot m^{-3}$, for muskeg or pond sediment samples are expressed as a percentage of the total mass of As and Ni per m^3 of substrate. The percentage of easily exchangeable contaminant mass would represent the total concentration in the solid material, if As or Ni has originated predominantly from adsorption to the substrate from the water, reflecting the adsorption capacity of the substrate. A somewhat consistent relationship between the total and easily exchangeable fraction of either element, if the majority of the element had originated in the water, but an irregular relationship is expected if the elements originated from solid phases (either sediment or natural mineralization).

2.6 Shallow Piezometer sampling

In the years 1993 to 1995, the piezometers were sampled using a vacuum pump with a tube suspended to the screened section of the piezometer to withdraw the sample, without prior bailing of the standpipe. The piezometers are located in the water table which **is** very close to the surface (saturated muskeg) and bailing the water may not be of great importance to determine representative water. However in 1997, **5** litres of water were withdrawn from the piezometers and the sixth litre was sampled. SP-1 through SP-9 generally recover very fast. The samples were filtered through 0.45 µm filters and submitted to SRC for elemental analysis, always including the concentrations of As and Ni. Water quality characteristics for all years where samples were collected are presented in Appendix 1, Tables 9a to 9e.

2.7 Surface Waters Southeast of the WRP Toward Ivison Bay

Over the years, several surface water sampling stations have been established, and new ones have been added to the areas as required. Map 1 shows all the surface sampling stations, representing two old drainage areas. Water samples from Stations 6.9.44, 6.9.4, 6.9.3, BT-3 Stn 50, BT-3, Stn 100, BT-3 Stn 150 and a shallow pool in the Ivison Wetland were collected during the August, 1997 site visit, and these were later analysed by SRC for As and Ni, among other parameters (see Appendix 1).

3.0 RESULTS AND DISCUSSION

In order to estimate the mass of the elements in the different components of the wetlands in the vicinity of the B-Zone waste rock pile, structurally different units (ponded- and muskeg-covered areas, indicated by the swamp symbol on Map 1, were defined.

The areas of drier boreal forest upland are excluded from the estimates, since they do not receive seepage or run-off. Surrounding the waste rock pile, 4 muskeg areas are differentiated. BT-1 to BT-4, named after the original numbers of the transects, were marked with rebars in 1992. In addition, one area, designated as Lake 1, serves as a control muskeg, i.e., does not receive seepages and represents background values.

The total area under consideration for estimating the distribution of contaminants on the uppermost strata (25 cm depth) is 124ha. This area comprises 107ha of muskeg and 17ha of wetlands ponds. The four areas, BT-1 (19ha), BT-2 (26ha), BT-3 (4ha) and BT-4 (3.3ha) and Lake 1 (71ha) are subdivided, relating the sampling stations to sections within them, for estimation purposes (referred to by letters in red, A to F). In was not considered appropriate to derive isoclines of the surface contaminant concentrations, since the sampling points are not equally distributed among the area.

Within each of the BT sections, the proportion covered by ponds ranges from **3%** to 18%. The remaining area of each section is muskeg. Details of the calculations of the mass of As, Ni , S , Fe and L.O.I are given in Appendix 1, which lists the individual samples used to represent specific respective areas, as well as the cases where average concentrations of the element were used to arrive at the estimates. In total, 52 samples have been analysed for As, Ni, Fe and 50 for L.O.I., including surface and deeper strata in the B-Zone area. For sulphur, only 30 sample analyses were completed.

The overall average concentration in the solid material are: **As** = 114 $\mu g \cdot g^{-1}$ (min 0.5 $\mu g \cdot g^{-1}$ - max 1200 $\mu g \cdot g^{-1}$); Ni = 82 $\mu g \cdot g^{-1}$ (min 1.4 $\mu g \cdot g^{-1}$ - max 690 $\mu g \cdot g^{-1}$); Fe = 1.3% (min 0.04% - max 28%); and Sulphur = 0.14 % (min 0.008% - max 0.6%). The organic matter as L.O.I.

averages 77 %, with a min of **1.5 %** and a maximum of 98%. These concentration ranges can be compared to literature ranges to obtain a reference point to the mineralized area of the B-Zone. S. E. Allen, in "Chemical Analysis of Ecological Materials" (Blackwell 1974), gives natural background concentrations for organic soil as: Ni - 5 to 500 μg·g^{-1}; As - 0.1 to 10 μg·g^{-1}; S - 0.03% to 0.4%; Fe - 0.2% to 0.5%. He reports the range for L.O.I. to be 30 to 50%. In 1985, A. Buchnea and A. van der Vooren reported in "Review and Assessment of the Known Naturally Occurring Concentrations of Radionuclides and Selected Non-Radionuclides Relevant to Uranium Mill Waste Management (DSS File no: 26SQ 23241-4-1691) concentrations in soil/ rock environments of 9 μg·g^{-1} for As, and means of several sample populations from different locations in Canada ranging from 1.6 μg·g^{-1} *to* 153 μg·g^{-1}. For nickel, they report in the same publication, a mean of 31 μg·g^{-1}, and a range of concentrations from 3.5 μg·g^{-1} to 605 (n = 2686).

The B-Zone wetland Ni concentrations fall into the reported range, although for As, the concentrations are somewhat higher than those reported. This is not surprising, since the reported range of 1.6 μg·g^{-1} to 153 μg·g^{-1} for As includes the mineralized areas of the Athabaska region. An average of 114 μg·g^{-1} for As in an area close to a former As-bearing ore body and directly exposed to waste rock pile, ore stock pile and haul road influences, in fact suggests good containment of contaminants. Concentrations much higher than those reported for natural mineralized areas in Canada might have been expected. Albeit the presence of the waste rock pile, the ore pile and the natural mineralization sediments and muskeg might have been expected to show higher range of contaminants. The increases in the concentrations range indicates that the sediments and the muskeg retain the contaminants and do not release them to the environment at large.

Although the number of sample analyses from the same location is limited which is separated by a time span, an increase over time can be noted (Table 3). Some locations were sampled both in 1992 and in again in 1997. For all locations, As and Ni concentrations have increased between 1992 and 1997 as expected, with the exception of Stn. 200. For Stn. 200, the concentrations essentially remained the same: 260 μg·g^{-1} dry weight in 1992 and 230 μg·g^{-1} in 1997for Ni and 390 μg·g^{-1} and 420 μg·g^{-1} dry weight of As respectively.

Table 3: Comparison of Total As and Ni Concentrations in Sediment and Muskeg Samples Collected at Similar Locations in Different Years.

Area	LOCATION		Type	Total As, ug.		d.w.	Total	, ug.	d.w.
	1992-93			1992	1993	1997	1992	199	1997
BT-1	Stn 200	Stn 200/205	Sediment	390		420	260		230
BT-1	LOC 1 SP6	BT-1 N	Muskeg		1.9	57		3.8	54
BT-2	Stn 100	Stn 100	Sediment	16		66	16		46
BT-3		SP-3 DH	Muskeg		1.8	56		3.4	34
BT-4	SP-4	Stn 200	Muskeg		14	51		12	35

d.w. - dry weight

One of the question which needs to be addressed is the mode (water or air) by which the increases in the vegetation or the sediment have taken occurred.. Both aerial and seepage transport would result in accumulation of metals on the surface. Therefore the first step in determining the pathway, is to evaluate if indeed the surface material differs from that collected from deeper strata.

In Figure I a and I b the sampling locations for which material was collected at the same place, but integrated over depth are presented with the respective As concentration. With the exception of three locations (SP-2, SP-5 and SP-8) the surface samples have higher concentrations of As than at deeper strata. In Figure 2a and 2b the concentrations of Ni are presented and the same locations have higher concentrations at depth than at the surface. They are located in BT- 1 , BT-2 and BT- 3 at the edge of the muskeg areas and may not be submerged all year round. However, the remainder of the samples indicate that the surface strata is enriched with the contaminants, which may imply both aerial and water transport.

The next step, is to evaluate how much has accumulated on the uppermost layers of the wetlands surrounding the waste rock pile. This is carried out through estimating the mass

Figure la: Comparison of As Concentration with Depth (SP1,2,3,4,5 8 LOCI)

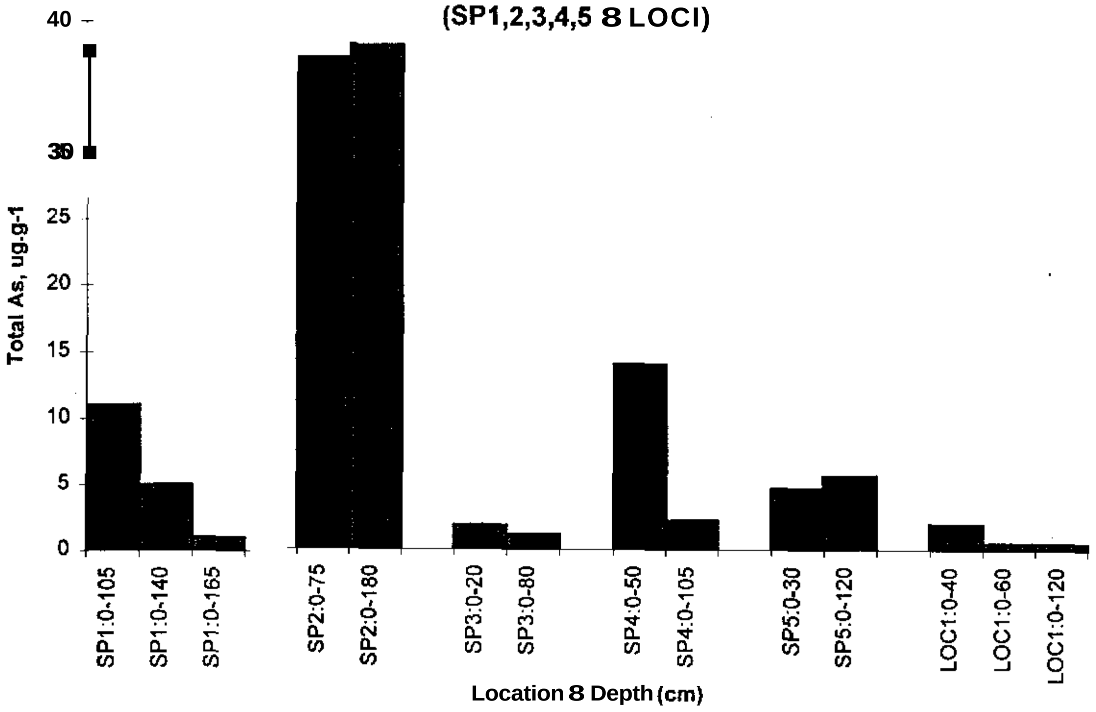


Figure lb: Comparison As Concentration with Depth (SP7,8,9, Stn 300 and Lake 1)

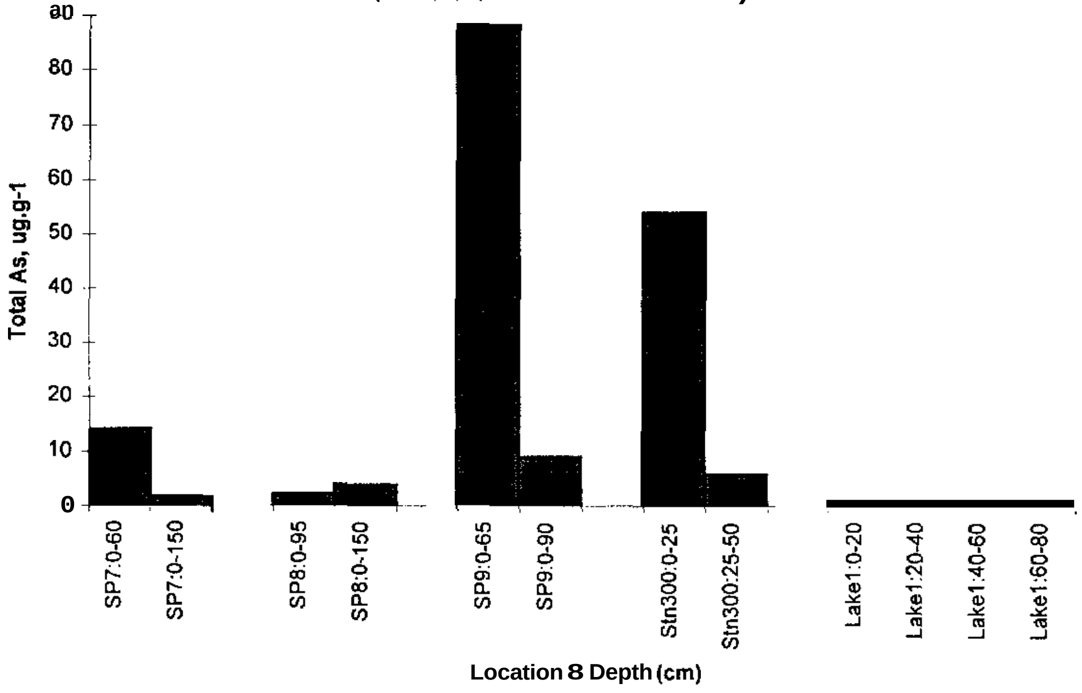


Figure 2a: Comparison of Ni Concentration with Depth (SP1,2,3,4,5 & LOC1)

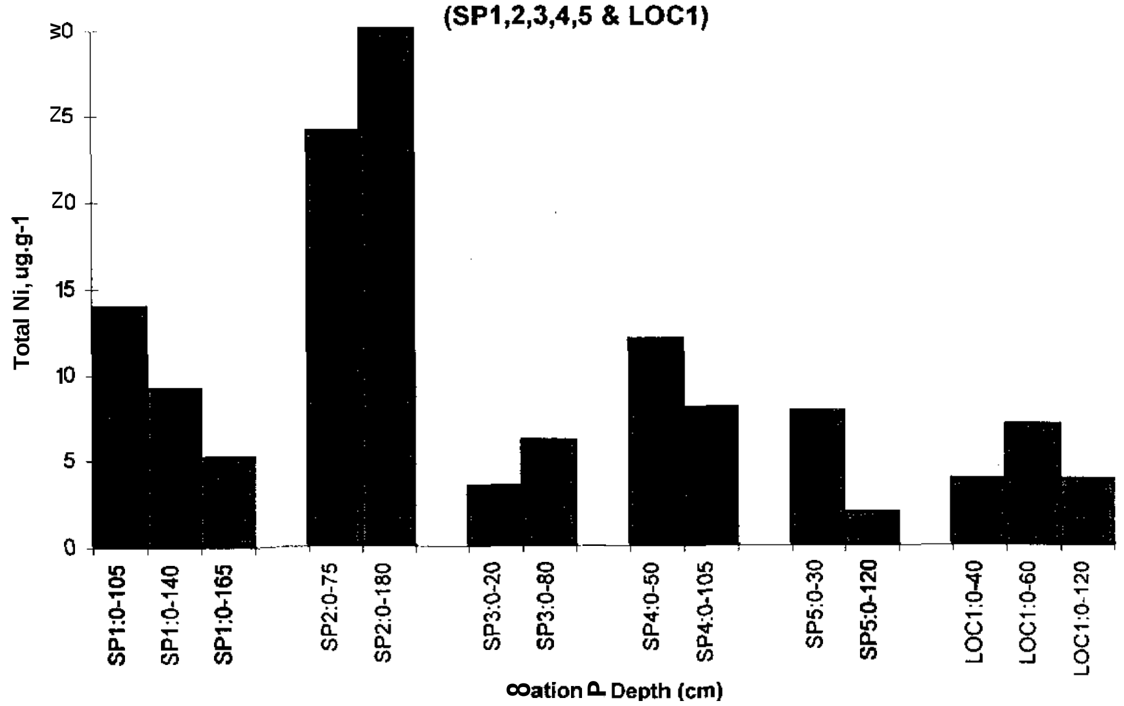
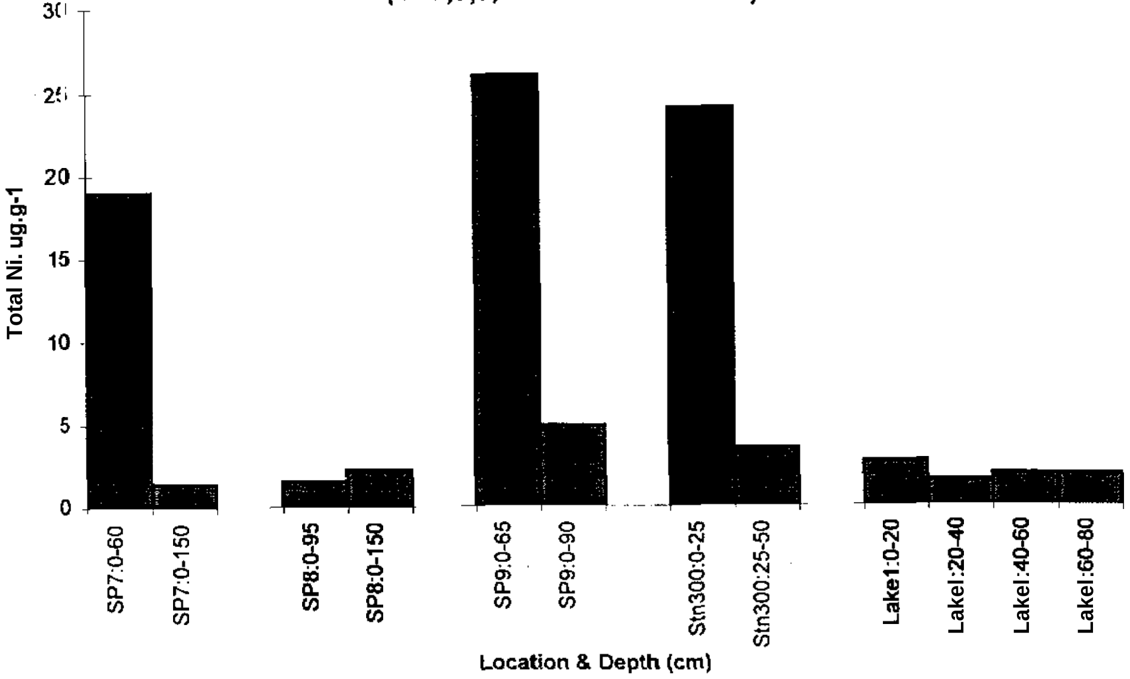


Figure 2b: Comparison of Ni Concentration with Depth (SP7,8,9, Stn 300 and Lake 1)



of an element in an environmental compartment. Although such estimates may be prone to a relative error, due to the assumptions which have to be used in the calculations, However the error will be consistent throughout the calculations, and facilitates relative comparison. Such comparisons can be used as indicators of the functions of environmental compartment comparing sediments, water and vegetation. These comparison will allow to evaluate the relative distribution of the contaminants in the different components of the wetlands, ie muskeg, pond water and sediment.

In Table 4 estimated masses of As, Ni, S , Fe and L.O.I. in muskeg and sediment solids in the vicinity of the B-Zone WRP are presented. The data used to calculate the specific estimates are presented in Appendix 1, Table 8a to Table 8e and a summary, from which the kg/ha values are derived is given in Appendix 2, Table A2-8.

Table 4: Arsenic, Nickel, Iron, Sulphur and LOI in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sedirnents and Pond Water.

	Muskeg **Surface -** 0.25 m					**Sediment** **Surface - 0.25m**					**Pond** **Water -** 0.5 m			
	kg/ha	kg/ha	kglha	kg/ha	t/ha	kg/ha	kg/ha	kg/ha	kg/ha	t/ha	kg/ha	kg/ha	kg/ha	kglha
BT-1	4.1	3.6	1,287	630	342	116	82	5,763	1,131	202	0.4	0.1	2.3	4.6
BT-2	2.0	2.0	858	2,616	170	84	78	2,555	1,580	286	2.0	0.2	1.6	2.6
BT-3	127	80	2,516	670	211	30	23	465	490	167	25	62	6.5	387
BT-4	13	6.5	12,599	1,205	255						0.18	0.11	71.4	34.6
LAKE 1	2.0	0.9	125	98	158	0.5	4.4	2,197	1,308	495	0.003	0.01	1.6	0.2

The estimates of the mass of As and Ni in the sediments/muskeg have used data integrated over time (Table 3) and a larger more recent set of samples might show a higher accumulated mass of metals.. On the other hand the relative differences between the different components of the muskeg/wetland areas which serve as a compartment for retention of contaminant will not change. The samples used for the mass estimates of the elements utilize 24 muskeg samples and 12 sediment surface samples, representing a total area of 124 ha of muskeg and ponds. The overall objective is to determine if the distribution of the contaminants reflects what would be expected , ie a greater mass accumulated in the sediment as compared to the vegetation. The results are discussed below summarizing the distribution for each element of relevance to the contaminant removal processes expected to take place, when the transport mechanism is through contaminated seepage. In section 3.1 and 3.2 the same data are used to evaluate the mode of transport and the sample characteristics which have lead **to** the accumulated mass of the elements. The estimates are derived from the actual area of the different sections of wetland surrounding the waste rock pile.

The areas of pond or muskeg vary from location to location, ranging for example for muskeg from the smallest area **E** in BT-1 with **1.2** ha to the largest area B in Lake 1 with 58 ha. The estimates are derived from the actual area of the different sections of wetland surrounding the waste rock pile. The areas of pond or muskeg vary from location to location, ranging for example for muskeg from the smallest area E in BT-1 with 1.2 ha to the largest area B in Lake 1 with 58 ha (Map 1 red letters).

Arsenic Distribution : Arsenic concentrations found in sediment are generally one to *two* orders of magnitude greater than those found in shallow muskeg solids with the exception of Lake 1 and BT-3. BT-3 has the highest quantity of As in the water. The area of ponds in the BT-3 area is very small and essentially has not permanent ponds, and the muskeg samples are collected from an area of a temporal pool/ pond which dry out easily, thus concentrating contaminants through evaporation resulting in not so healthy vegetation/ muskeg. There are no permanent ponds in the BT-4 area, while in the Lake 1 area no seepage reaches the pond and only aerial transport would account for the accumulation on the vegetationlmuskeg. The As mass BT-1 (4.1 kglha) and BT-2 (2.0 kglha to that of Lake 1 and suggest that this type of mass accumulation is derived mainly from the air. On the other hand, the mass accumulated in BT- 3 and BT-4 on the muskeg is much higher with 127 kg/ha and 13 kglha. These distributions suggest an accumulation in those pond sediments which have received seepages.

The area of BT-3 that is covered with muskeg contains a relatively large mass of As (127 kg/ha). This is due to the relatively high As concentrations (up to 372 $\mu g \cdot g^{-1}$) in the muskeg samples collected close to the WRP. WRP run-off to this area via seepages from beneath the perimeter road **is** the likely cause *of* these accumulation, as reflected in the mass of **As** in the water compartment (25 kglha). Overall, the estimate of As mass in muskeg and sediment in the B-Zone WRP vicinity indicates that the wetland pond sediments serve as sinks for As and water transport is suggested the major route, for those areas were seepages have entered ponds.

Nickel Distribution : The distribution of Ni mass in muskeg and sediments in the B-Zone WRP vicinity is, in many ways, similar to that for As. Pond sediments contain concentrations of at least one order of magnitude higher than muskeg solids, again with the exception of BT-3. The BT-3 Zone A area muskeg, which has accumulated Ni from WRP run-off passing beneath the WRP perimeter road has also more Ni in the water compartment with 62 kg/ ha as compared to generally 0.1 to 0.2 kg Iha for the other areas. The mass of Ni in the sediment, compared to the water column, particularly for the low water mass areas of BT-1 , BT-2 and Lake 1 reflect the pathway of the contaminants well. The muskeg mass of Ni is clearly lower with 0.9 kglha compared to the sediment with **4.4** kglha. Lake 1 is considered uncontaminated background area.

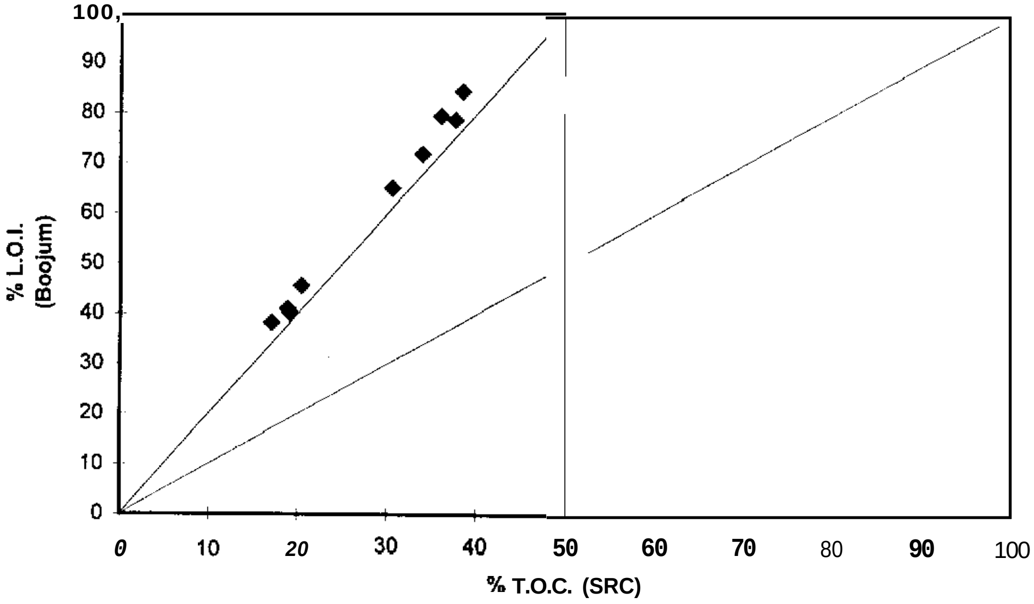
Iron Distribution: Iron is included in the estimates of the mass of elements, since both the literature and field and laboratory reactor experiments implicate iron in the removal process. The mass of Fe in muskeg compared to sediments is again higher in the sediment, with the same exception of BT-3. Iron is element, which is easily precipitated from the water and retained in sediment and on submerged vegetation. Iron in muskeg is reflecting more the content of the living vegetation. The mass of iron in the water in BT-3 and BT-4 is higher than in all other areas, and the iron precipitation onto the muskeg is evident in the accumulation of an estimated 12 t /ha on the muskeg form 71 kg/ha of the water. The mass of Fe generally in the water ranges from 1 to *6* kg/ha. Iron is not considered a element which **is** environmentally mobile in the same way than metals, as it readily precipitates and forms bog iron in the long term. Rather iron is cycled from the sediment to the water and a iron pool has to be available in the muskeg, which is evident from the distributions presented in Table **4.**

Sulphur Distribution: Sulphur concentrations in muskeg are generally similar to those in pond sediments for BT-1 and BT-2. This is expected, since the vegetation component of muskeg is greater than that of sediments, and vegetation generally has a larger component of organic sulphur. In BT-3 the lower mass of sulphur in the sediments might be , a reflection of the volatile bog gas (H_2S), which is lost from aquatic ecosystems under appropriate biogeochemical conditions. H_2S was detected by smell in the BT-1 and BT-3 sediments (measured low redox), but not in the Lake 1 sediments (measured moderate redox) where the sediment mass of sulphur is similar to BT-1 and BT-2 with 1 t of S in the sediment. Although anecdotal and evidence expressed by smell of H2S could reflect be used to reflect the microbial activity, which would be stimulated by nutrients supplied with the seepage. A systematic observation of smell was carried out on the laboratory samples. These are presented and discussed later in Section 3.2.

Loss on **ignition**: The distribution of organic matter as expressed by loss on ignition should reflect the fact that, in these muskeg/wetland type of ecosystems, organic matter decomposes relatively slowly, and muskeg should be higher in L.O.I. than sediments. This is indeed the case for all areas were samples were available (Table **4).** The lower L.O.I. values for the BT-3 area, reflects the fact that these substrates represent old streambed, where organic matter does not readily accumulate.

It is possible to derive the organic carbon component of **the** material in a given area by deriving a relationship of L.O.I. and TOC. The relationship between these two variables was derived for the 1997 samples and, as shown in Figure 3. About 50 % of the L.O.I. is present as organic carbon. With this relationship, the carbon supply for the microbial activities for contaminant removal and biomineralization in the sediments can be assessed for each area. From these evaluations it is clear that, for the areas BT-3 and BT-4, for example, organic amendments or reconfiguration of wetland to promote vegetative growth may be required.

Fig. 3: Comparison of % L.O.I. with TOC
B-Zone Wetland Substrates and B-Zone Pit Sediments



To further confirm the general principle of the contaminant retention capacity of wetland sediments, the distribution of the elements in the wetland compartments are calculated for the entire area surrounding the waste rock pile, considering the same compartments, water, sediment and muskeg. Based on a kg/ha basis using the entire area, the results are independent of the specific locations and the seepages.

Figures 4a to 4d represent the percentages of the total element concentration ($kg \cdot ha^{-1}$) that are distributed in the different environmental compartments. They show clearly that these elements are distributed primarily in the pond sediments, followed by the muskeg solids, with a relatively small fraction in the water. The question that immediately presents itself, is, of course, the following: once the contaminants are in the sediment, will they remain there. One could argue, that the stability of a muskeg lays in its history. Muskeg vegetation has been developed since the retreat of the continental ice sheet, reported for northern central Canada to have taken place about 7000 years ago. This would support a relatively stable long term environmental compartment.

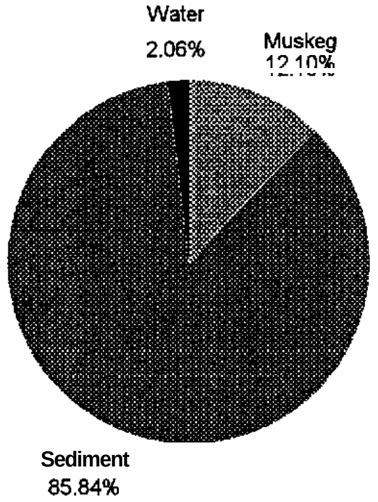


Fig. 4a: Distribution of As, kglha

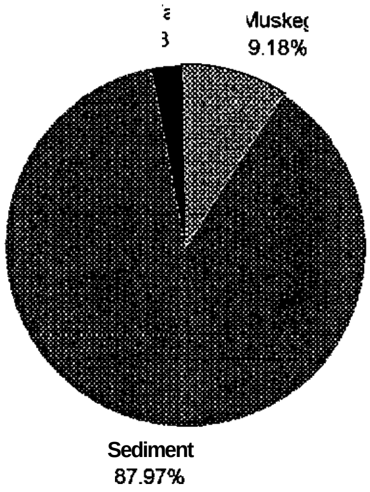


Fig. 4b: Distribution of Ni, kglha

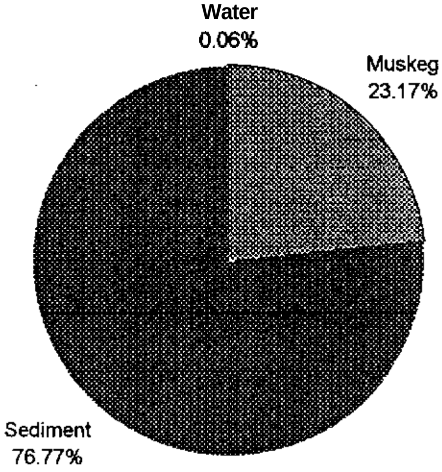


Fig. 4c: Distribution of Fe, kglha

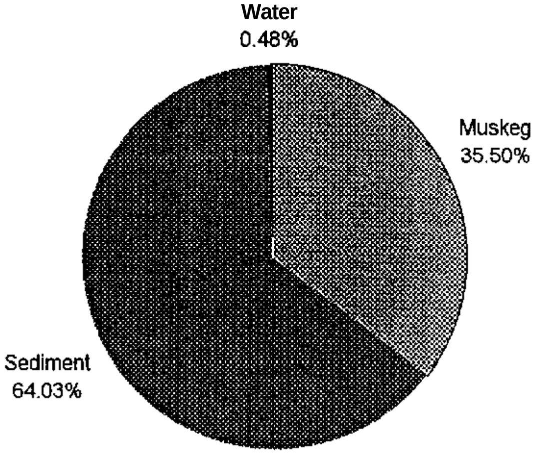


Fig. 4d: Distribution of S, kglha

3.1 Easily Exchangeable **As** and Ni in Muskeg and Sediments

The generally accepted way of determining the chemical form of a contaminant in soil is a sequential extraction series. These have been carried out on the sediments and it was identified that Ni is present as either a carbonate or sulphide and As is associated with organic extractable fraction and iron (Kalin, 1994. And Fyson , Kalin and Lui 1995).

For the transport of metals in the toe seepages the ultimate form in which the metals are retained represents only one component of the use of muskeg for seepage treatment. The question of how the contaminant behaves in the muskeg / pond system during run-off events or intense rainstorms is equally relevant. Such events would create a strong concentration gradient in the ponds. If contaminants are not well adsorbed, they would be released into the water due to a diffusion gradient over the sediment. During spring run-off, the contaminant loading from the seepages could be higher, since weathering products formed and stored in the waste rock pile would be flushed out.

To determinate this fraction of As and Ni which might be mobilized during storms, runoff and snow melt an easily exchangeable fraction of As and Ni was defined as that fraction which would be extracted by distilled water. Such extractions were carried out on the solid samples collected in 1992 and 1993. Sub-samples of 60mL wet volume were slurried with 120mL of distilled water, in aerobic conditions at room temperature. The concentrations of As and Ni were measured in the resultant extracted water.

For same samples excess water was contained in the bags. The excess water from the bag was compared to the extracts or leachates derived with distilled water for the same samples (Table 5). Although these comparison could be carried out for only a few samples (because few existed with excess water in the sampling bag), they give some insight into the effects of freezing and thawing, as compared to leaching. The concentrations reported essentially confirm that freezing and thawing does not alter greatly the leachability of the elements of concern.

Table 5: Comparison of **[As]** and **[Ni]** for Extracts and Excess Pore Water

Sampled Date	Area	Zone	Location	ARSENIC		NICKEL	
				Extract mg.L^{-1}	Excess mg.L^{-1}	Extract mg.L^{-1}	Excess mg.L^{-1}
19/06/92	BT-1	A	Stn200	0.199	<0.002	0.04	<0.01
09/06/93	BT-1	C	SP-7	0.02	0.061	<0.01	<0.01
09/06/93	BT-1	E	SP-8	<0.002	0.289	<0.01	0.09
09/06/93	BT-1	E	SP-8	0.041	0.092	<0.01	<0.01
09/06/93	BT-3	A	SP-2	0.187	0.213	0.01	0.02
09/06/93	BT-3	B	SP-3	<0.002	<0.002	<0.01	<0.01

In Figures 5a and 5b, the easily leachable fraction is plotted as a function of the total concentration of **As** and Ni. From such a plot, a well defined relationship is expected as is evident for Ni and part of the sample population for **As.** The samples with low solids concentrations have a high fraction of easily exchange **As** and Ni , reflecting their low adsorption capacity. **As** the concentrations in the solids increase removal of the contaminants by water is no longer possible. It is argued, that if the original transport mechanism of the contaminant from the water column to the sediments which is mainly adsorption, would be the dominant mechanism of contaminant accumulation, than the samples with higher concentrations in the solids should release the same fraction. **As** this is not the case, it is postulated, that in the deeper portions of the sediments the organic material serves to facilitates biomineralization processes which convert the contaminants into more stable forms.

On the other hand, if biomineralization is not taking place, then the material with higher concentrations should have the same quantity of easely exchangable contaminat than the material with lower contamiant concentrations, as the removal is just adsorption and not biomineralization.

For **As** where two mechanisms of mineralization were identified , both adsorption onto organic matter and precipitation with oxidized iron. For arsenic one could expect **two** types

Fig. 5a: B-Zone Vicinity Wetland Substrates, 1992-1993
Total As vs Easily Exchangeable As

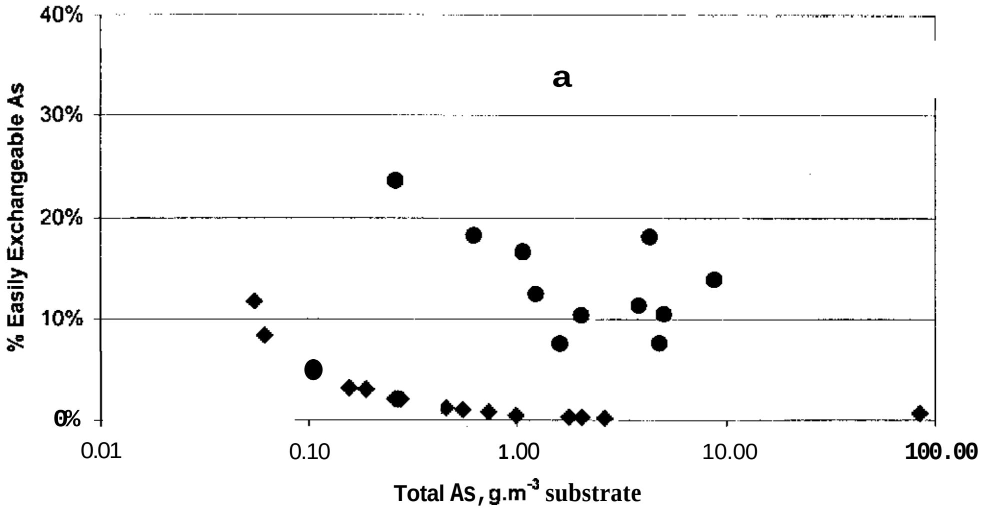
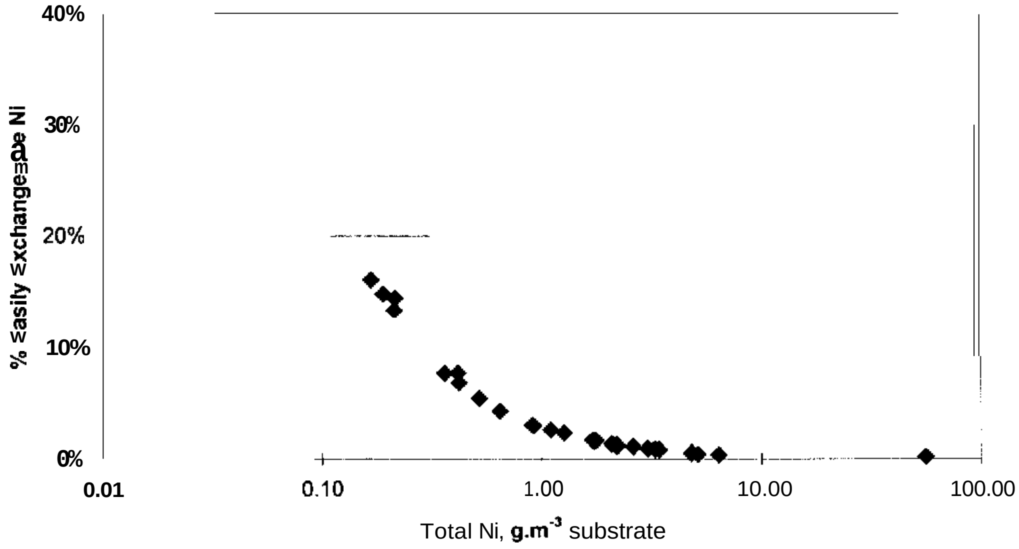


Fig. 5b: B-Zone Vicinity Wetland Substrates, 1992-93
Total Ni vs Easily Exchangeable Ni



of samples, where the higher concentrations are due to iron co-precipitation (lower water solubility) and those due to adsorption processes similar to Ni.

The relationship for As (Figure 5a) between % easely exchangable and total concentrations in substrate defines essentially two types of samples. One set of samples (diamonds) reflects that low concentrations in the material have higher fraction of easily exchangeable **As,** whereas the population of samples identified by circles show a less defined trend and display the second removal mechanism, precipitation with iron.

For Ni, which is proposed to be removed from the water column by only one mechanism, namely adsorption to organics , all samples follow the expected trend, representing a uniform sample population, where the lower concentration solid samples have higher exchangeable fractions (Figure 5b). This relationship is in clear contrast to that of As where the removal process identified in the laboratory has been associated with both adsorption onto organics and precipitation with iron. Although this represents indirect evidence of the proposed mechanisms of contaminant relegation from the water to the sediment, the data seem to support the results from the laboratory.

A different argument used in the interpretation of the relationship between the fraction of the desorbed material (easily exchangeable %) would suggest that the higher concentration of the material has a lower adsorption capacity or fewer adsorption contaminants sites for the contaminants. As the adsorption capacity of the material increases, the fraction removed by an easily exchangeable extract, i.e., distilled water, should decrease.

When the concentrations in the solid material are very low, the fraction of easily exchangeable **As** is highest. The easily exchangeable **As** fraction displays two adsorption sites, with only for the second type rarely releasing more than 20% of the arsenic, i.e. 80% is retained in the material. For the second adsorption site, the percentage retained is generally more than 90% or, conversely, 10% is exchangeable. Ni displays a consistent and uniform inverse relationship between the percentage of easily exchangeable Ni, and the total Ni concentration in the solid sample, i.e., the higher the total Ni concentration, the lower the percentage that is easily exchangeable.

3.2 As and Ni migration in the muskeg areas

In the previous section the data were examined using the easily exchangeable fraction and the solid concentrations to evaluate the proposed ongoing contaminant removal processes. However it could be argued, that sediments are enriched naturally with As and Ni due to the mineralization of the area. To dispel this argumentation, the data are further examined using relationships between elements to determine their origin. This analysis is based on the reasonable assumption, that if the contaminants are present in the muskeg samples at ratios similar to those in the waste rock pile, then the origin in the muskeg is mineralized.

In Appendix 2 the data are plotted for each relationship discussed. A summary of correlation coefficients (r) , ratios describing the slope of the linear regressions, the sample size used (n) and the level of significance (P) of the regression is given in Table 6. The regressions are carried out on a molar basis as these reflect the proportions of the minerals better than concentrations.

Sample	Form	r	ratio	n	P
Seepage	total	0 7973	0 57	70	<0.001
	dis	0 7313	0 55	121	<0 001
Rock		0 8963	0 44	96	<0 001
Muskeg	Surface	0 4843	121	37	<0 01
	Sediment	0 9670	0 75	12	<0 001

r: correlation coefficient; ratio: As / Ni; n: numbers of samples; p: significant levels

As can be expected , presented previously in the B-Zone waste rock report, the correlation between As and Ni is very significant in the waste rock. It describes the mineralization, a co-occurrence of As and Ni. This is also the case for the deeper portions of the sediments, which appear even better correlated with a r of 0.967 as compared to the rock which has an r of 0.896 at the same level of significance at < 0.001.

It is proposed, that in the deeper portions of the sediments, the biomineralization processes take place and therefore a different mineral should be formed. This would have a different slope than that of the waste rock , which is the case. This is also the case for the material on the surface of the sediments, were the origin could be dust . The slope of the surface sediments is very different from all other material and suggests possibly a combination of material. These same regression on the toe seepage waters show the same statistics for both dissolved and total **As** and Ni. The slope is the same for both forms reflecting its origin form the minerals in the host rock.

The interpretation of the regression lines is strongly suggesting that the muskeg does support biomineralization processes. Further evidence was obtained when the data were sorted from the highest to the lowest concentrations of both contaminants and associated with observations made on the samples. Hydrogen sulphide smell would indicate sulphate reducing bacteria are active. They should only be active at depth, **as** only there the material would support reducing condition. Finally the colour suggest the quality of biodegradable organic matter. Black depleted and brown higher in biodegradable carbon sources, or less mineralized.

In Table 7a observations on the samples from the wetlands are summarized in **4** concentration intervals. The detailed descriptions are given in Appendix 1. In Appendix 2 individual observations are associated with the concentrations of each sample.

Ninety one (91 %) percent of the samples in the **lowest** concentration interval are from a depth greater than 25 cm and 18% have hydrogen sulphide smell associated with them.

With respect to their colour, used as an indicator of utilization of the carbon sources (black, less degradable carbon available and brown relatively more biodegradable material) the low **As** samples have a higher fraction of black than brown colour. **As** the concentrations increase more samples are in the upper layer of the muskeg and they have a strong smell.

In Table 6b the same data are summarized for Ni and the same picture emerges as for As. These observations support further the proposed capacity of the muskeg wetlands to

Table 7a: **As** Concentration Intervals and Sample Description

As Concentration interval		Depth		Smell			Colour		
ug.g-1	n	0-25cm	>25cm	**NS**	H2S,P	other	Bk	Bn	other
0.5-1.7	11	1	10	9	2	0	5	3	3
1.8-9.0	11	1	10	7	3	1	7	3	1
11.0-88.0	18	11	7	2	10	6	4	10	4
90.0-120.0	12	12	0	1	11	0	0	12	0
SUM	**52**	**25**	**27**	**19**	**26**	**7**	**16**	**28**	**a**

Smell: NS-no **smell,** H2S-H2S **smell, P-pungent**

Colure: **Bk-black, Bn-brown.**

As Concentration interval		Depth		Smell			Colour		
ug.g-1	n	0-25cm	>25cm	NS	H2S,P	other	Bk	Bn	other
1.4-2.7	a	1	7	8	0	0	5	1	2
3.4-9.2	14	3	11	**8**	5	1	a	5	1
12.0-54.0	19	12	7	3	11	5	4	11	4
110.0-690.0	11	11	0	1	10	0	0	11	0
SUM	**52**	**27**	**25**	**20**	**26**	**6**	**17**	**28**	**7**

remove and immobilize As and Ni in the sediments. As biomineralization processes are evident in the sediments it is now possible to examine the muskeg samples further correlating those parameters relevant to the removal process from the water to the sediment, in a similar fashion that was carried out for rocks / seepage and muskeg samples. These regressions are carried out on the concentrations determined, as removal process from water to sediment has no stoichiometric basis as is the case for the mineralization.

The negative correlation of both **As** and Ni with L.O.I in the sediment suggests, that organic matter in the sediment is not associated with high concentrations of contaminants and therefore organic matter adsorption is not a dominant process, once the contaminant is relegated to the sediment. **As** of course the LOI concentrations are related to the content of vegetation or undegraded biomass this relationship is reasonable for the solids. As the organic matter is utilized through degradation, the biomineralization takes place and removes organic content, converting it to carbon dioxide and water or utilizing it as energy for biomineralization.

As was suggested previously, iron is not very mobile and samples with high iron content, should contain low organic matter reflected by the negative correlation coefficient. Sulphur concentrations in relation to L.O.I display two types of samples. In the samples with a low L.O.I content, ie those where the biodegradable organic matter has been utilized, the correlation is positive and very significant, suggesting that sulphate reducing activity as taken place, utilized the organic matter and converted the sulphate into sulphide minerals. On the other hand, when an abundance degradable organic matter is present in the sample, the correlation is less significant and weaker.

The correlation coefficient between As and S in Table 8 is non existent and non significant at both high and low concentration ranges. For Ni the same holds true, however the scatter plot in Appendix 2 (fig A2-8) for the lower concentration range suggest a trend although not linear. For both contaminants the correlation with iron is reasonable and significant, supporting to the suggested processes.

Table 8: Comparison of pairs of elements

pairs of elements	r	n	p
As/Ni	0.9781	52	0.001
As/L.O.I.	-0.4568	52	0.001
As/S	0.1019	29	>0.1
As/Fe	0.6220	51	0.001
Ni/L.O.I.	-0.4315	52	0.001
Ni/S	0.1387	29	>0.1
Ni/Fe	0.5277	51	0.001
Fe/LOI	-0.3923	51	0.01
S/LOI (a)	-0.5223	24	0.01
S/LOI (b)	0.9867	5	0.001

n = number of samples; r = correlation coefficient;
p = significant levels
(a): Range S: 0-6000 ug.g-1; LOI: 80-100 %
(b): Range S: 0-2500 ug.g-1; LOI: 0-25 %

In summary the data generated from the wetland muskeg area surrounding the waste rock pile support the presence of the natural processes which provide a permanent sink for the contaminants released from the mining activity. The data interpretation provides evidence of the presence of biomineralization processes almost unequivocally.

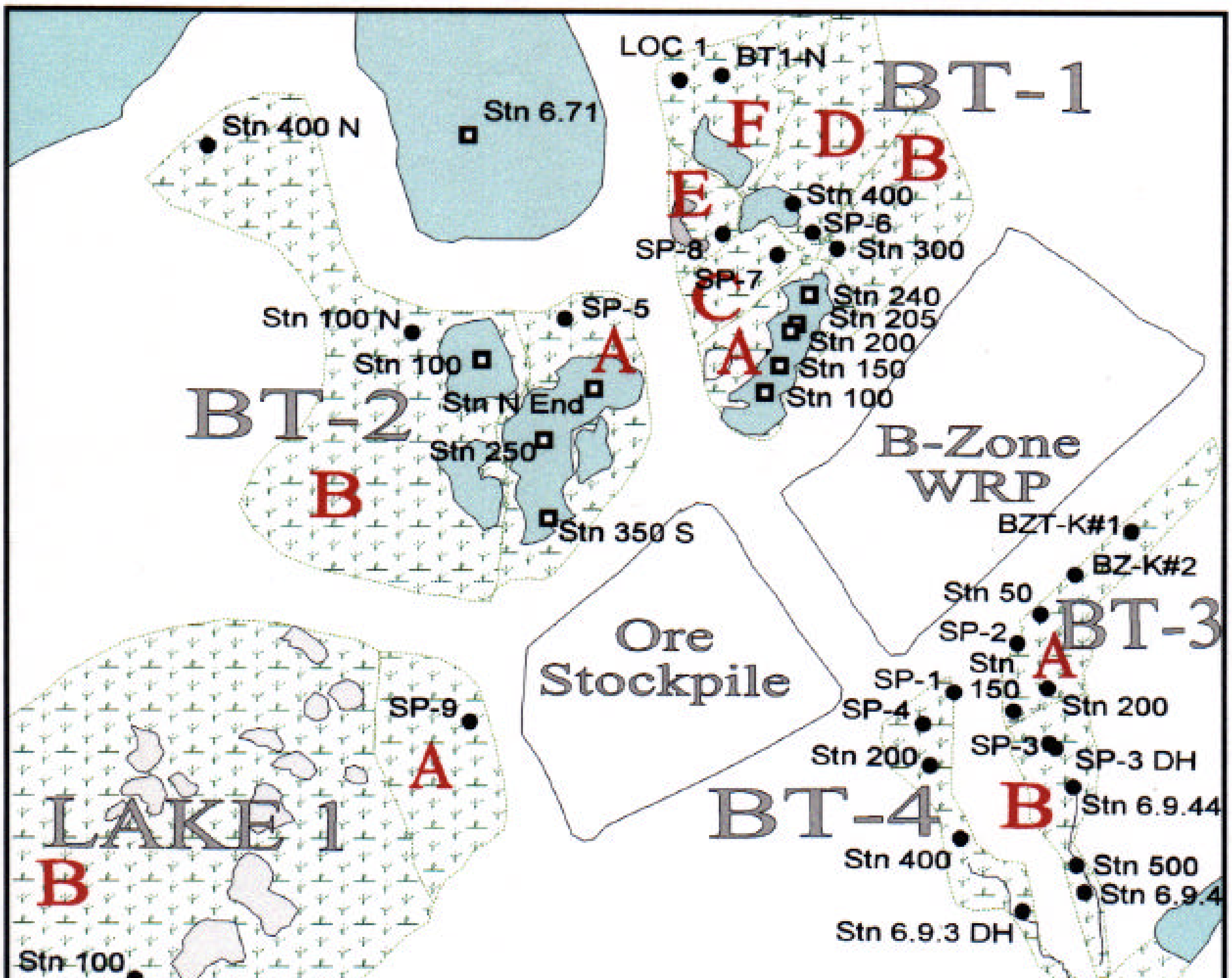
3.3 As and Ni Migration in BT-3 and BT-4 Surface Water

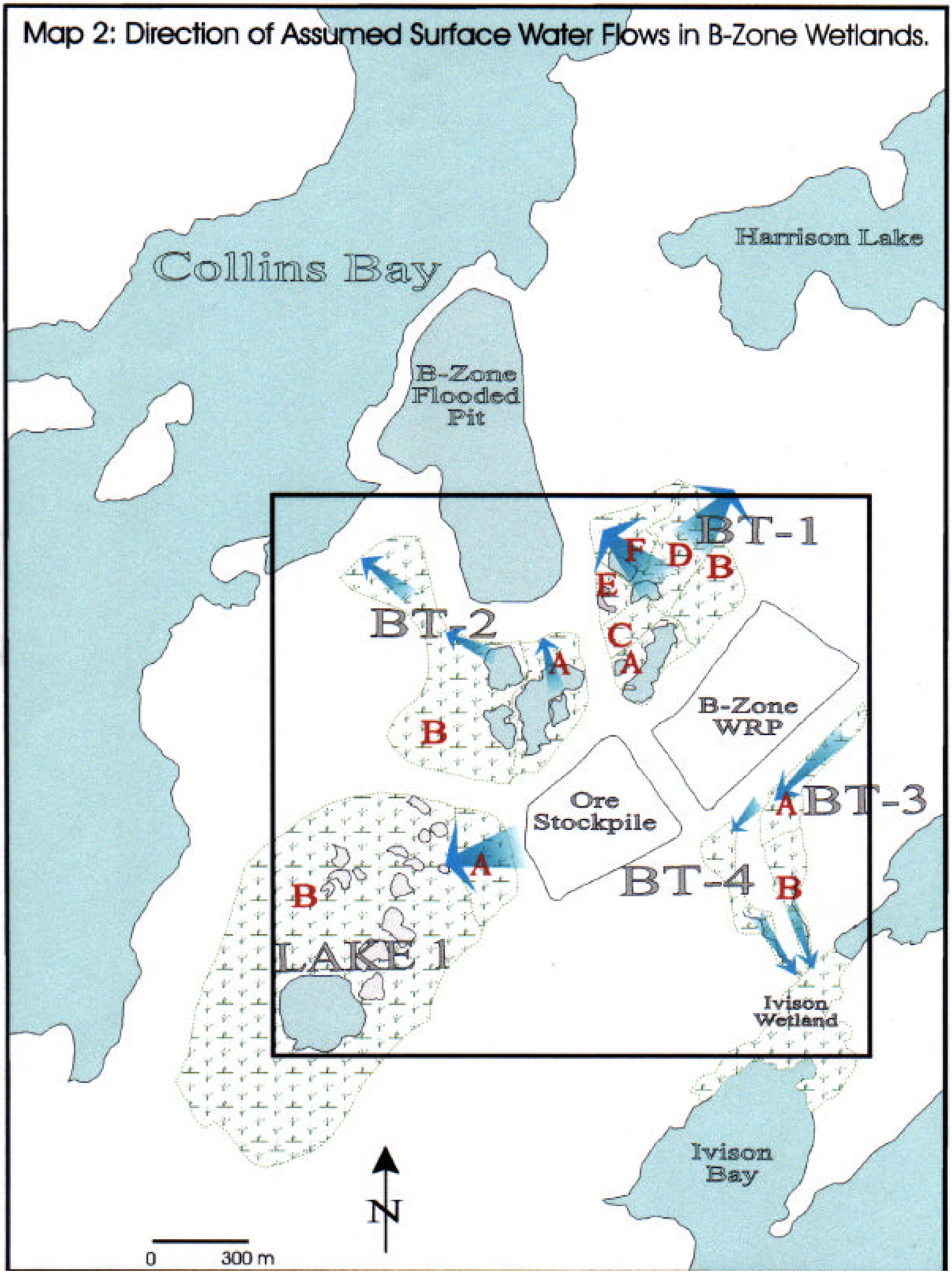
The removal of contaminants from seepages from the waste rock pile appears to be taking place in sediments, thus wetlands or muskeg areas require ponds to efficiently remove contaminants ie. residence time of the water in contact with the sediments. Map 2 outlines the general direction of surface water run-off, which is generally diffuse, determined by the surface topography.

No surface water flow pathways obviously link the WRP run-off collection system with the BT-1 area. Similarly, drainage from the vicinity of the ore pile, lined with a polyliner only occasionally enters the BT-2 area. However, some WRP run-off water contains elevated As and Ni concentrations which appear to have moved beneath the WRP perimeter road into the BT-3 Stn 50 and Stn 100 areas. Elevated As and Ni concentrations have been measured in ponds in these areas (Figures 6a and 6b). The stations are arranged in the figure by date, and by the assumed direction of the water flow, although the stations are not linked directly by surface streams. Actual streams emerge from the muskeg down gradient towards lvison Bay, draining BT-3 (Stn 6.9.44 and Stn 6.9.4) and BT-4 (Stn 6.9.3). Water quality has been periodically determined at these stations to examine whether As and Ni are being transported towards lvison Bay.

To date, there is little evidence that As or Ni is being transported by surface streams or shallow groundwater via the BT-4 area to Stn 6.9.3 to the lvison wetland. Arsenic concentrations at Stn 6.9.44 have ranged from between 0.001 and 0.01 $mg\cdot L^{-1}$, and Ni concentrations have ranged from 0.001 to 0.34 $mg\cdot L^{-1}$. In 1995 and 1996, As and Ni concentrations at Stn 6.9.44 remained below 0.01 $mg\cdot L^{-1}$. Further downstream at Stn

Map 1: B-Zone Sediment and Muskeg Profile Sampling Stations, 1992-97.





Map 2: Direction of Assumed Surface Water Flows in B-Zone Wetlands.

sampled from these piezometers has contained elevated As concentrations, compared to the SP-3 piezometers. SP-4 shallow groundwater contained particularly high As (up to 0.76 $mg{\cdot}L^{-1}$) and Ni (0.18 $mg{\cdot}L^{-1}$) concentrations in 1995. In 1997, Ni concentration continued to increase to 0.65 $mg{\cdot}L^{-1}$ while As concentration decreased to 0.14 $mg{\cdot}L^{-1}$. The shallow piezometer SP-9 is located near a section of the ore pile haul road and may periodically receive some surface run-off from the perimeter road, although this has not been directly observed. Dissolved As and Ni concentrations have remained elevated, compared to SP-3, in the years following 1993 to present (1997). This could be due to dusting from the ore pile.

Limited data exist for the shallow piezometers. An interpretation *of* the shallow hydrology together with the stratigraphy of the piezometers, may be required to define the shallow water movement in the vicinity of the wetlands. The wetland ponds during the summer can virtually dry out. This in turn may well affect the water quality in the shallow piezometers.

3.5 contaminants **sources:** Precipitates and evaporates on **waste** rock surfaces

Based on the seepages emerging at the base of the B-Zone waste rock pile a contaminant generation and release concept was developed and presented in the Collins Bay Decommissioning B-Zone waste rock pile; 1996 Final Report. The differences in chemical characteristics and contaminant release noted among approximately 29 temporal toe seepages suggested that, within the waste rock pile, weathering and oxidation products precipitate. In these precipitates Ni and As can accumulate. In turn the re-solubilisation of newly generated seepage from infiltrating water may result in different chemical characteristics of the emerging toe seepages. As these processes do not take place uniformly throughout the waste rock pile, toe seepages have different characteristics and those are different than having originated from weathering the waste rock.

In order to understand the stability or solubility of such secondary minerals / precipitates or evaporates, samples were collected during the September 1997 field trip from the surface of the waste rock pile, which appeared *to* have formed on rock surfaces or they had precipitated in the toe seepages.

This work is considered as exploratory to obtain some insight into understanding of the weathering/ precipitation processes which are associated with the waste rock pile. A better understanding of weathering and precipitation / evaporate formation processes could optimize environmental management in the long term.

Six solid samples from B-Zone waste rock piles are chosen for pH, conductivity, Em, Ni and As analysis. The qualitative description and chemistry derived from the slurries prepared with the field material 60 mL slurries prepared from the six samples are presented in Table 2.

The code BZWR -6 or 7 code refers to the sampling location of the seepages around the waste rock pile. The concentrations in the dried sample material of As and Ni in the As/Ni oxidized material and the WRP-P sludge are quite high with 1.7 % Ni and 1.5 % As respectively, in comparison to the other material which ranged from 0.03 % to 0.2 % for Ni and 0.02 % to 0.3 % for As (Table 2). The ratios of As and Ni concentrations in all but one of the samples are about 1 suggesting that they are the result of a reaction which involves similar proportions of both elements. The exception is the WRP-P sludge, which is enriched with **As** up to 6 %. Ni is not concentrated in the precipitated sludge (0.07 %) or not precipitated in the acidic seepage or alternatively Ni is not weathered in this particular seepage path in this location of the waste rock pile. The electrical conductivities are elevated for the samples with high concentrations of As and Ni and the pH values of these thick slurries, ie high solid ratio are low ranging from 2.7 to 3.9 with one exception the foam on the ditch, which has a higher pH of 5.1 (Table 2).

As the fresh slurries of the samples had low pH values, the dilution effects of water on the dry sample was quantified and the data are reported in Appendix 2 (Table A2-3).

The low pH measured in the fresh samples is a reflection of the wet volume/liquid ratio and not a result of oxidation reactions. This has been determined by storing the dilute 1 g/100 mL slurries in the refrigerator over time. The pH was measured periodically over a period of 404 h. It was confirmed that no reactions were evident, when the pH values were compared to the initial 1 h measurements (Table A2-4 in Appendix 2).

It was however noted from these series of experiments, that the nickel concentrations increased in two samples, the precipitated sludge of the WRP -P seepage and in the evaporate/ precipitate on the rocks AS/Ni oxidized. These results suggest, that when these precipitates are sitting in water they continue to release Ni. This is in contrast to the other materials evaluated with this series of experiments, where the concentrations remains the same. The precipitates are not stable, compared to the other material in this experimental series. Foam which forms on the ditch is quite stable and does not release too much Ni. The interpretation which may be derived from these preliminary results is that rain water would only transport a particular fraction of Ni to the seepages, not from the total rock mass.

Cumulative batch leaching was also performed on these precipitate / evaporate samples, which indicated that the solubility or release of contaminants can be a result of the solid liquid ratio . After **404** h of leaching the slurries , additional 125 mL of distilled water was added as each determination of Ni used about 5 mL of solution. The concentrations of nickel would be expected to be about 50 % of the original, if no further nickel is released from the solids (Data in table xxx in Appendix 2). This is the case for the sandstone, the sludge, the As/Ni oxidized sample and the ditch foam. However the heamatizxed sandstone and the Graphitic gneiss release more Ni. This suggests that the solubility in water is related to a continued oxidation process and or that the release is related to the ratio of the solid to the liquid of the slurry until equilibrium is reached.

Using these results, to assess the fraction which is water soluble contaminant in the precipitates % extractable has been calculated (Table 9). These percentages are interesting, since the precipitate on the rocks, referred to as As/ Ni oxidized , containing

Table 9: Percentage of **Extracted-Ni/As** in **Total-Ni/As** from Waste **Rock** Pile

Location	DH2O added (mL)	Extracted Ni (E-Ni) (mg/kg)	Total Ni (T-Ni) (mg/kg)	E-Ni in T-Ni (%)	Extracted As (E-As) (mg/kg)	Total As (T-As) (mg/kg)	E-As in T-As (%)
NW Ditch Foam	1900	933.3	2100	44.4	1280	3300	38.8
BZWR-7Graphitic Gneiss	1900	312.19	480	65.0	108.5	380	28.6
BZWR-6 Hematiied	1900	707.4	1300	54.4	571	2000	28.6
BZWR-6 As/Ni Oxidized	1900	4462.1	176000	2.5	3810	150000	2.5
BZWR-6 SS Area	1900	197	320	61.6	122.6	230	53.3
WRP-P Sludge	1900	607.2	740	82.1	2260	65600	3.4

the highest concentrations in the solid of **As** and Ni, shows the lowest fraction of both contaminants released to water. The sludge formed in the acid seepage at station **WRP-P** toe seepage, releases nearly all nickel to the water, but not the arsenic. **All** other materials tested release **44** % to 61 % of their nickel content and 28 to 53 % of their arsenic mass.

In summary the exploratory assessment of secondary precipitates / evaporates in comparison to the rocks on the waste rock pile surface allow the following conclusions. The precipitates are more leachable then the waste rock . Leachability of the contaminants is affected by the ratio of water to solids and the contaminants . Some precipitates, formed in acid toe seepages have low contaminant release but contain high concentrations of both **As** and Ni. Furthermore the gneiss and the sandstones have a finite quantity of Ni and **As** to release.

4.0 CONCLUSIONS

The experimental work on As and Ni retention by sediments, which had been carried out over the past 5 years in the field and the laboratory, was reported in the 1996 final report. In the same report, contaminant removal process from the water to the sediment was formulated and contaminant forms which accumulate in the sediment were identified, for both As and Ni. The ultimate challenge, however, lays in presenting evidence that these processes actually take place in the muskeg areas at large. Although it was noted from the control enclosures in BT-2 that even without organic amendment additions contaminant removal took place, such evidence can only be derived through empirical interpretation of characteristics of the samples in the key environmental components of the wetlands; ponds with water and sediment and the muskeg vegetation. In addition, concern was expressed, that if the contaminants are merely absorbed onto the organic matter and not biomineralized in the sediment, heavy rain events and snow melt would produce a diffusion gradient leading to release of the contaminants.

To address the ultimate challenge, solid samples from the muskeg and ponded areas that were collected in the past were used, in addition to new samples obtained in 1997. To address the concern that release due to a diffusion gradient would occur, distilled water extracts were prepared from the samples to quantify an easily exchangeable fraction of the contaminants. It can be concluded that this is not the case as the contaminants are biomineralized.

The data interpretation of the distribution of the contaminants in the muskeg and pond sediment lead us to conclude that As and Ni are being retained in the sediments. The processes which lead to the accumulation in the sediments seem to be those identified in the laboratory and enclosure experiments. Although the data can only be used to indirectly confirm biomineralization, the behaviour of the easily extractable fractions of both **As** and Ni and the correlation coefficients between key operative parameters in the processes are a strong indication that biomineralization is taking place. Although the data interpretation is somewhat complicated by the presence of contaminant enrichment on the surface of the muskeg substrates due to aerial deposition, the differences between muskeg substrate and sediment are clearly defined. Organic carbon and sulphur are abundantly present in those areas where contaminants accumulate. Iron, required for the removal of the contaminants from the seepage is also abundant.

It can be concluded through empirical interpretation of the data, that the proposed biomineralization processes take place in the muskeg areas around the waste rock pile. The mining activity has resulted in some aerial deposition of contaimants, but the accumulation in the pond sediments is significantly higher. Although the metals could be present throughout the area due to the natural mineralization this would be evidenced by higher concentrations in all strata regardless of depth. Clearly higher concentrations of As and Ni in solids material which represent the surface stratum were found compared to the concentrations in the material from deeper strata.

The sediments of BT-1 and BT-2 ponded areas have a higher mass of As and Ni than the control area (Lake 1) and are also higher than the respective values for the muskeg areas on a kg/ha basis. Even if all of the muskeg contaminant mass is attributed to aerial transport, the ponds which receive seepage from the ore pile and the waste rock pile periodically have significantly higher concentrations then from an aerial loading. Linear correlation coefficients between As and Ni in the waste rock reflect their mineralization. When the same correlations are made for muskeg and water, further evidence of biomineralization can be provided due to the differences in the slopes of the correlations. In the sediments a different minerals form is suggested, as compared to the waste rock. This supports further the conclusion that biomineralization in the sedirnents has taken place. Descriptive evidence derived from the samples of the muskeg or sediments, such a hydrogen sulphide smell, location and textural structure inferred microbial activity.

The data interpretation leads to the inevitable conclusion, that the sediments are actively sequestering contaminants to stable forms in the wetlands surrounding the waste rock pile and reflect the proposed contaminant removal processed identified from the experimental work.

APPENDIX 1

RAW DATA SUMMARY

LIST OF TABLES

Table 1: B-Zone Area Muskeg and Sediment Sample Data - Lab Description

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	LAB DESCRIPTION Driller Description	Lab Description	Colour	Texture	Smell	Moisture
19/06/92	BT-1	A	Stn200	dredge	sed	top20	Very fibrous mat. old root layer	peat w/IO	Gy,Bn	P W/IO,F,Sf,R,Tw	P	EW
25/08/97	BT-1	A	100	dredge	sed	top 20	sat. gray-d.br. coarse peat w roots	coarse peat	Gy,Bn	MOD,St,R,Sp,Si	H_2S	EW
25/08/97	BT-I	A	150	dredge	oed	top 20	sat. coarse peat w org.debris	coarse peat	DBn,Gy	SoTw,SoR,SoSt	P,H_2S	EW
25/08/97	BT-1	A	205	dredge	sed	top 20	sat.d.br. fine sediment	fine sediment	Bn,Gy,Y	MSt,SoR,LtOD,F,SI,	SgH_2S	EW
25/08/97	BT-1	A	240	dredge	sed	top 20	sat. l.br. coarse sed w org.debris	coarse sediment	Bn,Gy	MTw,R,OD,MeGt,SI	SgH_2S	EW
20/06/92	BT-1	B	Stn 300	core	mus	0-25	peat	coarse peat	Y,DO	FaU,St,Ce	P	M
20106192	BT-1	B	Stn 300	core	mus	25-50	peat	fine peat	Bn,O	FU/F, Ch,DeO	P	M
09/06/93	BT-1	C	SP-7	Cut	mus	60	peat	peat	Y,O,B	P,MR,Mle,MTw,G	P	S
09/06/93	BT-1	C	SP-7	Cut	mus	150	peat	peat	Bk,O	R,Tw,G	NS	EW
09/06/93	BT-1	D	SP-6	*cut*	mus	115	peat	peat	Bk,O	P.O. R. Tw,Sf	NS	W
09/06/93	BT-1	E	SP-8	Cut	mus	95	peat	peat	Bk,O	G,Sp,SoR,F	NS	M
09/06/93	BT-1	E	SP-8	cut	mus	150	peat	peat	Bk.O	P,Cy,FwR	NS	EW
09/06/93	BT-1	F	LOC 1	cut	mu5	40	peat	peat	Bk,O	MTw,MR,MDeO,P	NS	M
31/08/97	BT-1	F	North	cut	mus	0-25	l.br.coarse peat w roots	peat	LBn	MR,O	Or	VW
09/06/93	BT-1	F	LOC 1	cut	mus	60	peat	clay w/organics	Bk,O	Cy,O,SoP	NS	M
09/06/93	BT-1	F	LOC 1	cut	mus	120	sand w gravel	sand w/pebbles	Bn,O	CeSd,VaPe,SoR, SoTw, CyCh	NS	D
31/08/97	BT-1	F	North	Cut	mus	25-50	m.br.coarse peat w roots	peat	Bn,LBn	P,FwR,Sp, Sf	Or	VW
31/08/97	BT-1	F	North	Cut	mus	50-75	m.br.coarse peat w roots	peat	Bn,LBn	P,FwTw,VFwR,Sp,Sf	FOr	VW
31/08/97	BT-1	F	North	cut	mus	75-100	m.br.coarse peal w roots	peat	Bn,LBn	P,FwTw,VFwR,Sf,Sp	NS	VW
09/06/93	BT-2	A	SP-5	cut	mus	30	peat	peat	Y,Bn	P,G,MTw,MR	P	W
25/08/97	BT-2	A	250	dredge	sed	top 20	m.br. LS	gytia	Bn	LtOD,VF,ThSI	P	EW
25/08/97	BT-2	A	350 S	dredge	sed	top 20	sat. l.br./y fine sed with org.debris	fine sediment	LBn,YGy	MR,MGr,F,ThSI	P,H_2S	EW
25/08/97	BT-2	A	N End	dredge	sed	top 20	m.br. LS	gytia	DBn	MR,SoTw,SoOD,F,ThSI	P	Ew
09/06/93	BT-2	A	SP-5	cut	mus	120	peat	peat	Bk,O,Y	P,VF,Gt,SoR	NS	VS
31/08/97	BT-2	B	100N	cut	mus	0-25	dead sphagnum. m.br.	peat	LBn,Bn	P,MTw,SoR,Sp,Sf	Or	W
31/08/97	BT-2	B	4WN	cut	mus	0-25	live sphagnum, shrub +roots	sphagnum	LBn	MOD,MR,MTw,Mo,Sp	Or	M
19/06/92	BT-2	B	Stn100	dredge	sed	top 20	grey, org fins particles	fine peat	Bk,Bn	P,O,F,Sf,MR	P	VW
25/08/97	BT-2	B	100	dredge	sed	tap 20	m.br. LS	gytia	DBn	FwR,LtSt,FwOD,VF,ThSI	P,H_2S	EW
31/08/97	BT-2	B	400N	Cut	mus	25-35	sat. l. br peat	peat	LBn,Bn	P,SoTw,SoR,Sf,Sp	NS	W->VW
31/08/97	BT-2	B	100N	Cut	mus	25-50	fine m.br. grainy peat	peat	LBn,Bn	P,FwR,Sf,Sp	NS	VW
31/08/97	BT-2	B	4WN	Cut	mus	35-60	silty peat, m br., viscous	peat	DBn	P,SoTw,FwR,H,Sf,Sp	NS	VW
31/08/97	BT-2	B	100N	Cut	mus	5075	m.br. fine peat	peat	Bn,Lbn	P,RFw,FwTw,Sp,Sf	NS	WV
31/08/97	BT-2	B	4WN	cut	mus	60-100	liquid, sand,silt, gravel	fine peat	DBn	FwR,FwTw,Pe,FGt,Si	NS	EW
31/08/97	BT-2	B	100N	cut	sed	75-100	l.br. peat	peat	Bn,Dbn,LBn	P,VFwR,Sf,Sp	NS	W

Table 1: 8-Zone Area Muskeg and Sediment Sample Data - Lab Description (continuation)

							LAB DESCRIPTION					
Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Driller Description	Lab Description	Colour	Texture	Smell	Moisture
28108197	BT-3	A	BZW-T Zone	grab	mus	0-25		moss	LBn	Mo, Solid	NS	W
31/08/97	BT-3	A	50	Cut	mus	0-25	gray milky particulates on l.br.peat	peat	Bn,Gy	MOD,R,Tw,Sf,Sp	SgOr,P	M
31/08/97	BT-3	A	200	Cut	mus	0-25	sat. Ibr. coarse peat w roots	coarse peat	LBn	MOD,St,Tw,R,Sf,Sp	P,VSgH_2S	M
09/06/93	BT-3	A	SP-2	cut	mus	75	peat	peat	Bk,O	P,Gt	VSg H_2S	VW
24/08/97	BT-3	A	150	grab	algae	surface		ND	ND	ND	ND	ND
24108197	BT-3	A	150	grab	sed	top20		sediment	DBn	MTw,R	H_2S	EW
09/06/93	BT-3	A	SP-2	cut	mus	180	peat	peat	Bk,O	MO,P,R,Tw,DeO	DeOr	M->W
31/08/97	BT-3	A	50	cut	mus	25-50	l.br.peat, some particulates	peat	LBn	P,MR,MOD,FwTw,FwSt,Sf,Sp	P,SgOr	EW
31/08/97	BT-3	A	200	Cut	mus	25-50	sat. Ibr. coarse peat	peat	Bn,DBn	P,MR,SoTw,Sf,Sp	P, H_2S	W
31108197	BT-3	A	50	cut	mus	50-75	m.br.peat	peat	Bn,Lbn	P,FwR,St,Tw,Sp	SgH_2S	W
31/08/97	BT-3	A	200	cut	mus	50-75	sat. Ibr. coarse peat	peat	Bn,LBn	P,SoR,SoSt,FwTw,Sf,Sp	P, H_2S	VW
31/06/97	BT-3	A	50	cut	mus	75-100	m.br.peat	m peat	Bn,Dbn	MOD,R,St,Tw,Sp	SgH_2S	M
31/08/97	BT-3	A	200	cut	mus	75-100	sat. Ibr. coarse peat	peat	Bn,LBn	P,FwR,SoSt,FwTw,Sf,Sp	P, H_2S	W
09/06/93	ET-3	B	SP-3	Cut	mus	20	peat	peat	Bk,Y,O	P,DeO,R,Tw,Gt	H2S	VW
31108197	BT-3	B	500	cut	rnus	0-25	l.br.old sphagnum. live sedge roots	sphagnum	LBn	MSt,MR,SoTw,Mo,Sp	NS	M->W
31/08/97	ET-3	B	SP-3 DH	cut	mus	0-25	sat l.br. spahnumpeat. roots	sphagnum	LBn	MMo,MSt,MR,MTw,Sf	SgH_2S	VW
31/08/97	ET-3	B	500	cut	rnus	2550	l.br. saphnum. roots. coarse	peat	LBn	P,MSt,MTw,SoR,SoMo,Sp	M H_2S	W
31/08/97	BT-3	B	SP3 DH	Cut	mus	25-50	sat l.br. spahnumpeat. roots	sphagnum	Bn,LBn	MMo,MR,MTw,soSt,VSf,Sp	SgH_2S	W
31/08/97	BT-3	B	500	cut	mur	50-75	m.br. saphnum. roots, coarse	sphagnum	LBn,Bn	MTw,St,Mo,Sp	SgH_2S	EW
31/08/97	BT-3	B	SP-3 DH	Cut	mus	50-75	sat l.br. spahnumpeat, roots	peat	DBn,Dn	P,MR,SoSt,Tw,Sf,Sp	M H2S	W
31/08/97	BT-3	B	500	cut	mus	75-100	red-.br. saphnum. roots. coarse	peat	LBn,Bn	P,MSt,SoR,Mo,Sp	SgH_2S	W
31/08/97	BT-3	B	SP3 DH	cut	mus	75-100	sat l.br. spahnumpeat, roots	sphagnum	DBn,Bn	OD,MTw,SoR,LtSt,F,Sf,Sp	FH_2S	W
09/06/93	BT-3	B	SP-3	cut	mus	80	peat	peat	Bk,O	P,R,Tw,DeO,Gt	H2S	W
09/06/93	BT-4	A	SP-1	cut	mus	105	peat	peat	D,SIO	P,MO,R,Tw	SIOr	VM
09/06/93	BT-4	A	SP-4	Cut	mus	50	peat	peat	Bk,O	P,O,DeO,R,Twch	NS	M
31108197	BT-4	A	200	cut	mus	0-25	m.br.sat peat w sedge roots	peat	Bn,DBn	P,MR,SoSt,OD,Sf,Sp	SgH_2S	VW
31108197	BT-4	A	400	·cut	mus	0-25	coarse peat. d.br.	coase peat	Bn,DBn	MSt,Tw,SoR,Sp	SgH_2S	W
31/08/97	BT-4	A	6.9.3 DH	cut	mus	0-25	m.br. peat. coarse. red floc stain	peat	DBn	P,MR,Tw,FwLe,Sf,Sp	M H_2S	M
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	iron rich loose floc in pools	precipitate				
31108197	ET-4	A	200	cut	mus	25-50	sat. m.br. peat	peat	DBn,Bn	P,SoOD,R,Tw,St,F,Sf,Sp	SgOr	VW
31/08/97	BT-4	A	400	cut	mus	25-50	sat. peatd br. coarse	peat	Bn	P,SoTw,SoR,Sf,Sp	VSgH_2S,P	VW
31/08/97	ET-4	A	6.9.3 DH	cut	mus	2550	sat. carse d.br.peat	peat	DBn	P,H,SoTw,SoSt,Sf,F	M H_2S	M
31/08/97	BT-4	A	200	cut	mus	50-75	sat. m.br. peat. LS compact	peat	DBn	FP,SoR,SoSt,VF,Sf,Sp	Or,H_2S	VW
31108197	BT-4	A	400	cut	mus	50-75	sat. peatd br. coarse	peat	DBn,Bn	FP,FwR,FwSt,Sf,Sp	M H_2S	VW
31/08/97	BT-4	A	6.9.3. DH	cut	mus	50-75	sat. medium coarse d.be.peat	peat	DB"	P,H,FwR,SoTw,SoSt,,F,Sf,Sp	SgH_2S	M
31/08/97	BT-4	A	200	cut	mus	75-100	l.br. granular peat	peat	DBn	P,FwR,St,H,Sf,Sp	Or	W
31/08/97	BT-4	A	400	cut	mus	75-100	sat very wet d.br. fine LS-like	fine sphagnum	DBn	H,FwR,FwSt,VF	FH_2S	M
31/08/97	BT-4	A	6.9.3 DH	cut	rnus	75-90	sat silt @ 0.9 m, refusal	silt	Bn,Gy	LtOD,Sd,Pe,Gt	NS	M
09/06/93	BT-4	A	SP-1	cut	mus	140	gray till	sand w organics	B,Gy,W	Sd,IO,SoTw,SoR	NS	M
09106193	BT-4	A	SP-1	cut	mus	165	gray till w sand	silt/sand	Gy,W	Si,Sd,VF,MIO,SoTw	NS	D
09/06/93	ET-4	A	SP-4	cut	mus	105	clay	clayey till	Bk,Gy,W	P,T,Cy,MIO,SoR,SoCh,Sd	NS	M

Table 1: B-Zone Area Muskeg and Sediment Sample Data - Lab Description (continuation)

Sampled Date	Area	Location	Sample Type	Local Substrate	Sample Depth (cm)	LAB DESCRIPTION Driller Description	Lab Description	Colour	Texture	Smell	Moisture
09/06/93	LAKE1 A	SP-9	cut	mus	65	peat	peat	Y,Bn	P,G,O	NS	D->M
09/06/93	LAKE1 A	SP-9	cut	muskeg	90	clay	peat w clay	Bk,O	P,Cy,SoR,SoTw	NS	EW
19/06/92	LAKE1 E	Stn100	core	mus	0-20		peat	O	P	NS	EW
19/06/92	LAKE 1 B	centre	dredge	sed	top20		fine organics	DBn,Bk	U,O,FwR,F,Sf	P	EW
19/06/92	LAKE1 E	Stn100	core	mus	20-40		peat	Gn,O	P,MR,MTw	NS	M
19/06/92	LAKE1 E	Stn100	core	mus	40-60		peat	Bk	P,VSp	NS	Dr
19/06/92	LAKE1 B	Stn100	core	mus	60-80		peat	O,Bn	P,VF	NS	VM

rea: BT1,2,3,4: Locations originally named according to position along B-Zone transects (BT)

A to F: Area on map

Location: Transect map 100 intervals: DH=Drill Hole, LOC=Location, N=North, S=South, SP=Shallow Pitzo, Stn=Station

Sample type and local substrate: Cut=Cuttings, Dred=Dredge, Mus=Muskeg, Sed=Sediment

Driller Description: be=beige, br=brown, d=dark, l=light, LS=gytia, m=medium, sat=saturated, sed=sediment, org=organic, w=with

Colour: Bk-Black. Bn-Brown, D-Dark, Gn-Green, Gy-Grey, L-Light, 0-Orange, Rd-Red, SI-Slight, Tn-Tan, W-White

Texture: Ce-Coarse, Ch-Chunk, Cy-Clay, De-Decomposing. Dr-Drier, F-Fine. Fa-Fairly. Fw-Few, G-Grainy, Gr-GrassGt-Grit, H-Humus. IO-Inorganic, La-Larger, Le-Leaf, Lt-Little,
M-Many. Me-Medium, Mo-Moss. O-Organic, OD-Organic Debris. P-Peat, Pe-Pebble, R-Root. Sd-Sand, Sf-Soft, SI-Silty, SI-Sludge, So-Som.
Sp-Spongy, St-Straw. T-Till, Th-Thick, Tw-Twig, U-Uniform. V-Very. Va-Various. W/-With

Smell: Ds-Decomposing. F-Faint, M: Moderate. NS-No Smell, Or-Organic Smell, P-Pungent, Sg-Strong, SI-Slight, V-Very

Moisture: D-Dry, EW-ExcessWater, M-Moist, S-Saturated, V-Very. W-Wet

NA=Not Analyzed, ND=Not Determinated, NM–Not Measureable because of no enough water

Table 2: B-Zone Area Muskeg and Sediment Sample Data - Field and Lab Bulk Sample

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	FIELD BULK SAMPLE				LAB BULK SAMPLE			
							pH	Temp (C)	Cond (uS/cm)	Em (mV)	pH	Temp (C)	Cond (uS/cm)	Em (mV)
19/06/92	ET-I	A	Stn200	dredge	sed	top 20								
25/08/97	ET-I	A	100	dredge	hed	top 20	6.24	11.7	118	-66	6.22	25.5	59	-148
25/08/97	ET-1	A	150	dredge	sed	top 20	6.12	11.5	112	-55	5.92	24	81	-139
25/08/97	ET-1	A	205	dredge	sed	top 20	6.21	12.3	a7	-58	5.77	24	70	-148
25/08/97	ET-I	A	240	dredge	sed	top 20	6.18	12.1	74	4 6	5.87	24	59	-122
20/06/92	ET-I	E	Stn 300	core	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
20/06/92	BT-1	B	Stn 300	core	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-1	C	SP-7	cut	mus	60	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-I	C	SP-7	cut	mus	150	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-1	D	SP-6	cut	mus	115	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-1	E	SP-8	cut	mus	95	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-I	E	SP-8	cut	mus	150	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-I	F	LOC 1	cut	mus	40	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-I	F	North	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-1	F	LOC 1	cut	mus	60	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-I	F	LOC 1	cut	mus	120	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-I	F	North	w t	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-I	F	North	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-1	F	North	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
19/06/93	ET-2	A	SP-5	cut	mus	30	NM	NM	NM	NM	NM	NM	NM	NM
25/08/97	ET-2	A	250	dredge	sed	top 20	5.87	13	91	-12	5.64	25	55	-95
15/08/97	ET-2	A	350 S	dredge	sed	top 20	5.91	13.1	68	-19	5.54	24	68	-120
25/08/97	ET-2	A	N End	dredge	sed	top 20	5.74	12.5	68	-3	5.33	24	63	4 1
19/06/93	ET-2	A	SP-5	cut	mus	120	NM	NM	NM	NM	NM	NM	NM	NM
11/08/07	ET-2	E	100N	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
11/08/07	ET-2	E	400N	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	BT-2	E	Stn100	dredge	sed	top 20	NM	NM	NM	NM	NM	NM	NM	NM
25/08/97	BT-2	E	100	dredge	sed	top 20	5.46	12	84	-6	5.28	24	85	4 6
31/08/97	ET-2	B	400N	wt	mus	25-35	NM	NM	NM	NM	NM	NM	NM	NM
11/08/97	BT-2	E	100N	w t	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
11/08/97	ET-2	E	400N	cut	mus	35-60	NM	NM	NM	NM	NM	NM	NM	NM
11/08/97	ET-2	B	100N	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
11/08/97	ET-2	E	400N	w t	rnus	60-100	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-2	E	100N	cut	sed	75-100	NM	NM	NM	NM	NM	NM	NM	NM

Table 2: B-Zone Area Muskeg and Sediment Sample Data - Field and Lab Bulk Sample (continuation)

							FIELD BULK SAMPLE				LAB BULK SAMPLE			
Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	pH	Temp (C)	Cond (uS/cm)	Em (mV)	pH	Temp (C)	Cond (uS/cm)	Em (mV)
28/08/97	ET-3	A	BZW-T Zone	grab	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	50	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	200	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-3	A	SP-2	wt	mus	75	NM	NM	NM	NM	NM	NM	NM	NM
24/08/97	BT-3	A	150	grab	algae	surface	ND	ND	ND	ND	ND	ND	ND	ND
24/08/97	ET-3	A	150	grab	sed	top 20	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET-3	A	SP-2	Cut	mus	180	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	A	50	cut	muo	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	200	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	50	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	200	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	50	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	A	200	cut	mus	75.100	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-3	B	SP-3	cut	mus	20	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	B	500	Wt	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	E	SP-3 DH	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	B	500	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	B	SP3 DH	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	B	500	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET-3	B	SP-3 DH	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	B	500	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-3	E	SP3 DH	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-3	E	SP-3	cut	mus	80	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	ET4	A	SP-1	cut	mus	105	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-4	A	SP-4	cut	mus	50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	200	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	ET4	A	400	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	6.9.3 DH	cut	mus	0-25	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT4	A	Stn 6.9.3	grab	flocc	0-10								
31/08/97	BT4	A	200	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	400	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	6.9.3 DH	cut	mus	25-50	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	200	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	400	cut	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	6.9.3. DH	wt	mus	50-75	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	200	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT-4	A	400	cut	mus	75-100	NM	NM	NM	NM	NM	NM	NM	NM
31/08/97	BT4	A	6.9.3 DH	cut	mus	75-90	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT4	A	SP-1	cut	mus	140	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT4	A	SP-1	cut	mus	165	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	BT-4	A	SP-4	cut	mus	105	NM	NM	NM	NM	NM	NM	NM	NM

Table 2: B-Zone Area Muskeg and Sediment Sample Data - Field and Lab Bulk Sample (continuation)

							FIELD BULK SAMPLE				LAB BULK SAMPLE			
Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	pH	Temp (C)	Cond (uS/cm)	Em (mV)	pH	Temp (C)	Cond (uS/cm)	Em (mV)
09/06/93	LAKE 1	A	SP-9	cut	mus	65	NM	NM	NM	NM	NM	NM	NM	NM
09/06/93	LAKE 1	A	SP-9	cut	muskeg	90	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	LAKE1	B	Stn100	core	mus	0-20	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	LAKE 1	B	Stn100	core	mus	20-40	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	LAKE 1	B	Stn100	core	mus	40-60	NM	NM	NM	NM	NM	NM	NM	NM
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	NM	NM	NM	NM	NM	NM	NM	NM

Table 3: B-Zone Area Muskeg and Sediment Sample Data - Moisture, Density and Associated Data

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Density g/mL	Moisture Content %	Sample wet wt, g 60 mL sample	Sample dry wt (g)	Sample pore water vol., L	Extraction water vol. L (+120 mL)		Merck As in extract mg.L^{-1}	Hach Ni in extract mg.L^{-1}	Merck/Hach Extractable g.m^{-3} As	g.m^{-3} Ni
19/06/92	BT-I	A	Stn200	dredge	sed	top 20	0.99	78.3	59.500	12.920	0.047	0.167		0.8	0.050	2.2	0.14
25/08/97	BT-1	A	100	dredge	sed	top *m*	1.27	85.8	76.1	10.8	0.065	0.185		ND	ND	ND	ND
25/08/97	BT-1	A	150	dredge	sed	top *m*	1.22	85.6	73	10.5	0.063	0.183		ND	ND	ND	ND
25/08/97	BT-1	A	205	dredgs	sed	top 20	1.35	86.6	92.1	12.3	0.080	0.200		ND	ND	ND	ND
25/08/97	BT-I	A	240	dredge	sed	top 20	1.19	88.6	71.2	8.1	0.063	0.183		ND	ND	ND	ND
20/06/92	BT-I	B	Stn 300	con	mus	0-25	0.86	91.7	51.400	4.260	0.047	0.167		0.25	0.118	0.70	0.33
20/06/92	BT-I	B	Stn 300	con	mus	25-50	0.94	80.4	56.600	11.100	0.046	0.188		0.05	0.315	0.14	0.87
09/06/93	BT-1	C	SP-7	Cut	mus	60	0.88	86.9	52.600	6.900	0.046	0.166		0.05	0.514	0.14	1.42
09/06/93	BT-I	C	SP-7	*cut*	mus	150	1.24	87.7	74.500	9.200	0.065	0.185	<	0.05	0.418	0.15	1.28
09/06/93	BT-1	D	SP-6	Cut	mus	115	0.93	76.9	55.700	12.870	0.043	0.163	<	0.05	0.017	0.14	0.05
09/06/93	BT-I	E	SP-8	Cut	mus	95	0.93	86.4	56.000	7.610	0.048	0.168		0.05	0.416	0.14	1.17
09/06/93	BT-I	E	SP-8	Cut	mus	150	0.95	82.7	56.700	9.840	0.047	0.167		0.05	1.278	0.14	3.55
09/06/93	BT-I	F	LOC 1	*cut*	mus	40	0.97	75.4	58.400	14.300	0.044	0.164	<	0.05	0.324	0.14	0.89
31/08/97	BT-I	F	North	*Cut*	mus	0-25	0.71	91.6	42.8	36	0.039	0.159		ND	ND	ND	ND
09/06/93	BT-I	F	LOC 1	Cut	mus	60	0.81	61.2	48.400	18.790	0.030	0.150	<	0.05	2.474	0.12	6.17
09/06/93	BT-I	F	LOC 1	Cut	mus	120	1.31	91.7	78.800	63.410	0.072	0.192	<	0.05	0.032	0.16	0.10
31/08/97	BT-I	F	North	Cut	mus	25-50	0.71	89.7	42.6	4.4	0.038	0.158		ND	ND	ND	ND
31/08/97	BT-I	F	North	Cut	mw	50-75	0.85	94.3	50.8	2.9	0.048	0.168		ND	ND	ND	ND
31/08/97	BT-I	F	North	Cut	mus	75-100	0.76	94.7	45.5	2.4	0.043	0.163		ND	ND	ND	ND
09/06/93	BT-2	A	SP-5	*cut*	mus	30	1.07	85.2	64.100	9.510	0.055	0.175	<	0.05	0.548	0.15	1.59
25/08/97	BT-2	A	250	dredge	sed	top 20	1.22	92.1	73.2	58	0.067	0.187		ND	ND	ND	ND
25/08/97	BT-2	A	350 S	dredge	sed	top 20	1.15	86.1	69.1	9.6	0.060	0.180		ND	ND	ND	ND
25/08/97	BT-2	A	N End	dredge	sed	top 20	1.17	90.9	70.3	6.4	0.064	0.184		ND	ND	ND	ND
09/06/93	BT-2	A	SP-5	*cut*	mus	120	1.10	79.9	65.900	13.270	0.053	0.173		0.1	0.646	0.29	1.86
31/08/97	BT-2	B	IWN	cut	mus	0-25	0.75	89.1	44.8	4.9	0.040	0.160		ND	ND	ND	ND
31/08/97	BT-2	B	4WN	*cut*	mus	0-25	0.29	85.5	17.3	25	0.015	0.135		ND	ND	ND	ND
19/06/92	BT-2	B	Stn100	dredge	sed	top 20	1.05	71.3	62.900	18.050	0.045	0.165		0.25	0.339	0.69	0.93
25/08/97	BT-2	B	100	dredge	sed	top 20	1.35	92.8	81	5.8	0.075	0.195		ND	ND	ND	ND
31/08/97	BT-2	B	400N	Cut	mus	25-35	0.78	92.8	47.1	3.4	0.044	0.164		ND	ND	ND	ND
31/08/97	BT-2	B	100N	*cut*	mus	25-50	0.73	87.2	43.7	5.6	0.038	0.158		ND	ND	ND	ND
31/08/97	BT-2	B	400N	cut	mus	35-60	1.08	63.6	64.6	23.5	0.041	0.161		ND	ND	ND	ND
31/08/97	BT-2	B	IWN	*cut*	mus	55-75	0.77	92.2	46	3.6	0.042	0.162		ND	ND	ND	ND
31/08/97	BT-2	B	4WN	cut	mus	60-100	1.74	26.7	104.4	78.5	0.028	0.148		ND	ND	ND	ND
31/08/97	BT-2	B	100N	*Cut*	sed	75-100	0.64	90.6	38.3	3.6	0.035	0.155		ND	ND	ND	ND

Table 3: B-Zone Area Muskeg and Sediment Sample Data - Moisture, Density and Associated Data (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Density g/mL	Moisture Content %	Sample wet wt, g 60 mL sample	Sample dry wt (g)	Sample pore water vol., L	Extraction water vol. L (+120 mL)		Merck As in extract mg.L^{-1}	Hach Ni in extract mg.L^{-1}	Merck/Hach Extractable g.m^{-3} As	g.m^{-3} Ni
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0 2 5	1.04	70.1	62.3	18.6	0.044	0.164		ND	ND	ND	ND
31/08/97	BT-3	A	50	cut	mus	0 2 5	0.67	83.2	40.4	6.8	0.034	0.154		ND	ND	ND	ND
31/08/97	BT-3	A	200	cut	mus	0-25	0.69	89.4	41.6	4.4	0.037	0.157		ND	ND	ND	ND
09/06/93	BT-3	A	SP-2	Cut	mus	75	0.98	86.1	58.800	8.190	0.051	0.171		0.4	0.416	1.14	1.18
24/08/97	BT-3	A	150	grab	algae	surface	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND
24/08/97	BT-3	A	150	grab	sed	top 20	0.87	86.3	52	7.1	0.045	0.165		ND	ND	ND	ND
09/06/93	BT-3	A	SP-2	cut	mus	180	0.94	87.8	56.200	6.840	0.049	0.169		0.4	0.493	1.13	1.39
31/08/97	ET-3	A	50	Cut	mus	25-50	0.87	89.4	52.1	5.5	0.047	0.167		ND	ND	ND	ND
31/08/97	BT-3	A	200	Cut	mus	25-33	0.89	92.5	53.5	4	0.050	0.170		ND	ND	ND	ND
31/08/97	BT-3	A	50	cut	mur	52–75	0.88	91.2	52.5	4.6	0.048	0.168		ND	ND	ND	ND
31/08/97	BT-3	A	200	Cut	mus	50-75	0.80	92.1	48.3	3.8	0.045	0.165		ND	ND	ND	ND
31/08/97	BT-3	A	50	Cut	mus	75-100	0.72	88.5	43.3	5	0.038	0.158		ND	ND	ND	ND
31/08/97	BT-3	A	200	Cut	mus	75-100	1.09	93.3	65.3	4.4	0.061	0.181		ND	ND	ND	ND
09/06/93	BT-3	B	SP-3	Cut	mus	20	0.97	84.3	58.300	9.150	0.049	0.169	<	0.05	0.545	0.14	1.54
31/08/97	BT-3	B	500	Cut	mus	0 2 5	0.83	89.8	49.8	5.1	0.045	0.165		ND	ND	ND	ND
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	0.90	93.5	53.9	3.5	0.050	0.170		ND	ND	ND	ND
31/08/97	BT-3	B	500	cut	mus	25-50	0.79	93.1	58	4	0.054	0.174		ND	ND	ND	ND
31/08/97	BT-3	B	SP3 DH	cut	mus	25-50	0.84	93.4	50.2	3.3	0.047	0.167		ND	ND	ND	ND
31/08/97	BT-3	B	500	cut	mus	50-75	0.88	93.4	53	3.5	0.050	0.170		ND	ND	ND	ND
31/08/97	BT-3	B	SP-3 DH	cut	mus	50-75	0.82	90.9	49.4	4.5	0.045	0.165		ND	ND	ND	ND
31/08/97	BT-3	B	500	Cut	mus	75-100	0.88	93.3	52.5	3.5	0.049	0.169		ND	ND	ND	ND
31/08/97	BT-3	B	SP3 DH	Cut	mur	75-100	0.98	90.5	58	5.5	0.053	0.173		ND	ND	ND	ND
09/06/93	BT-3	B	SP-3	Cut	mus	80	1.28	61.2	76.900	10.710	0.047	0.167	<	0.05	0.302	0.14	0.84
09/06/93	BT-4	A	SP-1	cut	mus	105	0.89	83.4	53.600	8.880	0.045	0.165		0.4	0.170	1.10	0.47
09/06/93	BT-4	A	SP-4	cut	mus	50	0.95	84.8	57.000	8.660	0.048	0.168		0.05	0.155	0.14	0.43
31/08/97	BT-4	A	200	cut	mus	0-25	0.82	89.6	49	5.1	0.044	0.164		ND	ND	ND	ND
31/08/97	BT-4	A	400	Cut	mus	0-25	0.84	89.7	50.7	5.2	0.046	0.166		ND	ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	cut	mus	0-25	0.79	77.2	47.3	10.8	0.037	0.157		ND	ND	ND	ND
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10											
31/08/97	BT-4	A	200	cut	mus	25-50	1.01	87.8	60.6	7.4	0.053	0.173		ND	ND	ND	ND
31/08/97	BT-4	A	400	cut	mur	25-50	0.81	92.8	48.4	3.5	0.045	0.165		ND	ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	25-50	0.85	77.4	50.8	11.5	0.039	0.159		ND	ND	ND	ND
31/08/97	BT-4	A	200	cut	mus	50-75	1.09	83.7	65.5	10.7	0.055	0.175		ND	ND	ND	ND
31/08/97	BT-4	A	400	cut	mus	50-75	0.76	86.9	45.8	6	0.040	0.160		ND	ND	ND	ND
31/08/97	BT-4	A	6.9.3. DH	Cut	mus	5075	0.90	76.4	53.9	12.7	0.041	0.161		ND	ND	ND	ND
31/08/97	BT-4	A	200	cut	mus	75-100	0.69	84.1	41.4	6.6	0.035	0.155		ND	ND	ND	ND
31/08/97	BT-4	A	4 w	cut	mus	75-100	0.87	68.6	52.2	16.4	0.036	0.156		ND	ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	75-90	1.08	31.3	64.9	44.6	0.020	0.140		ND	ND	ND	ND
09/06/93	BT-4	A	SP-1	Cut	mus	140	0.90	42.1	54.100	31.340	0.023	0.143		0.05	0.103	0.12	0.25
09/06/93	BT-4	A	SP-1	cut	mus	165	1.19	16.8	71.200	59.420	0.012	0.132	<	0.05	0.075	0.11	0.16
09/06/93	BT-4	A	SP-4	Cut	mus	105	1.21	33.7	72.400	47.990	0.024	0.144		0.1	0.195	0.24	0.47

Table 3: B-Zone Area Muskeg and Sediment Sample Data - Moisture, Density and Associated Data (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Density g/mL	Moisture Content %	Sample wet wt, g 60 mL sample	Sample dry wt (g)	Sample pore water vol., L	Extraction water vol. L (+120 mL)	Merck As *in* extract mg.L^{-1}	Hach Ni in extract mg.L^{-1}	Merck/Hach Extractable g.m^{-3} As	g.m^{-3} Ni
09/06/93	LAKE1	A	SP-9	cut	mus	65	0.92	89.1	55.100	5.990	0.049	0.169	1.0	0.201	2.82	0.57
09/06/93	LAKE1	A	SP-9	*cut*	muskeg	90	1.07	79.0	64.200	13.510	0.051	0.171	0.1	1.092	0.28	3.11
19/06/92	LAKE1	B	Stn100	core	mus	0-20	0.75	91.8	45.200	3.720	0.041	0.161	< 0.05	0.078	0.13	0.21
19/06/92	LAKE1	B	centre	dredge	sed	top 20	1.07	80.5	64.400	12.550	0.052	0.172	< 0.05	0.201	0.14	0.58
19/06/92	LAKEI	B	Stn100	core	mus	20-40	0.60	90.7	35.900	3.320	0.033	0.153	< 0.05	0.247	0.13	0.63
19/06/92	LAKEI	B	Stn100	core	mus	40-60	0.62	81.4	37.400	6.970	0.030	0.150	< 0.05	0.229	0.13	0.57
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	0.95	88.1	56.800	6.730	0.050	0.170	0.1	0.311	0.28	0.88

Table 4: B-Zone Area Muskeg and Sediment Sample Data - Leaching Experiment

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	EXTRACT pH	Temp °C	Cond' us.cm^{-1}	Em mV	Assay No.		SRC As, Assay mg.L^{-1}		SRC Ni,Assay mg.L^{-1}	Based on SRC Extractable g.m^{-3} As	g.m^{-3} NI
19/06/92	BT-1	A	Stn200	dredge	sed	top 20	6.63	21.8	104	ND	6379		0.199		0.04	0.55	0.11
25/08/97	BT-1	A	100	dredge	sed	top 20	5.64	23	50	-130			ND		ND	ND	ND
25/08/97	BT-1	A	150	dredge	sed	top 20	5.72	23	60	-120			ND		ND	ND	ND
25/08/97	BT-1	A	205	dredge	sed	top 20	5.63	23	60	-164			ND		ND	ND	ND
25/08/97	BT-1	A	240	dredge	sed	top 20	5.41	23	32	-128			ND		ND	ND	ND
20/06/92	BT-1	B	Stn 300	core	mus	025	5.63	21.8	35	ND	6380		0.157	<	0.01	0.44	0.028
20/06/92	BT-1	B	Stn 300	core	mus	25-50	5.08	21.9	30	ND	6381		0.065	c	0.01	0.18	0.028
09/06/93	BT-1	C	SP-7	cut	mus	60	5.20	21.7	37	ND	6371		0.044	<	0.01	0.12	0.028
09/06/93	BT-I	C	SP-7	Cut	mus	150	5.33	21.8	40	ND	6372		0.02	<	0.01	*0.06*	0.031
09/06/93	BT-1	D	SP-6	Cut	mus	115	5.24	21.8	50	ND	6388	<	0.002	<	0.01	0.005	0.027
09/06/93	BT-I	E	SP-8	*Cut*	mus	95	4.90	21.8	55	ND	6374	<	0.002	<	0.01	0.006	0.028
09/06/93	BT-1	E	SP-8	Cut	mus	150	4.58	21.8	50	ND	6373		0.041	<	0.01	0.11	0.028
09/06/93	BT-1	F	LOC 1	*Cut*	mus	40	5.13	21.7	139	ND	6370	<	0.002	<	0.01	0.01	0.027
31/08/97	BT-I	F	North	*cut*	mus	0-25	4.59	20	25	284			ND		ND	ND	ND
09/06/93	BT-I	F	LOC 1	*Cut*	mus	60	5.03	21.7	90	ND	6369	c	0.002	c	0.01	0.005	0.025
09/06/93	BT-1	F	LOC 1	*Cut*	mus	120	4.52	22.1	155	ND	6367	<	0.002	<	0.01	0.006	0.032
31/08/97	BT-I	F	North	*cut*	mus	25-50	4.24	19.5	21	352			ND		ND	ND	ND
31/08/97	BT-I	F	North	Cut	mus	50-75	4.79	20	28	322			ND		ND	ND	ND
31/08/97	BT-1	F	North	cut	mus	75-100	4.21	19.5	22	348			ND		ND	ND	ND
09/06/93	BT-2	A	SP-5	cut	mus	30	5.20	21.6	42	ND	6377	c	0.002	c	0.01	0.006	0.029
25/08/97	BT-2	A	250	dredge	sed	top 20	4.96	23	45	-56			ND		ND	ND	ND
25/08/97	BT-2	A	350 S	dredge	sed	top 20	5.62	22	53	-110			ND		ND	ND	ND
25/08/97	ET-2	A	N End	dredge	sed	top 20	5.71	23	41	104			ND		ND	ND	ND
09/06/93	ET-2	A	SP-5	*cut*	mus	120	4.42	21.8	53	ND	6366		0.054	<	0.01	0.16	0.029
													ND		ND	ND	ND
31/08/97	BT-2	B	100N	Cut	mus	0-25	3.84	20	*50*	344			ND		ND	ND	ND
31/08/97	BT-2	B	4WN	Cut	mus	0-25	4.19	20	30	303			ND		ND	ND	ND
19/06/92	BT-2	B	Stn100	dredge	sed	tap 20	6.13	21.8	33	ND	6378		0.133		0.01	0.37	0.027
25/08/97	BT-2	B	100	dredge	sed	top 20	5.54	23	50	90			ND		ND	ND	ND
31/08/97	BT-2	B	4WN	Cut	mus	25-35	4.13	19.5	36	388			ND		ND	ND	ND
31/08/97	BT-2	B	100N	cut	mus	2550	3.78	19	48	356			ND		ND	ND	ND
31/08/97	BT-2	B	400N	cut	mus	35-60	4.06	20.5	42	239			ND		ND	ND	ND
31/08/97	BT-2	B	100N	*Cut*	mus	50-75	3.88	19	42	353			ND		ND	ND	ND
31/08/97	BT-2	B	400N	*Cut*	mus	60-100	4.5	20	19	309			ND		ND	ND	ND
31/08/97	BT-2	E	100N	*cut*	sed	75-100	4.02	21	31	333			ND		ND	ND	ND

Table 4: B-Zone Area Muskeg and Sediment Sample Data - Leaching Experiment (continuation)

						Sample	EXTRACT						SRC		SRC	Based on SRC Extractable	
Sampled Date	Area		Location	Sample Type	Local Substrate	Depth (cm)	pH	Temp °C	Cond us.cm^{-1}	Em mV	Assay No.		As, Assay mg.L^{-1}		Ni,Assay mg.L^{-1}	g.m^{-3} As	g.m^{-3} NI
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0-25	5.1	21	306	102			ND		ND	ND	ND
31/08/97	BT-3	A	50	cut	mus	0-25	5.74	20	52	128			ND		ND	ND	ND
31/08/97	BT-3	A	200	Cut	mus	0-25	4.77	19	24	242			ND		ND	ND	ND
09/06/93	BT-3	A	SP-2	cut	mus	75	5.26	21.8	97	ND	6361		0.187		0.01	0.53	0.028
24/08/97	BT-3	A	150	grab	algae	surface	ND	ND	ND	ND			ND		ND	ND	ND
24/08/97	BT-3	A	150	grab	Sal	top 20	4.86	21	651	88			ND		ND	ND	ND
09/06/93	BT-3	A	SP-2	Cut	mus	180	5.69	21.7	82	ND	6360		0.279	<	0.01	0.79	0.028
31/08/97	BT-3	A	50	cut	mus	25-50	5.49	20	28	198			ND		ND	ND	ND
31/08/97	BT-3	A	200	Cut	mus	25-50	4.26	19	30	289			ND		ND	ND	ND
31/08/97	BT-3	A	50	cut	mus	50-75	5.11	20	25	215			ND		ND	ND	ND
31/08/97	BT-3	A	200	cut	mus	50-75	4.41	20	28	324			ND		ND	ND	ND
31/08/97	BT-3	A	50	cut	mus	75-1W	5.08	20	20	247			ND		ND	ND	ND
31/08/97	BT-3	A	200	cut	mus	75-100	4.51	19.5	25	327			ND		ND	ND	ND
09/06/93	BT-3	B	SP-3	cut	mus	20	5.w	21.7	49	ND	6363	<	0.002	<	0.01	0.006	0.028
31/08/97	BT-3	B	500	cut	mus	0-25	5.58	24	32	5			ND		ND	ND	ND
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	4.24	23.5	37	253			ND		ND	ND	ND
31/08/97	BT-3	B	500	cut	mus	25-50	5.42	24	20	309			ND		ND	ND	ND
31/08/97	BT-3	B	SP3 DH	Cut	mus	25-50	4.2	24	40	371			ND		ND	ND	ND
31/08/97	BT-3	B	500	Cut	mus	50-75	5.24	24	41	74			ND		ND	ND	ND
31/08/97	BT-3	B	SP-3 DH	Cut	mus	50-75	4.11	24	35	282			ND		ND	ND	ND
31/08/97	BT-3	B	500	Cut	mus	75-100	5.24	23.5	29	238			ND		ND	ND	ND
31/08/97	BT-3	B	SP3 DH	cut	mus	75-100	4.2	24	32	152			ND		ND	ND	ND
09/06/93	BT-3	B	SP-3	cut	mus	80	5.26	21.7	72	ND	6362	<	0.002	<	0.01	0.006	0.028
09/06/93	BT-4	A	SP-1	Cut	mus	105	5.48	21.7	144	ND	6359		0.2	<	0.01	0.55	0.027
09/06/93	BT-4	A	SP-4	cut	mus	50	4.46	21.8	226	ND	6365	<	0.002	<	0.01	0.006	0.028
31/08/97	BT-4	A	200	Cut	mus	0-25	4.65	23.5	88	31			ND		ND	ND	ND
31/08/97	BT-4	A	400	cut	mus	0-25	5.47	23.5	144	-52			ND		ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	cut	mus	0-25	6.53	23	122	200			ND		ND	ND	ND
31/08/97	BT-4	A	Sin 6.9.3	grab	flocc	0-10											
31/08/97	BT-4	A	200	cut	mus	25-50	4.98	24	70	-2			ND		ND	ND	ND
31/08/97	BT-4	A	400	Cut	mus	25-50	5.33	24	74	23			ND		ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	25-50	6.2	24	53	-132			ND		ND	ND	ND
31/08/97	BT-4	A	200	Cut	mus	50-75	5.26	23.5	69	-46			ND		ND	ND	ND
31/08/97	BT-4	A	400	cut	mus	50-75	5.52	24	40	49			ND		ND	ND	ND
31/08/97	BT-4	A	6.9.3. DH	Cut	mus	50-75	6.13	24	41	-118			ND		ND	ND	ND
31/08/97	BT-4	A	200	Cut	mus	75-100	4.91	24	64	27			ND		ND	ND	ND
31/08/97	BT-4	A	400	Cut	mus	75-1W	5.51	24	63	41			ND		ND	ND	ND
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	75-90	5.17	24	57	27			ND		ND	ND	ND
09/06/93	BT-4	A	SP-1	Cut	mur	140	4.55	21.8	272	ND	6358	c	0.002	<	0.01	0.005	0.024
09/06/93	BT-4	A	SP-1	cut	mus	165	4.75	21.7	219	ND	6357	<	0.002	<	0.01	0.004	0.022
09/06/93	BT-4	A	SP-4	Cut	mus	105	5.85	21.8	88	ND	6364	<	0.002	<	0.01	0.005	0.024

Table 4: 8-Zone Area Muskeg and Sediment Sample Data - Leaching Experiment (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	EXTRACT pH	Temp °C	Cond $us.cm^{-1}$	Em mV	Assay No.		SRC As, Assay $mg.L^{-1}$		SRC Ni,Assay $mg.L^{-1}$	Based on SRC Extractable $g.m^{-3}$ As	$g.m^{-3}$ NI
09/06/93	LAKE 1	A	SP-9	cut	mus	65	5.09	21.8	77	ND	6576		0.4	<	0.01	1.2	0.028
09/06/93	LAKE1	A	SP-9	cut	muskeg	90	5.24	21.8	59	ND	6375		0.074	<	0.01	0.21	0.028
19/06/92	LAKE1	B	Stn100	core	mus	0-20	4.82	21.9	54	ND	6386	<	0.002	<	0.01	0.005	0.027
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	6.37	21.8	28	ND	6382	<	0.002	<	0.01	0.006	0.029
19/06/92	LAKE 1	B	Stn100	core	mus	20-40	4.70	22.0	50	ND	6385	<	0.002	<	0.01	0.005	0.025
19/06/92	LAKE 1	B	Stn100	core	mus	40-60	4.70	21.8	58	ND	6384	<	0.002	<	0.01	0.005	0.025
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	4.71	21.8	56	ND	6383		0.037	<	0.01	0.105	0.028

Table 5: B-Zone Area Muskeg and Sediment Sample Data - Excess Pore Water

							EXCESS PORE WATER							
Sampled Date	Area		Location	Sampl Type	Local ubstrat	Sample Depth (cm)	pH	Cond us.cm^{-1}	Temp °C	Em mV	Merck As mg.L^{-1}	Assay No.	SRC As, Assay mg.L^{-1}	SRC Ni,Assay mg.L^{-1}
19/06/92	BT-1	A	Stn200	dredge	ad	top 20	6.W	219	21.9		< 0.05	6392	<0.002	<0.01
25/08/97	BT-1	A	100	dredge	sod	top20	5.98	24	97	137			ND	ND
25/08/97	BT-1	A	150	dredge	sod	lop20	5.83	24	98	155			ND	ND
25/08/97	ET-I	A	205	dredge	red	top20	5.9	24	96	160			ND	ND
25/08/97	BT-1	A	240	dredge	sed	top20	5.05	24	79	197			ND	ND
20/06/92	BT-1	E	Stn 300	core	mus	0-25	NM	NM	NM	NM			ND	ND
20/06/92	BT-1	E	Stn 300	core	mus	2550	NM	NM	NM	NM			ND	ND
							NM	NM	NM	NM			ND	ND
09/06/93	BT-1	C	SP-7	cut	mus	60	NM	NM	NM	NM			ND	ND
09/06/93	BT-1	C	SP-7	cut	mua	150	5.08	52	22.5		0.1	6389	0.061	<0.01
09/06/93	BT-1	D	SP-6	cut	mus	115	NM	NM	NM	NM			ND	ND
09/06/93	BT-1	E	SP-8	cut	mus	95	NM	NM	NM	NM	2	6391	0.289	0.09
09/06/93	ET-I	E	SP-8	cut	mus	150	4.66	80	22.2		0.2	6390	0.092	<0.01
09/06/93	BT-1	F	LOC 1	cut	mur	40	NM	NM	NM	NM			ND	ND
31/08/97	ET-I	F	North	cut	mus	025		NM	NM	NM			ND	ND
							NM							
09/06/93	BT-1	F	LOC 1	Cut	mua	W	NM	NM	NM	NM			ND	ND
09/06/93	BT-1	F	LOC 1	cut	mus	120	NM	NM	NM	NM			ND	ND
31/08/97	BT-1	F	North	cut	mus	25-50	NM	NM	NM	NM			ND	ND
31/08/97	ET-I	F	North	cut	mur	50-15	NM	NM	NM	NM			ND	ND
31/08/97	BT-1	F	North	cut	mus	75100	NM	NM	NM	NM			ND	ND
09/06/93	ET-2	A	SP-5	Cut	mur	30								
25/08/97	ET-2	A	250	dredge	sed	top 20	5.75	24	60	173			ND	ND
25/08/97	ET-2	A	350 S	dredge	sed	top 20	5.89	25	147	-34			ND	ND
25/08/97	ET-2	A	N End	dredge	sed	top 20	5.63	24.5	65	116			NM	ND
09/06/93	ET-2	A	SP-5	Cut	mus	120	NM	NM	NM	NM			NM	NM
							NM	NM	NM	NM			NM	NM
31/08/97	ET-2	E	100N	cut	mus	0-25	NM	NM	NM	NM			NM	NM
31/08/97	ET-2	E	4WN	Cut	mus	0-25	NM	NM	NM	NM			NM	NM
19/06/92	BT-2	E	Stn100	dredge	sed	top 20	NM	NM	NM	NM			NM	NM
25/08/97	ET-2	E	100	dredge	sed	top 20	5.6	24	51	99			NM	NM
31/08/97	ET-2	E	400N	Cut	mus	25-35	NM	NM	NM	NM			NM	NM
31/08/97	ET-2	E	100N	Cut	mus	25-50	NM	NM	NM	NM’			NM	NM
31/08/97	ET-2	E	4WN	cut	mus	35-60	NM	NM	NM	NM			NM	NM
31/08/97	ET-2	E	100N	cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	ET-2	E	4WN	cut	mus	60-100	4.52	19	37	346			NM	NM
31/08/97	ET-2	E	100N	cut	sed	75-100	NM	NM	NM	NM			NM	NM

Table 5: B-Zone Area Muskeg and Sediment Sample Data - Excess Pore Water (continuation)

							EXCESS PORE WATER							
Sampled Date	Area		Location	Sampl Type	Local ubstrat	Sample Depth (cm)	pH	Cond us.cm^{-1}	Temp °C	Em mV	Merck As mg.L^{-1}	Assay No.	SRC As, Assay mg.L^{-1}	SRC Ni,Assay mg.L^{-1}
28/08/97	ET-3	A	BZW-T Zone	grab	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	ET-3	A	50	cut	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	A	2 w	cut	mus	0-25	NM	NM	NM	NM			NM	NM
09/06/93	ET-3	A	SP-2	cut	mus	75	NM	NM	NM	NM	0.4	6387	0.213	0.02
24/08/97	ET-3	A	150	grab	algae	surface	ND	ND	ND	ND			ND	ND
24/08/97	ET-3	A	150	grab	sed	top20	NM	NM	NM	NM			NM	NM
09/06/93	ET-3	A	SP-2	cut	mus	180	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	A	50	Cut	mus	25-50	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	A	200	Cut	mus	2550	NM	NM	NM	NM			NM	NM
31/08/97	ET-3	A	50	Cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	ET3	A	200	Cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	A	50	Cut	mus	75-100	NM	NM	NM	NM			NM	NM
31/08/97	ET-3	A	2 w	cut	mus	75-100	NM	NM	NM	NM			NM	NM
09/06/93	BT-3	E	SP-3	cut	mur	20	NM	NM	NM	NM	< 0.05	6388	<0.002	<0.01
31/08/97	ET-3	E	500	cut	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	ET3	E	SP-3 DH	cut	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	ET-3	B	500	cut	mus	25-50	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	B	SP3 DH	cut	mus	25-50	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	E	500	cut	mus	50-75	5.62	24	30	207			NM	NM
31/08/97	ET3	E	SP-3 DH	cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	BT-3	E	500	cut	mus	75-100	NM	NM	NM	NM			NM	NM
31/08/97	ET3	E	SP3 DH	Cut	mus	75-100	NM	NM	NM	NM			NM	NM
09/06/93	ET3	E	SP-3	Cut	mus	80	NM	NM	NM	NM			NM	NM
09/06/93	BT-4	A	SP-1	cut	mus	105	NM	NM	NM	NM			NM	NM
09/06/93	ET4	A	SP-4	cut	mus	50	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	200	Cut	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	400	Cut	mus	0-25	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	6,9,3 DH	cut	mus	025	NM	NM	NM	NM			NM	NM
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10								
31/08/97	BT-4	A	2 w	cut	mus	2550	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	4 w	cut	mus	25-50	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	6,9,3 DH	cut	mus	25-50	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	200	Cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	BT-4	A	400	cut	mu8	50-75	NM	NM	NM	NM			NM	NM
31/08/97	BT-4	A	6.9.3. DH	Cut	mus	50-75	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	200	cut	mus	75-100	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	4 w	Cut	mus	75-100	NM	NM	NM	NM			NM	NM
31/08/97	ET4	A	6,9,3 DH	Cut	mua	7590	NM	NM	NM	NM			NM	NM
09/06/93	BT-4	A	SP-1	Cut	mus	140	NM	NM	NM	NM			NM	NM
09/08/93	BT-4	A	SP-1	Cut	mus	165	NM	NM	NM	NM			NM	NM
09/06/93	ET4	A	SP-4	cut	mus	105	NM	NM	NM	NM			NM	NM

Table 5: B-Zone Area Muskeg and Sediment Sample Data - Excess Pore Water (continuation)

							EXCESS PORE WATER							
Sampled Date	Area		Location	Sampl Typ	Local ubstrat	Sample Depth (cm)	pH	Cond us.cm^{-1}	'Temp °C	Em mV	Merck Aa mg.L^{-1}	Assay No.	SRC As, Assay mg.L^{-1}	SRC Ni,Assay mg.L^{-1}
09/06/93	LAKE1	A	SP-9	cut	mus	65	NM	NM	NM	NM			NM	NM
09/06/93	LAKE1	A	SP-9	cut	muskeg	90	5.13	NM	NM	NM			NM	NM
19/06/92	LAKE 1	E	Stn100	core	mus	0-20	NM	NM	NM	NM			NM	NM
19/06/92	LAKE1	B	centre	dredge	sed	top 20	6.32	NM	NM	NM			NM	NM
19/06/92	LAKE 1	E	Stn100	core	mus	20-40	NM	NM	NM	NM			NM	NM
19/06/92	LAKE1	B	Stn100	core	mus	40-60	NM	NM	NM	NM			NM	NM
19/06/92	LAKE1	B	Stn100	core	mus	60-80	NM	NM	NM	NM			NM	NM

Table 6a: 8-Zone Area Muskeg and Sediment Sample Data -Elemental Analyses

Sampled				Sample	Local	Sample Depth	Element (ug/g, dw)												
Date	Area		Location	Type	Substrate	(cm)	Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K
19/06/92	BT-1	A	Stn200	dredge	sed	top20	0.5	18300	390	17	110	4.5	3600	4.5	12	30	23	16400	41W
25/08/97	BT-1	A	100	dredge	sed	top20	4.5	24100	350	22	110	0.9	3600	4.5	11	26	20	18300	5100
25/08/97	BT-1	A	150	dredge	sed	top20	4.5	25100	430	22	91	0.8	3400	4.5	10	23	18	18800	4700
25/08/97	BT-1	A	205	dredge	sed	top20	4.5	20900	420	23	91	0.8	2800	0.5	9.7	22	17	16100	4100
25/08/97	BT-1	A	240	dredge	red	top20	0.5	141W	210	14	89	0.6	4400	4.5	7	15	13	12600	2800
20/06/92	BT-1	B	Stn 300	core	mus	0-25	4.5	5200	54	19	33	4.5	17W	4.5	2.3	7.2	4.7	4900	2000
20/06/92	ET-1	B	Stn 300	core	mus	2550	4.5	1400	5.8	8	23	4.5	1300	-0.5	1.2	2.1	2.7	1500	320
09/06/93	BT-1	C	SP-7	cut	mus	60	-0.5	1800	14	13	28	4.5	2500	4.5	1	2.1	2.7	1600	690
09/06/93	BT-1	C	SP-7	cut	mus	150	4.5	720	1.7	8	25	4.5	4100	0.5	-0.5	0.7	1.3	12W	170
09/06/93	BT-1	D	SP-6	Cut	mus	115	0.5	4900	1.2	6	64	-0.5	3000	0.5	2.4	6	6.7	4400	490
09/06/93	ET-1	E	SP-8	Cut	mus	95	4.5	510	2.1	12	23	0.5	3100	0.5	4.5	1.1	1.5	1200	100
09/06/93	BT-1	E	SP-8	Cut	mus	150	4.5	910	3.8	17	26	4.5	3100	0.5	4.5	0.9	1.5	1300	250
09/06/93	BT-1	F	LOCI	Cut	mus	40	0.5	2300	1.9	12	39	4.5	1700	0.5	0.8	5.4	4.4	1900	170
31/08/97	BT-1	F	North	Cut	mus	0-25			57									2700	
09/06/93	BT-1	F	LOCI	cut	mus	60	4.5	6800	0.5	2	39	4.5	870	-0.5	0.9	13	6.5	880	220
09/06/93	BT-1	F	LOCI	cut	mus	120	-0.5	6000	0.5	2	15	4.5	850	-0.5	2.6	9.7	3.3	4400	660
31/08/97	BT-1	F	North	Cut	mus	25-50													
31/08/97	BT-1	F	North	cut	mus	50-75													
31/08/97	ET-1	F	North	cut	mus	75-100													
09/06/93	ET-2	A	SP-5	cut	mus	30	4.5	6300	4.6	11	56	4.5	26w	0.5	2.8	5.9	5.8	66w	1600
25/08/97	BT-2	A	250	dredge	sed	top 20	0.5	17600	210	34	88	0.7	37W	4.5	6.2	13	15	6400	4400
25/08/97	BT-2	A	350 S	dredge	sed	top 20	0.5	48900	nD	110	130	1.8	3000	4.5	17	30	42	19900	13200
25/08/97	BT-2	A	N End	dredge	sed	top 20	0.5	6600	90	16	64	-0.5	3400	0.5	4.1	7.2	9.2	3900	15W
09/06/93	ET-2	A	SP-5	cut	mus	120	4.5	370	5.6	12	24	4.5	1600	4.5	-0.5	0.7	1	640	120
31/08/97	ET-2	E	100N	cut	mus	0-25			16									36w	
31/08/97	ET-2	E	4WN	cut	mus	0-25			8.2									1300	
19/06/92	ET-2	B	Stn100	dredge	sed	top 20	4.5	27W	16	8	57	0.5	27W	0.5	1.5	3.9	6.4	1800	640
25/08/97	BT-2	B	100	dredge	red	top 20	-0.5	4500	66	7	71	4.5	3500	4.5	3.9	5.7	7.5	3000	1000
31/08/97	BT-2	B	4WN	cut	mus	25-35													
31/08/97	BT-2	E	1WN	Cut	mus	25-50													
31/08/97	BT-2	E	4WN	cut	mus	35-60													
31/08/97	BT-2	E	100N	cut	mus	50-75													
31/08/97	ET-2	B	4WN	cut	mus	60-100													
31/08/97	BT-2	E	100N	Cut	sed	75-100													

Table 6a: B-Zone Area Muskeg and Sediment Sample Data - Elemental Analyses (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Element (ug/g, dw)												
							Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K
28/08/97	BT-3	A	BZW-T Zone	grab	mus	025			1200									15700	
31/08/97	BT-3	A	50	Cut	mus	025			700									12600	
31/08/97	BT-3	A	200	cut	mus	025			63									3000	
09/06/93	BT-3	A	SP-2	Cut	mus	75	0.5	2200	37	10	42	9.5	6500	0.5	2.1	2.5	4.1	3900	430
24/08/97	BT-3	A	150	grab	algae	surface													
24/08/97	BT-3	A	150	grab	sed	top 20	-0.5	3600	140	14	39	-0.5	3700	-0.5	4	5.6	5.5	2200	910
09/06/93	BT-3	A	SP-2	Cut	mus	180	-0.5	2300	38	11	41	-0.5	5400	-0.5	2.1	1.9	5.4	2800	290
31/08/97	BT-3	A	50	cut	mus	25-50													
31/08/97	BT-3	A	200	Cut	mus	25-50													
31/08/97	BT-3	A	50	cut	mus	50-75													
31/08/97	BT-3	A	200	Cut	mus	50-75													
31/08/97	BT-3	A	50	Cut	mus	75-100			63									3000	
31/08/97	BT-3	A	200	cut	mus	75-100													
09/06/93	BT-3	B	SP-3	Cut	mus	20	-0.5	1700	1.8	9	27	-0.5	3600	0.5	1.1	1.9	5.1	2000	270
31/08/97	BT-3	B	MO	cut	mur	025			60									9400	
31/08/97	BT-3	B	SP-3 DH	cut	mus	025			56									3800	
31/08/97	BT-3	B	500	Cut	mus	25-50													
31/08/97	BT-3	B	SP3 DH	Cut	mus	25-50													
31/08/97	BT-3	B	5 w	cut	mus	50-75													
31/08/97	BT-3	B	SP-3 DH	cut	mu6	50-75													
31/08/97	BT-3	B	500	cut	mus	75-100													
31/08/97	BT-3	B	SP3 DH	cut	mus	75-100													
09/06/93	BT-3	B	SP-3	Cut	mus	80	0.5	2800	1.1	14	43	0.5	9700	-0.5	1.3	2.5	7	3100	460
09/06/93	BT-4	A	SP-1	cut	mus	105	-0.5	3600	11	9	63	0.5	5400	-0.5	1.6	2.3	6.4	2800	200
09/06/93	BT-4	A	SP-4	Cut	mus	50	-0.5	31W	14	11	44	0.5	4900	-0.5	1.8	3.5	8.1	5500	320
31/08/97	BT-4	A	200	Cut	mus	025			51									18400	
31/08/97	BT-4	A	400	cut	mus	025			140									38300	
31/08/97	BT-4	A	6.9.3 DH	cut	mus	025			31									106000	
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	010	-0.5	1800	78	70	59	-0.5	4000	5.3	1.3	4.1	-0.5	280000	3 w
31/08/97	BT-4	A	200	Cut	mus	25-50													
31/08/97	BT-4	A	4 w	Cut	mus	25-50													
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	25-50													
31/08/97	BT-4	A	200	Cut	mus	50-75													
31/08/97	BT-4	A	4 w	Cut	mus	5075													
31/08/97	BT-4	A	6.9.3. DH	cut	mus	52–75													
31/08/97	BT-4	A	200	cut	mus	75-100													
31/08/97	BT-4	A	400	Cut	mus	75-100													
31/08/97	BT-4	A	6.9.3 DH	cut	mus	75-90													
09/06/93	BT-4	A	SP-1	Cut	mus	140	-0.5	6100	5	5	37	-0.5	3000	-0.5	2.5	15	72	3900	910
09/06/93	BT-4	A	SP-1	cut	mus	165	-0.5	5000	1	4	22	0.5	2300	0.5	2.9	10	3.1	4000	1100
09/06/93	BT-4	A	SP-4	Cut	mus	105	-0.5	7600	22	5	48	-0.5	3600	-0.5	3.4	17	8.2	7300	1300

Table 6a: B-Zone Area Muskeg and Sediment Sample Data - Elemental Analyses (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K
							Element (ug/g, dw)												
09/06/93	LAKE1	A	SP-9	cut	mus	65	-0.5	3700	88	13	40	-0.5	2100	-0.5	1.9	4.7	5	3400	990
09/06/93	LAKE1	A	SP-9	cut	muskeg	90	-0.5	6300	5	4	56	-0.5	1600	-0.5	1.2	3.2	5.4	2200	290
19/06/92	LAKE1	B	Stn100	core	mus	0-20	-0.5	350	1.7	19	8.8	-0.5	780	2.1	-0.5	1	25	410	520
19/06/92	LAKE1	B	centre	dredge	sed	top 20	-0.5	2000	0.9	8	64	-0.5	4500	-0.5	0.7	11	5	4200	320
19/06/92	LAKE1	B	Stn100	core	mus	20-40	-0.5	550	1.1	22	17	-0.5	1200	-0.5	0.5	0.9	2.5	560	290
19/06/92	LAKE1	B	Stn100	core	mus	40-60	-0.5	1100	0.9	9	38	-0.5	2700	-0.5	-0.5	1.1	1.7	810	270
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	-0.5	680	0.7	9	20	4.5	2000	4.5	-0.5	0.9	3	430	270

Table 6b: B-Zone Area Muskeg and Sediment Sample Data - Elemental Analyses

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Element (ug/g, dw)												
							Mg	Mn	Mo	Na	Ni	P	Pb	S	Sr	Ti	V	Zn	Zr
19/06/92	BT-1	A	Stn200	dredge	sed	top 20	6800	200	30	-40	260	640	21	2100	60	880	55	55	19
25/08/97	ET-I	A	100	dredge	sed	top 20	5600	230	25	4 0	260	550	22		59	920	51	44	35
25/08/97	ET-I	A	150	dredge	sed	top20	4700	200	27	4 0	280	600	23		55	740	47	43	33
25/08/97	BT-I	A	205	dredge	sed	top20	4700	200	24	50	2 M	630	23		50	710	45	43	31
25/08/97	BT-I	A	240	dredge	sad	top20	3400	240	15	100	170	480	15		47	480	29	35	19
20/06/92	BT-I	B	Stn 300	core	mus	0-25	1800	81	9.3	410	24	290	7	900	19	160	12	25	5.8
20/06/92	BT-1	B	Stn 300	core	mus	25-50	320	33	0.5	270	35	410	-1	1100	83	29	3.5	11	1.8
09/06/93	ET-I	C	SP-7	Cut	mus	80	870	92	12	350	19	270	4	790	12	49	3.6	23	23
09/06/93	BT-I	C	SP-7	cut	mus	150	650	35	4.5	110	1.4	230	-1	1100	16	15	0.9	12	1.2
09/06/93	BT-1	D	SP-6	cut	mus	115	580	69	4.5	‘130	4.3	720	3	1900	27	180	11	12	2.6
09/06/93	ET-I	E	SP-8	cut	mus	95	670	28	-0.5	140	1.5	150	-1	570	14	13	0.7	22	-0.5
09/06/93	BT-I	E	SP-8	Cut	mus	150	730	28	4.5	150	2.2	200	-1	600	16	24	1.5	17	1.3
09/06/93	BT-1	F	LOC 1	cut	mus	40	380	20	4.5	90	3.8	830	-1	1400	12	30	2.1	7	0.9
31/08/97	BT-I	F	North	Cut	mus	0-25					54								
09/06/93	ET-I	F	LOC 1	cut	mus	60	130	7.9	4.5	-40	7	13W	2	1600	5.3	180	4.5	8.6	2.3
09/06/93	BT-1	F	LOC 1	cut	mus	120	1200	37	-0.5	-40	3.8	190	2	83	8.1	370	13	10	3.2
31/08/97	BT-1	F	North	cut	mus	25-50													
31/08/97	BT-1	F	North	cut	mus	50-75													
31/08/97	ET-1	F	North	cut	mur	75-100													
09/06/93	BT-2	A	SP-5	cut	mu5	30	13W	92	0.5	180	8	510	2	1000	25	180	10	20	3.7
25/08/97	BT-2	A	250	dredge	sed	top20	3000	140	12	200	220	700	24		52	340	44	44	26
25/08/97	BT-2	A	350 S	dredge	sed	top20	7200	180	35	170	670	910	83		110	780	130	58	49
25/08/97	BT-2	A	N End	dredge	sed	top20	1800	120	13	100	140	MO	12		33	190	20	32	14
09/06/93	ET-2	A	SP-5	cut	mus	120	340	18	-0.5	140	1.9	220	-1	660	9.7	13	0.7	13	-0.5
31/08/97	BT-2	B	100N	cut	mus	0-25					13								
31108197	BT-2	B	400N	cut	mus	0-25					8.1								
19/06/92	BT-2	B	Stn100	dredge	sed	top 20	710	98	1.2	130	16	650	3	2100	18	86	6.5	27	3
25/08/97	BT-2	B	100	dredge	sed	top 20	1200	140	1.4	160	46	750	10		30	160	12	32	9.1
31/08/97	BT-2	B	400N	Cut	mus	25-35													
31/08/97	BT-2	B	100N	Cut	mus	25-50													
31/08/97	BT-2	B	400N	Cut	mus	35-60													
31/08/97	BT-2	B	100N	cut	mus	50-75													
31/08/97	BT-2	B	400N	cut	mus	60-100													
31/08/97	BT-2	B	100N	cut	Sad	75-100													

Table 6b: B-Zone Area Muskeg and Sediment Sample Data - Elemental Analyses (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sr	Ti	V	Zn	Zr
							Element (ug/g, dw)												
28/08/97	BT-3	A	BZW-T Zone	grab	mur	025		160			690								
31/08/97	BT-3	A	350S	Cut	mur	0-25					630								
31/08/97	BT-3	A	200	cut	mus	0-25					39								
09/06/93	BT-3	A	SP-2	cut	mus	75	1800	140	2.4	220	24	450	-1	1900	31	51	4.6	34	1.8
24/08/97	BT-3	A	150	grab	algae	surface													
24/08/97	BT-3	A	150	grab	sed	top 20	1200	81	7.6	170	110	610	13		39	150	9.7	18	7.6
09/06/93	BT-3	A	SP-2	cut	mus	180	1300	130	3.2	200	30	420	-1	2200	25	57	5.6	12	1.8
31/08/97	BT-3	A	50	cut	mus	2550													
31/08/97	BT-3	A	200	cut	mus	25-50													
31/08/97	BT-3	A	50	cut	mus	50-75													
31/08/97	BT-3	A	200	Cut	mus	50-75													
31/08/97	BT-3	A	50	cut	mus	75-100					39								
31/08/97	BT-3	A	200	Cut	mus	75-100													
09/06/93	BT-3	B	SP-3	Cut	mus	20	840	72	0.5	120	3.4	420	3	1800	18	28	3.5	27	1.1
31/08/97	BT-3	B	MO	cut	mus	0-25					16								
31/08/97	BT-3	B	SP-3 DH	cut	mus	025					34								
31/08/97	BT-3	B	MO	Cut	mus	25-50													
31/08/97	BT-3	B	SP3 DH	cut	mur	2550													
31/08/97	BT-3	B	500	Cut	mur	50-75													
31/08/97	BT-3	B	SP-3 DH	Cut	mus	50-75													
31/08/97	BT-3	B	500	Cut	mus	75-100													
31/08/97	BT-3	B	SP3 DH	cut	mus	75-100													
09/06/93	BT-3	B	SP-3	cut	mus	60	1600	100	3.7	150	6.1	260	1	5700	38	55	6.3	28	3.3
09/06/93	BT-4	A	SP-1	cut	mus	105	1000	73	0.5	120	14	500	-1	3000	24	62	6.4	16	0.7
09/06/93	BT-4	A	SP-4	Cut	mus	50	1100	71	1.5	220	12	560	-1	3600	23	78	7.2	7.8	3.2
31/08/97	BT-4	A	200	Cut	mus	025					35								
31/08/97	BT-4	A	400	Cut	mus	025					43								
31/08/97	BT-4	A	6.9.3 DH	cut	mus	025					14								
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	660	110	0.5	260	15	3300	10		25	19	2.9	4.5	9.7
31/08/97	BT-4	A	200	cut	mus	25-50													
31/08/97	BT-4	A	4 w	Cut	mus	25-50													
31/08/97	BT-4	A	6.9.3 DH	Cut	mur	25-50													
31/08/97	BT-4	A	200	Cut	mus	50-75													
31/08/97	BT-4	A	400	Cut	mus	50-75													
31/08/97	BT-4	A	6.9.3. DH	Cut	mus	50-75													
31/08/97	BT-4	A	200	cut	mus	75-1W													
31/08/97	BT-4	A	4 w	Cut	mus	75-100													
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	75-90													
09/06/93	BT-4	A	SP-1	Cut	mus	140	13W	56	2.2	-40	9.2	350	1	1700	19	490	17	17	1.9
09/06/93	BT-4	A	SP-1	cut	mua	165	1600	63	-0.5	-40	52	360	2	180	16	610	12	17	7.1
09/06/93	BT-4	A	SP-4	cut	mus	105	2200	86	0.5	-40	8	430	2	720	25	790	24	17	5.6

Table 6b: B-Zone Area Muskeg and Sediment Sample Data - Elemental Analyses (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sr	Ti	V	Zn	Zr
							Element (ug/g, dw)												
09/06/93	LAKE1	A	SP-9	cut	mus	65	1100	41	1.2	240	26	390	4	1000	19	120	9	18	5
09/06/93	LAKE1	A	SP-9	*cut*	muskeg	90	360	32	-0.5	110	4.9	WO	3	1100	13	140	9.7	11	2.3
19/06/92	LAKE 1	B	Stn100	core	mus	0-20	500	93	-0.5	200	2.7	320	50	550	2.5	12	0.8	200	0.5
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	410	100	1.2	110	8.4	540	2	2500	22	72	5	40	2.2
19/06/92	LAKE 1	B	Stn100	core	mus	20-40	490	38	-0.5	220	1.5	320	6	500	7.8	13	0.7	29	0.7
19/06/92	LAKE 1	B	Stn100	core	mus	40-60	390	36	-0.5	140	1.9	420	-1	980	15	25	0.7	27	-0.5
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	360	26	-0.5	140	1.9	210	2	620	10	22	0.7	18	-0.5

Table 7: B-Zone Area Muskeg and Sediment Sample Data -Whole Sample Analyses

							WHOLE SAMPLE ANALYSES								(dw/ww)				
Sampled Date	Area		Location	Sampl Type	Local Substrate	Sample Depth (cm)	Assay No.	Assay As ug.g^{-1}dw	Assay NI ug.g^{-1}dw	Assay Fe ug.g^{-1}dw	Assay S ug.g^{-1}dw	TOC ug.g^{-1}dw	% TOC	Total As g.m^{-3}	Total NI g.m^{-3}	Total Fe g.m^{-3}	Total S g.m^{-3}	Total OC g.m^{-3}	% L.O.I.
19/06/92	BT-1	A	Stn200	dredge	sed	top20	6435	390	260	16400	2100			84.0	56.0	3532.7	452.4		24
25/08/97	BT-I	A	100	dredge	sed	top 20	6728	350	260	18300		190800	19.08	63.1	46.9	3298.3		34389.1	40
25/08/97	BT-1	A	150	dredge	sed	top20	6729	430	280	18800		203800	20.38	75.5	49.1	3299.0		35762.7	46
25/08/97	BT-I	A	205	dredge	sed	top20	6730	420	230	16100		188400	18.64	75.7	41.5	2902.7		33967.2	41
25/08/97	BT-1	A	240	dredge	sed	top20	6731	210	170	12600		305900	30.59	28.4	23.0	1701.0		41296.5	65
20/06/92	BT-I	B	Stn 300	core	mus	0-25	6412	54	24	4900	900			3.8	1.7	348.3	64.0		90
20/06/92	BT-1	B	Stn 300	core	mus	25-50	6413	5.8	3.5	1500	1100			1.1	0.6	277.4	203.4		95
09/06/93	BT-1	C	SP-7	cut	mus	60	6424	14	19	1600	790			1.6	2.2	183.9	90.8		98
09/06/93	BT-1	C	SP-7	cut	mus	150	6418	1.7	1.4	1200	1100			0.26	02	183.9	188.6		98
09/06/93	BT-1	D	SP-6	cut	mus	115	6415	1.2	4.3	4400	1900			0.26	0.9	943.9	407.6		91
09/06/93	BT-1	E	SP-8	cut	mus	95	6417	2.1	1.5	1200	570			0.27	0.2	152.2	72.3		98
09/06/93	BT-1	E	SP-8	cut	mus	150	6429	3.8	2.2	1300	600			0.62	0.4	213.1	98.4		96
09/06/93	BT-1	F	LOC 1	cut	mus	40	6433	1.9	3.8	1900	1400			0.45	0.9	454.1	334.6		96
31/08/97	BT-1	F	North	cut	mus	0-25	6732	57	54	27W				3.4	3.2	161.0			84.03
09/06/93	BT-I	F	LOC 1	Cut	mus	60	6422	0.5	7	880	1600			0.16	2.2	275.6	501.1		90
09/06/93	BT-I	F	LOC 1	Cut	mus	120	6416	0.5	3.8	4400	83			0.05	0.4	479.5	9.0		4
31/08/97	BT-1	F	North	Cut	mus	25-50													
31/08/97	BT-1	F	North	Cut	mus	50-75													
31/08/97	BT-1	F	North	cut	mus	75-100													
09/06/93	BT-2	A	SP-5	Cut	mus	30	6421	4.6	8	6600	1000			0.73	1.3	1046.6	158.6		90
25/08/97	BT-2	A	250	dredge	sed	top 20	6734	210	220	6400		338700	33.87	20.3	21.3	618.7		32741.0	72
25/08/97	BT-2	A	350 S	dredge	sed	top 20	6736	770	670	19900		170400	17.04	123.2	107.2	3184.0		27264.0	38
25/08/97	BT-2	A	N End	dredge	sed	top 20	6738	90	140	3900		359900	35.99	9.6	14.9	416.0		38389.3	80
09/06/93	BT-2	A	SP-5	cut	mus	120	6427	5.6	1.9	640	660			1.2	0.4	141.5	146.0		98
31/08/97	BT-2	B	100N	cut	mus	0-25	6735	16	13	3600				1.3	1.1	295.3			72.75
31/08/97	BT-2	B	4WN	Cut	mus	0-25	6737	8.2	8.1	1300				*0.34*	0.3	54.5			96.18
19/06/92	ET-2	B	Stn100	dredge	sed	top 20	E437	16	16	1800	2100			4.8	4.8	541.5	631.8		93
25/08/97	BT-2	B	100	dredge	sed	top 20	6733	66	46	3000		384100	38.41	6.4	4.4	290.0		37129.7	85
31/08/97	BT-2	B	4WN	Cut	mus	25-35													
31/08/97	BT-2	B	100N	Cut	mus	2550													
31/08/97	BT-2	B	4WN	Cut	mus	35-60													
31/08/97	BT-2	B	100N	Cut	mus	50-75													
31/08/97	BT-2	B	400N	Cut	mus	60-100													
31/08/97	BT-2	B	100N	Cut	sed	75-100													

Table 7: B-Zone Area Muskeg and Sediment Sample Data -Whole Sample Analyses (continuation)

							WHOLE SAMPLE ANALYSES								(dw/ww)				
Sampled Date	Area		Location	Sampl Type	Local ubstrat	Sample Depth (cm)	Assay No.	Assay As ug.g^{-1}dw	Assay Ni ug.g^{-1}dw	Assay Fe ug.g^{-1}dw	Assay S ug.g^{-1}dw	TOC ug.g^{-1}dw	% TOC	Total As g.m^{-3}	Total Ni g.m^{-3}	Total Fe g.m^{-3}	Total S g.m^{-3}	Total OC g.m^{-3}	% L.O.I.
28/08/97	ET-3	A	BZW-T Zone	grab	mus	025	6748	12W	690	15700				372.0	213.9	4867.0			
31/08/97	BT-3	A	50	Cut	mus	0-25	6738	7W	630	12600				78.9	71.0	1420.9			46.017
31/08/97	BT-3	A	200	Cut	mus	025	6740	63	39	3000				4.6	2.8	218.9			89.16
09/06/93	ET-3	A	SP-2	Cut	mus	75	6432	37	24	3900	1900			5.1	3.3	532.3	259.3		94
24/08/97	ET-3	A	150	grab	algae	surface	6588												
24/08/97	BT-3	A	150	grab	sed	top20	6727	140	110	2200		376000	37.6	16.6	13.0	260.3		44493.3	79
09/06/93	BT-3	A	SP-2	cut	mus	180	6428	38	30	28W	2200			4.3	3.4	319.4	251.0		93
31/08/97	BT-3	A	50	Cut	mus	25-50													
31/08/97	BT-3	A	2W	Cut	mus	25-50													
31/08/97	ET-3	A	50	Cut	mus	50-75													
31/08/97	ET-3	A	200	Cut	mus	5075													
31/08/97	BT-3	A	50	cut	mus	75-100		63	39	3000				52	3.2	249.4			89.6
31/08/97	ET-3	A	200	Cut	mus	75-100													
09/06/93	ET-3	E	SP-3	Cut	mus	20	6434	1.8	3.4	2wo	1800			0.3	0.5	305.1	274.6		95
31/08/97	ET-3	E	500	cut	mus	025	6741	60	16	9400				5.1	1.4	799.0			72.95
31/08/97	ET-3	B	SP-3 DH	Cut	mus	0-25	6742	56	34	3800				3.3	2.0	222.1			89.88
31/08/97	ET-3	B	500	Cut	mus	25-50													
31/08/97	BT-3	B	SP3 DH	Cut	mus	25-50													
31/08/97	BT-3	E	500	cut	mus	50-75													
31/08/97	BT-3	E	SP-3 DH	Cut	mus	50-75													
31/08/97	BT-3	E	500	cut	mus	75-100													
31/08/97	BT-3	E	SP3 DH	cut	mus	75-100													
09/06/93	BT-3	E	SP-3	Cut	mus	80	6423	1.1	6.1	31W	5700			0.5	3.0	1542.5	2836.2		93
09/06/93	BT-4	A	SP-1	cut	mus	105	6430	11	14	2800	3000			1.6	2.1	414.5	444.1		86
09/06/93	ET-4	A	SP-4	Cut	mus	50	6414	14	12	5500	3600			2.0	1.7	793.7	519.5		89
31/08/97	BT-4	A	200	Cut	mus	0-25	6743	51	35	18400				4.3	3.0	1569.2			90.29
31/08/97	BT-4	A	4 w	Cut	mus	025	6744	140	43	38300				12.1	3.7	3299.7			84.05
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	0-25	6745	31	14	106000				5.6	2.5	19120.3			58.32
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	6747	78	15	280000									
31/08/97	BT-4	A	200	Cut	mus	25-50													
31/08/97	BT-4	A	4 w	Cut	mus	25-50													
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	25-50													
31/08/97	ET4	A	200	Cut	mus	50-75													
31/08/97	ET4	A	400	cut	mus	50-75													
31/08/97	BT-4	A	6.9.3. DH	Cut	mus	50-75													
31/08/97	ET-4	A	200	cut	mus	75-100													
31/08/97	BT-4	A	4 w	Cut	mus	75-100													
31/08/97	BT-4	A	6.9.3 DH	cut	mus	75-90													
09/06/93	BT-4	A	SP-1	cut	mus	140	6426	5	9.2	3900	17W			2.6	4.8	2037.3	888.0		20
09/06/93	BT-4	A	SP-1	cut	mus	165	6420	1	5.2	4000	180			1.0	5.1	3951.0	177.8		1
09/06/93	BT-4	A	SP-4	Cut	mus	105	6425	2.2	8	7 m	720			1.8	6.4	5838.7	575.9		11

Table 7: B-Zone Area Muskeg and Sediment Sample Data - Whole Sample Analyses (continuation)

							WHOLE SAMPLE ANALYSES													
Sampled Date	Area		Location	Sampl Type	Local ubstrat	Sample Depth (cm)	Assay No.	Assay As ug.g^{-1}dw	Assay Ni ug.g^{-1}dw	*Assay* Fe ug.g^{-1}dw	Assay S ug.g^{-1}dw	TOC ug.g^{-1}dw	% TOC	Total As g.m^{-3}	Total NI g.m^{-3}	Total Fe g.m^{-3}	Total S g.m^{-3}	Total *OC* g.m^{-3}	% L.O.I.
09/06/93	LAKE1	A	SP-9	cut	mus	65	6431	88	26	3400	1000			8.8	2.6	339.5	99.9		93
09/06/93	LAKE 1	A	SP-9	cut	muskeg	90	6419	9	4.9	2200	1100			2.0	1.1	495.2	247.6		95
19/06/92	LAKE1	B	Stn100	core	mus	0-20	6441	1.7	2.7	410	550			0.11	0.2	25.4	34.1		98
19/06/92	LAKE 1	E	centre	dredge	sed	top20	6436	0.9	8.4	4200	2500			0.19	1.8	878.8	523.1		95
19/06/92	LAKE1	B	Stn100	core	mus	20-40	6440	1.1	1.5	560	500			0.06	0.1	31.0	27.7		98
19/06/92	LAKE1	B	Stn100	core	mus	40-60	6439	0.9	1.9	810	980			0.10	0.2	94.0	113.8		98
19/06/92	LAKE1	E	Stn100	core	mus	60-80	6438	0.1	1.9	430	620			0.08	0.2	48.2	69.6		98

Table 8a: Arsenic Mass in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sediments and Pond Water in B-Zone Vicinity.

Area	Zone	Muskeg (data for shallow samples used) Sampling Location	N	Total [As] Min g.m^{-3}	Max g.m^{-3}	Avg g.m^{-3}	Pond Sediment Sampling Location	N	Total [As] Min g.m^{-3}	Max g.m^{-3}	Avg g.m^{-3}	Pond Water Sampling Location	N	Diss. [As] Min g.m^{-3}	Max g.m^{-3}	Avg g.m^{-3}	Surface Area Muskeg Area ha	Pond Sediment Area ha	Tota Area ha	Muskeg Surface 0.25 m T [As] kg	Sediment Surface 0.25 m T [As] kg	Pond Water 0.5 m D [As] kg
BT-1	A	SP6*	1			0.26	Stn 100, 150, 200, 205, 240	5	28	84	65	Stn 200, 205, 250	7	0.02	0.42	0.14	1.6	1.7	3.3	1.0	282	1.2
	B	Stn 300	1			3.8						Stn 300	1			0.019	3.8		3.8	37		
	C	SP7	1			1.6	Stn 240*	1			28	Stn 300	1			0.019	1.4	0.33	1.8	5.7	24	0.032
	D	SP6	1			0.26	Stn 240*	1			28	Stn 400	1			0.069	3.9	0.85	4.7	2.5	60	0.29
	E	SP8	1			0.27	Stn 240*	1			28	Stn 300	1			0.019	12	020	1.4	0.83	14	0.019
	F	LOC1, BT1-N	2	0.45	3.4	1.9	Stn 240*	1			28	Stn 300	1			0.019	3.9	0.45	4.3	19	32	0.043
	SUM		6					6					9				16	3.6	19	66	412	1.6
BT-2	A	SP5	1			0.73	Stn 250, 350, N end	3	9.6	123	51	Stn 250	14	0.01	1.6	0.5912	4.1	3.0	7.1	7.56	383	8.9
	B	Stn 100N, 400	2	0.3436	1.3	0.83	Stn 100	2	4.8	6.4	5.6	Stn 100. 450N	6	0.02	0.16	0.095	17	1.9	19	36	27	0.91
	SUM		a					5					20				21	4.9	26	43	410	9.8
BT-3	A	BTZ-K#1, SP2, Stn 50, Stn 200	4	4.6	372	115	Stn 150	1			17	Stn 50,100	15	0.44	34	7.0	1.6	0.25	1.8	446	10	8.7
	B	SP3, SP3-DH, Stn 500	3	0.27	5.1	2.9						sbl6.9.4, 6.9.44	16	0.002	0.14	0.0321	2.1	0.1	2.2	15		0.02
	SUM		7					1					31				3.5	0.4	4.0	461	10	8.7
BT-4	A	SP1, SP4, Stn 200, Stn 400, Stn 6.9.3DH	5	1.6	12	5.1						Stn 6.9.3	4	0.008	0.086	0.035	3.2	0.1	3.3	42		0.02
LAKE	A	SP9	1			8.8											4.9		4.9	108		
	B	Lake 1 shore	1			0.11	Lake 1 centre	1			0.19	Lake 1	1			0.0005	58	8.3	66	15	3.9	0.02
	SUM		2					I					1				63	8.3	71	124	3.9	0.02
Total SUM			23					13					65				107	39.9	124	735	837	20

* sampling location near, but not in, zone

Table 8b: Nickel Mass in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sediments and Pond Water in B-Zone Vicinity.

Area	Zone	Muskeg (data for shallow samples used) Sampling Location	Muskeg N	Muskeg Total [Ni] Min g.m^{-3}	Muskeg Total [Ni] Max g.m^{-3}	Muskeg Total [Ni] Avg g.m^{-3}	Pond Sediment Sampling Location	Pond Sediment N	Pond Sediment Total [Ni] Min g.m^{-3}	Pond Sediment Total [Ni] Max g.m^{-3}	Pond Sediment Total [Ni] Avg g.m^{-3}	Pond Water Sampling Location	Pond Water N	Pond Water Diss. [Ni] Min g.m^{-3}	Pond Water Diss. [Ni] Max g.m^{-3}	Pond Water Diss. [Ni] Avg g.m^{-3}	Surface Area Muskeg Area ha	Surface Area Pond Sediment Area ha	Surface Area Total Area ha	Muskeg Surface-0.25 m T [Ni] kg	Sediment Surface-0.25 m T [Ni] kg	Pond Water 0.5 m D [Ni] kg
BT-1	**A**	SP6*	1			0.92	Stn 100, 150, 200, 205, 240	5	23	56	43	Stn 200, 205, 250	7	0.02	0.06	0.04	1.6	1.7	3.3	3.7	187	0.4
	B	Stn 300	1			1.7						Stn 300	1			0.008	3.8		3.8	16		
	C	SP7	1			2.2	Stn 240*	1			23	Stn 300	1			0.008	1.4	0.33	1.8	7.8	19	0.013
	D	SP6	1			0.92	Stn 240*	1			23	Stn 400	1			0.018	3.0	0.85	4.7	9.0	49	0.08
	E	SP8	1			0.19	Stn 240*	1			23	Stn 300	1			0.008	1 2	020	1.4	0.59	11	0.008
	F	LOC1, BT1-N	2	0.91	3.2	2.1	Stn 240*	1			23	Stn 300	1			0.008	3.9	0.45	4.3	20	26	0.018
SUM			6					6					9				16	3.6	19	67	292	0.6
BT-2	**A**	SP5	1			1.27	Stn 250, 350, N end	3	14.9	107	48	Stn 250	14	0.02	0.23	0.0675	4.1	3.0	7.1	13	359	1.0
	B	Stn 100N, 400N	2	0.3395	1.1	0.70	Stn 100	2	4.4	4.8	4.6	Stn 100, 450N	6	0.002	0.026	0.013	17	1.9	19	30	22	0.13
SUM			3					5					20				21	4.9	26	44	381	1.1
BT-3	**A**	**BTZ-K#1,SP2,** Stn 50, Stn 200	4	2.8	214	73	Stn 150	1			13	Stn 50,100	15	0.84	76	172	1.6	0.25	1.8	282	8	21.5
	B	SP3, SP3-DH, Stn 500	3	0.52	2.0	1.3						Stn 6.9.4, 6.9.44	15	0.003	0.34	0.03593	2.1	0.1	2.2	6.7		0.02
SUM			7					1					a0				5.6	0.4	4.0	289	8	21.6
BT-4	**A**	SP1,SP4, Stn 200, Stn 400, Stn 6.9.3DH	5	1.7	4	2.6						Stn 6.9.3	4	0.007	0.057	0.0215	3.2	0.1	3.3	21		0.01
LAKE	**A**	SP9	1			2.6											4.9		4.9	32		
	B	Lake 1 shore	1			0.17	Lake 1 centre	1			1.76	Lake 1	1			0.0020	58	8.3	66	24	36	0.08
SUM			2					1					1				63	8.3	71	56	36.4	0.08
Total SUM			23					13					64				107	39.9	124	467	718	23

* sampling location near, but not in, zone

Table 8c: Iron Mass in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sediments and Pond Water in B-Zone Vicinity.

Area	Zone	Muskeg (data for shallow samples used) Sampling Location	Muskeg N	Muskeg Total [Fe] Min g.m^{-3}	Muskeg Total [Fe] Max g.m^{-3}	Muskeg Total [Fe] Avg g.m^{-3}	Pond Sediment Sampling Location	Pond Sediment N	Pond Sediment Total [Fe] Min g.m^{-3}	Pond Sediment Total [Fe] Max g.m^{-3}	Pond Sediment Total [Fe] Avg g.m^{-3}	Pond Water Sampling Location	Pond Water N	Pond Water Diss. [Fe] Min g.m^{-3}	Pond Water Diss. [Fe] Max g.m^{-3}	Pond Water Diss. [Fe] Avg g.m^{-3}	Surface Area Muskeg Area ha	Surface Area Pond Sediment Area ha	Surface Area Total Area ha	Muskeg Surface-0.25 m T [Fe] kg	Sediment Surface-0.25 m T [Fe] kg	Pond Water 0.5 m D [Fe] kg
BT-1	A	SP6*	1			944	Stn 100, 150, 200, 205, 240	5	1701	3533	2947	Stn 200, 205, 250	7	0.10	0.59	0.40	1.6	1.7	3.3	3,824	12,737	3.5
	B	Stn 300	1			348						Stn 300	1			0.82	3.8		3.8	3,348		
	C	SP7	1			184	Stn 240*	1			1701	Stn 300	1			0.82	1.4	0.33	1.8	654	1.411	1.4
	D	SP6	1			944	Stn 240*	1			1701	Stn 400	1			0.15	3.9	0.85	4.7	9.174	3.628	0.64
	E	SP8	1			152	Stn 240*	1			1701	Stn 300	1			0.82	1.2	020	1.4	473	849	0.82
	F	LOC1, BT1-N	2	161	454	308	Stn 240*	1			1701	Stn 300	1			0.82	3.9	0.45	4.3	2,967	1,921	1.9
	SUM		6					6					9				16	3.6	19	20,439	20,545	8.2
BT-2	A	SP5	1			1047	Stn 250, 350, Nsnd	3	416	3184	1406	Stn 250	14	0.10	0.44	0.22	4.1	3.0	7.1	10.846	10.558	3.4
	B	Stn 100N, 400N	2	54	295	175	Stn 100	2	290	542	416	Stn 100, 450N	6	0.15	1.8	0.45	17	1.9	19	7,580	1.978	4.3
	SUM		3					6					20				21	4.9	26	18428	12536	7.6
BT-3	A	BTZ-K#1,SP2, Stn 50, Stn 200	4	219	4867	1760	Stn 150	1			260	Stn 50,100	14	0.04	3.6	1.4	1.6	0.25	1.8	6.819	163	1.8
	B	SP3, SP3-DH, Stn 500	3	222	799	442						Stn 6.9.4, 6.9.44	17	0.31	2.3	1.0	2.1	0.1	2.2	2,290		0.52
	SUM		7					1					31				3.6	0.4	4.0	9109	163	2.3
BT-4	A	SP1,SP4, Stn 200, Stn 400, Stn 6.9.3DH	5	414	19120	5039						Stn 6.9.3	5	0.10	47	14	3.2	0.1	3.3	40,939		7.1
LAKE	A	SP9	1			340											4.9		4.9	4.181		
	B	Lake 1 shore	1			25	Lake 1 centre	1			879	Lake 1	1			0.31	58	8.3	66	3,695	18,184	13
	SUM		2					1					1				63	8.3	71	7876	18183.7	12.83
Total SUM			23					13					66				107	39.9	124	96,790	51,428	38

* sampling location near, but not in, zone

Table 8d: Sulphur Mass in BT-1, BT-2, BT-3, BT 4 and Lake 1 Muskeg, Sediments and Pond Water in B-Zone Vicinity.

Area	Zone	Muskeg (data for shallow samples used)					Pond Sediment					Pond Water					Surface Area			Muskeg	Sediment	Pond
		Sampling Location	N	Total [S] Min g.m^{-3}	Total [S] Max g.m^{-3}	Total [S] Avg g.m^{-3}	Sampling Location	N	Total [S] Min g.m^{-3}	Total [S] Max g.m^{-3}	Total [S] Avg g.m^{-3}	Sampling Location	N	Diss. [S] Min g.m^{-3}	Diss. [S] Max g.m^{-3}	Diss. [S] Avg g.m^{-3}	Muskeg Area ha	Pond Sediment Area ha	Total Area ha	Surface-0.25 m T [S] kg	Surface-0.25 m T [S] kg	Water 0.5 m D [S] kg
BT-1	A	SP6*	1			408	Stn 200	1			452	Stn 200, 205, 250	5	1.13	2.3	1.0	1.6	1.7	3.3	1,651	1,955	14
	B	Stn 300	1			64						Stn 400*	1			0.30	3.8		3.8	615		
	C	SP7	1			91	Stn 200*	1			452	Stn 400*	1			0.30	1.4	0.33	1.8	323	375	0.50
	D	SP6	1			408	Stn 200*	1			452	Stn 400	1			0.30	3.9	0.85	4.7	3,961	965	1.3
	E	SP8	1			72	Stn 200*	1			452	Stn 400*	1			0.30	1.2	0.20	1.4	225	226	0.30
	F	LOC1	1			335	Stn 200*	1			452	Stn 400*	1			0.30	3.9	0.45	4.3	3,228	511	0.68
SUM			5					1					6				16	3.6	19	10,003	4,032	16
BT-2	A	SP5	1			1047	Stn 100*	1			632	Stn 250	9	0.03	1.2	0.41	4.1	3.0	7.1	10,846	4,744	6.2
	B	SP5*	1			1047	Stn 100	1			632	Stn 100, 450N	3	0.57	0.93	0.70	17	1.9	19	45,361	3,006	6.7
SUM			2					2					12				21	4.9	26	56,207	7,760	13
BT-3	A	SP2	1			259	SP3 muskeg*	1			275	Stn 50,100	14	11	336.7	108	1.6	0.25	1.8	1,005	172	135
	B	SP3	1			275						Stn 6.9.4, 6.9.44	22	0.07	8.7	1.6	2.1	0.1	2.2	1,422		0.80
SUM			2					1					36				3.6	0.4	4.0	2,427	172	135
BT-4	A	SP1,SP4	2	444	520	482						Stn 6.9.3	3	0.0	19	0.9	3.2	0.1	3.3	1,914		3.6
LAKE 1	A	SP9	1			100											4.9		4.9	1.230		
	B	Lake 1 shore	1			34	Lake 1 centre	1			523	Lake 1	1			< 0.03	58	8.3	66	4,956	10,824	1.4
SUM			2					1					1				63	8.3	71	6,186	10,824	1.4
Total SUM			13					5					58				107	39.9	124	78,738	22,777	169

* sampling location near, but not in zone

Table 8e: LOI Mass in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sediments and Pond Water in B-Zone Vicinity.

		Muskeg (data for shallow samples used)					Pond Sediment					Surface Area			Muskeg	Sediment	Pond
Area	Zone	Sampling Location	N	LOI Min g.m^{-3}	LOI Max g.m^{-3}	LOI Avg g.m^{-3}	Sampling Location	N	LOI Min g.m^{-3}	LOI Max g.m^{-3}	LOI Avg g.m^{-3}	Muskeg Area ha	Pond Sediment Area ha	Total Area ha	Surface 0.25 m LOI t	Surface 0.25 m LOI t	Water 0.5 m LOI t
BT-1	A	SP6*	1			194937	Stn 100, 150, 200, 205, 240	5	51332	87750	73102	1.8	1.7	3.3	790	316	0.0
	B	Stn 300	1			84012						3.0		3.8	615		
	C	SP7	1			112775	Stn 240*	1			87750	1.4	0.33	1.8	401	73	0.000
	D	SP6	1			194997	Stn 240*	1			87750	3.9	0.05	4.7	1895	187	0.00
	E	SP8	1			124188	Stn 240*	1			87750	12	0.20	1.4	386	44	0.000
	F	LOC1, BT1-N	2	50115	229776	139946	Stn 240*	1			87750	3.9	0.45	4.3	1350	99	0.000
	SUM		6					6				16	3.6	19	5438	719	0.0
BT-2	A	SP5	1			143208	Stn 250, 350, N end	3	61232	84896	71867	4.1	3.0	7.1	1485	540	0.0
	B	Stn 100N, 400N	2	40307	59678	49992	Stn 100	2	81751	280491	181121	17	1.9	19	2167	862	0.00
	SUM		3					5				21	4.9	26	3652	1401	0.0
BT-3	A	BTZ-K#1, SP2, Stn 50, Stn 200	3	51954	128376	81907	Stn 150	1			93259	1.6	0.25	1.8	317	58	0.0
	B	SP3, SP3-DH, Stn 500	3	52527	145092	86542						2.1	0.1	2.2	448		0.00
	SUM		6					1				3.6	0.4	4.0	766	58	0.0
BT-4	A	SP1, SP4, Stn 200, Stn 400, Stn 6.9.3DH	5	72412	128569	102055						3.2	0.1	3.3	829		0.00
LAKE 1	A	SP9	1			92641						4.9		4.9	1141		
	B	Lake 1 shore	1			60811	Lake 1 centre	1			197804	58	8.3	66	8831	4093	0.00
	SUM		2					1				63	8.3	71	9972	4093	0.00
Total SUM			22					13				107			20656	6271	0

• sampling location near, but not in, zone.

Table 9a: Shallow Piezorneters Water Quality - Piezorneters SP-1 and SP-2

Location	SP-1				SP-2				
Assay No.	5420	5463	5587	6552	4464	5421	5464	5588	6496
Date	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	24-Aug-97
T (C)	12.5	10.9	11.9	14.4	11.1	12.7	9.7	10.1	16.3
pH	4.86	5.29	4.31	5.56	4.96	4.8	5.43	4.95	5.32
Cond (uS/cm)	38	48	299	123	138	64	161	265	51.8
Em (mV)	-67	28	70		6	-80	9	50	
Eh (mV)	182	278	320	191	256	169	260	301	176
In mg/L Cl	2	5	2		1	2	3	3	
HCO3	5	12	1		2	4	1	1	
SO4	12	1	149	14	36	1	84	118	8.5
NH4,N	1.1		1.8		0.11	0.2		0.26	
TKN,N			10		0.98			3.3	
NO3,N	0.01		0.04		0.04	0.01		0.04	
P	0.08		0.79		0.79	0.09		0.63	
As	0.13	0.053	0.24	0.097	0.082	0.16	0.05	0.11	0.072
Ca	4	3	20		8.1	4	21	18	
Fe	1.9	2.3	6.2	1.6	5	1.6	6.3	7.3	2.1
K	0.9	3.4	7		3.1	2.6	4.9	5.9	
Mg	1	2	16		5.2	1	14	14	
Mn	0.073	0.064	0.5		0.26	0.12	0.81	0.73	
Na	2.9	5.6	13		3.5	2.2	4.7	7.3	
Ni	0.016	0.019	0.042	0.018	0.55	0.22	0.23	0.39	0.095
TDS			280		110			214	
Al			0.27					0.27	

Table 9b: Shallow Piezorneters Water Quality - Piezometers SP-3A and SP-3B

Location	SP-3A					SP-3B				
Assay No.	4465	5422	5465	5589	6497	4466	5423	5466	5590	6498
Date	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	24-Aug-97	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	24-Aug-97
T (C)	13.4	11.6	10.3	11.6	16.5	14.6	10.6	12.4	14.2	16.2
pH	5.78	5.38	5.95	5.8	5.68	5.27	5.25	6.18	6.38	5.04
Cond (uS/cm)	62	70	45	80	81	51	72	28	50	52
Em (mV)	-11	-129	-21	51		46	-61	22	96	
Eh (mV)	238	121	230	301	219	294	190	271	344	372
In mg/L Cl	0.8	2	2	2		0.2	3	3	3	
HCO3	33	27	32	37		17	26	10	20	
SO4	2.9	1	1	1	2.2	0.3	1	1	1	1.8
NH4,N	0.06	0.01		0.11		0.03	0.01		0.06	
TKN,N	0.93			6.4		2			1.2	
NO3,N	0.01	0.01		0.04		0.04	0.01		0.04	
P	0.18	0.02		0.26		0.24	0.32		0.26	
As	0.011	0.02	0.026	0.017	0.024	0.0005	0.0099	0.0086	0.0058	0.051
Ca	5.9	8	8	6		6.8	10	6	4	
Fe	1.4	2.6	3.1	2.9	2.1	1.1	3	1.9	3.7	6.3
K	1.3	1.3	2.6	1.2		0.3	1.4	0.9	0.7	
Mg	3.2	3	4	5		1.8	3	2	2	
Mn	0.12	0.17	0.16	0.14		0.19	0.27	0.13	0.15	
Na	1.4	0.9	1.4	2		0.8	1.9	1.2	1.8	
Ni	0.01	0.011	0.034	0.009	0.004	0.004	0.015	0.009	0.023	0.007
TDS	95			78		121			90	
Al				0.2					0.34	

Table 9c: Shallow Piezometers Water Quality - Piezometers SP-4 and SP-5

Location	SP-4					SP-5					
Assay No.	4467	5424	5467	5591	6553	4468	4469	5425	5468	5592	6554
						Surface	Bottom				
Date	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97	12-Jun-93	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97
T (C)	13.3	14.2	10	11.2		13.4	13	7.6	9	13.6	13.9
pH	5.63	4.92	5.22	5.07		6.28	4.8	5.61	5.14	6.24	5.54
Cond (uS/cm)	155	204	192	433	----	133	75	102	78	142	74.7
Em (mV)	129	-118	140	150	5.31	112	151	-134	46	75	
Eh (mV)	378	130	391	400	271	361	400	118	298	324	351
In mg/L Cl	1.3	3	4	3		1.4	2.2	6	5	13	
HCO3	20	1	1	6		56	33	29	11	43	
SO4	32	65	114	180	110	9.2	13	2	13	31	3.9
NH4,N	2	1.8		1.5		1.4	1.4	2		1.1	
TKN,N	3.3			5.9		3.6	4.4			52	
NO3,N	0.04	0.01		8.4		0.04	0.04	0.01		2.2	
P	0.48	0.45		2.7		0.39	0.39	0.22		1.6	
As	0.29	0.13	0.066	0.76	0.14	0.26	0.24	0.11	0.11	0.66	0.28
Ca	9.6	12	20	32		16	5.2	10	12	7	
Fe	1.3	7.3	2.4	5.5	1.6	0.13	0.46	5	3.1	0.79	8.3
K	4.4	6.5	7.8	7.6		2.8	2.3	3.7	1.6	4.6	
Mg	3.9	8	14	21		2.5	1.4	4	6	6	
Mn	0.37	0.25	0.46	1		0.74	0.1	0.22	0.19	0.077	
Na	5.1	7.3	7.8	12		3.2	13	7.4	1.6	21	
Ni	0.024	0.077	0.028	0.18	0.65	0.024	0.007	0.05	0.015	0.021	0.055
TDS	195			394		150	148			198	
Al				0.28						0.16	

Table 9d: Shallow Piezometers Water Quality - Piezometers SP-6 and SP-7

Location	SP-6					SP-7				
Assay No.	4470	5426	5469	5593	6555	4471	5427	5470	5594	6556
Date	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97
T (C)	11.2	10	10.2	12	13.3	11.7	10.3	9	12.1	13.8
pH	5.49	5.29	5.83	5.21	5.16	4.66	4.6	5.22	3.94	4.45
Cond (uS/cm)	58	69	48	69	55.2	31	33	21	36	44.1
Em (mV)	156	-75	-6	116		198	150	163	173	
Eh (mV)	406	176	245	366	389	448	401	415	423	500
In mg/L Cl	0.3	4	3	2		0.4	2	3	3	
HCO3	14	17	26	9		3	1	1	2	
SO4	0.2	26	2.5	1	2	0.2	1	3	1	1.2
NH4,N	0.43	0.57		0.7		0.5	0.07		0.07	
TKN,N	2.2			3.2		2.1			7	
NO3,N	0.04	0.01		1.5		0.04	<0.01		1.4	
P	0.23	0.14		0.8		0.33	0.04		0.22	
As	0.0037	0.11	0.013	0.028	0.01	0.047	0.034	0.028	0.03	0.058
Ca	6.9	7	6	3		1.5	3	3	1	
Fe	1.7	7.9	13	6.5	9.7	0.39	0.36	0.61	0.55	0.52
K	2.6	2.6	1.7	2		1.1	1.7	1.2	1.3	
Mg	1.4	3	3	2		0.4	<1	2	1	
Mn	0.27	0.28	0.35	0.16		0.021	0.025	0.019	0.019	
Na	1.1	0.8	1	1.3		1.1	1.7	1.8	1.9	
Ni	0.01	0.12	0.015	0.01	0.009	0.008	0.01	0.002	0.005	0.004
TDS	198			99		92			89	
Al				0.76					0.2	

Table 9e: Shallow Piezorneters Water Quality - Piezorneters SP-8 and SP-9

Assay No.	4472	5428	5471	5595	6557	4473	5429	5472	5596	6558
Date	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97	12-Jun-93	26-Jun-94	08-Sep-94	27-Jun-95	30-Aug-97
T (C)	11.7	12.8	10.1	13.8	13.9	14.1	16.5	11.6	11.4	12
pH	5.78	4.64	5.17	4.74	4.95	5.93	4.81	5.33	3.98	4.85
Cond (uS/cm)	41	99	60	44	53.4	98	107	98	184	96
Em (mV)	159	137	39	162		125	103	123	208	
Eh (mV)	409	386	290	410	428	373	350	373	458	277
In mg/L Cl	0.7	15	11	7		10	18	27	36	
HCO3	26	1	1	4		27	10	1	1	
SO4	0.5	9	5	2.5	0.55	2.4	7	6	15	10
NH4,N	0.2	0.15		0.05		0.02	0.01		1.6	
TKN,N	1.4			1.5		1.4			18	
NO3,N	0.04	0.01		0.22		0.04	0.01		1.6	
P	0.35	0.2		0.29		0.26	0.18		2.8	
As	0.051	0.3	0.19	0.13	0.13	0.041	0.55	0.18	0.34	0.33
Ca	7.3	4	4	1		10	6	6	10	
Fe	0.12	1	5.5	2.8	5	0.12	2.6	0.44	1.1	4.5
K	0.9	4.9	2.4	2.8		2.2	4.7	6.9	4.6	
Mg	1.3	2	4	1		2.2	3	5	7	
Mn	0.16	0.1	0.2	0.054		0.2	0.19	0.16	0.26	
Na	1	2.2	1.9	2.3		2.3	2.2	2.7	3.6	
Ni	0.015	0.009	0.009	0.007	0.008	0.006	0.29	0.11	0.26	0.11
TDS	83			36		118			148	
Al				0.16					0.4	

Table 10a: SRC Detection Limits for Solid and Filter Paper Samples

Parameter	Limit	Units
SOLID SAMPLES		
C, organic	0.01	%
C, total	0.01	%
SO_4	10	$\mu g.g^{-1}$
N, NO_2+NO_3	1	$\mu g.g^{-1}$
TKN	1	$\mu g.g^{-1}$
N, total	1	$\mu g.g^{-1}$
As	0.2	$\mu g.g^{-1}$
B	1	$\mu g.g^{-1}$
P	10	$\mu g.g^{-1}$
Ag	0.5	$\mu g.g^{-1}$
Al	2	$\mu g.g^{-1}$
Ba	0.5	$\mu g.g^{-1}$
Be	0.5	$\mu g.g^{-1}$
Ca	1	$\mu g.g^{-1}$
Cd	0.5	$\mu g.g^{-1}$
Co	0.5	$\mu g.g^{-1}$
Cr	0.5	$\mu g.g^{-1}$
Cu	0.5	$\mu g.g^{-1}$
Fe	0.5	$\mu g.g^{-1}$
K	40	$\mu g.g^{-1}$
Mg	2	$\mu g.g^{-1}$
Mn	0.5	$\mu g.g^{-1}$
Mo	0.5	$\mu g.g^{-1}$
Na	40	$\mu g.g^{-1}$
Ni	0.5	$\mu g.g^{-1}$
Pb	1	$\mu g.g^{-1}$
Sr	0.5	$\mu g.g^{-1}$
Ti	0.5	$\mu g.g^{-1}$
V	0.5	$\mu g.g^{-1}$
Zn	0.5	$\mu g.g^{-1}$
Zr	0.5	$\mu g.g^{-1}$
L.O.I.	0.01	%
^{210}Po	0.02	$Bq.g^{-1}$
^{226}Ra	0.02 or 0.05	$Bq.g^{-1}$
U	0.1 or 0.2	$\mu g.g^{-1}$
FILTER PAPER		
As	0.05	µg/paper
Ni	0.05	µg/paper

Table 10b: Detection Limits for Water Samples

Parameter	Limit	Units
Ca	0.1	$mg.L^{-1}$
Cl	0.1	$mg.L^{-1}$
HCO_3	1	$mg.L^{-1}$
K	0.2	$mg.L^{-1}$
Mg	0.1	$mg.L^{-1}$
Na	0.1	$mg.L^{-1}$
SO_4	0.1	$mg.L^{-1}$
Total Alkalinity	1	$mg.L^{-1}$
Total Hardness	1	$mg.L^{-1}$
Organic carbon	0.2	$mg.L^{-1}$
NH_4 as N	0.01	$mg.L^{-1}$
NO_3 as N	0.01	$mg.L^{-1}$
Total Phosphorus	0.01	$mg.L^{-1}$
B	0.001	$mg.L^{-1}$
F	0.01	$mg.L^{-1}$
Hg	0.05	$\mu g.L^{-1}$
Se	0.001	$mg.L^{-1}$
Ag	0.001	$mg.L^{-1}$
Al	0.005	$mg.L^{-1}$
As, dissolved	0.5	$\mu g.L^{-1}$
As, total	0.5	$\mu g.L^{-1}$
Ba	0.001	$mg.L^{-1}$
Be	0.001	$mg.L^{-1}$
Cd	0.001	$mg.L^{-1}$
Co	0.001	$mg.L^{-1}$

Parameter	Limit	Units
Cr	0.001	$mg.L^{-1}$
Cu	0.001	$mg.L^{-1}$
Fe	0.001	$mg.L^{-1}$
Mn	0.001	$mg.L^{-1}$
Mo	0.001	$mg.L^{-1}$
Ni, total	0.001	$mg.L^{-1}$
Ni, dissolved	0.001	$mg.L^{-1}$
Pb	0.002	$mg.L^{-1}$
Si, soluble	0.01	$mg.L^{-1}$
Sr	0.001	$mg.L^{-1}$
Ti	0.001	$mg.L^{-1}$
V	0.001	$mg.L^{-1}$
Zn	0.005	$mg.L^{-1}$
Zr	0.001	$mg.L^{-1}$
TDS	1	$mg.L^{-1}$
TSS	1	$mg.L^{-1}$
Conductivity	1	$\mu S.cm^{-1}$
pH	-	units
^{210}Pb	0.02	$Bq.L^{-1}$
^{210}Po	0.005	$Bq.L^{-1}$
^{226}Ra, dissolved	0.005	$Bq.L^{-1}$
^{226}Ra, total	0.005	$Bq.L^{-1}$
^{230}Th	0.01	$Bq.L^{-1}$
U, dissolved	0.5	$\mu g.L^{-1}$
U, total	0.5	$\mu g.L^{-1}$

Table 11: Toe Seepage, 1992 - 1997 Data

SAMPLE DATE	18-Sep92					24-Aug-97
OPERATOR	Boojum	Boojum	SRC	SRC	Boojum	SRC
SAMPLING LOCATION	WRP-A	WRP-B	WRP-B	WRP-B	WRP-B	WRP-B
				17002	5612	21799
FIELD						
Temp. (C)	4.3	3.2	10.6	13.2	13.1	14.2
pH	4.99	4.69	4.56	4.83	4.73	4.42
Cond. (umhos/cm)	1240	1480	1380	970	1429	1399
Em (mV)	223	206	186	251	290	
Eh (mV)	478	461	437	500	539	511
Flow, *Us*	0.008	0.018	0.051	0.007		
LAB						
pH			4.53	5.09		4.32
Cond. (umhos/cm)						900
Acidity (mg/l)	15	65	34.2	18.6		63.1
In mg/L: Al			0.25		0.35	0.49
As			36.2	11	96	30
Total As					120	
Ba						
Ca			131	108	195	
Dissolved Fe			0.01 7	0.038	0.026	0.045
Total Fe					0.094	
K			30	29	43	
Mg			60	58	88	
Diss. Mn			3	2.6	3.1	
Total Mn						
Na			49	40	30	
Diss. Ni			37	25	90	35
Total Ni					90	
Si			11			
Bq/L Diss Ra 226						3.1
Bq/L Total Ra 226						
Diss U						**0.05**
Total U						
In mg/L: Chloride			2	2	2	
Bicarbonate			1	<1	7	
Sulphate			660	595	995	650
Fl						
Nitrate (as N)			18.18	14.09	14	3.7
Ammonia (as N)				1	0.28	0.57
N, Tot Kjeldhal					1.8	
P, total				2.6	4	12
T.D.S.			1170		1830	
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	18-Sep-92	17-Aug-93	08-Sep-94	18-Sep-92	15-Sep-95	24-Aug-97
OPERATOR	Boojum	SRC	SRC	Boojum	Boojum	SRC
SAMPLING LOCATION	WRP-C	WRP-C	WRP-c	WRP-D	WRP-D	WRP-D
			17003		5786	21804
FIELD						
Temp. (C)	0.8	5.1	6.8	5.4	5.8	8.9
pH	4.72	4.51	4.75	4.25	4.56	4.45
Cond. (umhos/cm)	1470	1380	820	1640	1736	1566
Em (mV)	208	179	249	248	246	
Eh (mV)	465	433	502	502	500	516
Flow, L/s	0.025	0.036	0.006	0.007	0.031	
LAB						
pH		4.44	6.21			4.38
Cond. (umhos/cm)						1200
Acidity (mg/l)	55	33.4	14	65		147.6
In mg/L: Al		0.32				0.9
As		34.4	11		78	75
Total As					79.5	
Ba						
Ca		126	108		170	
Dissolved Fe		0.01	0.01		0.016	0.019
Total Fe					0.45	
K		29	29		30	
Mg		57	58		86	
Diss. Mn		2.8	2.6			
Total Mn						
Na		46	39		29	
Diss. Ni		37	25		96	96
Total Ni					99	
Si		10				
Bq/L Diss Ra 226						5.3
Bq/L Total Ra 226						
Diss U						0.02
Total U						
In mg/L: Chloride		2	2		<1	
Bicarbonate		<1	<1		2	
Sulphate		625	588		916	740
F						
Nitrate (as N)		17.04	13.64		17	7.4
Ammonia (as N)			1		9.7	9.2
N, Tot Kjeldhal						
P, total			5		36	33
T.D.S.		1140			1730	
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE		18-Sep-92	17-Aug-93	26-Jun-94	08-Sep-94	18-Sep-92	26-Jun-94
OPERATOR		Boojum	SRC	SRC	SRC	Boojum	SRC
SAMPLING LOCATION		WRP-E	WRP-E	WRP-E	WRP-E1	WRP-F	WRP-F
					17004		10843
FIELD							
	Temp. (C)	2.3	5.5	6	15.7	1.6	13.3
	pH	4.59	4.3	3.89	3.61	4.09	3.38
	Cond. (umhos/cm)	1920	1950	1211	2280	2280	1868
	Em (mV)	229	174	157	238	225	176
	Eh (mV)	485	428	411	485	481	425
	Flow, L/s	0.050	0.037	0.033		0.017	0.018
L A B							
	pH		4.43	4.79	3.84		4.02
	Cond. (umhos/cm)						
	Acidity (mg/l)	175	118	150.4	652.8	253	586.9
In mg/L:	Al		0.98				
	As		94.4	115	520		410
	Total As						
	Ba						
	Ca		177	196	284		280
	Dissolved Fe		0.098	0.028	0.074		0.05
	Total Fe						
	K		33	32	45		39
	Mg		83	92	147		133
	Diss. Mn		6	6.1	4.8		16
	Total Mn						
	Na		34	31	51		35
	Diss. Ni		103	130	270		400
	Total Ni						
	Si		19				
Bq/L	Diss Ra 226						
Bq/L	Total Ra 226						
	Diss U						
	Total U						
In mg/L:	Chloride		2	1	4		2
	Bicarbonate		<1	<1	<1		<1
	Sulphate		980	1060	1500		1700
	Fl						
	Nitrate (as N)		21.13	1.8	13.18		2.9
	Ammonia (as N)			13	3.67		3.8
	N, Tot Kjeldhal						
	P, total			42	178		111
	T.D.S.		1820				
	T.S.S.						
	Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE OPERATOR SAMPLING LOCATION	24-Aug-97 SRC WRP-F 21802	18-Sep-92 Boojum WRP-G	24-Aug-97 SRC WRPG 21805	18-Sep-92 Boojum WRP-H	18-Sep-92 Boojum WRP-I	17-Aug-93 SRC WRP-I
FIELD						
Temp. (C)	7.6	3.2	13.2	2.1	3.1	11
pH	3.98	4.39	4.4	4.52	5.18	5.09
Cond. (umhoslcm)	3720	2000	1070	1600	718	952
Em (mV)		229		230	208	221
Eh (mV)	544	484	524	486	463	471
Flow, Us		0.012		0.028	0.200	0.025
LAB						
pH	4.11		4.58			5.13
Cond. (umhos/cm)	2180		680			
Acidity (mg/l)	1120	72	28.4	25	10	17.3
In mg/L: Al	4.6		0.29			0.63
As	320		0.025			0.094
Total As						
Ba						
Ca						68
Dissolved Fe	0.18		0.022			0.47
Total Fe						
K						18
Mg						30
Diss. Mn						4.2
Total Mn						
Na						23
Diss. Ni	1060		5.1			3.5
Total Ni						
Si						12
Bq/L Diss Ra 226	6.6		3.6			
Bq/L Total Ra 226						
Diss U	0.218		21.1			
Total U						
In mg/L: Chloride						2
Bicarbonate						<1
Sulphate	3250		400			335
Fl						
Nitrate (as N)	8.5		13			25
Ammonia (as N)	6.1		6.9			
N, Tot Kjeldhal						
P. total	92		0.28			
T.D.S.						638
T.S.S.						
Total Hardness						

Table II: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	26-Jun-94	08-Sep-94	18-Sep-92	18-Aug-93	18-Sep-92	25-Jun-94
OPERATOR	SRC	SRC	Boojum	SRC	Boojum	
SAMPLING LOCATION	WRP-I	WRP-I	WRP-J	WRP-J	WRP-K	WRP-K
	10844	17005				
FIELD						
Temp. (C)	12.7	12.8	14	17.1	3.7	17.6
pH	4.1	4.93	5.56	6	5.13	3.97
Cond. (umhos/cm)	690	795	645	697	676	273
Em (mV)	158	205	154	142	188	174
Eh (mV)	407	454	411	388	443	420
Flow, Us	0.050	0.003	0.233	0.035	0.010	0.003
LAB						
pH	4.63	5.02		6.45		
Cond. (umhos/cm)						
Acidity (mg/l)	124.6	33.1	7	4.7	15	
In mg/L: Al				0.11		
As	0.27	2.7		0.215		
Total As						
Ba						
Ca	67	82		54		
Dissolved Fe	0.018	0.008		0.14		
Total Fe						
K	16	22		11		
Mg	31	40		20		
Diss. Mn	3.5	4.4		3.8		
Total Mn						
Na	16	22		23		
Diss. Ni	3.7	4.7		3.6		
Total Ni						
Si				9.4		
Bq/L Diss Ra 226						
Bq/L Total Ra 226						
Diss U						
Total U						
In mg/L: Chloride	2	2		2		
Bicarbonate	1	2		5		
Sulphate	293	390		219		
Fl						
Nitrate (as N)	20	20.45		27.27		
Ammonia (as N)	5.6	6.75				
N, Tot Kjeldhal						
P, total	0.08	0.62				
T.D.S.				476		
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	18-Sep-92	08-Sep-94	08-Sep-94	24-Aug-97	18-Sep-92	18-Aug-93
OPERATOR	Boojum	SRC	SRC	SRC	Boojum	SRC
SAMPLING LOCATION	WRP-L	WRP-L	WRP-L1	WRP-L1	WRP-M	WRP-M
		17006	17007	6512		
FIELD						
Temp. (C)	5.1	9.4	9.3	14.5	3.1	10.6
pH	4.57	5.01	5.4	4.65	5.65	5.54
Cond. (umhos/cm)	311	920	805	1440	1340	1376
Em (mV)	260	173	144		195	111
Eh (mV)	514	424	395	515	450	362
Flow, L/s	0.023	0.007	0.007		0.067	0.035
LAB						
pH		5.97	6.21	4.58		5.7
Cond. (umhos/cm)				800		
Acidity (mg/l)	10	20.6	14	46.9	20	29
In mg/L: Al				0.51		0.4
As		13	5	21		25
Total As						
Ba						
Ca		155	124			132
Dissolved Fe		0.006	0.001	0.11		0.11
Total Fe						
K		24	22			20
Mg		56	43			47
Diss. Mn		5.7	5.3			4.2
Total Mn						
Na		21	20			21
Diss. Ni		54	46	48		46
Total Ni						
Si						14
Bq/L Diss Ra 226				1.2		
Bq/L Total Ra 226						
Diss U				0.028		
Total U						
In mg/L: Chloride		3	2			2
Bicarbonate		5	6			4
Sulphate		652	493	550		530
Fl						
Nitrate (as N)		41.82	40.45	38		51.36
Ammonia (as N)		8.25	6.17	12		
N, Tot Kjeldhal						
P. total		6.3	2.4	3.8		
T.D.S.						1080
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	25-Jun-94	18-Sep-92	19-Aug-93	26-Jun-94	08-Sep-94	27-Jun-95
OPERATOR		Boojum	SRC	SRC	SRC	Boojum
SAMPLING LOCATION	WRP-M	WRP-N	WRP-N	WRP-N	WRP-N	WRP-N
				10845	17008	5609
FIELD						
Temp. (C)	15.8	3.5	15.9	16.7	11.2	15.6
pH	3.79	4.07	4.02	3.84	3.87	4.01
Cond. (umhos/cm)	653	1559	1625	1005	1060	936
Em (mV)	156	211	222	142	254	312
Eh (mV)	403	466	469	388	504	559
Flow, L/s	0.003	0.067	0.027	0.009	0.007	0.003
LAB						
pH			4.12	4.91	4.16	
Cond. (umhos/cm)						
Acidity (mg/l)		170	144.1	34	131.2	
In mg/L: Al			1.7			0.69
AS			116	25	97	9.2
Total As						9.6
Ba						
Ca			140	118	162	105
Dissolved Fe			0.31	0.14	0.056	0.078
Total Fe						0.52
K			23	12	26	13
Mg			59	44	66	38
Diss. Mn			5.5	4.7	5.9	4.2
Total Mn						
Na			25	14	26	15
Diss. Ni			103	46	110	32
Total Ni						32
Si			22			
Bq/L Diss Ra 226						
Bq/L Total Ra 226						
Diss U						
Total U						
In mg/L: Chloride			2	2	4	2
Bicarbonate			<1	<1	<1	1
Sulphate			650	489	780	448
Fl						
Nitrate (as N)			40.22	19	40.45	62
Ammonia (as N)				4	10.00	2.7
N, Tot Kjeldhal						3.5
P, total				7.3	34	5
T.D.S.			1480			808
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	24-Aug-97	19-Aug-93	26-Jun-94	08-Sep-94	31-Aug-96	24-Aug-97
OPERATOR	SRC	SRC	SRC	SRC	SRC	SRC
SAMPLING LOCATION	WRP-N	WRP-N1	WRP-N1	WRP-N1	WRP-N1	WRP-N1/N2
	6511		10846	17009		21803
FIELD						
Temp. (C)	15.3	3.6	10.8	6.8	12.5	
pH	4.12	5.22	3.57	5.05	4.75	4.5
Cond. (umhos/cm)	950	1165	1005	630	690	840
Em (mV)		201	142	223	266	
Eh (mV)	553	456	392	476	515	528
Flow, L/s		0.120		0.041	0.027	
LAB						
pH	4.07	5.44	4.26	5.42		4.76
Cond. (umhoslcm)	280					480
Acidity (mg/l)	40.4	18.7	173.9	50.9		20.2
In mg/L: Al	1.1	0.3			0.61	0.52
As	1.8	6.24	130	5.8	0.14	0.022
Total As					0.18	
Ba					0.017	
Ca		103	122	93	95	
Dissolved Fe	0.082	0.043	0.12	0.001	0.017	0.018
Total Fe					0.25	
K		20	16	21	19	
Mg		49	57	50	36	
Diss. Mn		5.6	4.6	4.4	7.7	
Total Mn						
Na		23	17	19	11	
Diss. Ni	22	18	120	17	8.5	6.1
Total Ni					8.6	
Si		11				
Bq/L Diss Ra 226	2.4					2.9
Bq/L Total Ra 226						
Diss U	1.02					6.2
Total U						
In mg/L: Chloride		2	2	3	2	
Bicarbonate		5	<1	3	4	
Sulphate	410	432	575	413	400	320
Fl					0.28	
Nitrate (as N)	5.3	37.27	7.3	32.05	27.73	19
Ammonia (as N)	3.1		3.4	4.33	9.2	8
N, Tot Kjeldhal						
P, total	0.9		45	3.4	0.1	0.46
T.D.S.		856				
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	19-Aug-93	26-Jun-94	18-Sep-92	17-Aug-93	26-Jun-94	18-Sep-92
OPERATOR	SRC	SRC	Boojum	SRC	SRC	Boojum
SAMPLING LOCATION	WRP-N2	WRP-N2	WRP-0	WRP-0	WRP-0	WRP-P
		10847			10848	
FIELD						
Temp. (C)	5.3	17.6	0.7	9	18.1	4.2
pH	4.71	3.38	4.18	3.89	3.55	2.49
Cond. (umhos/cm)	1885	1258	1382	1770	1682	4550
Em (mV)	263	181	261	187	172	413
Eh (mV)	517	427	518	439	418	668
Flow, Us	0.110		0.250	0.092	0.029	0.167
LAB						
pH	4.93	4.29		4.21	4.28	
Cond. (umhos/cm)						
Acidity (mg/l)	24.6	37.1	60	75.3	126.8	918
In mg/L: Al	0.72			2.4		56
As	11.8	12		54.3	68	16.4
Total As						41.2
Ba						
Ca	195	131		175	195	280
Dissolved Fe	0.014	0.05		0.18	0.019	63
Total Fe						85
K	28	22		30	27	50
Mg	94	62		90	84	210
Diss. Mn	9.4	4.3		7.4	11	13
Total Mn						
Na	24	28		33	26	24
Diss. Ni	51	56		75	120	310
Total Ni						320
Si	16			20		
Bq/L Diss Ra 226						0.25
Bq/L Total Ra 226						5
Diss U						27
Total U						27.6
In mg/L: Chloride	3	2		4	3	3
Bicarbonate	<1	<1		<1	<1	NIL
Sulphate	860	680		865	1020	2390
Fl						
Nitrate (as N)	44.31	2.6		18.18	3.8	44.32
Ammonia (as N)		5			3.4	16
N, Tot Kjeldhal						16
P, total		8.8			24	1.2
T.D.S.	1600			1590		
T.S.S.						120
Total Hardness						

Table 11 : Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	17-Aug-93	26-Jun-94	08-Sep94	27-Jun-95	31-Aug-96	24-Aug-97
OPERATOR	**SRC**	SRC	**SRC**	Boojum	**SRC**	**SRC**
SAMPLING LOCATION	WRP-P	WRP-P	WRP-P	WRP-P	WRP-P	WRP-P
		10849	17010	5613		21797
FIELD						
Temp. (C)	14.5	20.3	13.2	16.4	15	13.9
pH	2.68	1.94	2.19	2.08	2.5	2.51
Cond. (umhos/cm)	3150	4510	3300	4060	3230	4300
Em (mV)	325	454	419	492	498	
Eh (mV)	573	698	668	739	746	735
Flow. ***Us***	0.045	0.030	0.004	0.0007	0.004	
LAB						
pH	2.76	2.65	2.58			2.67
Cond. (umhos/cm)						2110
Acidity (mg/l)	375.9	1722.9	1079.9			1457.8
In mg/L: Al	**26**			62	81	71
As	95.7	16	17	4.6	13.1	11
Total As				6.5	13.4	
Ba					**0.006**	
Ca	197	292	262	273	245	
Dissolved Fe	3.1	220	**120**	40	220	110
Total Fe				41	230	
K	38	56	50	51	43	
Mg	118	253	204	191	193	
Diss. Mn	8.6	18	13	19	12	
Total Mn						
Na	20	**22**	20	15	16	
Diss. Ni	236	390	330	470	310	280
Total Ni				470	320	
Si	30					
Bq/L Diss Ra 226						**5.4**
Bq/L Total Ra 226						
Diss U						1.54
Total U						
In mg/L: Chloride	3	3	4	2	3	
Bicarbonate	<1	<1	<1	<1	<1	
Sulphate	1560	3590	2810	2740	3010	2530
Fl					0.18	
Nitrate (as N)	24.09	1.2	24.77	44	16.82	15
Ammonia (as N)		16	10.83	14	17	16
N, Tot Kjeldhal				14		
P, total		7.6	3.9	1.7	5.5	2.2
T.D.S.	2700			4290		
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	08-Sep-94	27Jun-95	19-Aug-93	27Jun-95	24-Aug-97	24-Aug-97
OPERATOR	*SRC*	Boojum	SRC	Boojum	SRC	**SRC**
SAMPLING LOCATION	WRP-R	WRP-R	WRT-1	WRP-T	WRP-U	WRP Kill Z2
	17011	5610		5611	21812	21806
FIELD						
Temp. (C)	10.4	12.7	16.9	14.3	10.7	14.3
pH	4.03	3.98	4.27	3.75	4.44	5.7
Cond. (umhoslcm)	1310	1744	595	1783	891	87
Em (mV)	305	347	235	375		
Eh (mV)	556	596	481	623	1394	340
Flow, Us	0.146	0.096		0.013		
L. A B						
pH	4.39		4.19		4.73	5.03
Cond. (umhos/cm)					282	48
Acidity (mg/l)	139.5		14.4		44.4	44.2
In mg/L: Al		1.3	0.33	3	0.49	0.36
As	55	19	5.05	10	26	2.6
Total As		19		10		
Ba						
Ca	209	213	43	212		
Dissolved Fe	0.27	0.002	0.056	0.017	0.086	4.8
Total Fe		0.57		14		
K	32	31	12	30		
Mg	95	91	19	87		
Diss. Mn	8.9	8.2	1.7	8.6		
Total Mn						
Na	32	30	12	30		
Diss. Ni	100	65	12	62	37	0.53
Total Ni		65		62		
Si			5.2			
Bq/L Diss Ra 226					2.2	0.3
Bq/L Total Ra 226						
Diss U					0.128	0.06
Total U						
In mg/L: Chloride	4	5	1	5		
Bicarbonate	<1	<1	<1	<1		
Sulphate	1110	995	236	995	380	5.9
Fl						
Nitrate (as N)	20.91	130	12.04	130	14	-0.01
Ammonia (as N)	3.50	2.9		2.2	4	0.64
N, Tot Kjeldhal		3.4		2.9		
P, total	16	9.6		5.2	12	3.2
T.D.S.		1770	416	1800		
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	18-Sep-92	17-Aug-93	25-Jun-94	08-Sep-94	27-Jun-95	11-May-92
OPERATOR	Boojum	SRC	SRC	SRC	Boojum	Cameco
SAMPLING LOCATION	STN 16	STN 16	STN 16	STN 16	Stn. 16	BZWR-1
			10841	17001	5601	
FIELD						
Temp. (C)	4.1	14.4	12.7	13.7	11.8	2.5
pH	4.89	4.3	3.42	4.14	3.07	4.5
Cond. (umhos/cm)	2140	2510	965	1220	1026	592
Em (mV)	225	214	206	227	283	
Eh (mV)	480	462	455	475	533	
Flow, *Us*	0.008	0.007	0.004		0.005	
LAB						
pH		4.71	4.05	4.06		4.57
Cond. (umhos/cm)						
Acidity (mg/l)	45	33	53.4	108		
In mg/L: Al		1.6			0.78	
As		105	25	4.6	9.2	12.4
Total As					9.8	14
Ba						
Ca		290	128	252	121	
Dissolved Fe		<0.001	0.064	0.057	0.017	
Total Fe					0.16	
K		36	22	32	23	
Mg		147	47	91	48	
Diss. Mn		17	5.2	10	5.5	
Total Mn						
Na		70	20	40	18	
Diss. Ni		138	58	88	51	13
Total Ni					52	15
Si		18				
Bq/L Diss Ra 226						6.5
Bq/L Total Ra 226						8
Diss U						0.376
Total U						0.725
In mg/L: Chloride		7	2	5	2	
Bicarbonate		<1	<1	<1	<1	
Sulphate		1500	620	1220	645	341
Fl						
Nitrate (as N)		20	0.87	8.41	5.3	
Ammonia (as N)			0.5	0.62	0.37	
N, Tot Kjeldhal					0.53	
P, total			7.6	2.6	5.5	
T.D.S.		2490			1050	622
T.S.S.						
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	11-Aug-92	10-May-93	03-Aug-93	28-Aug-93	13-Jun-94	26-Jun-94
OPERATOR	Cameco	Cameco	Cameco	Cameco	Cameco	SRC
SAMPLING LOCATION	BZWR-1	BZWR-1	BZWR-1	BZWR-1	BZWR-1	BZWR-1 10836
FIELD						
Temp. (C)	3.5	20.6			1.5	6.9
pH	3.9	6.3	4.2		4.1	3.65
Cond. (umhos/cm)	951	646	1630		1389	1425
Em (mV)						166
Eh (mV)						419
Flow, Us						0.067
LAB						
pH	3.74	5.12	4.25	4.08	4.19	4.63
Cond. (umhos/cm)		742	1790	1760	1630	
Acidity (mg/l)						124.6
In mg/L: Al						
As	61.1	0.367	49	58.2	44	5.4
Total As	68.8	0.456	49	59	45	
Ba						
Ca					175	178
Dissolved Fe						0.068
Total Fe					0.87	
K					26	27
Mg					75	82
Diss. Mn						9.2
Total Mn						
Na					27	23
Diss. Ni	61	8.5	72	71	85	100
Total Ni	65	9.8	74	72	85	
Si						
Bq/L Diss Ra 226	6	1.7	7.5	6.5	3.5	
Bq/L Total Ra 226	7.5	2	a	7.5	8	
Diss U	0.073	1.4	0.207	0.174	0.153	
Total U	0.152	1.57	0.198	0.174	0.231	
In mg/L: Chloride					3	3
Bicarbonate					<1	<1
Sulphate	692		925	910	858	905
Fl						
Nitrate (as N)					17	7.3
Ammonia (as N)					2.8	3.1
N, Tot Kjeldhal						
P, total					3.59	0.01
T.D.S.	1380	577	1710	1620	1610	
T.S.S.		42	<1	< 1		
Total Hardness					745	

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	06-Jul-94	26-Jun-94	28-Aug-94	08-Sep94	19-Sep94	26-Oct-94
OPERATOR	Cameco	SRC	Cameco	SRC	Cameco	Cameco
SAMPLING LOCATION	BZWR-1	BZWR-1A	BZWR-1A	BZWR-1A	BZWR-1A	BZWR-1A
		10837		17012		
FIELD						
Temp. (C)	9.1	3.5	4	3.9	2.7	2
pH	4.1	3.57	4.2	4.03	4.1	4.4
Cond. (umhos/cm)	1327	1467	1420	1210	1348	1756
Em (mV)		148		246		
Eh (mV)		403		501		
Flow, Us		0.250	0.1	0.123		
LAB						
pH	4.11	4.51	4.1	4.38	4.15	4.06
Cond. (umhos/cm)	1580		2020		2020	2100
Acidity (mg/l)		151		110.6		
In mg/L: Al						
As	43	63	60	57	54	63
Total As	44		60		58	65
Ba						
Ca	162	[illegible]	216	208	213	233
Dissolved Fe		0.09	0.04	0.08	<0.001	0.02
Total Fe	0.056					
K	24	27	33	33	32	32
Mg	69	83	93	94	97	94
Diss. Mn		11		8.8		
Total Mn						
Na	22	23	35	32	35	32
Diss. Ni	74	120	96	100	97	110
Total Ni	75		110		99	110
Si						
Bq/L Diss Ra 226	5.5		5.5		5	5
Bq/L Total Ra 226	6.5		5.5		5	5.5
Diss U	0.148		0.094		0.09	0.08
Total U	0.191		0.096		0.091	0.081
In mg/L: Chloride	3	3	3	4	4	5
Bicarbonate	<1	<1	<1	<1	<1	<1
Sulphate	782	990	1040	1110	1100	1160
Fl						
Nitrate (as N)	21	6.4	20	20.68	21	28
Ammonia (as N)	2.5	3.4	4.4	3.58	4.1	4.1
N, Tot Kjeldhal						
P, total	6.21	0.01	6.21	5.23	3.59	8.50
T.D.S.	1550		2080		2000	2130
T.S.S.						
Total Hardness	688		921		930	968

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	25-Jun-95	20-Jul-95	03-Aug-95	27-Aug-95	23-Sep-95	08-Oct-95
OPERATOR	Cameco	Cameco	Cameco	Camew	Cameco	Camew
SAMPLING LOCATION	BZWR-1A	BZWR-1A	BZWR-1A	BZWR-1A	BZWR-1A	BZWR-1A
FIELD						
Temp. (C)	3.1			2		3
pH	4.1	4.4		4.2		4
Cond. (umhos/cm)	1526	1450		1080		1718
Em (mV)						
Eh (mV)						
Flow, L/s						
LAB						
pH	4.42	4.44	3.98	4.2	4.1	4.07
Cond. (umhos/cm)	1860	1940	1470	1380	1870	2040
Acidity (mg/l)						
In mg/L: Al						
As	20	22	49	29	40	44.4
Total As	20	25	50	31	41	45.2
Ba						
Ca	211	229	153	139	209	222
Dissolved Fe	0.037	0.1	0.31	0.13	0.016	1.1
Total Fe						
K	28	32	28	24	30	32
Mg	87	92	68	66	88	94
Diss. Mn						
Total Mn						
Na	30	31	22	16	31	34
Diss. Ni	69	76	70	61		94
Total Ni	69	82	71	65	96	98
Si						
Bq/L Diss Ra 226	4	4	4	5	5	5
Bq/L Total Ra 226	4	4.7	4	5	5	5
Diss U	0.038	0.039	0.526	0.43	0.397	0.087
Total U	0.061	0.063	0.57	0.448	0.4	0.271
In mg/L: Chloride	5	5	3	3	4	5
Bicarbonate	<1	<1	<1	<1	<1	<1
Sulphate	1020	1060	745	702	1020	1130
Fl						
Nitrate (as N)	32	38	22	3.2	25	29
Ammonia (as N)	2.9		2.7	21	7.7	4.1
N, Tot Kjeldhal						
P. total	2.75		3.04	2.94	5.23	4.25
T.D.S.	1810	1930	1370	1290	1830	1980
T.S.S.						
Total Hardness	884	949	661	618	883	940

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	31-Aug-96	24-Aug-97	31-May-92	11-Aug-92	18-Sep-92	10-May-93
OPERATOR	Cameco	SRC	Cameco	Cameco	Boojum	Cameco
SAMPLING LOCATION	BZWR-1A	BZWR-1A	BZWR-2	BZWR-2	BZWR-2	BZWR-2
		21794			0.37	
FIELD						
Temp. (C)	4.6	3	4	6	1.1	16.6
pH	4.19	4.08	4.2	4.3	4.72	5.7
Cond. (umhoslcm)	1000	1660	632	1059	1574	602
Em (mV)	261				264	
Eh (mV)	515	557			521	
Flow, L/s	0.270					
LAB						
pH		4.2	4.25	4.62		4.35
Cond. (umhoslcm)		660				663
Acidity (mg/l)		101			40	
In mg/L: Al	1.6	1.9				
As	25.5		23.4	28.6		2.4
Total As	25.3	33	26.4	32.5		2.4
Ba	0.018					
Ca	205					
Dissolved Fe	0.086					
Total Fe	0.019	0.021				
K	30					
Mg	101					
Dss. Mn	8.6					
Total Mn						
Na	23					
Diss. Ni	81		15	44		7.6
Total Ni	a3	76	16	43		8.5
Si						
Bq/L Diss Ra 226			2.5	2.5		2.5
Bq/L Total Ra 226		5.2	7	3.5		6
Diss U			0.6	0.088		1.25
Total U		0.232	1.11	0.377		1.52
In mg/L: Chloride	4					
Bicarbonate	<1					
Sulphate	1040	900	341	715		
Fl	0.47					
Nitrate (as N)	19.32	16.00				
Ammonia (as N)	3.7	3.9				
N, Tot Kjeldhal						
P, total	10	13				
T.D.S.			652	1460		493
T.S.S.						240
Total Hardness						

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	03-Aug-93	17-Aug-93	28-Aug-93	13-Jun-94	26-Jun-94	06-Jul-94
OPERATOR	Cameco	SRC	Cameco	Cameco	SRC	Cameco
SAMPLING LOCATION	BZWR-2	BZWR-2	BZWR-2	BZWR-2	BZWR-2 10838	BZWR-2
FIELD						
Temp. (C)		5.2		3	10.6	10
pH	4.2	4.41		4.6	4.05	4.4
Cond. (umhos/cm)	1100	1700		1405	851	755
Em (mV)		167			166	
Eh (mV)		421			417	
Flow, L/s		0.132			0.005	
LAB						
pH	4.38	4.8	4.67	4.6	5.56	4.36
Cond. (umhos/cm)	1190		1790	1600		889
Acidity (mg/l)		22.2			27.4	
In mg/L: Al		1				
As	2.8	12.2	10.1	10	2.8	1.2
Total As	2.9		10.4	11		1.6
Ba						
Ca		220		183	94	95
Dissolved Fe		0.001		2.3	0.25	
Total Fe						5.7
K		27		23	16	14
Mg		98		72	41	35
Diss. Mn		10			5	
Total Mn						
Na		27		22	12	13
Diss. Ni	19	54	49	44	16	10
Total Ni	21		50	50		11
Si		20				
Bq/L Diss Ra 226	1.6		2.5	4		1.2
Bq/L Total Ra 226	1.7		3	4.5		1.5
Diss U	1.18		0.316	0.319		1.2
Total U	t.2		0.332	0.529		1.72
In mg/L: Chloride		4		3	3	2
Bicarbonate		1	<1	1	<1	<1
Sulphate	108	780	865	755	418	372
F						
Nitrate (as N)		39.31		29	16	16
Ammonia (as N)				6.3	4.1	3.5
N, Tot Kjeldhal						
P, total				0.85	0.16	0.26
T.D.S.	1020	1450	1530	1390		707
T.S.S.	<1		1			
Total Hardness				752		381

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	05-Oct-97	26-Jun-94	31-May-92	11-Aug-92	18-Sep-92	10-May-93
OPERATOR	SRC	SRC	Cameco	Cameco	Boojum	Cameco
SAMPLING LOCATION	BZWR-2	BZWR-2A	BZWR-3	BZWR-3	BZWR-3	BZWR-3
	20275	10839			0.1	
FIELD						
Temp. (C)		9.9	5	14.5	1.7	20
pH		4.05	4.4	3.8	4.09	5.3
Cond. (umhos/cm)		1718	423	492	1010	978
Em (mV)		160			341	
Eh (mV)		411			597	
Flow, Us		0.030				
LAB						
pH	3.95	5.41	4.46	4.19		4.36
Cond. (umhos/cm)	1700					971
Acidity (mg/l)		67.4			27	
In mg/L: Al						
As	33.2	25	0.059	0.204		0.056
Total As	33.7		0.909	0.286		1.02
Ba						
Ca	159	250				
Dissolved Fe		0.004				
Total Fe	0.25					
K	28	29				
Mg	82	96				
Diss. Mn		13				
Total Mn						
Na	20	26				
Diss. Ni	57	94	1.8	6		4.6
Total Ni	57		1.7	6.1		4.9
Si						
Bq/L Diss Ra 226	2.6		0.9	5		0.6
Bq/L Total Ra 226	3		2	5		4
Diss U	1.03		1.11	9.97		0.864
Total U	1.08		1.9	9.98		1.13
In mg/L: Chloride	3	4				
Bicarbonate	<1	2				
Sulphate	768	1120	129	224		
Fl						
Nitrate (as N)	43	9.7				
Ammonia (as N)	9	9.4				
N, Tot Kjeldhal						
P, total	14.00	3.59				
T.D.S.	1540		397	720		734
T.S.S.						1120
Total Hardness	734					

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	13-Jun-94	31-May92	11-Aug-92	18-Sep-92	10-May-93	18-Aug-93
OPERATOR	Cameco	Cameco	Cameco	Boojum	Cameco	SRC
SAMPLING LOCATION	BZWR-3	BZWR-4	BZWR-4	BZWR-4	BZWR-4	BZWR-4
				0.02		
FIELD						
Temp. (C)	5.5	15	12.5	4.4	21.1	11
pH	4.4	4.4	4	4.8	4.5	4.39
Cond. (umhos/cm)	686	338	1108	1825	1264	1562,
Em (mV)				181		132
Eh (mV)				436		382
Flow, ***Us***						0.003
LAB						
pH	4.49	4.37	4.31		4.23	4.54
Cond. **(umhos/cm)**	760				858	
Acidity **(mg/l)**				75		67
In mg/L: Al						1
AS	0.093	20.4	12.2		21	64.6
Total As	0.3	24.9	18.7		35	
Ba						
Ca	66					171
Dissolved Fe						0.57
Total Fe	6.3					
K	15					23
Mg	31					66
Diss. **Mn**						7.2
Total Mn						
Na	**12**					20
Diss. Ni	3.8	19	49		39	96
Total Ni	4.5	18	50		46	
Si						21
Bq/L Diss Ra 226	0.4	0.35	1.7		0.3	
Bq/L Total Ra 226	1.7	0.6	7		20	
Diss U	0.553	0.108	0.059		0.109	
Total U	0.787	0.354	0.331		0.112	
In **mg/L:** Chloride	2					2
Bicarbonate	**<1**					1
Sulphate	231	154	528			628
Fl						
Nitrate (as **N**)	33					44.31
Ammonia (as **N**)	3					
N, Tot Kjeldhal						
P, total	0.05					
T.D.S.	559	327	1160		716	1320
T.S.S.					2300	
Total Hardness	292					

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	28-Aug-93	08-Sep-94	02-Jun-92	11-Aug-92	18-Sep-92	10-May-93
OPERATOR	SRC	SRC	Cameco	Cameco	Boojum	Cameco
SAMPLING LOCATION	BZWR-4	BZWR-4	BZWR-5	BZWR-5	BZWR-5	BZWR-5
					0.1	
FIELD						
Temp. (C)		9.7	5.5	16	2.5	22.6
pH		4.14	4.8	4.5	5.19	5.6
Cond. (umhos/cm)		1020	598	659	865	860,
Em (mV)					185	
Eh (mV)					441	
Flow, Us		0.002				
LAB						
pH	4.21	4.68	4.49	4.96		4.28
Cond. (umhos/cm)						496
Acidity (mg/l)		67.1			15	
In mg/L: Al						
As	57	**50**	0.014	0.106		0.092
Total As	58		0.071	0.172		0.13
Ba						
Ca	144	154				
Dissolved Fe		0.35				
Total Fe	0.78					
K	23	28				
Mg		69				
Diss. Mn		5.9				
Total Mn						
Na	21	20				
Diss. Ni	69	74	4.8	4.5		2.6
Total Ni	73		5	4.5		2.6
Si						
Bq/L Diis Ra 226	3.5		2.5	4		0.9
Bq/L Total Ra 226	6.5		25	6		2
Diss U	0.071		2.11	0.413		0.089
Total U	0.281		2	0.497		0.213
In mg/L: Chloride	3	4				
Bicarbonate	nil	<1	NIL			
Sulphate	585	670	336	244		
Fl						
Nitrate (as N)	**50**	70.00				
Ammonia (as N)	21	20.83				
N, Tot Kjeldhal						
P, total	21	20				
T.D.S.	1420		660	580		362
T.S.S.						110
Total Hardness	589					

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	03-Aug-93	18-Aug-93	28-Aug-93	25-Aug-95	02-Jun-92	11-Aug-92
OPERATOR	Cameco	SRC	Cameco	Cameco	Cameco	Cameco
SAMPLING LOCATION	BZWR-5	BZWR-5	BZWR-5	BZWR-5	BZWR-6	BZWR-6
FIELD						
Temp. (C)		4.4		13	5	12.5
pH	4.6	5.08		5.1	4.2	3.8
Cond. (umhos/cm)	960	1057		550	989	1387
Em (mV)		151				
Eh (mV)		406				
Flow, L/s		0.036				
LAB						
pH	4.76	5.34	4.58	5.12	3.63	3.69
Cond. (umhoslcm)	1020		981	790		
Acidity (mg/l)		11.2				
In mg/L: Al		0.52				
As	0.25	0.278	0.25	0.018	48	102
Total As	0.312		0.27	0.2	60	102
Ba						
Ca		89		66		
Dissolved Fe		0.02		0.09		
Total Fe						
K		21		15		
Mg		38		29		
Diss. Mn		5.3				
Total Mn						
Na		18		13		
Diss. Ni	8.7	10	9.5	7.5	95	94
Total Ni	9.6		9.6	7.6	100	96
Si		16				
BqlL Diss Ra 226	2.5		4.5	4	3	6.5
Bq/L Total Ra 226	2.5		4.5	4	3	6.5
Diss U	0.617		0.946	1	<0.0005	0.236
Total U	0.629		1.02	1.04	0.085	0.211
In mg/L: Chloride		2		2		
Bicarbonate		1	<1	4		
Sulphate	410	398	381	318	704	850
Fl						
Nitrate (as N)		31.13		8.2		
Ammonia (as N)				12		
N, Tot Kjeldhal						
P, total				0.11		
T.D.S.	828	759	706	609	1480	1750
T.S.S.	<1		9			
Total Hardness				284		

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	18-Sep-92	10-May-93	17-Aug-93	28-Aug-93	13-Jun-94	26-Jun-94
OPERATOR	Boojum	Cameco	SRC	Cameco	Cameco	SRC
SAMPLING LOCATION	BZWR-6	BZWR-6	BZWR-6	BZWR-6	BZWR-6	BZWR-6
	0.1					10840
FIELD						
Temp. (C)	4.7	21.6	14.2		5	13.1
pH	3.9	4.6	3.73		4.1	3.64
Cond. (umhos/cm)	2240	1481	2210		1497	1235
Em (mV)	249		192			184
Eh (mV)	503		440			433
Flow, L/s			0.031			0.083
LAB						
pH		4.51	3.8	3.87	4.02	4.39
Cond. (umhos/cm)		1300		1860	1620	
Acidity (mg/l)	303		214.8			267.9
In mg/L: Al			2.2			
As		11.5	179	54.4	180	210
Total As		14.6		55.6	190	
Ba						
Ca			213		158	168
Dissolved Fe			0.085			0.058
Total Fe					0.58	
K			35		28	29
Mg			107		69	78
Diss. Mn			8.6			5.4
Total Mn						
Na			41		28	29
Diss. Ni		46	147	75	130	150
Total Ni		47		85	130	
Si			26			
Bq/L Diss Ra 226		1.9		6	3.5	
Bq/L Total Ra 226		2.5		6	3.5	
Diss U		0.0049		0.497	0.08	
Total U		0.035		0.517	0.127	
In mg/L: Chloride			4		1	1
Bicarbonate			1		<1	<1
Sulphate			1140	935	808	895
Fl						
Nitrate (as N)			24.09		3.4	2.6
Ammonia (as N)					1.9	1.8
N, Tot Kjeldhal						
P, total					23.86	28.10
T.D.S.		1132	2200	1700	1680	
T.S.S.		6		<1		
Total Hardness					678	

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	06-Jul-94	25-Jun-95	20-Jul-95	25-Aug-95	15-Sep-95	24-Aug-97
OPERATOR	Cameco	Cameco	Cameco	Cameco	Boojum	SRC
SAMPLING LOCATION	BZWR-6	BZWR-6	BZWR-6	BZWR-6	BZWR-6	BZWR-6
					5785	21795
FIELD						
Temp. (C)	11.5	14.3		15	8.2	14.4
pH	3	3.7	4.1	3.9	3.91	4.47
Cond. (umhoslcm)	1555	1360	1020	1200	1786	1279
Em (mV)					271	
Eh (mV)					523	521
Flow, L/s					0.013	
LAB						
pH	3.83	4.06	4.04	3.99		4.08
Cond. (umhos/cm)	1830	1480	1240	1740		660
Acidity (mg/l)						123.4
In mg/L: Al						0.78
As	220	74	80	51	121	
Total As	230	75	82	52	125	61
Ba						
Ca	171	146	132	156	172	
Dissolved Fe		0.051	0.62	0.044	0.039	
Total Fe	0.18				0.05	0.019
K	29	32	24	28	29	
Mg	78	69	54	79	80	
Diss. Mn						
Total Mn						
Na	30	24	23	30	31	
Diss. Ni	160	91	79	140	110	
Total Ni	160	93	82	140	120	83
Si						
Bq/L Diss Ra 226	4	4.5	2.5	3.5		
Bq/L Total Ra 226	5	5	3	3.5		2.8
Diss U	0.09	0.083	0.116	0.064		
Total U	0.108	0.104	0.18	0.069		0.048
In mg/L: **Chloride**	1	2	2	2	2	
Bicarbonate	<1	<1	<1	<1	<1	
Sulphate	928	798	668	838	901	680
F						
Nitrate (as N)	4.1	7.2	4.8	4.5	13	3.6
Ammonia (as N)	2.1	1.7	1.2	12	3.4	1.1
N, Tot Kjeldhal						
P. total	28.43	7.52	12.75	35.95	54	26
T.D.S.	2160	1490	1270	1850	1790	
T.S.S.						
Total Hardness	747	648	551	714		

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	05-Oct-97	30-Jun-94	06-Jul-94	28-Aug-94	08-Sep-94	19-Sep-94
OPERATOR	SRC	Cameco	Cameco	Cameco	SRC	Cameco
SAMPLING LOCATION	BZWR-6	BZWR-7	BZWR-7	BZWR-7	BZWR-7	BZWR-7
	20276				17014	
FIELD						
Temp. (C)			9.1	10	10.2	6.5
pH		5.1	4.5	4.8	4.74	4.7
Cond. (umhos/cm)		1569	1763	4620	1260	1379
Em (mV)					253	
Eh (mV)					504	
Flow, L/s				<0.01	0.017	
LAB						
pH	3.88	4.75	4.44	4.57	5.24	4.75
Cond. (umhos/cm)	1690	1650	2140	1910		1880
Acidity (mg/l)					142.4	
In mg/L: Al						
As	220	100	130	130	120	110
Total As	220	130	130	140		110
Ba						
Ca	157	150	204	182	166	179
Dissolved Fe					0.011	
Total Fe	0.06	0.9	2	0.64		0.18
K	26	37	37	34	34	33
Mg	81	74	96	87	83	86
Diss. Mn					4	
Total Mn						
Na	25	24	34	32	30	34
Diss. Ni	140	110	160	130	120	110
Total Ni	140	140	160	130	120	120
Si						
Bq/L Diss Ra 226	2.6	1.2	1.7	0.9		1
Bq/L Total Ra 226	2.9	1.6	1.7	1.3		1.3
Diss U	0.023	0.027	0.012	0.0091		0.0064
Total U	0.025	0.031	0.034	0.031		0.011
In mg/L: Chloride	1	2	2	2	2	2
Bicarbonate	<1	2	<1	<1	<2	3
Sulphate	829	795	1180	968	905	990
Fl						
Nitrate (as N)	7.9	2	5	16	14.77	17
Ammonia (as N)	3.8	7.3	13	16	11.67	16
N, Tot Kjeldhal						
P, total	99	10.13	15.03	15.69	14.71	10.46
T.D.S.	1850	1560	2250	1960		1800
T.S.S.						
Total Hardness	725	678	903	812		800

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	25-Jun-95	20-Jul-95	25-Aug-95	08-Oct-95	31-Aug-96	24-Aug-97
OPERATOR	Cameco	Cameco	Cameco	Cameco	Cameco	SRC
SAMPLING LOCATION	BZWR-7	BZWR-7	BZWR-7	BZWR-7	BZWR-7	BZWR-7
						21796
FIELD						
Temp. (C)	13.3		15	5	12.5	10.7
pH	4.3	4.6	4.2	4.6	4.54	4.47
Cond. (umhos/cm)	1288	1470	1290	1450	1150	1658
Em (mV)					228	
Eh (mV)					477	509
Flow, Us					0.03	
LAB						
pH	4.46	4.47	3.93	4.67		4.65
Cond. (umhos/cm)	1400	1890	1820	1740		1020
Acidity (mg/l)						159.9
In mg/L: Al						0.4
As	47	47	52	81	98.2	
Total As	47	49	56	81	116	89
Ba					0.03	
Ca	135	189	179	166	169	
Dissolved Fe	0.64	1	0.04	0.02	0.006	
Total Fe					1.4	0.008
K	34	37	32	31	30	
Mg	61	84	82	78	89	
Diss. Mn					6.2	
Total Mn						
Na	26	30	35	30	24	
Diss. Ni	67	150	140	90	120	
Total Ni	67	170	140	90	140	110
Si						
Bq/L Diss Ra 226	1	1.5	3.5	1		
Bq/L Total Ra 226	1.6	2	4	1.1		2
Diss U	0.0095	0.022	0.06	0.007		
Total U	0.039	0.095	0.069	0.011		0.012
In mg/L: Chloride	1	1	2	2	1	
Bicarbonate	<1	<1	<1	2	1	
Sulphate	735	1060	932	888	982	890
Fl					0.23	
Nitrate (as N)	11	10	4.4	19	6.82	7.00
Ammonia (as N)	5.6	12	11	10	9.3	10
N, Tot Kjeldhal						
P, total	5.88	24.18	31.05	11.11	39	38
T.D.S.	1300	2040	2060	1620		
T.S.S.						
Total Hardness	587	817	784	735		

Table 11: Toe Seepage
1992 - 1997 Data (continuation)

SAMPLE DATE	**05-Oct-97**	**18-Sep-92**	**17-Aug-93**	**08-Sep-94**	**24-Aug-97**
OPERATOR	SRC	Boojum	Boojum	Boojum	SRC
SAMPLING LOCATION	BZWR-7 **20277**	BZWRD-6	BZWRD-6	BZWRD-6	BZW-T 1 21807
FIELD					
Temp. (C)		0.9	3.9	9.7	12.2
pH		4.19	4.5	4.2	4.86
Cond. (umhos/cm)		1382	1800	1320	350
Em (mV)					
Eh (mV)		265	205	246	530
Flow, L/s					
LAB					
pH	4.9		4.4	4.6	4.98
Cond. (umhos/cm)	1470				222
Acidity (mg/l)			87	79	24
In mg/L: Al			1.7		0.3
As	66		64	49	0.87
Total As	66				
Ba					
Ca	141		175	206	
Dissolved Fe			0.02	0.051	0.036
Total Fe	0.015				
K	25		31	32	
Mg	74		85	95	
Diss. Mn			7.1	8.5	
Total Mn					
Na	21		33	33	
Diss. Ni	76		76	98	3.9
Total Ni	76				
Si					
Bq/L Diss Ra 226	1.3				0.6
Bq/L Total Ra 226	1.5				
Diss U	0.018				0.126
Total U	0.014				
In mg/L: Chloride	1		3	4	
Bicarbonate	4		1	<1	
Sulphate	832		890	1080	130
Fl					
Nitrate (as N)	9.20				4.30
Ammonia (as N)	7.2			3.75	0.18
N, Tot Kjeldhal			21	19	
P. total	30			4.1	0.7
T.D.S.	1390		1670		
T.S.S.					
Total Hardness	656				

APPENDIX 2

DATA ANALYSIS

LIST OF TABLES AND FIGURES

Table A2-1 Sorted As concentrations with sample descriptions

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Assay As ug.g^{-1}dw	Driller Description
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0-25	1200	
25/08/97	BT-2	A	350 S	dredge	sed	top 20	770	sat. l.br./y fine sed with org.debris
31/08/97	BT-3	A	50	Cut	mus	0-25	700	gray milky particulates on l.br.peat
25/08/97	BT-1	A	150	dredge	sed	top 20	430	sat. coarse peat w org.debris
25/08/97	BT-1	A	205	dredge	sed	top 20	420	sat.d.br. fine sediment
19/06/92	BT-I	A	Stn200	dredge	sed	top 20	390	Very fibrous mat, old root layer
25/08/97	BT-I	A	100	dredge	sed	top m	350	sat. gray-d.br. coarse peat w roots
25/08/97	BT-I	A	240	dredge	sed	top 20	210	sat. l.br. coarse sed w org.debris
25/08/97	BT-2	A	250	dredge	sed	top m	210	m.br. LS
31/08/97	BT 4	A	400	Cut	mus	0-25	140	coarse peat, d.br.
24/08/97	BT-3	A	150	grab	sed	top 20	140	
25/08/97	BT-2	A	N End	dredge	sed	top 20	90	m.br. LS
09/06/93	LAKE 1	A	SP-9	Cut	mus	65	88	peat
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	78	Iron rich loose floc in pools
25/08/97	BT-2	B	100	dredge	sed	top 20	66	m.br. LS
31/08/97	BT-3	A	200	cut	mus	0-25	63	sat. Ibr. coarse peat w roots
31/08/97	BT-3	A	50	Cut	mus	75-100	63	m.br.peat
31/08/97	BT-3	B	500	Cut	mus	0-25	60	l.br.old sphagnum, live sedge roots
31/08/97	BT-1	F	North	Cut	mus	0-25	57	l.br.coarse peat w rook
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	56	sat l.br. spahnumpeat, roots
20/06/92	BT-I	B	Sin 300	core	mus	0-25	54	peat
31/08/97	BT-4	A	200	Cut	mus	0-25	51	m.br.sat peat w sedge roots
09/06/93	BT-3	A	SP-2	cut	mus	180	38	peat
09/06/93	BT-3	A	SP-2	Cut	mus	75	37	peat
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	0-25	31	m.br. peat, coarse, red floc stain
31/08/97	BT-2	B	100N	Cut	mus	0-25	16	dead sphagnum, m.br.
19/06/92	BT-2	B	Stn100	dredge	sed	top 20	16	grey, org fine particles
09/06/93	BT-1	C	SP-7	Cut	mus	60	14	peat
09/06/93	BT-4	A	SP-4	cut	mus	50	14	peat
09/06/93	BT-4	A	SP-1	Cut	mus	105	11	peat
09/08/93	LAKE 1	A	SP-9	Cut	muskeg	90	9	clay
31/08/97	BT-2	B	400N	Cut	mus	0-25	8.2	live sphagnum, shrub +roots
20/06/92	BT-I	B	Stn 300	core	mus	25-50	5.8	peat
09/06/93	BT-2	A	SP-5	Cut	mus	120	5.6	peat
09/06/93	BT-4	A	SP-1	cut	mus	140	5	gray till

Table A2-1 Sorted As concentrations with sample descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Assay As ug.g^{-1}dw	Driller Description
09/06/93	BT-2	A	SP-5	cut	mus	30	4.6	peat
09/06/93	BT-1	E	SP-8	cut	mus	150	3.8	peat
09/06/93	BT-4	A	SP-4	Cut	mus	105	2.2	clay
09/06/93	BT-1	E	SP-8	cut	mus	95	2.1	peat
09/06/93	BT-1	F	LOC 1	Cut	mus	40	1.9	peat
09/06/93	BT-3	B	SP-3	Cut	mus	20	1.8	peat
09/06/93	BT-1	C	SP-7	Cut	mus	150	1.7	peat
19/06/92	LAKE 1	B	Stn100	core	mus	0-20	1.7	
09/06/93	BT-1	D	SP-6	Cut	mus	115	1.2	peat
09/06/93	BT-3	B	SP-3	Cut	mus	80	1.1	peat
19/06/92	LAKE 1	B	Stn100	core	mus	20-40	1.1	
09/06/93	BT-4	A	SP-1	Cut	mus	165	1	gray till w sand
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	0.9	
19/06/92	LAKE 1	B	Stn100	core	mus	40-60	0.9	
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	0.7	
09/06/93	BT-1	F	LOC 1	Cut	mus	60	0.5	peat
09/06/93	ET-I	F	LOC 1	Cut	mus	120	0.5	sand w gravel

Area: BT1,2,3,4: Locations originally named according to position along B-Zone transects (BT)

A to F: Area on map

Location: Transect map 100 intervals: DH=Drill Hole, LOC=Location, N=North, S=South, SP=Shallow Pitzo, Stn=Station

Sample type and local substrate: Cut=Cuttings, Dred=Dredge, Mus=Muskeg, Sed=Sediment

Driller Description: be=beige, br=brown, d=dark, l=light, LS=gytia, m=medium, sat–saturated, sed=sediment, org=organic, w=with

Colour: Bk-Black, Bn-Brown, D-Dark, Gn-Green, Gy-Grey. L-Light. 0-Orange, Rd-Red, Sl-Slight, Tn-Tan. W-White

Texture: Ce-Coarse. Ch-Chunk, Cy-Clay, De-Decomposing, Dr-Drier, F-Fine. Fa-Fairly Fw-Few. G-Grainy. Gr-GrassGt-Grit, H-Humus, IO-Inorganic,
La-Larger, Le-Leaf, Li-Little, M-Many, Me-Medium, Mo-Moss, 0-Organic, OD-Organic Debris. P-Peat. Pe-Pebble, R-Root, Sd-Sand,
Sf-Soft, Si-Silty, Sl-Sludge, So-Some, Sp-Spongy, St-Straw, T-Till, Th-Thick, Tw-Twig, U-Uniform, V-Very, Va-Various, W/-With

Smell: De-Dewmposing, F-Faint, M: Moderate, NS-No Smell. Or-Organic Smell, P-Pungent, Sg-Strong, Si-Slight, V-Very

Moisture: D-Dry, EW-Excess Water, M-Moist, S-Saturated, V-Very, W-Wet

NA=Not Analyzed, ND=Not Determinated, NM=Not Measureable because of no enough water

Table A2-1 Sorted As concentrations with sample descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Assay As ug.g^{-1}dw	LAB DESCRIPTION Lab Description	Colour	Texture	Smell	Moisture
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0-25	1200	moss	LBn	Mo, Solid	NS	W
25/08/97	ET-2	A	350 S	dredge	sed	top 20	770	fine sediment	LBn,YGy	MR,MGr,F,ThSl	P,H2S	EW
31/08/97	ET-3	A	50	Cut	mus	0-25	700	peat	Bn,Gy	MOD,R,Tw,Sf,Sp	SgOr,P	M
25/08/97	ET-I	A	150	dredge	sed	top 20	430	coarse peat	DBn,Gy	SoTw,SoR,SoSt	P,H2S	EW
25/08/97	BT-1	A	205	dredge	sed	top 20	420	fine sediment	Bn,Gy,Y	MSt,SoR,LtOD,F,Sl,	SgH2S	EW
19/06/92	ET-I	A	Stn200	dredge	sed	top 20	390	peat w/IO	Gy,Bn	P W/IO,F,Sf,R,Tw	P	EW
25/08/97	BT-1	A	100	dredge	sed	top 20	350	coarse peat	Gy,Bn	MOD,St,R,Sp,Si	H2S	EW
25/08/97	BT-1	A	240	dredge	sed	top 20	210	coarse sediment	Bn,Gy	MTw,R,OD,MeGt,Sl	SgH2S	EW
25/08/97	ET-2	A	250	dredge	sed	top 20	210	gytia	Bn	LtOD,VF,ThSl	P	EW
31/08/97	ET-4	A	400	Cut	mus	0-25	140	coase peat	Bn,DBn	MSt,Tw,SoR,Sp	SgH2S	W
24/08/97	BT-3	A	150	grab	sed	top 20	140	sediment	DBn	MTw,R	H2S	EW
25/08/97	ET-2	A	N End	dredge	sed	top 20	90	gytia	DBn	MR,SoTw,SoOD,F,ThSl	P	Ew
09/06/93	LAKE1	A	SP-9	cut	mus	65	88	peat	Y,Bn	P,G,O	NS	D->M
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	78	precipitate				
25/08/97	ET-2	E	100	dredge	sed	top 20	66	gytia	DBn	FwR,LtSt,FwOD,VF,ThSl	P,H2S	EW
31/08/97	ET-3	A	200	Cut	mus	0-25	63	coarse peat	LBn	MOD,St,Tw,R,Sf,Sp	P,VSgH2S	M
31/08/97	ET3	A	50	Cut	mus	75-100	63	m peat	Bn,Dbn	MOD,R,St,Tw,Sp	SgH2S	M
31/08/97	ET3	E	500	cut	mus	0-25	60	sphagnum	LBn	MSt,MR,SoTw,Mo,Sp	NS	M->W
31/08/97	BT-1	F	North	cut	mus	0-25	57	peat	LBn	MR,O	Or	VW
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	56	sphagnum	LBn	MMo,MSt,MR,MTw,Sf	SgH2S	VW
20/06/92	ET-1	E	Stn 300	wre	mus	0-25	54	coarse peat	Y,DO	FaU,St,Ce	P	M
31/08/97	BT-4	A	200	Cut	mus	0-25	51	peat	Bn,DBn	P,MR,SoSt,OD,Sf,Sp	SgH2S	VW
09/06/93	ET-3	A	SP-2	cut	mus	180	38	peat	Bk,O	MO,P,R,Tw,DeO	DeOr	M->W
09/06/93	ET3	A	SP-2	cut	mus	75	37	peat	Bk,O	P,Gt	VSg H2S	VW
31/08/97	BT-4	A	6.9.3 DH	Cut	mus	0-25	31	peat	DBn	P,MR,Tw,FwLe,Sf,Sp	M H2S	M
31/06/97	ET-2	E	100N	Cut	mus	0-25	16	peat	LBn,Bn	P,MTw,SoR,Sp,Sf	or	W
19/06/92	ET-2	E	Stn100	dredge	sed	top 20	16	fine peat	Bk,Bn	P,O,F,Sf,MR	P	VW
09/06/93	BT-1	C	SP-7	Cut	mus	60	14	peat	Y,O,B	P,MR,Mle,MTw,G	P	S
09/06/93	BT-4	A	SP-4	Cut	mus	50	14	peat	Bk,O	P,O,DeO,R,Twch	NS	M
09/06/93	BT-4	A	SP-1	Cut	mus	105	11	peat	D,SlO	P,MO,R,Tw	SlOr	VM
09/06/93	LAKE 1	A	SP-9	Cut	muskeg	90	9	peat w clay	Bk,O	P,Cy,SoR,SoTw	NS	EW
31/08/97	BT-2	E	400N	cut	mus	0-25	8.2	sphagnum	LBn	MOD,MR,MTw,Mo,Sp		

Table A2-I Sorted As concentrations with sample descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Assay As ug.g^{-1}dw	LAB DESCRIPTION				
								Lab Description	Colour	Texture	Smell	Moisture
20/06/92	BT-1	B	Stn 300	core	mus	25-50	5.8	fine peat	Bn,O	FU/F, Ch,DeO	P	M
09/06/93	BT-2	A	SP-5	Cut	mus	120	5.6	peat	Bk,O,Y	P,VF,Gt,SoR	NS	VS
09/06/93	BT4	A	SP-1	Cut	mus	140	5	sand w organics	B,Gy,W	Sd,IO,SoTw,SoR	NS	M
09/06/93	BT-2	A	SP-5	cut	mus	30	4.6	peat	Y,Bn	P,G,MTw,MR	P	W
09/06/93	BT-1	E	SP-8	Cut	mus	150	3.8	peat	Bk,O	P,Cy,FwR	NS	EW
09/06/93	BT-4	A	SP-4	Cut	mus	105	2.2	clayey till	Bk,Gy,W	PTCy,MIO,SoR,SoCh,Sd	NS	D
09/06/93	BT-1	E	SP-8	Cut	mus	95	2.1	peat	Bk,O	G,Sp,SoR,F	NS	M
09/06/93	BT-1	F	LOC 1	Cut	mus	40	1.9	peat	Bk,O	MTw,MR,MDeO,P	NS	M
09/06/93	BT-3	B	SP-3	Cut	mus	20	1.8	peat	Bk,Y,O	P,DeO,R,Tw,Gt	H2S	VW
09/06/93	BT-1	C	SP-7	Cut	mus	150	1.7	peat	Bk,O	R,Tw,G	NS	EW
19/06/92	LAKE1	B	Stn100	wre	mus	0-20	1.7	peat	O	P	NS	EW
09/06/93	BT-1	D	SP-6	Cut	mus	115	1.2	peat	Bk,O	P,O, R, Tw,Sf	NS	W
09/06/93	BT-3	B	SP-3	Cut	mus	80	1.1	peat	Bk,O	P,R,Tw,DeO,Gt	H2S	W
19/06/92	LAKE 1	B	Stn100	wre	mus	20-40	1.1	peat	Gn,O	P,MR,MTw	NS	M
09/06/93	BT-4	A	SP-1	Cut	mus	165	1	silt/sand	Gy,W	Si,Sd,VF,MIO,SoTw	NS	D
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	0.9	fine organics	DBn,Bk	U,O,FwR,F,Sf	P	EW
19/06/92	LAKE1	B	Stn100	core	mus	40-60	0.9	peat	Bk	P,VSp	NS	Dr
19/06/92	LAKE 1	B	Stn100	wre	rnus	60-80	0.7	peat	O,Bn	P,VF	NS	VM
09/06/93	BT-1	F	LOC 1	Cut	mus	60	0.5	clay w/organics	Bk,O	Cy,O,SoP	NS	M
09/06/93	BT-1	F	LOC 1	Cut	mus	120	0.5	sand w/pebbles	Bn,O	CeSd,VaPe,SoR, SoTw, Cy	NS	D

Area: BT1,2,3,4: Locations originalty named according to position along B-Zone transects (BT)

A to F: Area on map

Location: Transect map 100 intervals; DH=Drill Hole, LOC–Location, N=North, S=South, SP=Shallow Pitzo, Stn=Station

Sample type and local substrate: Cut=Cuttings, Dred=Dredge, Mus=Muskeg, Sed=Sediment

Driller Description: be=beige, br=brown, d=dark, l-light, LS=gytla, m=medium, sat=saturated, sed=sediment, org=organic, w=with

Colour: Bk-Black, Bn-Brown, D-Dark, Gn-Green, Gy-Grey. L-Light, 0-Orange, Rd-Red, Sl-Slight. Tn-Tan, W-White

Texture: Ce-Coarse. Ch-Chunk, Cy-Clay, De-Decomposing, Dr-Drier, F-Fine. Fa-Fairly. Fw-Few. G-Grainy, Gr-Grass Gt-Grit, H-Humus, io-Inorganic,
La-Larger, Le-Leaf, Li-Little, M-Many, Me-Medlum, MQ-Moss, 0-Organic, OD-Organic Debris, P-Peat, Pe-Pebble, R-Root, Sd-Sand,
Sf-Soft, Si-Silty, Sl-Sludge, So-Some, Sp-Spongy, St-Straw, T-Till, Th-Thick, Tw-Twig. U-Uniform, V-Very. Va-Various, W/-With

Smell: De-Decomposing, F-Faint. M: Moderate, NS-No Smell, Or-Organic Smell, P-Pungent, Sg-Strong, Sl-Slight, V-Very

Moisture: D-Dry, EW-Excess Water, M-Moist, S-Saturated, V-Very, W-Wet

NA=Not Analyzed, ND=Not Determinated. NM=Not Measureable because of no enough water

Table A2-2: Sorted Ni concentrations with sample descriptions

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Ni,Assay ug.g-1 dw	Driller Description
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0-25	690	
25/08/97	BT-2	A	350 S	dredge	sed	top 20	670	sat. l.br./y fine sed with org.debris
31/08/97	BT-3	A	50	cut	mus	0-25	630	gray milky particulates on l.br.peat
25/08/97	BT-1	A	150	dredge	sed	top 20	280	sat. coarse peat w org.debris
19/06/92	BT-1	A	Stn200	dredge	sed	top m	260	Very fibrous mat, old root layer
25/08/97	BT-1	A	100	dredge	sed	top 20	260	sat. gray-d.br. coarse peat w roots
25/08/97	BT-1	A	205	dredge	sed	top 20	230	sat.d.br. fine sediment
25/08/97	BT-2	A	250	dredge	sed	top 20	220	m.br. LS
25/08/97	BT-1	A	240	dredge	sed	top 20	170	sat. l.br. coarse sed w org.debris
25/08/97	BT-2	A	N End	dredge	sed	top 20	140	m.br. LS
24/08/97	BT-3	A	150	grab	sed	top 20	110	
31/08/97	BT-1	F	North	cut	mus	0-25	54	l.br.coarse peat w roots
25/08/97	BT-2	B	100	dredge	sed	top 20	46	m.br. LS
31/08/97	BT-4	A	400	Cut	mus	0-25	43	coarse peat, d.br.
31/08/97	BT-3	A	200	Cut	mus	0-25	39	sat. Ibr. coarse peat w roots
31/08/97	BT-3	A	50	Cut	mus	75-100	39	m.br.peat
31/08/97	BT-4	A	200	Cut	mus	0-25	35	m.br.sat peat w sedge roots
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	34	sat l.br. spahnum peat, roots
09/06/93	BT-3	A	SP-2	Cut	mus	180	30	peat
09/06/93	LAKE 1	A	SP-9	Cut	mus	65	26	peat
20/06/92	ET-I	B	Stn 300	wre	mus	C-25	24	peat
09/06/93	BT-3	A	SP-2	Cut	mus	75	24	peat
09/06/93	BT-1	C	SP-7	Cut	mus	60	19	peat
31/08/97	BT-3	B	500	cut	mus	0-25	16	l.br.old sphagnum, live sedge roots
19/06/92	BT-2	B	Stn100	dredge	sed	top 20	16	grey, org fine particles
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	15	Iron rich loose floc in pools
31/08/97	BT4	A	6.9.3 DH	Cut	mus	0-25	14	m.br. peat, coarse, red floc stain
09/06/93	BT-4	A	SP-I	Cut	mus	105	14	peat
31/08/97	BT-2	B	100N	cut	mus	0-25	13	dead sphagnum, m.br.
09/06/93	BT-4	A	SP-4	Cut	mus	50	12	peat
09/06/93	BT-4	A	SP-1	Cut	mus	140	9.2	gray till
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	8.4	
31/08/97	BT-2	B	400N	Cut	mus	0-25	8.1	live sphagnum, shrub +roots
09/06/93	BT-2	A	SP-5	Cut	mus	30	8	peat
09/06/93	BT-4	A	SP-4	Cut	mus	105	8	clay

Table A2-2: Sorted Ni concentrations with sample descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Ni,Assay ug.g-1 dw	Driller Description
09/06/93	BT-1	F	LOC 1	Cut	mus	60	7	peat
09/06/93	BT-3	B	SP-3	Cut	mus	80	61	peat
09/06/93	BT-4	A	SP-1	Cut	mus	165	52	gray till w sand
09/06/93	LAKE 1	A	SP-9	cut	*muskeg*	90	49	clay
09/06/93	BT-1	D	SP-6	Cut	mus	115	43	peat
09/06/93	BT-1	F	LOC 1	cut	mus	40	3.8	peat
09/06/93	BT-1	F	LOC 1	Cut	mus	120	38	sand w gravel
20/06/92	BT-1	B	Stn 300	core	mus	2550	35	peat
09/06/93	BT-3	B	SP-3	Cut	mus	20	34	peat
19/06/92	LAKE 1	B	Stn100	core	mus	0-20	27	
09/06/93	BT-1	E	SP-8	cut	mus	150	22	peat
09/06/93	BT-2	A	SP-5	Cut	mus	120	19	peat
19/06/92	LAKE1	B	Stn100	wre	mus	40-60	19	
19/06/92	LAKE1	B	Stn100	wre	mus	60-80	19	
09/06/93	BT-1	E	SP-8	Cut	mus	95	15	peat
19/06/92	LAKE 1	B	Stn100	wre	mus	20-40	1.5	
09/06/93	BT-1	C	SP-7	Cut	mus	150	14	peat

Area: BT1,2,3,4: Locations originally named according to position along B-Zone transects (BT)

A to F: Area on map

Location: Transect map 100 intervals; DH=Drill Hole, LOC=Location, N=North, S=South, SP=Shallow Pitzo, Stn=Station

Sample type and local substrate: Cut=Cuttings, Dred=Dredge, Mus=Muskeg, Sed–Sediment

Driller Description: be=beige, br=brown, d=dark, l=light, LS=gytia, m=medium, sat=saturated, sed=sediment, org=organic, w=with

Colour: Bk-Black, Bn-Brown, D-Dark, Gn-Green, Gy-Grey, L-Light, 0-Orange, Rd-Red, Sl-Slight, Tn-Tan, W-White

Texture: Ce-Coarse. Ch-Chunk, Cy-Clay, De-Decomposing, Dr-Drier. F-Fine, Fa-Fairly. Fw-Few, G-Grainy, Gr-GrassGt-Grit, H-Humus, 10-Inorganic, La-Larger, Le-Leaf, Lt-Little, M-Many. Me-Medium, Mo-Moss, 0-Organic, OD-Organic Debris, P-Peat, Pe-Pebble. R-Root, Sd-Sand, Sf-Soft, Si-Silty, Sl-Sludge, So-Some, Sp-Spongy, St-Straw, T-Till, Th-Thick, Tw-Twig, U-Uniform, V-Very, Va-Various. W/-With

Smell: De-Decomposing, F-Faint, M: Moderate, NS-No Smell, Or-Organic Smell, P-Pungent, Sg-Strong, VFA

Moisture: D-Dry, EW-Excess Water, M-Moist, S-Saturated. V-Very, W-Wet

NA=Not Analyzed, ND=Not Determinated, NM=Not Measureable because of no enough water

Table A2-2: Sorted Ni Concentrations with Sample Descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	NI,Assay ug.g-1 dw	Lab Description	Colour	Texture	Smell	Moisture
28/08/97	BT-3	A	BZW-T Zone	grab	mus	0-25	690	moss	LBn	Mo, Solid	NS	W
25/08/97	BT-2	A	350 S	dredge	sed	top 20	670	fine sediment	LBn,YGy	MR,MGr,F,T	P,H_2S	EW
31/08/97	BT-3	A	50	Cut	mus	0-25	630	peat	Bn,Gy	MOD,R,Tw,S	SgOr,P	M
25/08/97	BT-1	A	150	dredge	sed	top 20	280	coarse peat	DBn,Gy	SoTw,SoR,S	P,H_2S	EW
19/06/92	BT-1	A	Stn200	dredge	sed	top 20	260	peat w/IO	Gy,Bn	P W/IO,F,Sf,	P	EW
25/08/97	BT-I	A	100	dredge	sed	top 20	260	coarse peat	Gy,Bn	MOD,St,R,Sp	H_2S	EW
25/08/97	BT-1	A	205	dredge	sed	top 20	230	fine sediment	Bn,Gy,Y	MSt,SoR,LtO	SgH_2S	EW
25/08/97	BT-2	A	250	dredge	sed	top 20	220	gytia	Bn	LtOD,VF,ThS	P	EW
25/08/97	BT-1	A	240	dredge	sed	top 20	170	coarse sedim	Bn,Gy	MTw,R,OD,M	SgH_2S	EW
25/08/97	BT-2	A	N End	dredge	sed	top 20	140	gytia	DBn	MR,SoTw,So	P	EW
24/08/97	BT-3	A	150	grab	sed	tap 20	110	sediment	DBn	MTw,R	H_2S	EW
31/08/97	BT-1	F	North	Cut	mus	0-25	54	peat	LBn	MR,O	or	VW
25/08/97	BT-2	B	100	dredge	sed	top 20	46	gytia	DBn	FwR,LtSt,Fw	P,H_2S	EW
31/08/97	BT-4	A	400	Cut	mus	0-25	43	coase peat	Bn,DBn	MSt,Tw,SoR,	SgH_2S	W
31/08/97	BT-3	A	200	Cut	mus	0-25	39	coarse peat	LBn	MOD,St,Tw,	P,VSgH_2S	M
31/08/97	BT-3	A	50	cut	mus	75-100	39	m peat	Bn,Dbn	MOD,R,St,T	SgH_2S	M
31/08/97	BT-4	A	200	Cut	mus	0-25	35	peat	Bn,DBn	P,MR,SoSt,O	SgH_2S	VW
31/08/97	BT-3	B	SP-3 DH	Cut	mus	0-25	34	sphagnum	LBn	MMo,MSt,M	SgH_2S	VW
09/06/93	BT-3	A	SP-2	cut	mus	180	30	peat	Bk,O	MO,P,R,Tw,	DeOr	M->W
09/06/93	LAKE 1	A	SP-9	cut	mus	65	26	peat	Y,Bn	P,G,O	NS	D->M
20/06/92	BT-1	B	Stn 300	wre	mus	0-25	24	coarse peat	Y,DO	FaU,St,Ce	P	M
09/06/93	BT-3	A	SP-2	Cut	mus	75	24	peat	Bk,O	P,Gt	VSg H_2S	VW
09/06/93	BT-1	C	SP-7	cut	mus	60	19	peat	Y,O,B	P,MR,Mle,M	P	S
31/08/97	BT-3	B	500	Cut	mus	0-25	16	sphagnum	LBn	MSt,MR,SoT	NS	M->W
19/06/92	BT-2	B	Stn100	dredge	sed	top XI	16	fine peat	Bk,Bn	P,O,F,Sf,MR	P	VW
31/08/97	BT-4	A	Stn 6.9.3	grab	flocc	0-10	15	precipitate				
31/08/97	BT-4	A	6.9.3 DH	cut	mus	0-25	14	peat	DBn	P,MR,Tw,Fw	M H_2S	M
09/06/93	BT-4	A	SP-1	Cut	mus	105	14	peat	D,SIO	P,MO,R,Tw	SIOr	VM
31/08/97	BT-2	B	100N	Cut	mus	0-25	13	peat	LBn,Bn	P,MTw,SoR,	Or	W
09/06/93	BT-4	A	SP-4	cut	mus	50	12	peat	Bk,O	P,O,DeO,R,T	NS	M
09/06/93	BT-4	A	SP-I	cut	mus	140	9.2	sand w organ	B,Gy,W	Sd,IO,SoTw,	NS	M
19/06/92	LAKE 1	B	centre	dredge	sed	top 20	6.4	fine organics	DBn,Bk	U,O,FwR,F,S	P	EW
31/08/97	BT-2	B	400N	Cut	mus	0-25	8.1	sphagnum	LBn	MOD,MR,MT	Or	M
09/06/93	BT-2	A	SP-5	Cut	mur	30	8	peat	Y,Bn	P,G,MTw,MR	P	W
09/06/93	BT-4	A	SP-4	Cut	mus	105	8	clayey till	Bk,Gy,W	P,T,Cy,MIO,	NS	M
09/06/93	BT-1	F	LOC 1	cut	mus	60	7	clay w/organi	Bk,O	Cy,O,SoP	NS	M

Table A2-2: Sorted Ni Concentrations with Sample Descriptions (continuation)

Sampled Date	Area		Location	Sample Type	Local Substrate	Sample Depth (cm)	Ni,Assay ug.g-1 dw	Lab Description	Colour	Texture	Smell	Moisture
09/06/93	BT-3	B	SP-3	cut	mus	80	6.1	peat	Bk,O	P,R,Tw,DeO,	H2S	W
09/06/93	BT-4	A	SP-1	cut	mus	165	5.2	silt/sand	Gy,W	Si,Sd,VF,MIO	NS	D
09/06/93	LAKE 1	A	SP-9	cut	muskeg	90	4.9	peat w clay	Bk,C	P,Cy,SoR,So	NS	EW
09/06/93	BT-1	D	SP-6	cut	mus	115	4.3	peat	Bk,C	P,O, R, Tw,Sf	NS	W
09/06/93	BT-1	F	LOC 1	cut	mus	40	3.8	peat	Bk,C	MTw,MR,MD	NS	M
09/06/93	BT-1	F	LOC 1	cut	mus	120	3.8	sand w/pebbl	Bn,C	CeSd,VaPe,	NS	D
20/06/92	BT-1	B	Stn 300	core	mus	25-50	3.5	fine peat	Bn,C	FU/F, Ch,De	P	M
09/06/93	BT-3	B	SP-3	cut	mus	20	3.4	peat	Bk,Y,C	P,DeO,R,Tw,	H2S	VW
19/06/92	LAKE1	B	Stn100	core	mus	0-20	2.7	peat	O	P	NS	EW
09/06/93	BT-1	E	SP-8	cut	mus	150	2.2	peat	Bk,C	P,Cy,FwR	NS	EW
09/06/93	BT-2	A	SP-5	cut	mus	120	1.9	peat	Bk,O,Y	P,VF,Gt,SoR	NS	VS
19/06/92	LAKE 1	B	Stn100	core	mus	40-60	1.9	peat	Bk	P,VSp	NS	Dr
19/06/92	LAKE 1	B	Stn100	core	mus	60-80	1.9	peat	O,Bn	P.VF	NS	VM
09/06/93	BT-1	E	SP-8	cut	mus	95	1.5	peat	Bk,O	G,Sp,SoR,F	NS	M
19/06/92	LAKE1	B	Stn100	core	mus	20-40	1.5	peat	Gn,C	P,MR,MTw	NS	M
09/06/93	BT-1	C	SP-7	cut	mus	150	1.4	peat	Bk,O	R,Tw,G	NS	EW

Area: BT1,2,3,4: Locations originally named according to position along B-Zone transects (BT)

A to F: Area on map

Location: Transect map 100 intervals; DH-Drill Hole, LOC=Location, N=North, S=South, SP=Shallow Pitzo, Stn=Station

Sample type and local substrate: Cut=Cuttings, Dred=Dredge, Mus=Muskeg, Sed=Sediment

Driller Description: be=beige, br=brown, d=dark, l=light, LS=gytia, m=medium, sat=saturated, sed=sediment, org=organic, w=with

Colour: Bk-Black. Bn-Brown. D-Dark, Gn-Green, Gy-Grey, L-Light, 0-Orange, Rd-Red, SI-Slight, Tn-Tan, W-White

Texture: Ce-Coarse. Ch-Chunk, Cy-Clay, De-Decomposing, Dr-Drier. F-Fine, Fa-Fairly, Fw-Few, G-Grainy, Gr-Grass Gt-Grit, H-Humus, 10-Inorganic,
La-Larger, Le-Leaf, Lt-Little, M-Many, Me-Medium, MO-Moss, 0-Organic, OD-Organic Debris, P-Peat, Pe-Pebble, R-Root, Sd-Sand,
Sf-Soft, Si-Silty, SI-Sludge, So-Some. Sp-Spongy, St-Straw, T-Till, Th-Thick, Tw-Twig, U-Uniform, V-Very, Va-Various, W/-With

Smell: Oe-Decomposing, F-Faint, M: Moderate, NS-No Smell, Or-Organic Smelt, P-Pungent. Sg-Strong, VFA

Moisture: D-Dry, EW-Excess Water, M-Moist, S-Saturated. V-Very, W-Wet

NA=Not Analyzed, ND=Not Deterrninated, NM=Not Measureable because of no enough water

Fig. A2-1 a: As vs Ni (waste rock)

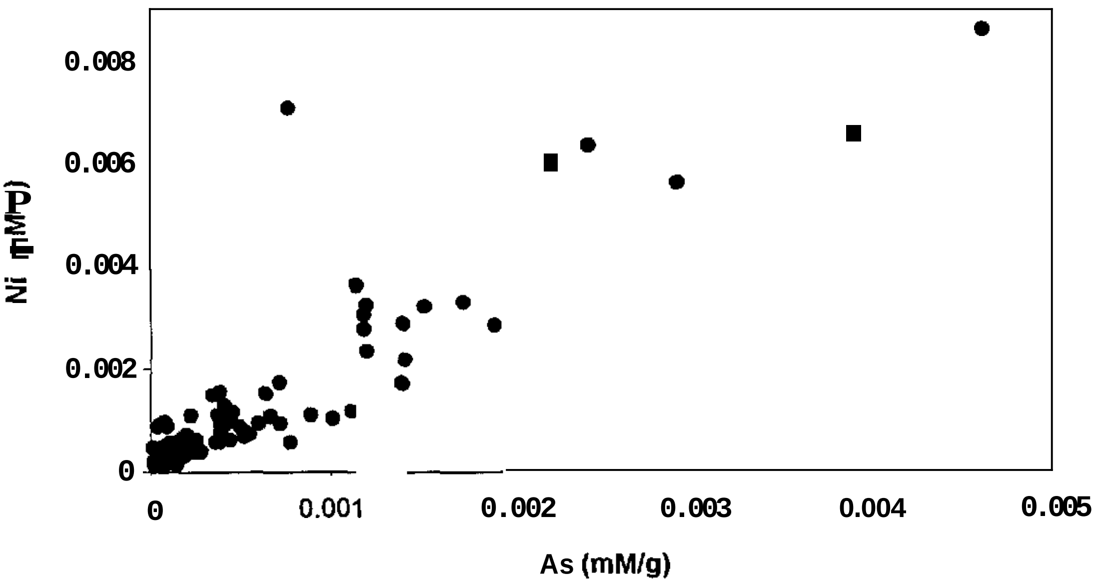
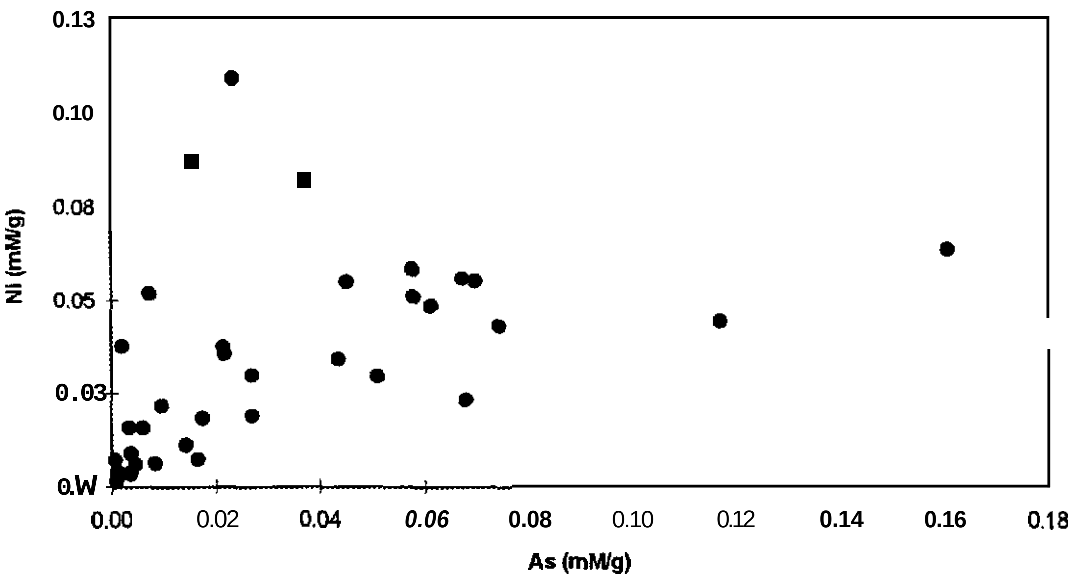
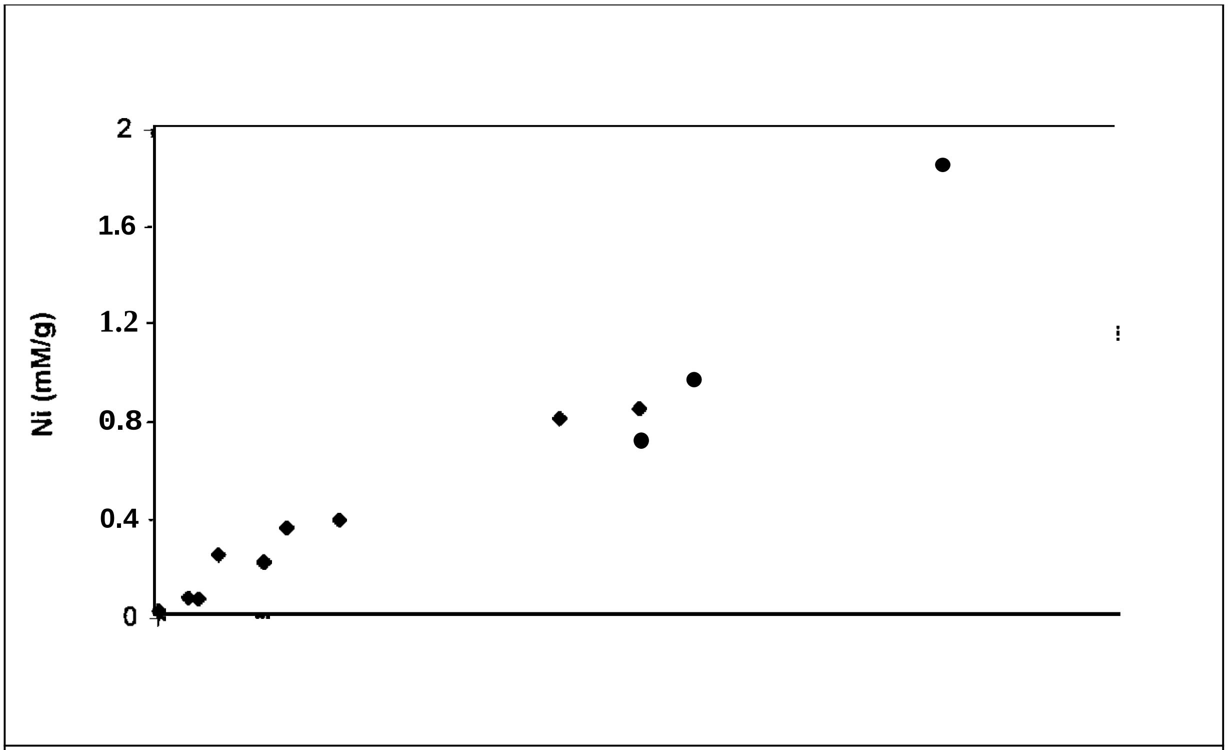


Fig. A2-1 b: As vs Ni (muskeg-surface)




2
1.6
1.2
0.8
0.4
0
Ni (mM/g)

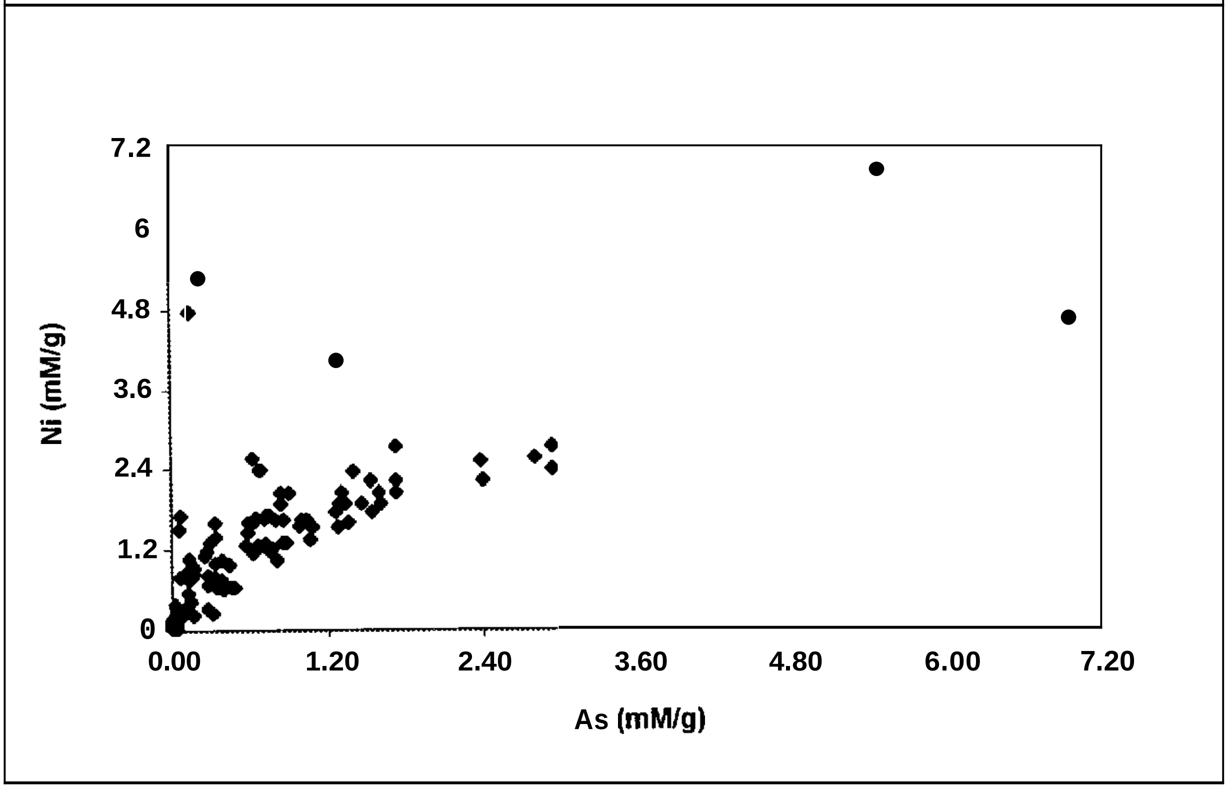

7.2
6
4.8
3.6
2.4
1.2
0
0.00
1.20
2.40
3.60
4.80
6.00
7.20
Ni (mM/g)
As (mM/g)

Fig. A2-1 e: As vs Ni (seepage -total)

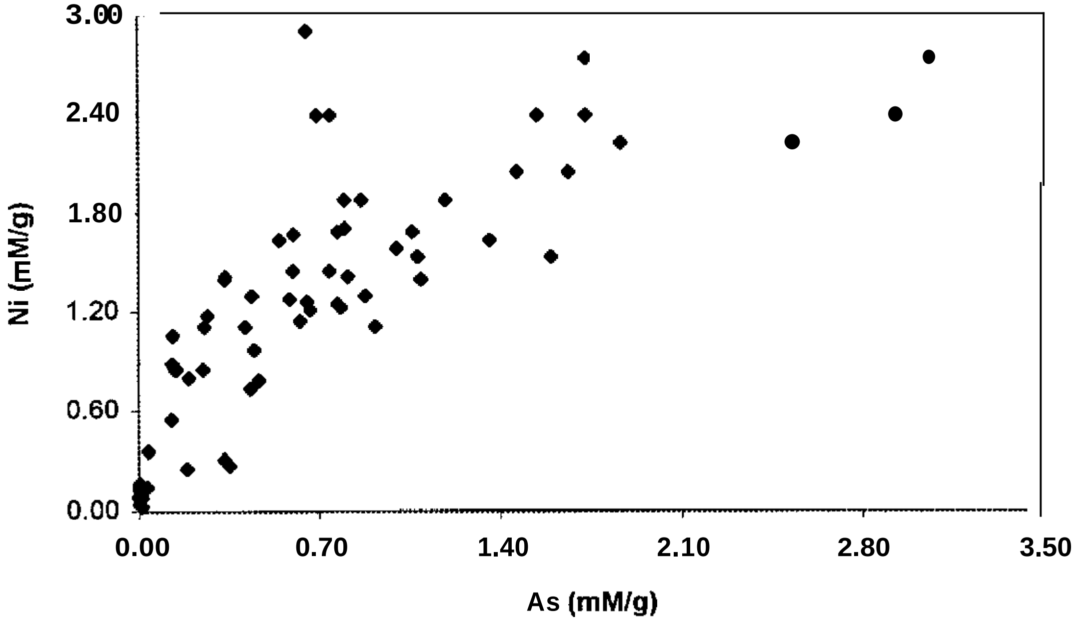


Fig. A2-2: Comparison of Merk As with SRC As

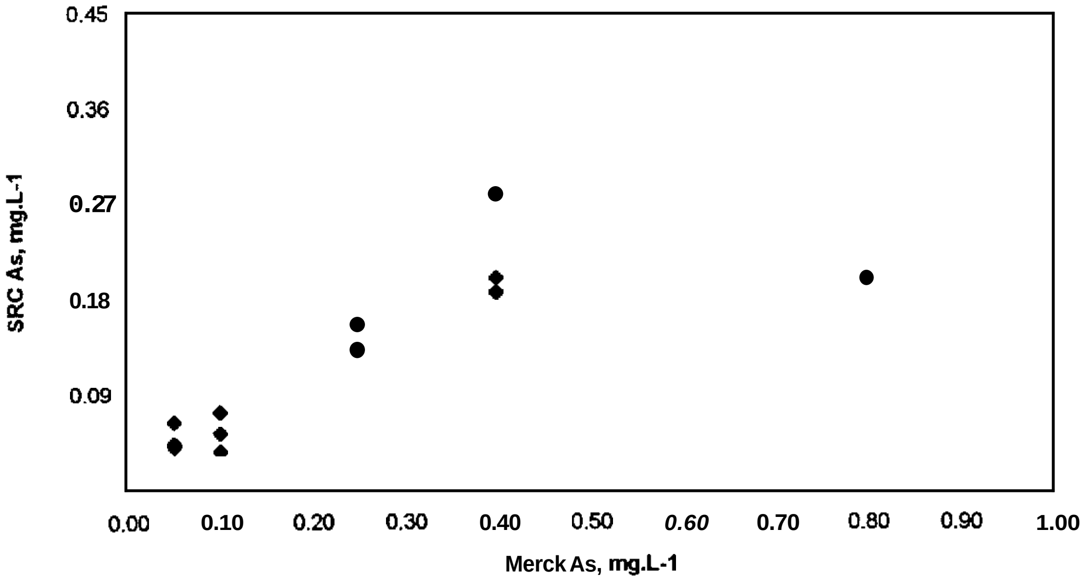


Fig A2-3: As vs L.O.I.

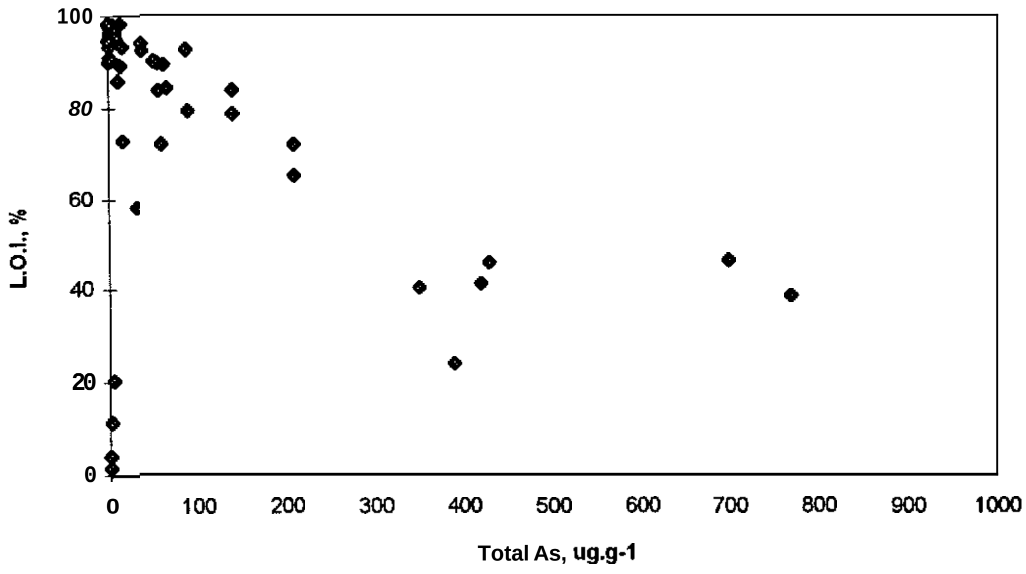


Fig.A2-4: Ni vs L.O.I.

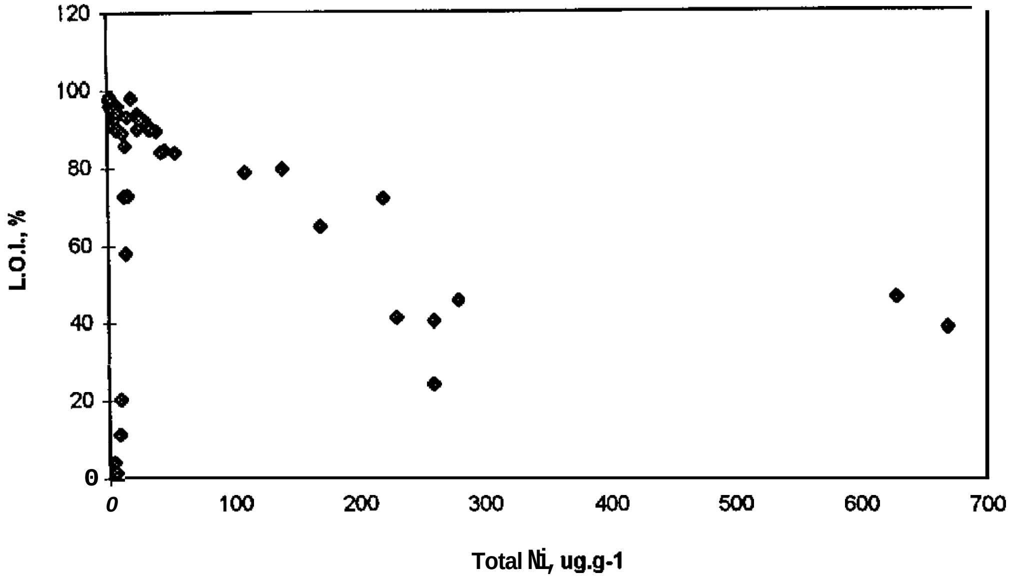


Fig. A2-5 a: Fe vs L.O.I. (range Fe: 0-150000 ug.g-1)

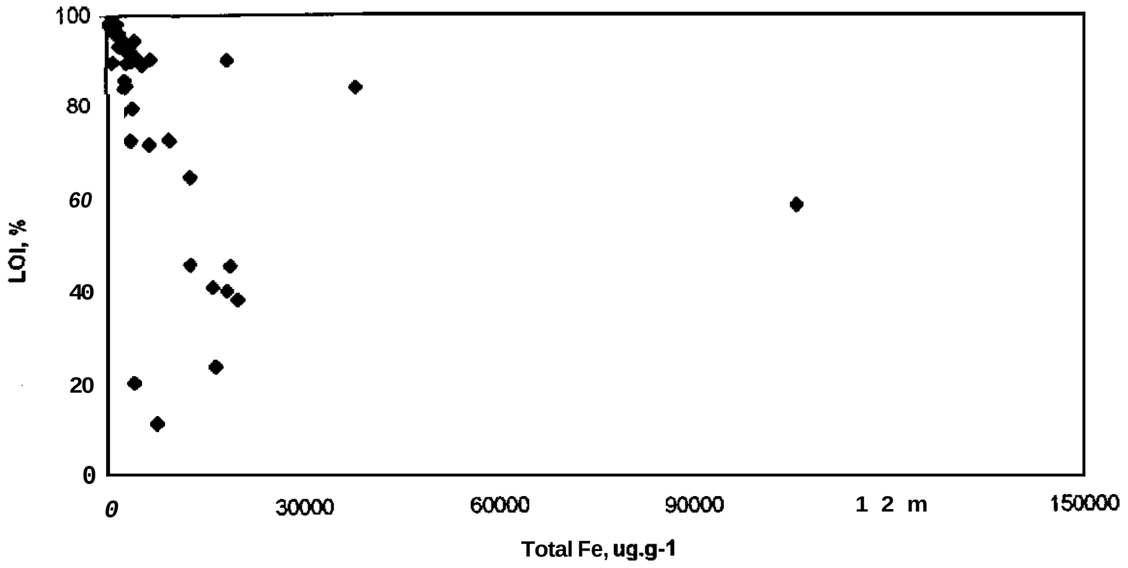


Fig. A2-5 b: Fe vs L.O.I. (range Fe: 0-30000 ug.g-1)

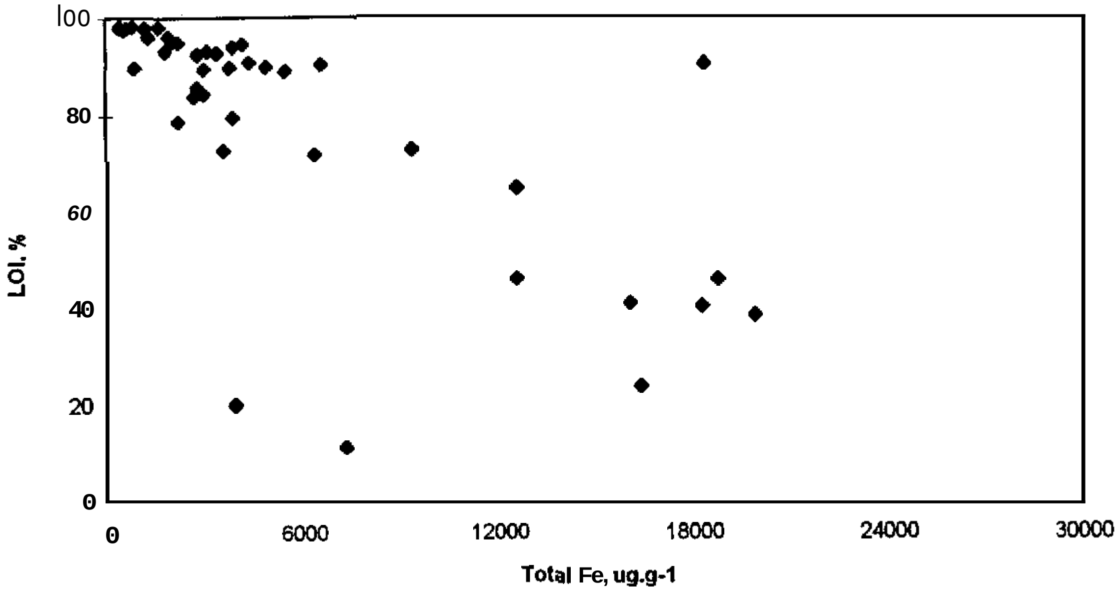


Fig. A2-6 a: S vs L.O.i.
(range S: 0-6000 ug.g-1; LOI: 80-100%)

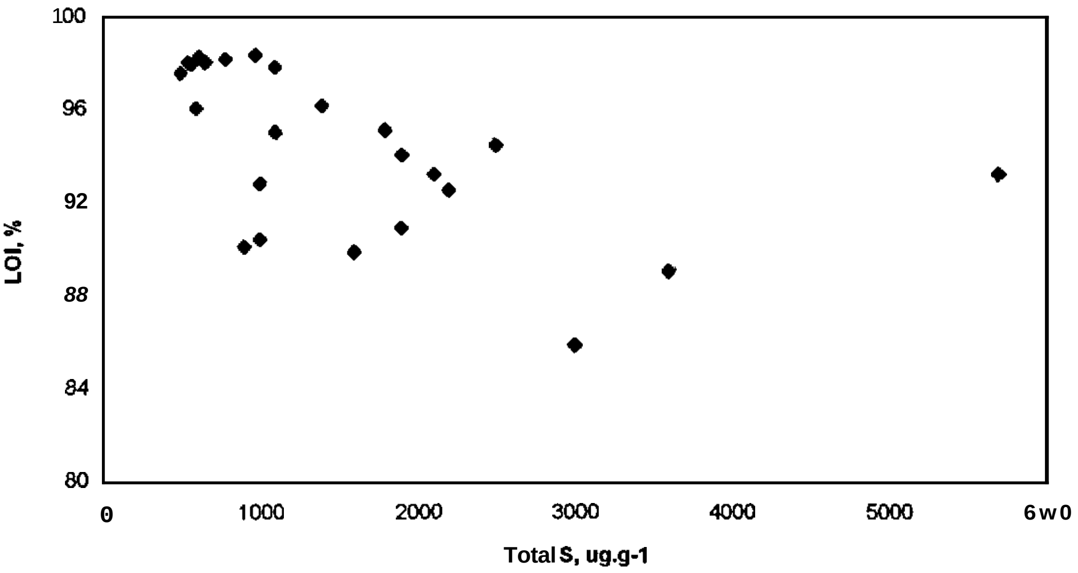


Fig.A2-6 b: S vs L.O.I.
(range S: 0-2500 ug.g-1; LOI: 80-100%)

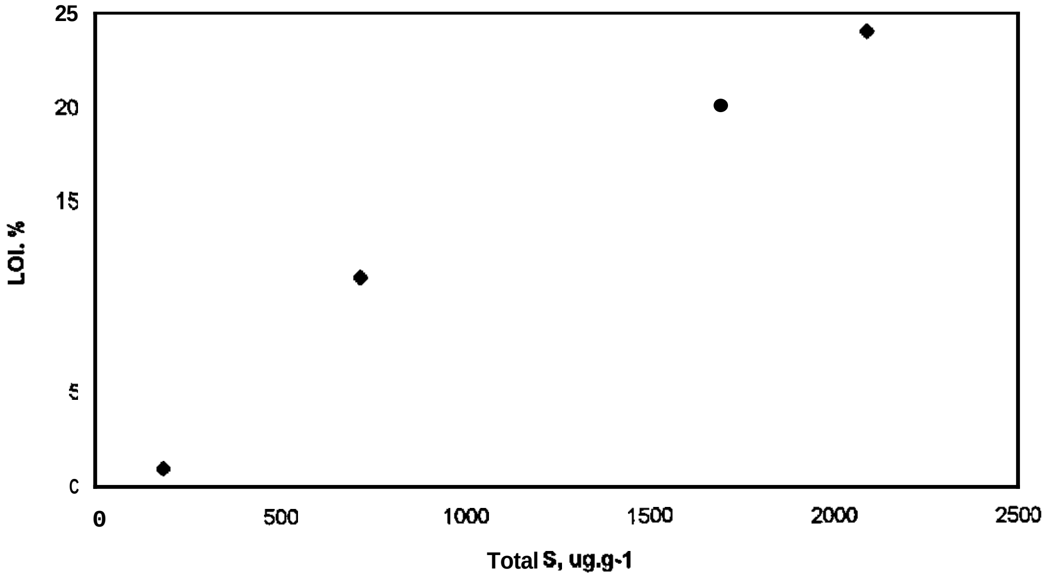


Fig. A2-7 a: As vs S
(range As: 0-150 ug.g-1; S: 0-6000 ug.g-1)

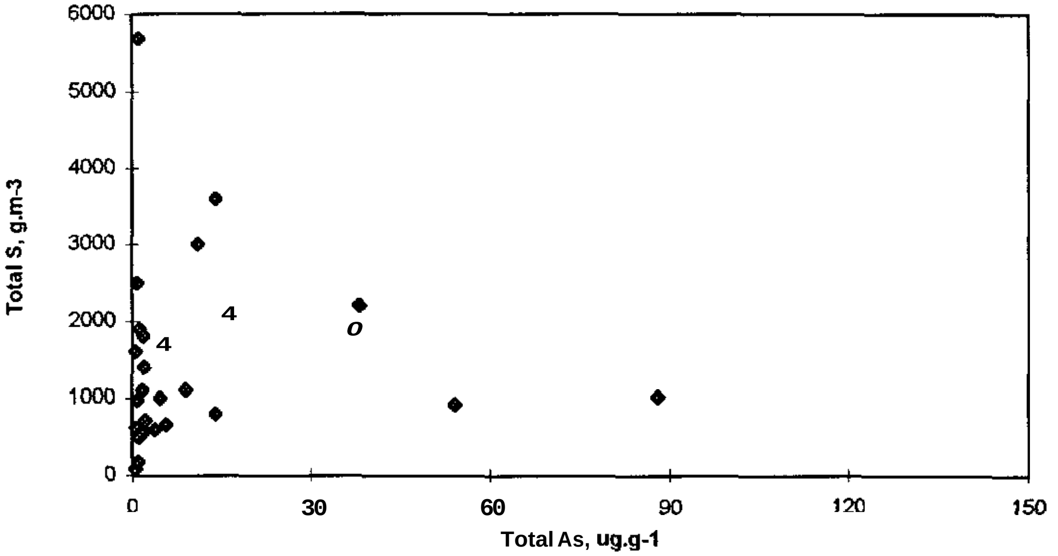


Fig. A2-7 b: As vs S
(range As: 0-30; S: 0-2000)

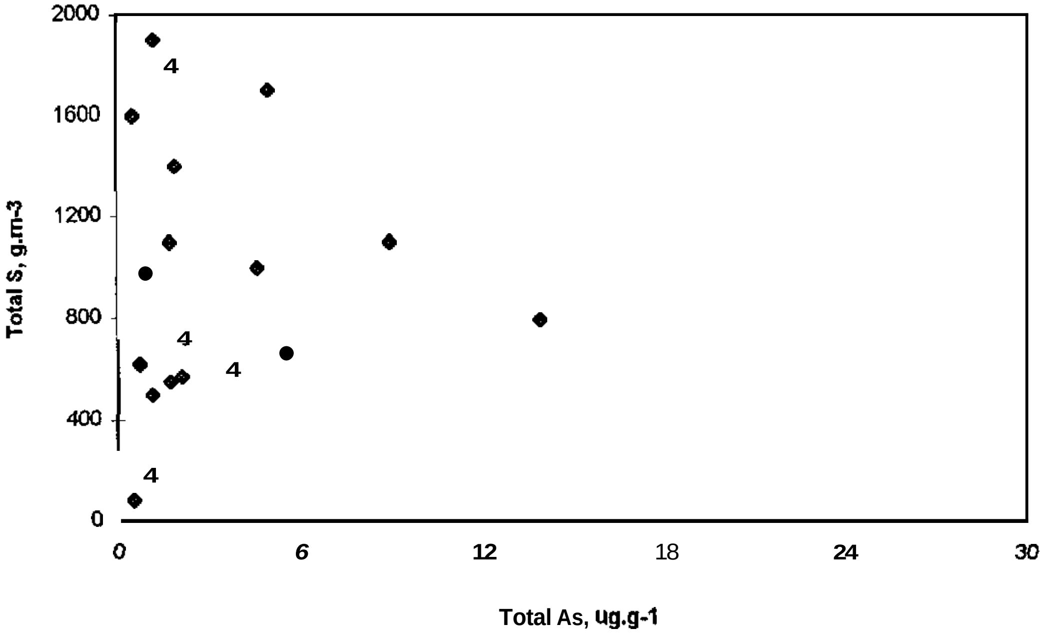


Fig. A2-8 a: Ni vs S
(range Ni: 0-300 ug.g-1; S: 0-6000 ug.g-1)

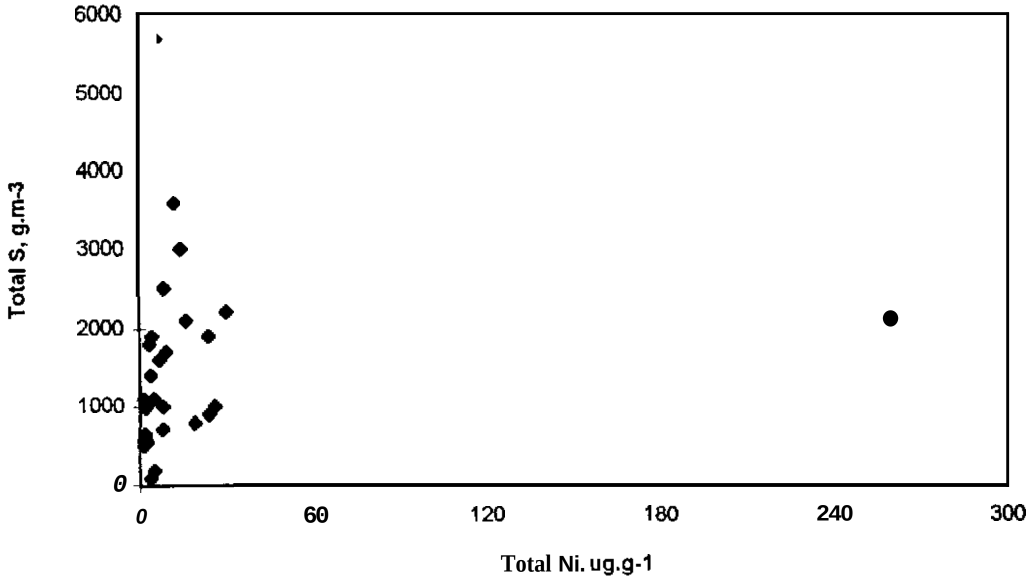


Fig. A2-8 b: Ni vs S
(range Ni: 0-40 ug.g-1; S:0-4000 ug.g-1)

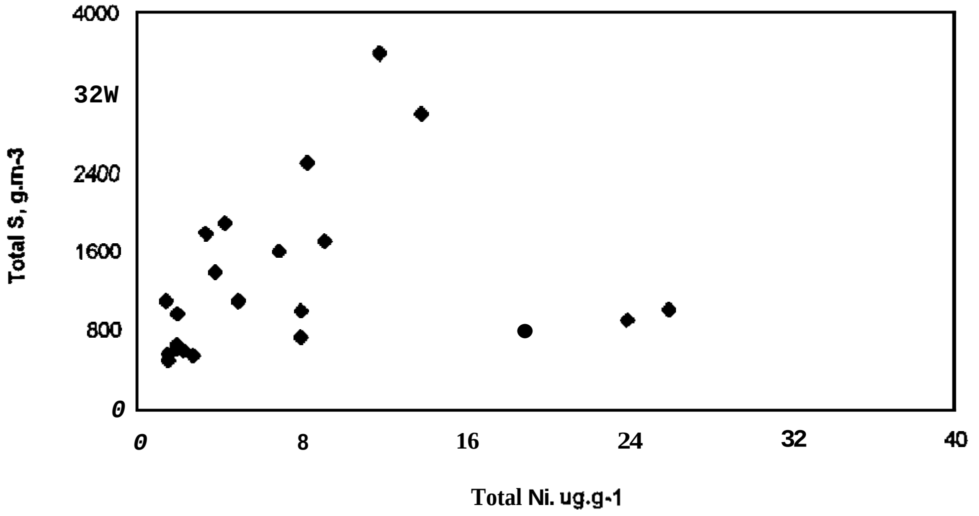


Fig. A2-9 a: As vs Fe
(range As: 0-1000 ug.g-1; Fe: 0-50000 ug.g-1)

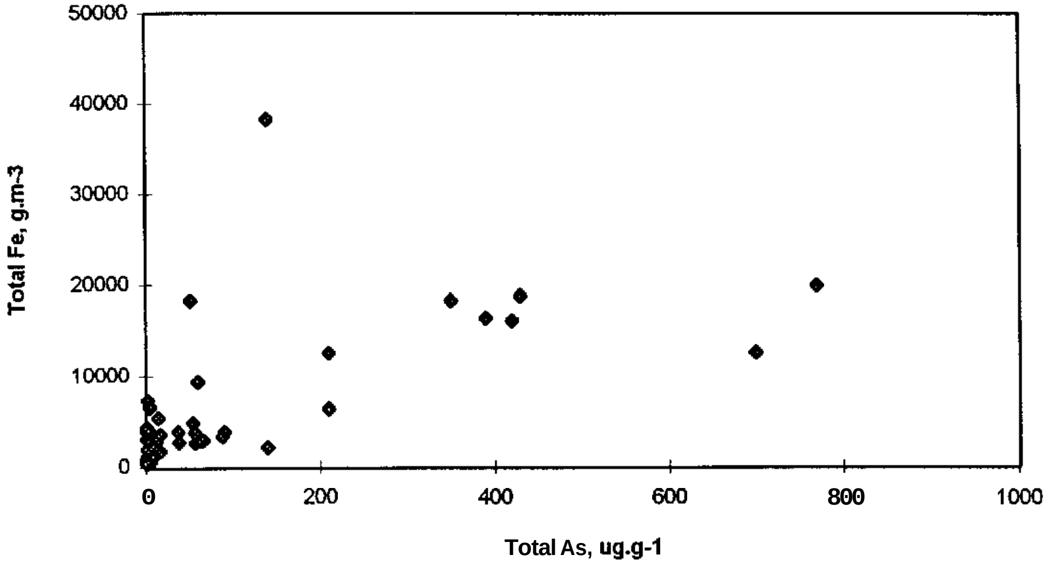


Fig. A2-9 b: As vs Fe
(range As: 0-200ug.g-1; Fe: 10000 ug.g-1)

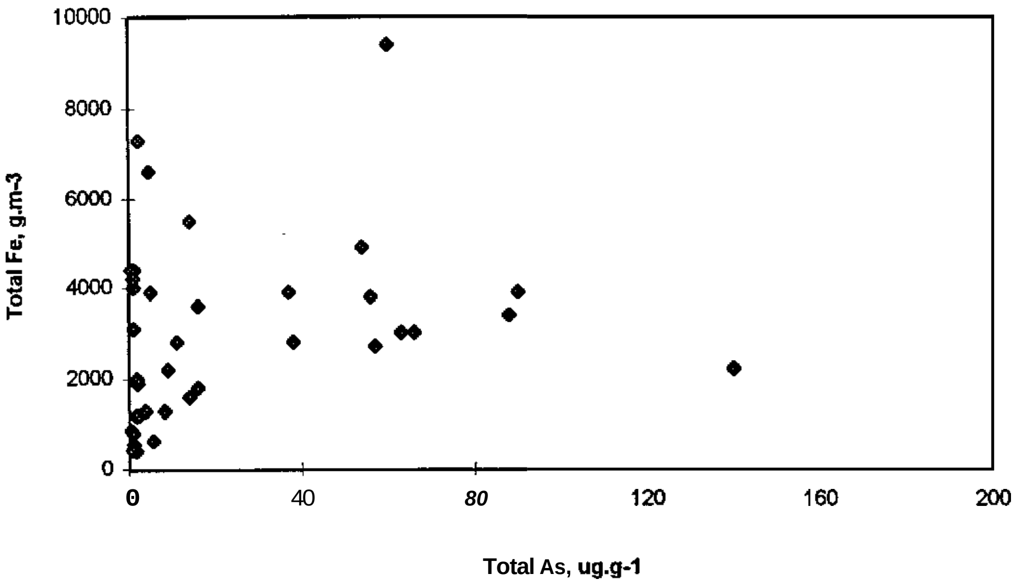


Fig. A2-10 a: Ni vs Fe
(range Ni 0-700 ug.g-1; Fe: 0-50000 ug. g-1)

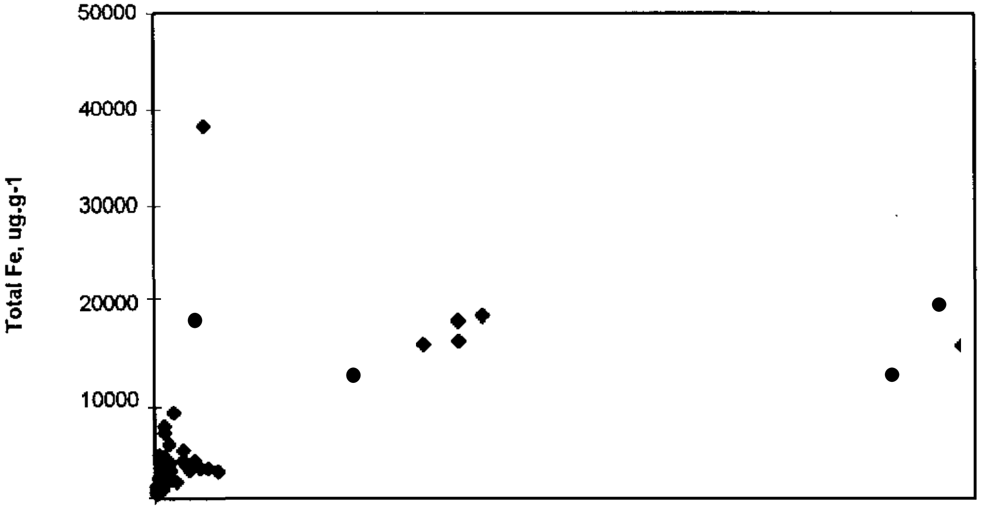


Fig. A2-10 b: Ni vs Fe
(range Ni: 0-100 ug.g-1; Fe: 0-10000 ug.g-1)

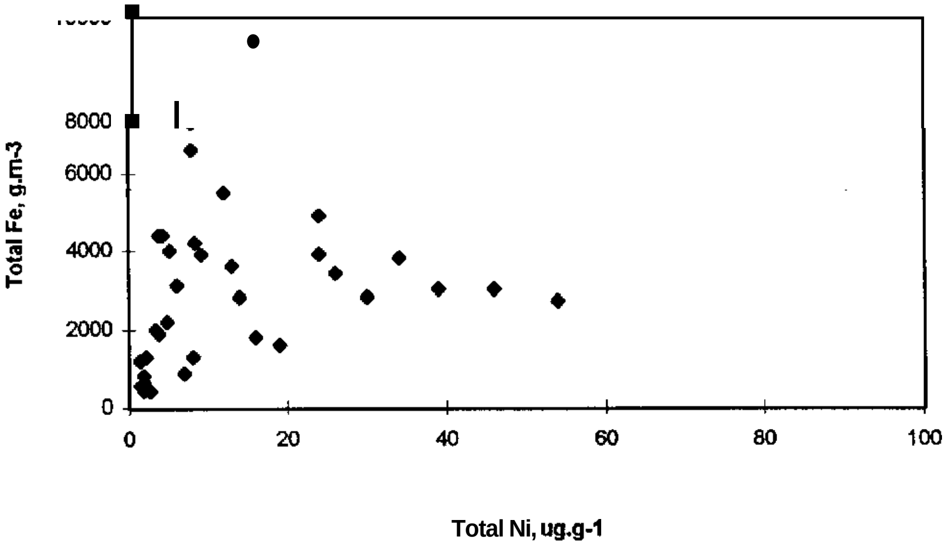


Table A2 -3: pH Comparison for 6-Zone Waste *Rock* Pile Solids / Ratio Effect on pH

Location	60 mL wet sample : 120 mL DH2O slurry				1 g dry sample : 100 mL DH2O slurry	
	dry weight (g/60 mL)	moisture (%)	1g dry sample : DH_2O ratio (calculated)	pH	1 g dry sample : DH_2O ratio (measured)	pH
NW Ditch Foam	6.1	79.2	1g : 23.5mL	5.08	1g : 100mL	5.49
BZWR-7Graphitic Gneiss	75.1	8.2	1g : 1.7mL	3.89	1g : 100mL	6.12
BZWR-6 Hematizxed	70.3	10.5	1g : 1.8mL	3.7	1g : 100mL	6.04
BZWR-6 As/Ni Oxidized	56.8	24.5	1g : 2.4mL	3.45	1g : 100mL	5.21
BZWR-6 SS Area	79.1	6.3	1g : 1.6mL	3.98	1g : 100mL	6.27
WRP-P Sludge	26.2	65.1	1g : 6.4mL	2.77	1g : 100mL	3.3

Table A2-4: Extractable Ni in Slurris of B-Zone Waste Rock Piles

Location	pH							Ni (mg/L)						
	(1g:100mL slurry)					(diluted to 200mL after 404h)		(1g:100mL slurry)					(diluted to 200mL after 404h)	
	1 h	67h	168 h	236 h	404 h	406.5 h	427.5 h	1 h	67h	72 h	236 h	404 h	406.5 h	427.5 h
New Ditch Foam	5.49	5.58	5.85	5.89	5.94	6.2	5.65	2.299	4.058	3.033	3.837	3.72	1.706	1.669
BZWR-7 Graphitic Gneiss	6.12	5.96	6.13	6.19	6.09	6.4	6.07	0.699	0.883	0.877	1.035	1.127	0.717	0.711
BZWR-6 Hematizxed	6.04	5.82	5.86	5.94	5.94	6.31	6.16	1.076	1.233	1.263	1.482	1.409	1.009	1.038
BZWR-6 As/Ni Oxidized	5.21	5.37	5.48	5.55	5.42	5.86	5.85	6.108	5.72	25.93	35.40	34.06	12.63	12.32
BZWR-6 Area SS	6.27	6.05	6.27	6.3	6.25	6.21	6.32	0.775	0.896	1.14	1.011	0.987	0.493	0.524
WRP-P Sludge	3.3	3.1	2.96	2.98	2.96	3.22	3.25	3.141	5.177	7.681	7.344	7.169	2.904	2.771

Table A2-5: Extracted Ni and As in Slurries of B-Zone Waste Rock Pile

Decant cycle	New Ditch Foam			BZWR-7 Graphitic			BZWR-6 Hematiz			BZWR-6 As/Ni Oxi			BZWR-6 Area S			WRP-P Sludge		
	DH2O added (mL)	Ni (mg/L)	As (mg/L)	DH2O added (mL)	Ni (mg/L)	AS	DH2O added (mL)	Ni (mg/L)	As (mg/L)	DH2O added (mL)	Ni (mg/L)	As (mg/L)	DH2O added (mL)	Ni (mg/L)	As (mg/L)	DH2O added (mL)	Ni (mg/L)	As (mg/L)
1	200	1.669	>3	200	0.711	0.8	200	1.038	2	200	12.32	>3	200	0.524	0.5	200	2.771	>3
2	100	0.646	1	100	0.514	0.1	100	1.067	0.25	100	2.325	2	100	0.256	0.05	100	0.115	1.5
3	100	0.686	0.8	100	0.394	0.05	100	0.699	0.2	100	1.86	1.7	100	0.201	0.03	100	0.072	1
4	100	0.57	0.7	100	0.342	0.02	100	0.6	0.1	100	1.506	1.5	100	0.118	0.01	100	0.056	0.7
5	100	0.477	0.5	100	0.195	0.01	100	0.542	0.05	100	1.344	1.5	100	0.093	0.005	100	0.053	0.4
6	100	0.44	0.4	100	0.118	0.005	100	0.437	0.03	100	1.445	1.2	100	0.063	0.005	100	0.056	0.3
7	100	0.462	0.4	100	0.124	0.01	100	0.391	0.2	100	1.384	1.2	100	0.047	0.005	100	0.069	0.2
8	100	0.416	0.4	100	0.087	0.01	100	0.308	0.08	100	1.255	1.2	100	0.1	0.001	100	0.047	0.2
9	200	0.339	0.3	200	0.078	0.01	200	0.201	0.05	200	1.046	2	200	0.078	0.01	200	0.047	2.5
10	200	0.354	0.3	200	0.047	0	200	0.186	0.05	200	0.895	2.2	200	0.109	0.03	200	0.118	3
11	200	0.265	0.3	200	0.047	0.03	200	0.124	0.2	200	0.923	>3	200	0.053	0.02	200	0.093	>3
12	200	0.293	0.2	200	0.047	0	200	0.13	0.2	200	0.978	2.5	200	0.038	0	200	0.044	0.2
13	200	0.201	0.2	200	0.047	0	200	0.139	0.2	200	0.892	2.2	200	0.047	0	200	0.032	0.2
DH2O(blank)	-	0.032	0	-	0.032	0	-	0.032	0	-	0.032	0		0.032	0		0.032	0

Table A2 -6: Cumulative Extracted Ni and As in Solids from B-Zone Waste Rock Pile

Decant cycle	New Ditch Foam			BZWR-7 Graphitedc Gneiss			BZWR-6 Hematizxed			BZWR-6 As/Ni Oxidized			BZWR-6 Area SS			WRP-P sludge		
	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)	DH2O added (mL)	Ni (mg/kg)	As (mg/kg)
1	200	327.4	>600	200	135.82	80	200	201.2	400	200	2457.6	>600	200	98.42	100	200	547.8	>600
2	100	61.41	100	100	48.21	10	100	103.5	25	100	229.31	200	100	22.41	5	100	8.31	150
3	100	65.41	80	100	36.21	5	100	66.71	20	100	182.81	170	100	16.91	3	100	4.01	100
4	100	53.81	70	100	31.01	2	100	56.81	10	100	147.41	150	100	8.61	1	100	2.41	70
5	100	44.51	50	100	16.31	1	100	51.01	5	100	131.21	150	100	6.11	0.5	100	2.11	40
6	100	40.81	40	100	8.61	0.5	100	40.51	3	100	141.31	120	100	3.11	0.5	100	2.41	30
7	100	43.01	40	100	9.21	1	100	35.91	20	100	135.21	120	100	1.51	0.5	100	3.71	20
8	100	38.41	40	100	5.51	1	100	27.61	8	100	122.31	120	100	6.81	0.1	100	1.51	20
9	200	61.4	60	200	9.22	2	200	33.82	10	200	202.82	200	200	9.22	2	200	3.02	250
10	200	64.4	60	200	3.02	0	200	30.82	10	200	172.62	440	200	15.42	6	200	17.22	300
11	200	46.6	60	200	3.02	6	200	18.42	20	200	178.22	>600	200	4.22	4	200	12.22	>600
12	200	52.2	40	200	3.02	0	200	19.62	20	200	189.22	500	200	1.22	0	200	2.42	40
13	200	33.8	40	200	3.02	0	200	21.42	20	200	172.02	440	200	3.02	0	200	0.02	40
Total	1900	933.3	1280	1900	312.19	108.5	1900	707.4	571	1900	4462.1	3810	1900	197	122.6	1900	607.2	2260

Table A2 -7: Chemistry in Slurries of B-Zone Waste Rock Pile

				ZWR-7 Graphitic Gneis						ZWF	As/Ni Oxidized		BZ...R-6 A... SS			WRP-P		udge
ecan cycle	H2O dded			H2C ddec (mL)	pH	Cond (us/cr	H2O added (mL)			H2C dded (mL)	pH	Cond. (us/cm)	DH2O added (mL)	pH	Cond (us/cn	H2O dded (mL)	pH	Cond (us/cn
1	200	5.65	87.6	200	6.07	36.5	200	6.16	41.4	200	5.85	91.4	200	6.32	39.6	200	3.25	377
2	100	5.96	43	100	6.2	40	100	6.3	40	100	6.27	44	100	6.44	41	100	3.65	155
3	100	6.06	41	100	6.29	41	100	6.4	40	100	6.39	43	100	6.52	40	100	3.8	124
4	100	6.3	34.2	100	6.16	33.1	100	6.26	33.3	100	6.38	36.7	100	5.95	32.9	100	3.87	101.
5	100	6	34.4	100	6.45	33.6	100	6.4	33.6	100	6.52	36.4	100	6.33	33.4	100	3.92	90.4
6	100	6.36	37	100	6.6	43.2	100	6.67	42.7	100	6.67	45.2	100	6.74	42.6	100	3.96	101.
7	100	6.25	36.9	100	6.58	43.7	100	6.65	42.8	100	6.66	46.2	100	6.76	42.3	100	3.99	100.
a	100	6.2	37.2	100	6.56	36.7	100	6.65	42.2	100	6.65	44.9	100	6.75	42.1	100	4.14	86
9	200	5.97	43.5	200	6.54	36.8	200	6.63	42.3	200	6.66	44.8	200	5.74	42.2	200	4.48	71
10	200	6.05	31	200	6.35	30	200	6.12	30	200	6.34	33	200	3.38	30	200	4.55	53
11	200	6.66	33	200	6.61	32	200	6.59	33	200	6.54	33	200	5.61	31	200	4.55	47
12	200	6.45	39	200	6.17	39	200	6.34	38	200	6.35	42	200	5.44	39	200	4.64	51
13	200	6.33	39	200	6.27	39	200	6.33	39	200	6.28	41	200	6.37	38	200	4.81	49
H2C	-	6.53	39		6.53	39	-	6.53	39		6.53	39		3.53	39	-	6.53	39
lank	-	6.51	33.2	-	6.51	33.2	-	6.51	33.2		6.51	33.2		3.51	33.2	-	6.51	33.2

Table A2-8: Arsenic, Nickel, Iron, Sulphur and LOI Mass in BT-1, BT-2, BT-3, BT-4 and Lake 1 Muskeg, Sediments and Pond Water.

Area	Zone	Surface Area Pond			Muskeg Surface - 0.25 m					Sediment Surface - 0.25 m					Pond Water - 0.5 m			
		Muskeg Area ha	Sediment Area ha	Total Area ha	Total As kg	Total Ni kg	Total Fe kg	Total S kg	Total LOI t	Total As kg	Total Ni kg	Total Fe kg	Total S kg	Total LOI t	Total As kg	Total Ni kg	Total Fe kg	Total S kg
BT-1	A	1.6	1.7	3.3	1.0	3.7	3,824	1,651	790	282	187	12,737	1,955	316	1.2	0.4	3.5	14
	B	3.8		3.8	37	16	3,348	615	615									
	C	1.4	0.33	1.8	5.7	7.8	654	323	401	24	19	1,411	375	73	0.032	0.013	1.4	0.50
	D	3.9	0.85	4.7	2.5	9.0	9,174	3,961	1,895	60	49	3,628	965	187	0.29	0.08	0.64	1.3
	E	1.2	0.20	1.4	0.83	0.59	473	225	386	14	11	849	226	44	0.019	0.008	0.82	0.30
	F	3.9	0.45	4.3	19	20	2,967	3,228	1,350	32	26	1,921	511	99	0.043	0.018	1.9	0.68
	SUM	**16**	**3.6**	**19**	**66**	**57**	**20,439**	**10,003**	**5,438**	**412**	**292**	**20,545**	4,032	**719**	**1.6**	**0.5**	**8.2**	**16**
BT-2	A	4.1	3.0	7.1	7.56	13	10,846	10,846	1,485	383	359	10,558	4,744	540	8.9	1.0	3.4	6.2
	B	17	1.9	19	36	30	7,580	45,361	2,167	27	22	1,978	3,006	862	0.91	0.13	4.3	6.7
	SUM	**21**	**4.9**	**26**	**43**	**44**	**18,426**	**56,207**	**3,652**	**410**	**381**	**12,536**	**7,750**	**1,401**	**9.8**	**1.1**	**7.6**	**13**
3T-3	A	1.6	0.25	1.8	446	282	6,819	1,005	317	10	8	163	172	58	8.7	21.5	1.8	135
	B	2.1	0.1	2.2	15	6.7	2,290	1,422	448						0.02	0.02	0.52	0.80
	SUM	**3.6**	**0.4**	**4.0**	**461**	**289**	**9,109**	**2,427**	**766**	**10**	**8**	**163**	**172**	**58**	**8.7**	**21.6**	**2.3**	**135**
3T-4	A	**3.2**	**0.1**	**3.3**	**42**	**21**	**40,939**	**3,914**	**829**						**0.02**	**0.01**	**7.1**	**3.5**
AKE	A	4.9		4.9	108	32	4,181	1,230	1,141									
	B	58	8.3	66	15	24	3,695	4,956	8,831	3.9	36	18,184	10,824	4,093	0.02	0.08	13	1.4
	SUM	**63**	**8.3**	**71**	**124**	**56**	**7,876**	**6,186**	**9,972**	**3.9**	**36**	**18,184**	**10,824**	**4,093**	**0.02**	**0.08**	**13**	**1.4**
	SUM	**107**	**17**	**124**	**735**	**467**	**96,790**	**78,738**	**20,656**	**837**	**718**	**51,428**	**22,777**	**6,271**	**20**	**23**	**38**	**169**

APPENDIX 3

CALCULATION OF TOTAL WATER SOLUBLE FRACTION

Appendix 3: Total water soluble quantity:

Extractable Ni and As in solids (mglkg) from B-Zone Waste Rock Pile are calculated based on the following equation and the results list in Appendix 2 (Table A2-5).

$$\text{Ni (mg/kg)} = \frac{(\text{[Ni] in slurry} - \text{[Ni] in DH2O}) \text{ (mg/L)} * \text{DH20 added (mL)} \; 11000}{\text{Dry sample weight (g)}} * 1000$$

where: [Ni] in **DH2O(distilled water)** = **0.0319** mg/L

$$\text{As (mg/kg)} = \frac{(\text{[As] in slurry} - \text{[As] in DH2O}) \text{ (mg/L)} * \text{DH20 added (mL)} \; 11000}{\text{Dry sample weight (g)}} * 1000$$

where: [As] **in DH2O(distilled water)** = 0 mg/L

The percentage of extracted Ni (E-Ni) or **As (E-As)** in total Ni (T-Ni) or As (T-As) are calculated based on the following equation (Table **9):**

$$\text{E-Ni in T-Ni (\%)} = \frac{\text{Extracted Ni (mglkg)}}{\text{Total Ni (mglkg)}} * 100 \qquad \text{E-As in T-As (\%)} = \frac{\text{Extracted As (mglkg)}}{\text{Total As (mglkg)}}$$

*100

APPENDIX 4

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Wetlands for Treatment of Arsenic and Nickel:
A Decommissioning Approach for Waste Rock Pile Seepage*

M. Kalin, M.P. Smith
Boojum Research Limited
468 Queen Street East, LL2
Toronto, Ontario M5A 1T7

ABSTRACT

A waste rock pile in northern Saskatchewan, *Canada* consisting of 5.6 million m^3 of waste rock was generated by open pit mining of uranium between 1984 and 1991. Decommissioning options for the waste rock pile are based on the geochemical and hydrological conditions of the pile and the surrounding environment. The contaminants of concern are As and Ni. The total contaminant mass which is likely to be mobilized from the waste rock pile is estimated between 240 t and 403 t for As, and 357 t and 447 t for Ni. The annual release rate is estimated for As at 1.7 $t.y^{-1}$ and for Ni, 4.9 $t.y^{-1}$. Presently, seepage from the waste rock pile is collected and chemically treated. The waste rock pile is surrounded by fens and muskeg. the wetland equivalents in boreal ecosystems. This physical setting lends itself to implementing a self-sustainable decommissioning approach utilizing the muskeg and fens which surround the pile. The fens have been studied over the past five years for their ability to retain As and Ni in the sediments. Field experiments, complemented by laboratory studies, have established a contaminant removal capacity for Ni of between 0.07 $g.m^{-2}.d^{-1}$ and 0.1 $g.m^{-2}.d^{-1}$, and for As, between 0.08 $g.m^{-2}.d^{-1}$ and 0.1 $g.m^{-2}.d^{-1}$ can be removed. The area of the wetlands available to mediate the annual contaminant load is 18 ha. At maximum. 16 ha are required during the ice free season to accommodate the seepage accumulation from spring run-off and the flow generated during the summer. Microbial community activity is the main factor facilitating ongoing contaminant removal from the seepage water. The treatment capacity has been demonstrated for both natural fen sediments. and for sediiments amended with organic matter additions to stimulate microbial activity.

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INTRODUCTION

In decommissioning mine waste management areas, a wide range of options for the restoration of the mine wastes are typically evaluated. The primary long-tern concern is the release of contaminant compounds from weathering mining wastes such as waste rock and tailings. With sufficient net atmospheric precipitation, contaminated seepages commonly emerge from the toe of waste rock piles which, in many cases, require treatment in order to protect surface water quality of the receiving aquatic environment. Since weathering processes are slow, contaminant release and the need for its treatment can span decades or longer. Chemical treatment of waste rock seepages generates sludge containing high metal concentrations, which in turn require containment and long-term storage facilities. The search for low maintenance alternatives to chemical treatment over the last decade has included assessments of natural treatment options, such as the utilization of sediments in wetlands as self-sustaining contaminant removal systems.

A review of the 35 papers (1), describing various types of wetlands as treatment options for mine effluents, revealed that. when the pH of such systems is above 4.5 and the acidity is less than 300 $mg \cdot L^{-1}$, these passive approaches are very effective. This paper reports the results of a five year study which has lead to the integration of existing wetlands surrounding a waste rock pile as treatment areas for removal of contaminants from toe seepages.

Several studies (e.g., 2, 3) have demonstrated the capacity of wetlands to remove heavy metals from contaminated waters in a wide variety of situations. Stimulation of sediment microbiology through addition of readily degradable organic carbon, such as potato waste or alfalfa pellets, has been proven to augment metal removal and improve seepage characteristics (2). The effectiveness of such amendments was tested using sediments from the wetlands adjacent to the waste rock pile, both in the laboratory using reactors (4, 5) and in the field in enclosed sections of an adjacent fen *(6).* The forms of contaminants which accumulated in sediments of the enclosures and in the laboratory reactors were also identified (7).

SITE DESCRIPTION

An open pit uranium mining operation, located on the Harrison Peninsula of Wollaston Lake, northern Saskatchewan, 58° 11' N, 103° 41' W (Figure 1), generated a 5.6 million m^3 waste rock pile between 1984 and 1991. The waste rock pile is comprised of approximately 9.1 million tonnes of material placed within a 26.2 ha area, including a peripheral run-off collection ditch system (Figure 2). Over the eight year operation, waste rock was enddumped and compacted by bulldozer. The waste rock included till, overburden sand, sandstone @leached. hematized, limonized), *quartz* biotite gneiss and graphitic gneiss excavated from the open pit.

Since completion of pile in 1991, no contouring, capping or revegetating has taken place. The waste rock pile is exposed to an average total precipitation of *565* mm (1972-1995 average), while the net annual precipitation is estimated at 230 mm. The annual average temperature is -4.7° C (1951-1980).

To address the weathering characteristics. the waste rock pile has been studied in three major sampling and laboratory testing campaigns. The conclusions drawn from these tests were-that, first, there may be sufficient neutralizing minerals present in the waste pile to buffer drainage between slightly acidic and neutral pH values; second, the graphitic gneiss material. although present in relatively limited quantities, indicates a potential for acid generation, and it is expected that drainage from this material will influence the overall average drainage water quality; and third, bleached limonitic sandstone, which represents the largest portion of the rock pile, released stored oxidations products during the initial flushing stages. indicating that potential exists for the short-term release of metals.

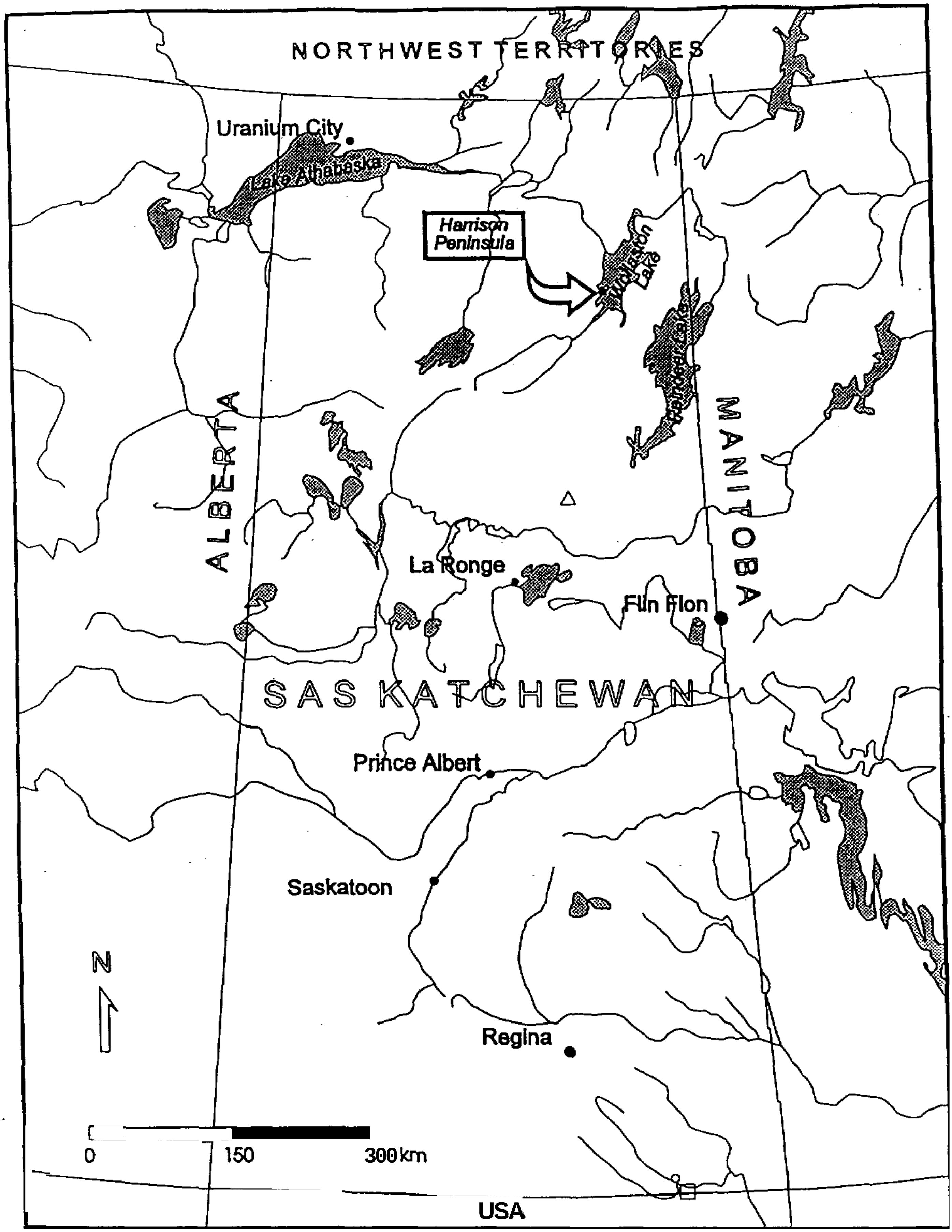

Figure 1 - Location of Harrison Peninsula, Wollaston Lake, northern Saskatchewan, Canada.

The waste rock was deposited in a muskeg **area,** and three fens are located immediately adjacent to the pile (Figure **2).** Hydrogeological studies **of** the vicinity indicate that the fens northwest of the waste rock pile, comprised of shallow, open water ponds overlying muskeg sediments, are perched water bodies.

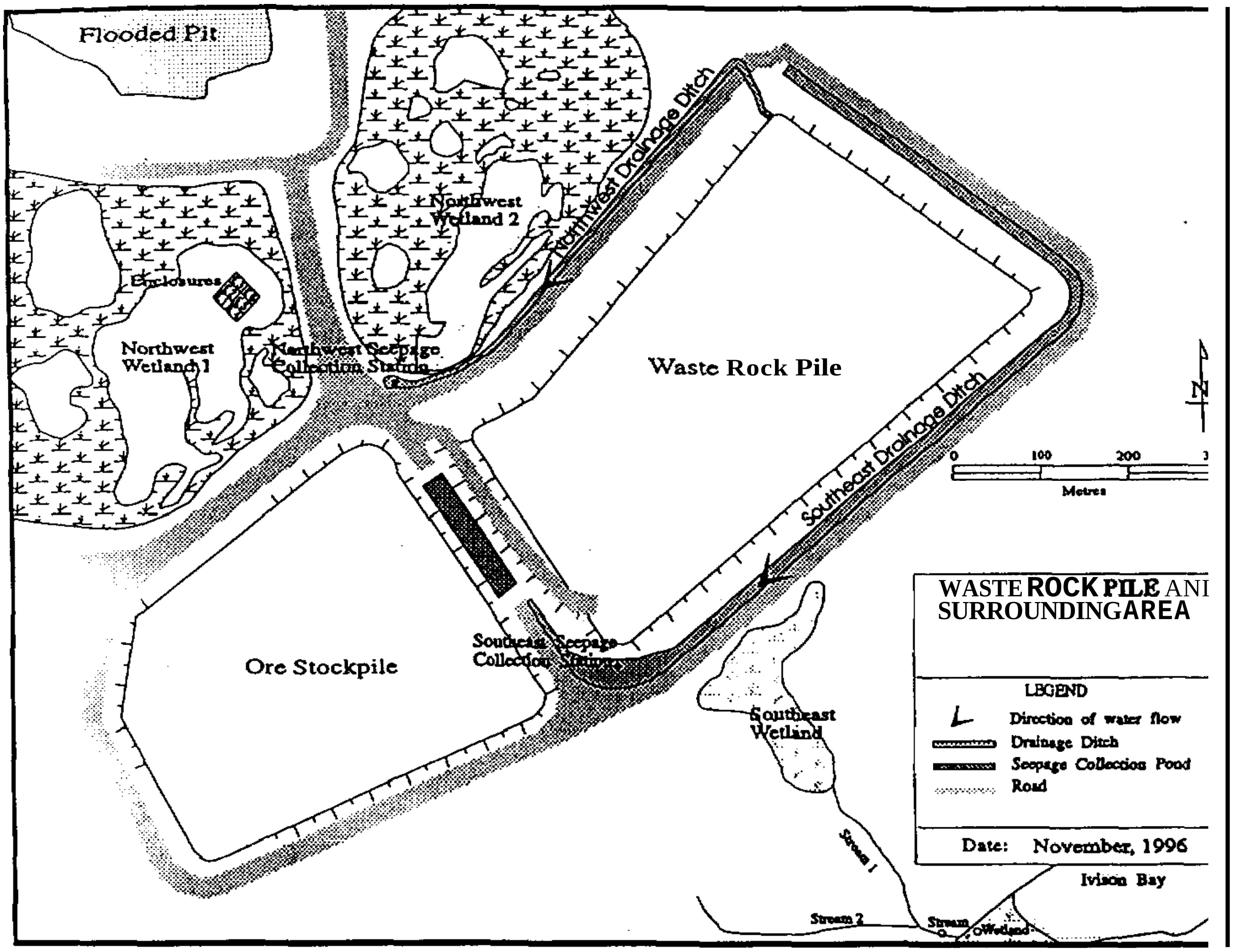

Figure **2** - The waste **rock** pile and surrounding area.

These wetland areas **are** being examined **for** their possible use as treatment systems for seepage draining from the waste rock pile, given their hydrological **and** biological conditions. Following decommissioning. seepage emerging from the waste rock pile would be directed into the wetlands where the contaminants would be retained in the sediments.

SEEPAGE **CHARACTERISTICS**

Seepages emerge from the waste **rock** pile principally from the first bench, or the toe of the pile. On the southwest side, seepages emerge from the sides **of** the inner banks of the seepage collection ditch, or from the *first bench of* the waste **rock** pile, then **flowing** overland to the perimeter ditch. On the northwest side, all seepages emerge from the bottom of the pile. but flow overland, crossing the perimeter road and drain into the collection ditch. Seepages have not been observed along the southwest side adjacent to the ore stockpile area. The site lay-out, including the waste rock pile, the Northwest and Southeast drainage ditches and the wetlands, **is** given in Figure **2.**

Seepage is collected and pumped for treatment at the Northwest Seepage Collection Station and also at the Southeast Seepage Collection Station (Figure **2).** The water quality of seepage collecting at these stations in presented in Table I.

Seepage waters collected at the Northwest and Southeast pumping stations have, on average, low pH (4.3 and 3.3, respectively) and relatively high conductivities (1100 and 1670 $\mu S.cm^{-1}$) and total dissolved solids (TDS) concentrations (1022 and 1538 $mg.L^{-1}$, respectively). Calcium and sulphate are major constituents contributing to these solutions' high TDS. Both total arsenic and nickel are present in elevated concentrations in solutions collected at the Northwest and Southeast Seepage Collection Stations, averaging 30 and 27 $mg.L^{-1}$ As and 47 and 99 $mg.L^{-1}$ Ni, respectively. Seepage waters also contain elevated concentrations of biologically-available forms of nitrogen (nitrate, ammonia, Kjeldahl nitrogen) and phosphate, essential nutrients which will support the microbial treatment **process.**

Table I - Chemical/Physical Parameters, Major Anion and Cation Concentrations in Northwest (1987-1996) and Southeast (1994-1995) Seepage Collection Stations water

	Northwest Seepage Collection Station					Southeast Seepage Collection Station				
	1987 - 1996					1994 - 1996				
	Avg.	S.D.	Min	Max	N	Avg.	S.D.	Min	Max	N
Temp (°C)	12	5.7	0.50	21	24	17	5.0	11.3	26.0	5
pH	4.3	4.1	3.3	6.8	44	3.3	3.4	3.0	6.3	5
Cond ($uS.cm^{-1}$)	1104	782	35	3540	34	1669	235	1461	2010	5
Eh (mV)	477	54	368	574	12	463	213	97	634	4
In $mg.L^{-1}$ Acidity	72	57	3.3	158	5	186				I
Alkaliity	5.0				l					0
TDS	1022	964	10	4170	23	1538	463	923	2040	3
TSS	384	790	1.0	3580	48	4.5	0.50	4.0	5.0	2
Tot Hardness	478	543	17	2030	12					0
Cl	2.6	1.7	0.60	7.0	30	4.2	2.0	2.0	8.0	5
F	0.13	0.12	0.03	0.49	IS	0.84				I
HCO_3	2.8	1.8	<0.1	7.0	22	I.0	0	<1.0	I.0	4
NH_3-N	3.2	2.4	0.12	8.5	27	3.2	1.6	0.12	4.2	5
NO_3-N	45	43	3.0	128	24	28	22	4.5	71	5
SO_4	592	4%	9.8	2320	32	1058	99	965	1210	5
Tot PO,	25	24	0.11	89	24	28	16	13	58	5
TKN	4.1	1.5	I.4	5.8	9	4.4	0.15	4.2	4.5	2
AI	13	20	0.11	68	20	8.5				I
Total As	30	36	0.13	130	40	27	12	13	46	5
Ba	0.13	0.14	0.02	0.46	18	0.019				I
Ca	120	93	1.6	441	31	201	25	167	230	5
Tot Fe	6.1	I2	0.09	44	17	4.4	2.1	0.86	8.5	4
K	22	15	1.9	68	31	23	10	6.2	33	4
Mg	54	46	2.0	227	31	91	IS	80	122	5
Mn	3.5	2.3	0.28	7.3	26	8.0	2.6	4.4	11	4
Na	22	19	1.4	88	26	21	8.2	5.3	28	5
Total Ni	47	55	0.56	220	40	99	19	77	130	4

CONTAMINANT LOADS

The annual loads of As and Ni which must be removed by passive treatment system can be calculated by multiplying the average quality of seepage water reporting to the seepage collection stations (in $mg.L^{-1}$) by the estimated annual flow volumes (in $L.y^{-1}$).

.Between **1992** to **1995**, seepage flow from the waste rock pile was monitored using records of seepage volumes pumped over the ice-free season at the Northwest and Southeast Seepage Collection Stations. However. seepage volumes pumped in over the ice free season and the amount of precipitation in the same period were poorly correlated. based on detailed records from a weather station on the waste rock pile. Therefore. flow volumes were instead calculated by multiplying the areas of the waste rock pile and perimeter ditch system (**26.2** ha) by the estimated annual net precipitation (**228** mm.y^{-1}), yielding a volume of **59,642** $m^3.y^{-1}$ (Table II). This value represents the best approximation between the field measurements and estimates derived from pumping records.

In Table II, the estimated As and Ni loads are presented. Based on seven surveys of individual toes seepages emerging from the base of the waste rock pile, there is some indication that more seepage reports to the Southeast (0.33 L.s^{-1}), compared to the Northwest (0.17 L.s^{-1}), Seepage Collection Station. Therefore, two-thirds (64 %) of the run-off volume was assigned to the Southwest Seepage for calculation of its contribution to the annual As and Ni load. Each year, removal of as much as 1.7 t of As and **4.9** t of Ni will be required in the treatment system (Table II).

Table II - Estimated Annual Arsenic and Nickel Loads in Waste Rock Pile Seepages.

Seepage Collection Station	Average Total [As] mg.L^{-1}	Average Total [Ni] mg.L^{-1}	Net Precipitation on Pile (26.2 ha, 228 mm.y^{-1}) $m^3.y^{-1}$	Fraction of Pile Drainage Basin %	Annual As load t.y^{-1}	Annual Ni load t.y^{-1}
Northwest (1987-1996)	30	47	59,642	34	0.61	0.95
Southeast (1994-1996)	21	99	59.642	66	1.1	3.9
					As	Ni
				Total Load, t.y^{-1}	1.7	4.9

The inventory of the total mass of As and Ni contained in the waste rock pile which might be leached with time was estimated based on the results of whole rock analyses, **25** hour leach and humidity cell tests and sequential extraction procedures (data not shown). The estimate mass of As which may be leached ranges from **240** t to ***400*** t, while for Ni, **350** t to **450** t. Previously, it was estimated that 1.7 tonnes of As and **4.9** tonnes of Ni leave the pile each year (Table II). This results in the projection that the arsenic supply in the pile will be depleted in 140 to 240 years and nickel will be depleted in the range of 73 to **91** years.

CONTAMINANT REMOVAL CAPACITY OF WETLAND SEDIMENTS

The waste rock conditions. the hydrological conditions and the contaminant release rates from the waste rock pile, suggest that decommissioning plans have to consider at least a time span of **100** to **200** years for As and Ni. Although this is relatively short in comparison to radiological concerns raised in the uranium sector. it remains a time span exceeding the life of the mining activities on the peninsula. Wetlands as passive treatment options have received extensive attention as possible polishing/treatment areas.

The microbial activity of the muskeg sediments could be enhanced through addition of easily degradable organic material. Consequently, As and Ni is removed from the water through organic complexation as a result of decomposition of organic mater. The pH would be elevated due, in part. to microbial iron reduction. In the deeper portions of the sediments. where low Eh is maintained, metals form either carbonates or sulphides which are relatively stable environmentally and are removed from the weathering cycle. These As and Ni removal processes. expected to take place in the sediments, formed the working hypothesis which has been tested both in the laboratory and in the field since **1992.**

The ability of muskeg sediments to remove Ni and As from waste rock pile seepage water has been demonstrated both in the field and in the laboratory (Table III). The rates for the field enclosures are lower, but of the same order of magnitude as in the laboratory reactors. This is not surprising, since the field rates are underestimated, and the process is not optimized. The average As removal rate in the field enclosures was 0.076 mg·m^{-2}·d^{-1}, while in the laboratory reactor experiments, the average As removal rate was very similar, at 0.1 mg·m^{-2}·d^{-1}. The field enclosure Ni removal rates averaged 0.078 g·m^{-2}·d^{-1}, while in the laboratory reactors Ni removal rates averaged 0.104 mg·m^{-2}·d^{-1} (Table III). There was, however. a high degree of variability in the field results due to long intervals between sampling.

Table III - Overview of Observed As and Ni Removal Rates (g.m^{-2}.d^{-1}) and As and Ni Removal Ability (g.m^{-2}) by Sediments Based on Field Enclosures and Laboratory Reactors Data.

	ARSENIC					NICKEL				
	Removal Rate			Removal			Removal Rate		Removal	
	Avg	Max	N	Ability		Avg	Max	N	Ability	
	g.m^{-2}.d^{-1}	g.m^{-2}.d^{-1}		g.m^{-2}		g.m^{-2}.d^{-1}	g.m^{-2}.d^{-1}		g.m^{-2}	
FIELD	0.076	0.16	7	17	(a)	0.078	0.17	7	48	(a)
LABORATORY (c)	0.10	0.22	7	51		0.10	0.33	7	59	(b)

a Total mass of diss As. in g.m^{-2} added to enclosures July-92 to June-95; max removal ability not reached.
b Final Ni maximum removal ability was not reached by end of lab reactor experiment.
c Laboratory removal rates based on observed concentrations decreases in known volumes over recorded time.

The maximum loads of As and Ni which can be added before the removal process is halted were derived based on the laboratory reactor responses to repeated additions of contaminants. Based on these data. 1 m^2 of muskeg sediment (with addition of 637 g·m^{-2} of potato waste) is able to remove, without any further addition of organic matter, 52 g·m^{-2} for As and a minimum of 59 g·m^{-2} for Ni (Table III). The field enclosures received loads of 17 g·m^{-2} As and 48 g·m^{-2} Ni, the total mass of dissolved As and Ni added to the enclosures between July 1992 and August, 1995 (Table I), without any signs of the removal process slowing. The contaminant removal ability of the field enclosures did not appear to be exceeded. The reactors have no ability to regenerate sediment through organic carbon production, while sediment regeneration in the enclosures is possible through primary productivity by the phytoplankton community. Actual contaminant removal ability of the sediments may be much higher than estimated, and saturation may never be reached. By continuous production of organics, formed through decomposition of organic matter, new sediment layers will accumulate, burying and mineralizing the contaminants in deeper strata of the sediment.

SEEPAGE TREATMENT SYSTEM REQUIREMENTS

Estimates of actual annual dissolved Ni and As loads from waste rock pile seepages (Northwest pumping station rates and average concentrations) for the years 1992 to 1995 are calculated to assess the capacity of the contaminant removal ability of wetland sediments, based on the static laboratory and field test results (Table IV). Using the water quality data from the seepage collection stations and that volume of run-off which reported to the seepage collection station, the actual loads which would reach the wetlands and could be treated can be calculated. The annual loads, 270 kg As and 720 kg Ni per year (1992-1995 average) based on pumping records, are used to estimated the required area for removal, without optimisation of the microbial system at work.

Table IV - Areas of Wetland Required to Support As and Ni Removal Based on Laboratory Reactor and Field Enclosure Removal Rates.

ARSENIC

Year	Days in Period	Estimated As Load, kg, in snow-free season	Area Required 1992 - 1995 Enclosure Rates $0.076\ g.m^{-2}.d^{-1}$		Area Required Laboratory Reactor Rates $0.100\ g.m^{-2}.d^{-1}$	
1992	157	69	0.6	ha	0.4	ha
1993	162	347	2.8	ha	2.1	ha
1994	138	236	2.3	ha	1.7	ha.
1995	113	428	5.0	ha	3.8	ha
Avg		270	2.7	ha	2.0	ha

NICKEL

Year	Days in Period	Estimated Ni Load, kg, in snow-free season	Area Required Enclosure Rates $0.078\ g.m^{-2}.d^{-1}$		Area Required Laboratory Reactor Rates $0.104\ g.m^{-2}.d^{-1}$	
1992	157	97	0.8	ha	0.6	ha
1993	162	483	3.8	ha	2.9	ha
1994	138	886	8.2	ha	6.2	ha
1995	113	1410	16.0	ha	12.0	ha
		719	7.2	ha	5.4	ha

Total areas available, 18 ha
(Northwest Wetland 2, 2.4 ha, Northwest Wetland 1.6.1 ha, Southeast Wetland, 3.7 ha, West Lake, 5.6 ha).

The estimated waste rock pile As and Ni loads for the 1992 to 1995 snow-free seasons, and the field enclosure and laboratory reactor As and Ni removal rates, are used to estimate the required wetland area to contaminant removal (Table III). For As, required wetland area estimates range from 0.4 ha (1994 load, lab reactor rate) to 5.0 ha (1995 load, field enclosure rate). For Ni. required wetland area estimates range from 0.6 ha (1992 Ni load, lab reactor rate) to 16 ha (1995 Ni load, field enclosure rate). The largest required area, 16 ha, based on the increased flow estimates in 1995, is close to the total area of wetlands in the vicinity of the waste rock pile (18 ha).

The area of active wetland sediment underlying open water required to removal annual loads of As and Ni is estimated at 7.2 ha (Table IV). This area is considerably less than the combined areas of the two northwest wetlands, and construction of additional wetland area will not be required. It should also be noted that only the area of wetland with a water cover was used in the area estimate. Polishing capacity is also present in partially emergent areas along the perimeters of the wetlands. The areas of wetlands required for contaminant removal were based on the ice free-season alone, while additional removal can be anticipated over the remainder of the year. During the course of the enclosures field work, it was observed that the water levels of the wetlands, overlying perched water tables, decreased each season by up to 0.3 m. The bulk of waste rock pile seepage water is anticipated during spring run-off, when the capacity of the wetlands for water is largest. All calculations regarding wetland treatment capacity were based on conservative estimates of contaminant loads and removal rates.

SUSTAINABILITY OF PASSIVE TREATMENT APPROACH

It is anticipated that the key question which will be raised, in relation to utilizing wetlands as passive treatment systems, is whether the processes observed in the field enclosures and laboratory reactors will operate in the long term. Generally, peat muskeg/fen-type ecosystems evolve in areas with low productivity and low decomposition rates. Decomposition of organic carbon, however, is essential for the support of biologically-mediated contaminant removal in the sediments. The top 0.15 m of sediment can be assumed to be the active zone supporting the microbial community which, in turn, assists contaminant removal. The period required for replacement of the organic content of **this** layer should be the same as, or less than, the period **over** which the **As** and Ni removal ability of the sediments is exhausted, if the claim to sustainability of the process is to be substantiated.

The number of years over which **As** and Ni will be removed by the existing wetland area can be estimated. **This** is based on a wetland treatment system size of 7.2 ha and the annual average collected **As** **and** Ni loads, 270 kg·yr^{-1} and 719 kg·y^{-1} respectively, generated by the waste rock pile (Table IV). presently, the current wetland sediment, without regeneration **of** organic carbon, could support **As** removal **for 14** years, and Ni removal for at least **6** years. Estimates for the length **of** the time the pile will generate contaminants until the supply is exhausted range from 140 years to **240** years for **As.** and from 73 to 91 years for Ni.

The active sediment layer will have to regenerate approximately ten times until the waste rock pile **As** and Ni supply **is** exhausted. The wetlands will likely be capable **of** accommodating all of the contaminants over the period in which As and Ni leaches from **the** pile, through occasional addition of carbon sources, as was the case in the enclosures, or through ecological engineering measures which provide additional sediment and carbon. The sustainability of the process can be addressed through an evaluation of biological capacity of the area and the potential of increasing productivity through ecological engineering measures, such as floating wetland vegetation covers.

In Table V, it is estimated that the organic **carbon content of** the active sediment layer must **be** replaced every **6** years, in order to maintain the contaminant **removal** processes. There **are** 0.15 m^3 per m^2 of fresh sediment in the top 0.15 m layer of the wetlands. **Assuming** a **dry** weight **of** 15 kg per 100 kg of fresh sediment (85 % water), there are **22.5** kg of organic matter m^{-2}, or 7.9 kg organic carbon (34 % organic carbon; 8). To replace this 7.9 kg of organic carbon in the top 0.15 m over *6* years, the required new organic carbon production must be 1.3 **kg·m^{-2}** every **year.**

Table V - **Years** of Treatment Until Removal Capacity Reached
Scenario 1: No New Sediment Production.

Area of Treatment System		7 ha
Average **As** load		270 **kg.yr^{-1}**
Average Ni **load**		719 **kg.yr^{-1}**
As Removal capacity		52 **g.m^{-2}**
Ni Removal capacity	>	***59*** g.m^{-2}
As per year		**4** g.m^{-2}.y^{-1}
Ni per year		10.0 g.m^{-2}.y^{-1}
As: ***Years*** to **capacity**		13.9 years
Ni: years to capacity	>	***5.9*** years

Phytoplankton (suspended microscopic algae) organic carbon production is estimated, based on literature values, at 0.37 **kg·m^{-2}·y^{-1}** for a eutrophic lake (8), while submerged macrophyte, emergent macrophyte and allochthonous carbon input are estimated at 0.12, 1.43 and 0.04 **kg·m^{-2}·y^{-1}** (8). totalling 0.64 **g·m^{-2}·y^{-1}**. This productivity estimate, based on the literature values, is therefore about half the organic carbon production required to replace the organic carbon content of the top 0.15 m of sediment every *6* years.

The Northwest Wetland 1 phytoplankton productivities were calculated based on counts of a single, dominant phytoplankton species, *Dictyosphaerium simplex*, in this wetland. This species alone can be

. estimated to produce organic carbon at a rate of 0.008 to 0.19 $kg \cdot m^{-2} \cdot y^{-1}$, an amount comparable to that reported for eutrophic systems in more temperate latitudes (8). The high productivity is not surprising, since the nutrient supply from the waste rock pile is plentiful both in nitrogen and phosphate. The pile is estimated to leach phosphate for 4,000 years at 0.5 t per year. Hence, it is reasonable to assume that any ecosystem in this area, such as wetlands, receiving nutrients borne in waste rock pile seepage can be anticipated to maintain high productivities in the long term.

In 1995. floating wetland vegetation rafts were installed to test the possibility that additional carbon could be produced through ecological engineering measures. Floating cattail rafts have been employed elsewhere to provide a cover over passive treatment systems in order to reduce wind-induced water mixing and to provide degradable organic matter to the microbial consortia responsible for contaminant removal. Systems covered with floating cattail rafts *can* be used for removal of metals from mine drainage through promoting and maintaining reducing conditions (1, 9). **The** establishment of mature plants **on rafts** from seedlings in 1995, and regrowth the following spring (1996) demonstrates that **this** approach can be used to add to the current organic carbon production.

CONCLUSION

This paper **summarized** an approach for a waste management area in the mineral sector which will lead to the integration of passive treatment systems when decommissioning is required. Based on the setting of the waste rock pile in a muskeg area, and the expected loads of contaminants in seepages, no further addition of wetland ***area*** is required for this **site. *As*** a backup **measure,** additions of organic matter to the wetlands sediments can be **used,** should the seepage **loading increase** or the microbial activity of the sediment decrease. The current estimates of organic matter production suggest **that** the **use** of the wetlands in decommissioning and restoration efforts represents an environmentally acceptable sustainable solution, the ultimate objective of all restoration activities.

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