

**FINAL
REPORT ON**

**BASELINE SOIL AND VEGETATION CHEMISTRY
FOR THE PROPOSED
NICO PROJECT**

Submitted to:

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1 INTRODUCTION

Fortune Minerals Limited (Fortune) is proposing to develop the NICO Cobalt-Gold-Bismuth-Copper Project (Project) mine approximately 160 kilometres (km) northwest of Yellowknife in the Northwest Territories (NWT). The Project is located within the Marian River drainage basin, approximately 10 km east of Hislop Lake at a latitude of 63°33' North and a longitude of 116°45' West. The Project site is about 50 km northeast of the nearest community, Whatì.

Baseline chemical concentrations are required for vegetation that is typically consumed by humans and wildlife. In the developer's assessment report (DAR), these data are used to predict future concentrations of chemicals as a result of air deposition of particulates that could contain metals, which could potentially be emitted from the Project. This is done to satisfy a clause in a standard terms of reference that require an evaluation of the bioaccumulation of contaminants in traditional food sources due to changes in air quality resulting from a proposed project. Soil quality samples from each of the vegetation collection sites are required for these predictions.

2 METHODS

The objective of the 2007 study was to collect soil and vegetation from 5 soil-vegetation community types within and adjacent to the proposed mine footprint. Stratification of the study area into 5 primary vegetation community types was based on the current classifications of soil and vegetation types. Although soil and vegetation types could be classified at a finer scale, these 5 community types represent the dominant soil-plant associations in the study area for the proposed mine site and are based on the ecological land cover classification (ELC) for the Project area. The ELC system approach maps land cover types that are defined by relatively distinct biophysical characteristics, such as dominant vegetation species and associated soil and site characteristics. The following 5 vegetation community types were identified:

- Marsh/graminoid fen;
- Treed Fen or Treed Bog (i.e., these 2 community types were combined as one type for the purpose of this report);
- Coniferous spruce;
- Mixedwood spruce – paper birch – aspen; and
- Bedrock open conifer.

The objective of the 2008 study was to collect additional baseline data to characterize metal concentrations for the wildlife risk assessment. The study consisted of sampling aquatic vegetation (roots and leaves) from the edges of 6 waterbodies.

Plant and soil sample locations are described and presented in Table 2-1 and Figure 2-1.

Table 2-1 Soil and Vegetation Chemistry Sample Locations

Site	NAD 83 Zone 11W UTM Co-ordinates		Soil-Vegetation Class	Sample Identification	Sample Type
	Easting	Northing			
Samples collected in 2007					
FRA001	513574	7046213	Bedrock open conifer	FRA001 L	Birch
				FRA001S	Soil
				FRA001C	Lichen
FRA002	513491	7046419	Marsh/graminoid fen	FRA002 R	Sedge - Root
				FRA002 H	Sedge - Shoot
				FRA002 S	Soil
FRA003	513458	7046458	Coniferous spruce	FRA003 L	Alder
				FRA003 S	Soil
				FRA003 C	Lichen
FRA004	513795	7045901	Marsh/graminoid fen	FRA004 R	Sedge - Root
				FRA004 H	Sedge - Shoot
				FRA004 S	Soil
FRA005	514066	7045800	Marsh/graminoid fen	FRA005 R	Sedge - Root
				FRA005 H	Sedge - Shoot
				FRA005 S	Soil
				FRA005 M	Submerged Macrophyte
FRA006	514310	7045660	Marsh/graminoid fen	FRA006 R	Sedge - Root
				FRA006 H	Sedge - Shoot
				FRA006 S	Soil
				FRA006 M	Submerged Macrophyte
FRA007	513885	7045657	Treed Fen / Treed Bog	FRA007 L	Willow
				FRA007 S	Soil
				FRA007 C	Lichen
FRA008	513830	7045547	Coniferous spruce	FRA008 L	Alder
				FRA008 S	Soil
				FRA008 C	Lichen
FRA009	513847	7045404	Mixedwood spruce- paper birch-aspen	FRA009 L1	Alder
				FRA009 L2	Birch
				FRA009 S	Soil
FRA010	513779	7045358	Treed Fen / Treed Bog	FRA010 L	Willow
				FRA010 S	Soil
				FRA010 C	Lichen
FRA011	512072	7046137	Mixedwood spruce- paper birch-aspen	FRA011 L1	Alder
				FRA011 L2	Birch
				FRA011 S	Soil

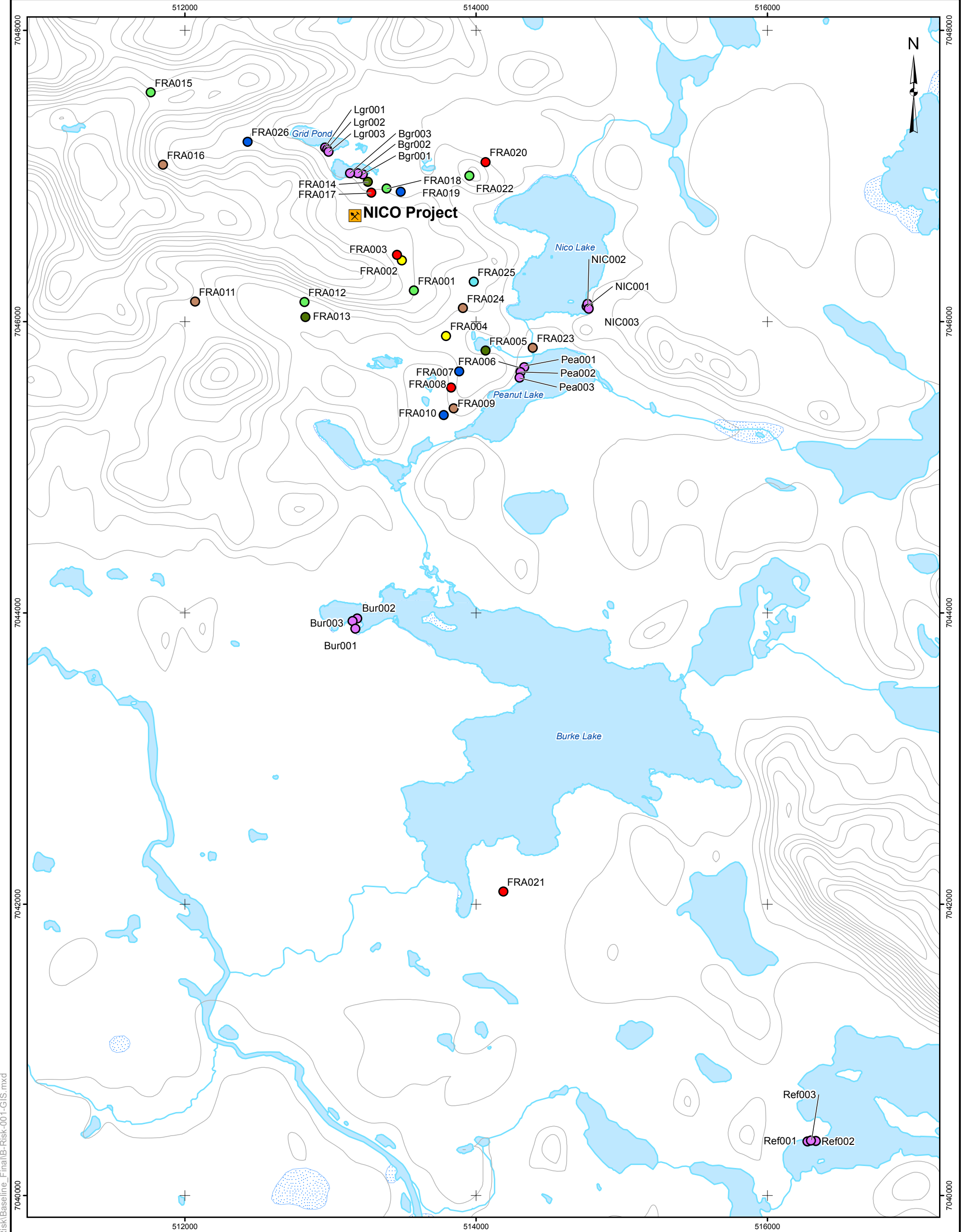
Table 2-1 Soil and Vegetation Sample Locations (continued)

Site	NAD 83 Zone 11W UTM Co-ordinates		Soil-Vegetation Class	Sample Identification	Sample Type
	Easting	Northing			
FRA012	512823	7046133	Bedrock open conifer	FRA012 L	Birch
				FRA012 S	Soil
				FRA012 C	Lichen
FRA013	512829	7046031	Marsh/graminoid fen	FRA013 R	Sedge - Root
				FRA013 H	Sedge - Shoot
				FRA013 S	Soil
				FRA013 M	Submerged Macrophyte
FRA014	513259	7046960	Marsh/graminoid fen	FRA014 R	Sedge - Root
				FRA014 H	Sedge - Shoot
				FRA014 S	Soil
				FRA014 M	Submerged Macrophyte
FRA015	511768	7047573	Bedrock open conifer	FRA015 L	Birch
				FRA015 S	Soil
				FRA015 C	Lichen
FRA016	511852	7047076	Mixedwood spruce- paper birch-aspen	FRA016 L1	Birch
				FRA016 L2	Alder
				FRA016 S	Soil
FRA017	513282	7046885	Mixedwood spruce- paper birch-aspen	FRA017 L	Alder
				FRA017 S	Soil
				FRA017 C	Lichen
FRA018	513387	7046913	Bedrock open conifer	FRA018 L	Birch
				FRA018 S	Soil
				FRA018 C	Lichen
FRA019	513483	7046891	Treed Fen / Treed Bog	FRA019 L	Willow
				FRA019 S	Soil
				FRA019 C	Lichen
FRA020	514067	7047095	Coniferous spruce	FRA020 L	Alder
				FRA020 S	Soil
				FRA020 C	Lichen
FRA021	514188	7042086	Coniferous spruce	FRA021 L1	Alder
				FRA021 S	Soil
				FRA021 C	Lichen
FRA022	513956	7047001	Bedrock open conifer	FRA022 L	Birch
				FRA022 S	Soil
				FRA022 C	Lichen
FRA023	514391	7045819	Mixedwood spruce- paper birch-aspen	FRA023 L1	Alder
				FRA023 L2	Birch
				FRA023 S	Soil

Table 2-1 Soil and Vegetation Sample Locations (continued)

Site	NAD 83 Zone 11W UTM Co-ordinates		Soil-Vegetation Class	Sample Identification	Sample Type
	Easting	Northing			
FRA024	513911	7046092	Mixedwood spruce-paper birch-aspen	FRA024 L1	Alder
				FRA024 L2	Birch
				FRA024 S	Soil
FRA025	513985	7046274	Treed Fen / Treed Bog	FRA025 L	Bogberry (<i>Myrica gale</i>)
				FRA025 S	Soil
				FRA025 C	Lichen
FRA026	512432	7047234	Treed Fen / Treed Bog	FRA026 L	Willow
				FRA026 S	Soil
				FRA026 C	Lichen
Samples collected in 2008					
Bgr001	513223	7047010	Marsh/graminoid fen	Bgr001	Sedge
Bgr002	513188	7047018	Marsh/graminoid fen	Bgr002	Sedge
Bgr003	513136	7047018	Marsh/graminoid fen	Bgr003	Sedge
Bur001	513185	7043960	Marsh/graminoid fen	Bur001	Sedge
Bur002	513153	7043943	Marsh/graminoid fen	Bur002	Sedge
Bur003	513172	7043891	Marsh/graminoid fen	Bur003	Sedge
Lgr001	512965	7047195	Marsh/graminoid fen	Lgr001	Sedge
Lgr002	512979	7047181	Marsh/graminoid fen	Lgr002	Sedge
Lgr003	512989	7047165	Marsh/graminoid fen	Lgr003	Sedge
Nic001	514760	7046104	Marsh/graminoid fen	Nic001	Sedge
Nic002	514766	7046120	Marsh/graminoid fen	Nic002	Sedge
Nic003	514775	7046087	Marsh/graminoid fen	Nic003	Sedge
Pea001	514331	7045686	Marsh/graminoid fen	Pea001	Sedge
Pea002	514306	7045653	Marsh/graminoid fen	Pea002	Sedge
Pea003	514299	7045614	Marsh/graminoid fen	Pea003	Sedge
Ref001	516276	7040370	Marsh/graminoid fen	Ref001	Sedge
Ref002	516333	7040372	Marsh/graminoid fen	Ref002	Sedge
Ref003	516300	7040375	Marsh/graminoid fen	Ref003	Sedge

UTM = Universal Transverse Mercator



LEGEND

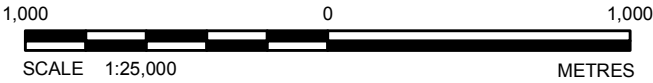
- NICO PROJECT
- CONTOUR (10 METRE INTERVAL)
- PROPOSED NICO PROJECT ACCESS ROAD
- WATERCOURSE
- WATERBODY
- WETLAND

SOIL AND VEGETATION CHEMISTRY SAMPLE LOCATION

- ALDER, BIRCH, SOIL (2007)
- ALDER, SOIL, LICHEN (2007)
- BIRCH, SOIL, LICHEN (2007)
- BOGBERRY, SOIL, LICHEN (2007)
- SEDGE (2008)
- SEDGE, SOIL (2007)
- SEDGE, SOIL, SUBMERGED MACROPHYTE (2007)
- WILLOW, SOIL, LICHEN (2007)

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83



PROJECT		FORTUNE MINERALS LIMITED NICO DEVELOPERS ASSESSMENT REPORT		
TITLE		SOIL AND VEGETATION CHEMISTRY SAMPLE LOCATIONS		
Golder Associates Edmonton, Alberta		FILE No. B-Risk-001-GIS		
		PROJECT No. 08-1373-0017		SCALE AS SHOWN
		DESIGN	GC	20 Nov. 2008
		GIS	CW	25 Mar. 2009
		CHECK	LY	17 Nov. 2010
		REVIEW	GA	17 Nov. 2010

FIGURE: 2-1

2.1.1 2007 Sampling

In 2007, the objective was to collect a composite soil sample and plant tissues for each soil-vegetation class. Plant types were selected based on the primary forage for herbivores. For example, muskrats feed primarily in aquatic habitats and their diet typically consists of roots and shoots of emergent (e.g., sedge [*Carex* spp.]) and submergent macrophytes (e.g., *Potamogeton*, *Myriophyllum* spp.). While other animals such as moose feed in terrestrial environments and browse on new stems and leaves of deciduous shrubs such as alder (*Alnus crispa*), willow (*Salix* spp.), and paper birch (*Betula papyrifera*), and lichens.

The following samples were collected from the sampling area:

- soil – 26 samples;
- sedge – 6 samples;
- submergent macrophytes – 4 samples;
- alder – 10 samples;
- willow – 5 samples;
- paper birch – 10 samples; and
- lichen – 15 samples.

When collecting vegetation samples, Teflon-coated stainless steel scissors were used to snip the tips of the plants. The scissor blades were then rinsed with a mild detergent and deionized water between each sample. Field staff wore nitrile gloves while collecting samples and changed gloves between samples.

New growth from deciduous shrubs (alder, willow, paper birch) was collected from 0.5 metres (m) to 2 m above ground level. Samples were placed in large freezer bags with a label indicating the date, plant species, ELC type, location, and global positioning system (GPS) coordinates. The label was placed in a small plastic bag and then placed in the sample bag. At camp, the samples were kept as cool as possible; then in Yellowknife, samples were frozen, and transported to Alberta Research Council (ARC) laboratories for ICP-emission scan for total metals. The lowest possible detection limits were used.

Sample FRA025L was collected as a willow sample and later identified as *Myrica gale* (bogberry). This sample was included as it was assumed that metal uptake in the bogberry would be similar to willow, since the concentrations measured in the bogberry sample were similar to the concentrations measured in the willow samples.

Sedge roots, leaves, and branches were collected and placed into large food-grade plastic bags. The entire plant was removed from the soil (sediment), and the roots washed and cleaned of sediment. A label indicating the date, ELC type, location, and GPS coordinates was placed in a small plastic bag and then placed in the sample bag. In Yellowknife, samples were frozen, and then transported to ARC laboratories for ICP-emission scan for total metals.

The protocol used for sedges was followed for the collection of submergent macrophytes. Once at camp, the samples were taken from the bags and air-dried. Once dry, submergent macrophytes were placed in large plastic bags with appropriate labels, and kept as cool as possible.

Lichen was collected by snipping the top portion of the plant. Samples were placed in medium food-grade plastic bags with a label indicating the date, plant species, ELC type, location, and GPS coordinates. Labelling and storage practices were the same as used for sedges.

Soil samples were collected by using a nylon trowel. The trowel was rinsed with a mild detergent and deionized water between each sample. Nitrile gloves were worn while collecting samples and changed between samples. Any organic material on top of the soil was moved aside and samples were collected from the top 10 centimetres (cm) of the soil horizon.

Each soil sample consisted of a composite of 5 sub-samples. One sub-sample was collected from the base of the plant, and 4 sub-samples were collected from an area adjacent to the plant from which leaf samples were collected. Labelling and storage practices were the same as used for sedges.

2.1.2 2008 Sampling

Sedges were collected and placed in large plastic bags. The entire plant was removed from the soil (sediment), and the roots washed and cleaned of sediment. A label indicating the date, and location was placed in a small plastic bag and then placed in the sample bag. The samples were kept as cool as possible and then transported to ARC laboratories for ICP-emission scan for total metals. Detection limits were similar to those used in 2007.

3 RESULTS

3.1.1 2007 Plant and Soil Sample Program

3.1.1.1 Soil

Metal concentrations in soil samples are presented in Table 3-1. All analyzed parameters were detected in all of the soil samples. Concentrations were compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health – Residential Land Use (2007) (Table 3-2). Of the 23 metals analyzed, 13 have CCME soil quality guidelines. Metals concentrations exceeded the CCME guidelines for arsenic, barium, copper, selenium, uranium, and zinc. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: aluminum, antimony, arsenic, barium, beryllium, bismuth, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc.

The variability is not associated with location. The locations that had the highest number of parameters identified as maximum concentrations were FRA019, FRA026 and FRA023, and the location with the highest number of parameters with minimum concentrations, FRA025S, was located in the middle of these three locations. Soil types were characterized as being peat/organic material for almost all samples. There were no differentiating qualities between locations with maximum concentrations versus those with minimum concentrations; therefore, it is expected that localized geological differences were the reason for the observed variability.

Table 3-1 Metal Concentrations in Soil Samples (2007)

Parameter	Concentration [mg/kg dry weight]										
	Detection Limit	FRA001 S 04-Aug-2007	FRA002 S 04-Aug-2007	FRA003 S 04-Aug-2007	FRA004 S 04-Aug-2007	FRA005 S 04-Aug-2007	FRA006 S 04-Aug-2007	FRA007 S 04-Aug-2007	FRA008 S 04-Aug-2007	FRA009 S 04-Aug-2007	FRA010 S 04-Aug-2007
Aluminum	0.9	23557	5265	14364	16456	610	31970	24206	32565	44843	1070
Antimony	0.002	0.84	0.70	1.04	2.8	0.59	0.63	0.81	0.41	0.23	0.23
Arsenic	0.009	28.8	5.85	9.82	63.5	132	49.2	35.6	3.18	1.92	4.71
Barium	0.3	327	111	389	161	41.1	342	299	368	456	53.9
Beryllium	0.009	0.98	0.85	0.72	0.91	0.035	0.95	0.73	1.04	1.45	0.045
Bismuth	0.02	1.12	0.72	0.62	0.52	0.076	0.46	0.84	0.15	0.06	0.060
Boron	0.09	26.6	12.8	23.7	33.1	9.35	35.8	30.4	35.6	27.5	17.9
Cadmium	0.003	0.46	0.12	0.27	0.36	0.10	0.15	0.45	0.21	0.13	0.23
Chromium	0.09	20.5	1.61	8.11	24.2	0.94	40.2	34.5	14.3	13.2	1.1
Cobalt	0.003	2.92	6.03	14.7	10.4	4.6	9.78	24.5	2.98	2.65	2.1
Copper	0.09	21.2	22.4	8.4	91.9	6.77	28.4	32.5	8.14	6.24	8.21
Lead	0.002	9.22	1.95	7.38	4.26	2.05	9.88	7.94	7.83	9.98	1.18
Manganese	0.07	93.4	28.4	4182	97.5	62.8	301	546	137	191	68.9
Mercury	0.02	0.19	0.12	0.15	0.084	0.14	0.082	0.095	0.054	0.039	0.12
Molybdenum	0.002	1.27	2.73	0.62	9.27	2.79	3.34	1.96	0.35	0.19	0.94
Nickel	0.009	7.94	3.91	4.73	18.8	1.44	21.6	27	4.15	4.19	2.1
Selenium	0.2	0.91	0.94	0.36	4.03	0.36	0.93	0.79	0.25	0.56	0.28
Silver	0.001	0.35	0.048	0.19	0.16	0.019	0.29	0.22	0.29	0.18	0.038
Strontium	0.007	39.1	24.8	39.6	105	47.5	135	93.7	101	146	30.5
Thallium	0.001	0.21	0.12	0.25	0.25	0.025	0.34	0.30	0.32	0.34	0.018
Uranium	0.001	9.61	42.4	1.21	287	5.76	14.2	3.91	1.13	0.82	1.08
Vanadium	0.009	36.3	1.84	20.7	20.4	2.55	43.1	34.7	25.2	23.6	1.44
Zinc	0.2	35.6	7.57	77.5	20.6	29.9	48.5	67.4	22.1	29	21.7

Table 3-1 Metal Concentrations in Soil Samples (2007) (continued)

Parameter	Concentration [mg/kg dry weight]										
	Detection Limit	FRA011 S 04-Aug- 2007	FRA012 S 04-Aug- 2007	FRA013 S 04-Aug- 2007	FRA014 S 04-Aug- 2007	FRA015 S 04-Aug- 2007	FRA016 S 04-Aug- 2007	FRA017 S 04-Aug- 2007	FRA018 S 04-Aug- 2007	FRA019 S 04-Aug- 2007	FRA020 S 04-Aug- 2007
Aluminum	0.9	5228	55807	24991	21726	21344	5983	50693	8368	60328	53155
Antimony	0.002	0.61	1.69	1.17	4.31	1.61	1.15	0.48	0.4	0.42	0.29
Arsenic	0.009	3.62	6.98	30.1	243	183	92.1	9.81	5.92	13.5	3.69
Barium	0.3	108	486	260	205	341	123	489	415	535	505
Beryllium	0.009	0.94	2.3	1.32	1.33	0.53	1.94	1.35	0.52	2	1.49
Bismuth	0.02	0.21	4.07	0.5	5.56	28.2	12.5	0.6	0.14	0.65	0.23
Boron	0.09	12.2	70.9	36.4	29.6	20	15.2	38.3	16.5	54.6	31.9
Cadmium	0.003	0.17	0.14	0.64	0.36	0.18	0.20	0.051	0.60	0.25	0.097
Chromium	0.09	2.3	37.7	25.3	16.6	8.47	1.38	47.4	8.25	63.4	29.6
Cobalt	0.003	1.78	3.77	77.6	131	38	362	12.5	8.18	21.7	4.97
Copper	0.09	22.3	20.5	142	368	1147	769	19.1	12.9	38.6	101
Lead	0.002	3.07	6.64	5.25	5.49	8.89	2.6	13	6.82	14.7	13
Manganese	0.07	33.9	115	3106	458	65.7	364	235	2039	473	259
Mercury	0.02	0.096	0.14	0.11	0.19	1.61	0.15	0.101	0.32	0.067	0.041
Molybdenum	0.002	2.4	0.92	12.8	13.5	2.7	0.38	0.36	0.46	1.31	0.29
Nickel	0.009	4.57	10.7	16.6	14.9	2.59	11.6	17.7	6.22	32.6	9.56
Selenium	0.2	0.81	0.39	0.92	3.24	1.64	0.88	0.49	0.55	0.55	0.28
Silver	0.001	0.047	0.25	0.18	0.21	0.73	0.070	0.36	0.10	0.40	0.36
Strontium	0.007	30.80	61.8	98.9	80.2	22.8	35.9	148	52.4	172	171
Thallium	0.001	0.10	0.30	0.32	0.32	0.24	0.085	0.42	0.26	0.47	0.33
Uranium	0.001	51.5	1.96	23.5	98	13.2	5.13	3.94	2.03	11.3	1.62
Vanadium	0.009	2.64	66.4	35.2	22.3	18.6	2.74	57.3	12.8	71.8	41.7
Zinc	0.2	9.9	35.1	120	37.7	44.1	15.4	32.7	111	63.8	27.2

Table 3-1 Metal Concentrations in Soil Samples (2007) (continued)

Parameter	Concentration [mg/kg dry weight]									
	Detection Limit	FRA021 S 04-Aug-2007	FRA022 S 04-Aug-2007	FRA023 S 04-Aug-2007	FRA024 S 04-Aug-2007	FRA025 S 04-Aug-2007	FRA026 S 04-Aug-2007	Mean	Minimum	Maximum
Aluminum	0.9	34776	39443	33207	28957	435	27469	25647	435	60328
Antimony	0.002	0.4	1.35	0.821	1.4	0.52	4.39	1.13	0.23	4.39
Arsenic	0.009	51.1	5.57	691	587	12.9	3076	206	1.92	3076
Barium	0.3	305	456	589	288	36.6	259	306	36.6	589
Beryllium	0.009	1.34	1.33	1.3	1.27	0.021	2.04	1.11	0.021	2.3
Bismuth	0.02	0.22	0.91	0.63	26.3	0.12	30.2	4.45	0.060	30.2
Boron	0.09	32.8	82.8	21.7	20.3	12.2	35	30	9.35	82.8
Cadmium	0.003	0.17	0.29	0.69	0.27	0.068	0.33	0.27	0.05	0.69
Chromium	0.09	37.7	28.1	40.3	20.8	0.78	19.9	21	0.78	63.4
Cobalt	0.003	25.9	2.9	117	78.4	1.29	225	46	1.29	362
Copper	0.09	24	34.5	77.5	27.6	4.79	948	154	4.79	1147
Lead	0.002	8.95	12.6	10.1	6.78	0.534	5.92	7.15	0.53	14.7
Manganese	0.07	213	109	8511	452	43.9	341	866	28.4	8511
Mercury	0.02	0.099	0.24	0.11	0.075	0.063	0.44	0.19	0.039	1.61
Molybdenum	0.002	0.80	8.04	6.65	2.08	3.96	1.8	3.15	0.19	13.5
Nickel	0.009	18.9	7.77	30.9	7.33	0.38	17.9	12	0.38	32.6
Selenium	0.2	0.68	0.487	1.34	0.35	0.49	6.47	1.11	0.25	6.47
Silver	0.001	0.17	0.52	0.26	0.32	0.023	0.21	0.23	0.019	0.73
Strontium	0.007	107	68.8	144	81	54.2	131	85	22.8	172
Thallium	0.001	0.32	0.44	0.51	0.18	0.031	0.55	0.27	0.018	0.55
Uranium	0.001	2.71	3.69	12.5	2.75	0.99	78.8	26	0.82	287
Vanadium	0.009	41.8	65.4	53.6	36.1	0.71	19.5	29	0.71	71.8
Zinc	0.2	42.5	45.2	238	27.4	4.47	210	55	4.47	238

mg/kg= milligrams per kilogram

Table 3-2 Metal Concentrations in Soil Samples Compared to CCME Residential Guidelines

Parameter	Concentration (mg/kg)				Number of Samples that Exceed Guideline
	Mean	Minimum	Maximum	CCME Residential Guidelines ^a	
Aluminum	25647	435	60328	-	n/a
Antimony	1.13	0.23	4.39	-	n/a
Arsenic	206	1.92	3076	12	15/26
Barium	306	36.6	589	500	3/26
Beryllium	1.11	0.021	2.3	-	n/a
Bismuth	4.45	0.060	30.2	-	n/a
Boron	30	9.35	82.8	-	n/a
Cadmium	0.27	0.05	0.69	10	none
Chromium	21	0.78	63.4	64	none
Cobalt	46	1.29	362	-	n/a
Copper	154	4.79	1147	63	8/26
Lead	7.15	0.53	14.7	140	none
Manganese	866	28.4	8511	-	n/a
Mercury	0.19	0.039	1.61	6.6	none
Molybdenum	3.15	0.19	13.5	-	n/a
Nickel	12	0.38	32.6	50	none
Selenium	1.11	0.25	6.47	1	5/26
Silver	0.23	0.019	0.73	-	n/a
Strontium	85	22.80	172	-	n/a
Thallium	0.27	0.018	0.55	1	none
Uranium	26	0.82	287	23	6/26
Vanadium	29	0.71	71.8	130	none
Zinc	55	4.47	238	200	2/26

^a Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Residential Scenario, CCME 2007.

- = no guideline; n/a = not applicable; mg/kg= milligrams per kilogram

3.1.1.2 Vegetation

Concentrations of metals in submergent vegetation samples are presented in Table 3-3. Selenium was not detected in FRA006 M, and silver was not detected in FRA005 M. All other parameters were detected in all samples. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: arsenic, bismuth, cobalt, copper, selenium, silver, and uranium.

The locations with the highest number of parameters with maximum concentrations were FRA013M and FRA014M (10 and 9 parameters, respectively). FRA014 is close to Grid Pond; however, FRA013 is approximately 1000 m south of FRA014 and is west of the project area. Therefore, the variability is likely due to local conditions.

Table 3-3 Metal Concentrations in Submergent Vegetation Samples (2007)

Parameter	Concentration [mg/kg dry weight]							
	Detection Limit	FRA005 M 04-Aug-2007	FRA006 M 04-Aug-2007	FRA013 M 04-Aug-2007	FRA014 M 04-Aug-2007	Mean ^a	Minimum	Maximum
Aluminum	0.5	318	706	3040	1423	1372	318	3040
Antimony	0.001	0.11	0.037	0.35	0.34	0.21	0.037	0.35
Arsenic	0.005	46.2	23	4.37	125	50	4.37	125
Barium	0.01	73.5	37.9	52.4	30.3	49	30.3	73.5
Beryllium	0.005	0.028	0.029	0.26	0.088	0.10	0.028	0.26
Bismuth	0.005	0.05	0.015	0.09	0.49	0.16	0.015	0.49
Boron	0.05	40.8	16.1	13.1	18.4	22	13.1	40.8
Cadmium	0.002	0.328	0.38	0.27	0.42	0.35	0.27	0.42
Chromium	0.05	1.75	2.65	3.43	2.31	2.54	1.75	3.43
Cobalt	0.002	11.6	1.85	14	149	44	1.85	149
Copper	0.05	4.73	6.31	55.9	73.1	35	4.73	73.1
Lead	0.001	0.34	0.44	0.97	1.8	0.89	0.34	1.8
Manganese	0.005	307	170	663	369	377	170	663
Mercury	0.01	0.042	0.034	0.052	0.029	0.039	0.029	0.052
Molybdenum	0.001	0.6	1.010	1.29	4.39	1.82	0.6	4.39
Nickel	0.005	2.99	3.01	4.2	3.23	3.36	2.99	4.2
Selenium	0.0649	0.19	<0.0649	0.39	0.73	0.33	<0.0649	0.73
Silver	0.00058	<0.00058	0.0039	0.031	0.013	0.012	<0.00058	0.031
Strontium	0.004	55	55.3	40.8	54	51	40.8	55.3
Thallium	0.0006	0.014	0.073	0.076	0.071	0.058	0.014	0.076
Uranium	0.0006	1.63	0.44	10.4	14.7	6.79	0.44	14.7
Vanadium	0.005	0.95	1.64	3.96	2.39	2.24	0.95	3.96
Zinc	0.09	34.9	47.2	36.5	41.7	40	34.9	47.2

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.

< = less than; mg/kg= milligrams per kilogram.

Concentrations of metals in sedges collected are presented in Table 3-4. Beryllium and mercury were not detected in samples FRA005 R and FRA006 R. Selenium was not detected in FRA004 R, FRA005 R, FRA006 R, and FRA013 R. Silver was not detected at FRA004 R, FRA006 R, and FRA014 R. Bismuth was not detected in FRA006 R. All other parameters were detected in all samples. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: aluminum, antimony, arsenic, beryllium, bismuth, cobalt, copper, lead, molybdenum, nickel, silver, thallium, and uranium. Site locations FRA014R and FRA002R both had 9 parameters that had the maximum concentrations; all other locations had fewer parameters that represented the maximum. Location FRA014R was in close proximity to Grid Pond; however, location FRA002R is 60 m to the south of FRA014R. Therefore, the variability is likely due to local conditions.

Concentrations of metals in willow samples collected are presented in Table 3-5. Beryllium, mercury, selenium, and silver were not detected in any of the samples. Thallium was not detected in sample FRA025 L, and bismuth was not detected in FRA007 L and FRA0019 L. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: arsenic, bismuth, cadmium, cobalt, manganese, nickel, and uranium. The locations with the highest number of parameters with maximum concentrations were FRA026 and FRA019. This result is similar to the two locations with the maximum number of soil parameters, although FRA019 had a higher number of maximum concentrations for soil samples.

Concentrations of metals in alder leaves collected are presented in Table 3-6. Antimony was not detected in sample FRA008L. Beryllium was not detected in FRA016 L2, FRA021 L1, FRA023 L1, and FRA024 L1. Bismuth was not detected in FRA020 L, FRA021 L1, FRA023 L1, and FRA024 L1. Mercury, selenium, and silver were not detected in any of the samples. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: aluminum, arsenic, bismuth, cadmium, cobalt, molybdenum, nickel, thallium, uranium, and vanadium. None of the sample locations had a large number of parameters that had maximum concentrations. All locations had at least one parameter that represented the maximum concentration and no location had more than 3 parameters that represented the maximum concentrations.

Concentrations of metals in birch leaves collected are presented in Table 3-7. Beryllium was only detected in 3 samples (FRA001 L, FRA012 L, and FRA018 L). Mercury was only detected in three samples (FRA001 L,

FRA009 L2, and FRA023 L2). Selenium was only detected in FRA012 L. Silver was not detected in 4 samples and bismuth was not detected in 1 sample. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: arsenic, bismuth, cadmium, cobalt, manganese, molybdenum, nickel, silver, thallium, vanadium, and zinc. Site locations FRA018L and FRA015L had 7 and 5 parameters that had the maximum concentrations, respectively. Location FRA018L was in close proximity to Grid Pond (20 m); however, location FRA015L is 1000 m to the northwest of FRA018L. Therefore, the variability is likely due to local conditions.

Table 3-4 Metal Concentrations in Sedge Samples (2007)

Parameter	Concentration [mg/kg dry weight]									
	Detection Limit	FRA002 R 04-Aug-2007	FRA004 R 04-Aug-2007	FRA005 R 04-Aug-2007	FRA006 R 04-Aug-2007	FRA013 R 04-Aug-2007	FRA014 R 04-Aug-2007	Mean ^a	Minimum	Maximum
Aluminum	0.25	1329	197	38.6	72.9	92.7	481	369	38.6	1329
Antimony	0.00125	0.086	0.05	0.016	0.0059	0.0088	0.16	0.054	0.0059	0.16
Arsenic	0.00625	1.4	2.91	15.3	3.84	0.15	19.6	7.20	0.15	19.6
Barium	0.0125	71.1	27.1	15.1	49.9	25.6	15.1	34	15.1	71.1
Beryllium	0.00625	0.24	0.016	<0.00625	<0.00625	0.0098	0.037	0.051	<0.00625	0.24
Bismuth	0.00075	0.155	0.03	0.0024	<0.00075	0.0093	0.220	0.070	<0.00075	0.22
Boron	0.0625	5.89	6.49	3.68	6.42	4.72	6.41	5.60	3.68	6.49
Cadmium	0.0025	0.13	0.036	0.021	0.071	0.058	0.047	0.061	0.021	0.13
Chromium	0.0625	0.52	0.45	0.30	0.52	0.32	0.70	0.47	0.30	0.70
Cobalt	0.0025	2.89	0.70	1.13	0.17	0.24	10.1	2.54	0.17	10.1
Copper	0.0625	10.4	8.42	0.90	9.16	5.37	15.8	8.34	0.90	15.8
Lead	0.00125	0.82	0.13	0.033	0.034	0.062	0.20	0.21	0.033	0.82
Manganese	0.00625	76	191	155	725	132	117	233	76	725
Mercury	0.0125	0.10	0.022	<0.0125	<0.0125	0.015	0.020	0.029	<0.0125	0.10
Molybdenum	0.00125	1.11	1	0.22	2.29	0.53	3.01	1.36	0.22	3.01
Nickel	0.00625	1.6	0.62	0.15	0.34	0.26	0.57	0.59	0.15	1.6
Selenium	0.125	0.27	<0.125	<0.125	<0.125	<0.125	0.14	<0.125	<0.125	0.27
Silver	0.00075	0.0079	<0.00075	0.024	<0.00075	0.0009	<0.00075	0.0056	<0.00075	0.024
Strontium	0.005	20.6	18.7	13.3	27.4	11.7	16.4	18	11.7	27.4
Thallium	0.00075	0.062	0.0071	0.002	0.014	0.0041	0.022	0.018	0.002	0.062
Uranium	0.00075	3.55	3.53	0.23	0.082	0.29	3.73	1.90	0.082	3.73
Vanadium	0.00625	0.53	0.33	0.19	0.24	0.18	0.58	0.34	0.18	0.58
Zinc	0.0625	18.9	19.2	13	42.6	30.2	22	24	13	42.6

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.

< = less than; mg/kg= milligrams per kilogram.

Table 3-5 Metal Concentrations in Willow Leaf Samples (2007)

Parameter	Concentration [mg/kg dry weight]								
	Detection Limit	FRA007 L 04-Aug-2007	FRA010 L 04-Aug-2007	FRA019 L 05-Aug-2007	FRA025 L ^a 05-Aug-2007	FRA026 L 05-Aug-2007	Mean ^b	Minimum	Maximum
Aluminum	0.25	11.2	23	12.9	10.6	25.4	16.6	10.6	25.4
Antimony	0.00125	0.0035	0.0031	0.0092	0.0084	0.0071	0.0063	0.0031	0.0092
Arsenic	0.00625	0.067	0.307	0.025	0.259	0.764	0.28	0.025	0.76
Barium	0.0125	11	5.78	14.9	2.25	3.63	7.5	2.25	14.9
Beryllium	0.00625	<0.00625	<0.00625	<0.00625	<0.00625	<0.00625	<0.00625	<0.00625	<0.00625
Bismuth	0.00075	<0.00075	0.017	<0.00075	0.0016	0.04	0.011	<0.00075	0.04
Boron	0.0625	19.5	14.9	15.8	15.9	36.5	20.5	14.9	36.5
Cadmium	0.0025	0.541	0.172	0.642	0.0072	0.018	0.28	0.0072	0.64
Chromium	0.0625	0.103	0.168	0.116	0.106	0.146	0.13	0.10	0.17
Cobalt	0.0025	0.594	1.11	0.968	0.064	7.62	2.07	0.064	7.62
Copper	0.0625	3.79	5.49	3.84	0.93	6.23	4.06	0.93	6.23
Lead	0.00125	0.025	0.039	0.025	0.045	0.017	0.03	0.017	0.045
Manganese	0.00625	252	141	226	251	21.8	178	21.8	252
Mercury	0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125
Molybdenum	0.00125	0.256	0.26	0.41	1.86	0.697	0.70	0.26	1.86
Nickel	0.00625	0.22	0.531	0.993	0.056	<0.00625	0.36	0.056	0.99
Selenium	0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125
Silver	0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075
Strontium	0.005	26.3	23.4	42.5	8.31	26.4	25	8.31	42.5
Thallium	0.00075	0.001	0.0063	0.003	<0.00075	0.0016	0.0025	0.001	0.0063
Uranium	0.00075	0.0012	0.0054	0.0024	0.014	0.0091	0.0064	0.0012	0.014
Vanadium	0.00625	0.022	0.045	0.010	0.012	0.073	0.032	0.010	0.073
Zinc	0.0625	157	82.4	95.6	36.8	43.1	83	36.8	157

^a FRA025 L - *Myrica gale* (bogberry) leaf sample - assumed the same as willow.

^b Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.

< = less than; mg/kg= milligrams per kilogram.

Table 3-6 Metal Concentrations in Alder Leaf Samples (2007)

Parameter	Concentration [mg/kg dry weight]												Mean ^a	Minimum	Maximum
	Detection Limit	FRA003 L 04-Aug-2007	FRA008 L 04-Aug-2007	FRA009 L1 04-Aug-2007	FRA011 L1 04-Aug-2007	FRA016 L2 05-Aug-2007	FRA017 L 05-Aug-2007	FRA020 L 05-Aug-2007	FRA021 L1 05-Aug-2007	FRA023 L1 05-Aug-2007	FRA024 L1 05-Aug-2007				
Aluminum	0.25	39.5	49.2	72.4	37.9	19.5	15.4	102	19.2	48.6	9.01	41.27	9.01	102	
Antimony	0.00125	0.0031	<0.00125	0.0036	0.0036	0.0032	0.0042	0.0044	0.0053	0.005	0.010	0.0043	<0.00125	0.010	
Arsenic	0.00625	0.064	0.081	0.036	0.44	0.21	0.11	0.025	0.072	0.23	0.31	0.16	0.025	0.44	
Barium	0.0125	15.6	12.2	16.3	10.9	4.89	8.55	13.4	12.8	8.45	3.03	10.61	3.03	16.3	
Beryllium	0.00625	0.032	0.022	0.020	0.011	<0.00625	0.0078	0.0272	<0.00625	<0.00625	<0.00625	0.013	<0.00625	0.032	
Bismuth	0.00075	0.040	0.0008	0.005	0.046	0.008	0.003	<0.00075	<0.00075	<0.00075	<0.00075	0.010	<0.00075	0.046	
Boron	0.0625	4.21	5.97	3.44	13.2	9.08	14.7	11.6	7.56	16.4	10.3	9.65	3.44	16.4	
Cadmium	0.0025	0.0095	0.0055	0.0088	0.0055	0.004	0.0055	0.0093	0.043	0.0061	0.012	0.011	0.004	0.043	
Chromium	0.0625	0.15	0.16	0.19	0.14	0.093	0.16	0.16	0.15	0.19	0.10	0.15	0.093	0.19	
Cobalt	0.0025	1.15	2.26	1.85	0.48	23.7	1.62	2.19	2.74	0.17	2.18	3.83	0.17	23.7	
Copper	0.0625	5.14	5.83	4.63	6.89	8.22	6.71	17	6.34	7.13	7.41	7.53	4.63	17	
Lead	0.00125	0.025	0.031	0.069	0.043	0.014	0.019	0.032	0.021	0.011	0.046	0.031	0.011	0.069	
Manganese	0.00625	180	38.5	108	110	26.6	65.5	75.2	205	157	84.2	105	26.6	205	
Mercury	0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	
Molybdenum	0.00125	0.14	0.14	0.25	0.76	0.18	0.03	0.15	2.2	0.91	3.23	0.80	0.03	3.23	
Nickel	0.00625	3.08	2.22	2.61	1.18	0.32	3.38	5.03	1.66	0.99	0.34	2.08	0.32	5.03	
Selenium	0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	
Silver	0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	<0.00075	
Strontium	0.005	10.9	36.1	26.7	12.5	6.23	17.6	22.1	16.6	21	6.02	17.58	6.02	36.1	
Thallium	0.00075	0.021	0.0009	0.0024	0.0016	<0.00075	0.0019	0.0021	0.0009	<0.00075	0.001	0.0040	<0.00075	0.021	
Uranium	0.00075	0.0027	0.0034	0.0057	0.016	0.0024	0.028	0.0018	0.0019	0.003	0.002	0.0066	0.0018	0.028	
Vanadium	0.00625	0.033	0.026	0.084	0.048	0.021	0.045	0.037	0.024	0.052	0.0076	0.038	0.0076	0.084	
Zinc	0.0625	16.9	18.5	18.3	13.7	19.5	25.1	19.6	33.6	31.1	7.74	20.40	7.74	33.6	

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.

< = less than; mg/kg= milligrams per kilogram.

Table 3-7 Metal Concentrations in Birch Leaf Samples (2007)

Parameter	Concentration [mg/kg dry weight]												Mean ^a	Minimum	Maximum
	Detection Limit	FRA001 L 04-Aug-2007	FRA009 L2 04-Aug-2007	FRA011 L2 04-Aug-2007	FRA012 L 04-Aug-2007	FRA015 L 05-Aug-2007	FRA016 L1 05-Aug-2007	FRA018 L 05-Aug-2007	FRA022 L 05-Aug-2007	FRA023 L2 05-Aug-2007	FRA024 L2 05-Aug-2007				
Aluminum	0.25	23.1	42.2	15.9	27.4	89.7	11.5	34.5	24.2	9.99	10.2	28.9	9.99	89.7	
Antimony	0.00125	0.0022	0.0038	0.0025	0.0031	0.010	0.0047	0.014	0.0025	0.0067	0.0048	0.0054	0.0022	0.014	
Arsenic	0.00625	0.074	0.10	0.15	0.20	0.70	0.28	0.044	0.13	0.15	0.19	0.20	0.044	0.70	
Barium	0.0125	58.7	40.4	44.8	22.4	28.2	23.1	104	54	57.3	32.4	46.5	22.4	104	
Beryllium	0.00625	0.0084	<0.00625	<0.00625	0.013	<0.00625	<0.00625	0.017	<0.00625	<0.00625	<0.00625	<0.00625	<0.00625	0.017	
Bismuth	0.00075	0.0074	0.004	0.014	0.015	0.06	0.009	<0.00075	0.0089	0.0068	0.004	0.01	<0.00075	0.060	
Boron	0.0625	8.12	13.8	11.7	4.84	6.2	11.7	9.41	10.3	15.6	16.9	10.9	4.84	16.9	
Cadmium	0.0025	0.205	0.31	0.11	0.025	0.053	0.12	0.21	0.21	0.082	0.040	0.14	0.025	0.31	
Chromium	0.0625	0.199	0.21	0.14	0.14	0.24	0.12	0.19	0.29	0.23	0.14	0.19	0.12	0.29	
Cobalt	0.0025	0.273	0.27	0.21	0.14	4.4	4.54	0.98	0.31	0.062	0.59	1.18	0.062	4.54	
Copper	0.0625	3.82	3.9	4	4.45	9.65	4.1	4.6	3.87	3.43	4.92	4.67	3.43	9.65	
Lead	0.00125	0.042	0.079	0.032	0.023	0.070	0.027	0.097	0.062	0.040	0.024	0.050	0.023	0.097	
Manganese	0.00625	237	466	166	74.5	159	63.7	645	240	165	256	247	63.7	645	
Mercury	0.0125	0.015	0.015	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	<0.0125	0.024	<0.0125	<0.0125	<0.0125	0.024	
Molybdenum	0.00125	0.033	0.022	0.047	0.014	0.015	0.030	0.016	0.19	0.086	0.080	0.053	0.014	0.19	
Nickel	0.00625	1.05	0.60	0.38	2.68	0.27	0.13	1.22	0.38	0.34	0.17	0.72	0.13	2.68	
Selenium	0.125	<0.125	<0.125	<0.125	0.168	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	0.073	<0.125	0.17	
Silver	0.00075	0.0037	0.041	<0.00075	0.0009	0.0044	<0.00075	0.009	<0.00075	0.0015	<0.00075	0.0062	<0.00075	0.041	
Strontium	0.005	11.6	17	11.5	13.1	7.48	9.44	27.6	13.4	23.3	8.26	14.3	7.48	27.6	
Thallium	0.00075	0.004	0.0033	0.0096	0.014	0.0029	0.0051	0.019	0.0057	0.0041	0.0015	0.0069	0.0015	0.019	
Uranium	0.00075	0.0025	0.014	0.014	0.0038	0.011	0.0019	0.0084	0.0065	0.0017	0.0022	0.0067	0.0017	0.014	
Vanadium	0.00625	0.041	0.068	0.028	0.016	0.11	0.014	0.046	0.071	0.057	0.011	0.046	0.011	0.11	
Zinc	0.0625	70.5	129	54.5	17	141	68.3	91	96.8	221	68.8	96	17	221	

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.
< = less than; mg/kg= milligrams per kilogram.

Concentrations of metals in lichen collected are presented in Table 3-8. Beryllium was not detected in FRA003 C, FRA007 C, FRA008 C, FRA010 C, FRA019 C, and FRA025 C. Selenium was only detected in FRA015 C. Variability was observed within the observed metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: aluminum, antimony, arsenic, beryllium, boron, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver, thallium, uranium, and vanadium. Concentrations of 16 parameters were identified as the maximum concentration at site location FRA015C, which is approximately 1000 m northwest of Grid Pond. Concentrations of several parameters (e.g., aluminum, antimony, arsenic, barium, bismuth, chromium, cobalt, copper, lead, mercury, selenium, uranium, and vanadium) were substantially higher at this location than measured anywhere else. Lichen typically take up metals via airborne distribution of dust rather than uptake from soil; therefore, the source of metals may have been due dust generated by a nearby road.

3.1.2 2008 Plant Sample Program

Concentrations of metals in sedges collected in 2008 are presented in Table 3-9. Beryllium was detected in Bur003, Lgr001, Lgr003, Nic003, Pea002, and Ref001. Selenium was only detected in Lgr001. Variability was observed within the metal concentrations. The maximum value was over an order of magnitude greater than the minimum value for the following metals: aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, thallium, uranium, and vanadium. The majority of the maximum concentrations were measured in samples collected from Pea002, which was one of the 3 sample locations on the west side of Peanut Lake. Concentrations at Pea002 were also often higher than those measured in samples collected 20 m north and south of Pea002 (i.e., Pea001 and Pea003). It is unknown why this anomaly was observed.

Table 3-8 Metal Concentrations in Lichen (2007)

Parameter	Concentration [mg/kg dry weight]																		
	Detection Limit	FRA001C 04-Aug-2007	FRA003 C 04-Aug-2007	FRA007 C 04-Aug-2007	FRA008 C 04-Aug-2007	FRA010 C 04-Aug-2007	FRA012 C 04-Aug-2007	FRA015 C 05-Aug-2007	FRA017 C 05-Aug-2007	FRA018 C 05-Aug-2007	FRA019 C 05-Aug-2007	FRA020 C 05-Aug-2007	FRA021 C 05-Aug-2007	FRA022 C 05-Aug-2007	FRA025 C 05-Aug-2007	FRA026 C 05-Aug-2007	Mean ^a	Minimum	Maximum
Aluminum	0.25	171	107	99.7	116	80.7	256	3620	165	230	141	181	114	540	183	210	414	80.7	3620
Antimony	0.00125	0.0083	0.011	0.0069	0.0075	0.0074	0.0137	1.38	0.015	0.0098	0.012	0.028	0.020	0.030	0.026	0.022	0.11	0.0069	1.38
Arsenic	0.00625	0.26	0.24	0.20	0.15	0.17	0.89	101	0.36	0.31	0.23	1.33	0.42	0.44	0.85	3.16	7.33	0.15	101
Barium	0.0125	11.7	12.1	17.5	22.2	9.65	5.34	44.8	21.3	9.09	25.4	16.7	21.9	13.3	17.6	11	17	5.34	44.8
Beryllium	0.00625	0.0064	<0.00625	<0.00625	<0.00625	<0.00625	0.0093	0.084	0.0086	0.007	<0.00625	0.011	0.0066	0.020	<0.00625	0.011	0.012	<0.00625	0.084
Bismuth	0.01	0.012	0.017	0.005	0.002	0.005	0.09	27.1	0.005	0.0029	0.016	0.085	0.093	0.011	0.004	0.12	1.84	0.002	27.1
Boron	0.0625	0.34	0.36	1.15	1.34	0.59	0.13	1.64	2.84	0.56	2.03	1.57	1.01	0.88	2.41	1.55	1.23	0.129	2.84
Cadmium	0.0025	0.076	0.040	0.028	0.052	0.028	0.048	0.084	0.087	0.047	0.049	0.036	0.026	0.058	0.036	0.029	0.048	0.026	0.087
Chromium	0.0625	0.20	0.19	0.18	0.2	0.14	0.28	1.6	0.24	0.34	0.23	0.30	0.17	0.45	0.29	0.26	0.34	0.135	1.6
Cobalt	0.0025	0.092	0.050	0.070	0.11	0.036	0.12	12.8	0.21	0.23	0.23	0.15	0.15	0.11	0.071	1.86	1.09	0.036	12.8
Copper	0.0625	0.94	0.92	1.1	2.06	0.98	3	987	1.64	0.76	2.03	8.19	1.42	1.37	1.59	4.11	68	0.76	987
Lead	0.00125	0.34	0.30	0.28	0.31	0.27	0.53	4.6	0.39	0.51	0.44	0.52	0.39	0.8	0.66	0.36	0.71	0.27	4.6
Manganese	0.00625	32.1	58.9	120	174	150	18.3	29.4	230	37.9	260	154	126	20.3	174	32.6	108	18.3	260
Mercury	0.0125	0.028	0.024	0.027	0.04	0.031	0.027	0.41	0.055	0.024	0.046	0.066	0.056	0.037	0.055	0.030	0.064	0.024	0.41
Molybdenum	0.00125	0.028	0.021	0.029	0.046	0.024	0.031	0.48	0.029	0.026	0.18	0.030	0.029	0.34	0.13	0.26	0.11	0.021	0.48
Nickel	0.00625	0.18	0.13	0.17	0.39	0.12	0.23	1.03	0.37	0.28	1.57	0.58	0.24	0.35	0.13	0.20	0.40	0.116	1.57
Selenium	0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	0.49	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	<0.125	0.491
Silver	0.00075	0.0058	0.0042	0.0033	0.023	0.0083	0.15	0.079	0.0052	0.0049	0.0084	0.0077	0.0058	0.0081	0.0014	0.0086	0.021	0.0014	0.15
Strontium	0.005	1.89	1.99	5.22	9.2	1.92	1.69	5.75	5.2	2.26	9.05	5.9	5	2.91	5.68	6.82	4.70	1.69	9.2
Thallium	0.00075	0.0032	0.0034	0.0031	0.0058	0.0032	0.0061	0.042	0.014	0.0048	0.0067	0.031	0.0086	0.012	0.0053	0.0073	0.010	0.0031	0.042
Uranium	0.00075	0.026	0.012	0.011	0.0079	0.008	0.0238	2.71	0.036	0.032	0.021	0.025	0.013	0.097	0.026	0.32	0.22	0.0079	2.71
Vanadium	0.00625	0.23	0.20	0.20	0.20	0.17	0.37	2.63	0.264	0.50	0.27	0.32	0.21	0.79	0.39	0.33	0.47	0.17	2.63
Zinc	0.0625	17.2	12.5	14.4	29	13.6	11	16.6	24.6	11.3	20.3	23.1	17.2	13	20.7	13	17	11	29

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.

< = less than; mg/kg= milligrams per kilogram.

Table 3-9 Metal Concentrations in Sedge Samples (2008)

Parameter	Concentration [mg/kg dry weight]																					
	Detection Limit	Bgr001 17-Aug-08	Bgr002 17-Aug-08	Bgr003 17-Aug-08	Bur001 17-Aug-08	Bur002 17-Aug-08	Bur003 17-Aug-08	Lgr001 17-Aug-08	Lgr002 17-Aug-08	Lgr003 17-Aug-08	NIC001 19- Aug-08	NIC002 19-Aug-08	NIC003 19-Aug-08	Pea001 17-Aug-08	Pea002 17-Aug-08	Pea003 17-Aug-08	Ref001 17-Aug-08	Ref002 17-Aug-08	Ref003 17-Aug-08	Mean ^a	Minimum	Maximum
Percent Moisture		81.5	85.2	81.4	80.8	81	79.5	78.4	78.6	80.8	74.4	73.8	72.8	76.3	81	67.9	81.6	79.2	65.1	77.7	65.1	85.2
Aluminum	3.75	32.7	37.7	47.4	53	61	497	64.5	34	109	193	118	1677	84.6	1372	74.4	1068	40.1	116	316	32.7	1677
Antimony	0.00125	0.083	0.19	0.051	0.0031	0.0052	0.050	0.11	0.054	0.086	0.0066	0.0036	0.045	0.0052	0.12	0.010	0.027	0.0062	0.0059	0.048	0.0031	0.192
Arsenic	0.05	26.7	53.2	39.6	0.48	0.86	2.34	57	43.2	34.7	3.2	2.22	13	0.73	25.9	2.39	1.92	1.02	0.47	17	0.465	57
Barium	0.125	7.95	5.82	7.01	31.8	24.4	16.9	6.69	5.42	7.66	34.7	26.8	31.5	72.5	49.8	33.8	53.1	42.5	23.2	27	5.42	72.5
Beryllium	0.00625	< 0.00625	< 0.00625	< 0.00625	< 0.00625	< 0.00625	0.023	0.011	< 0.00625	0.0093	< 0.00625	< 0.00625	0.057	< 0.00625	0.0746	< 0.00625	0.0381	< 0.00625	< 0.00625	< 0.00625	< 0.00625	0.0746
Bismuth	0.00075	0.0079	0.015	0.0102	0.0031	0.0013	0.0085	0.031	0.0201	0.0422	0.0021	0.0009	0.0054	0.0104	0.0676	0.0053	0.0109	0.0014	0.0012	0.014	0.0009	0.0676
Boron	1	4.61	5.28	5.86	11	5.34	8.19	5.72	4.06	4.61	7.78	6.21	7.93	9.49	10.6	7.6	11.6	8.52	8.78	7.4	4.06	11.6
Cadmium	0.0075	0.008	0.0086	0.011	0.033	0.26	0.034	0.011	0.016	0.011	0.085	0.011	0.019	0.024	0.062	0.014	0.020	0.010	0.025	0.037	0.008	0.26
Chromium	0.375	0.3	0.29	0.33	1.29	0.29	1.04	0.32	0.28	0.30	0.31	0.27	1.11	0.48	2.41	0.42	1.81	0.29	0.32	0.66	0.266	2.41
Cobalt	0.0125	2.69	4.42	4.85	0.10	0.20	0.40	7.09	7.68	6.91	0.15	0.17	0.91	0.16	1.15	0.16	0.97	0.24	0.23	2.14	0.102	7.68
Copper	0.125	3.22	5.2	5.48	1.56	2.18	4.35	7.26	6.21	9.13	3.14	1.83	4.04	8.31	11.1	12.3	3.9	1.16	2.12	5.14	1.16	12.3
Lead	0.0025	0.029	0.033	0.029	0.069	0.058	0.24	0.072	0.024	0.043	0.062	0.050	0.26	0.035	0.49	0.044	0.38	0.039	0.061	0.11	0.0239	0.49
Manganese	0.0375	103	52.4	43.9	347	150	89.8	83.9	84	92.5	168	222	174	590	257	501	815	379	354	250	43.9	815
Mercury	0.000003	0.0046	0.0055	0.004	0.0085	0.0062	0.011	0.0036	0.0022	0.0026	0.0010	0.0027	0.0054	0.003	0.015	0.0060	0.0054	0.0050	0.0049	0.0054	0.00104	0.015
Molybdenum	0.01	0.89	1.11	0.37	0.17	0.31	0.68	0.34	0.20	0.28	1.39	0.92	0.66	1.72	1.98	0.53	0.78	0.44	1.04	0.77	0.173	1.98
Nickel	0.075	0.15	0.23	0.19	0.34	0.30	1.19	0.21	0.13	0.22	0.25	0.14	0.68	0.60	2.44	0.33	1.34	0.19	0.22	0.51	0.134	2.44
Selenium	0.25	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	0.128	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	< 0.125	0.128
Silver	0.00625	0.0043	0.0034	0.0038	0.0068	0.0069	0.0138	0.0041	0.0048	0.0046	0.004	0.0033	0.013	0.018	0.022	0.0065	0.013	0.0038	0.0042	0.0078	0.0033	0.022
Strontium	0.01	9.18	10	9.02	28.2	15	20.5	8.16	7.22	6.76	16.7	47.3	17.6	36.6	33.9	19.7	23.6	17.4	20.5	19	6.76	47.3
Thallium	0.00375	0.0021	0.0022	0.0032	0.0025	0.0034	0.014	0.0046	0.0074	0.0041	0.0026	0.0034	0.013	0.0095	0.18	0.015	0.020	0.0051	0.0039	0.016	0.0021	0.18
Uranium	0.00375	0.45	0.88	1.25	0.0087	0.048	0.44	0.65	0.45	0.79	0.038	0.031	0.64	0.055	1.93	0.090	0.66	0.033	0.039	0.47	0.0087	1.93
Vanadium	0.0625	0.12	0.17	0.12	0.099	0.13	1.95	0.20	0.095	0.17	0.22	0.15	1.57	0.17	2.98	0.21	2.32	0.10	0.17	0.61	0.0954	2.98
Zinc	0.25	28	18.1	18.8	40.8	30.9	31.3	27.3	20.9	25.4	20.1	18.7	18.1	25	39.4	40.8	29.5	29.8	33	27	18.1	40.8

^a Where values were less than detection limits, one half detection limits were used to calculate the mean concentration.
< = less than; mg/kg= milligrams per kilogram.

4 SUMMARY

Samples of alder, willow, birch, lichen, corresponding soils, and sedges and submergent macrophytes were collected for metals analyses. All analyzed parameters were detected in all soil samples collected and the majority of analyzed parameters were detected in all vegetation samples. Considerable natural variability was observed in the samples analyzed. Parameters were considered to have substantial natural variability if the maximum concentration was more than ten times higher than the minimum concentration for each media type sampled. Soil had the greatest variability with 21 of the 23 parameters analyzed having more than an order of magnitude difference. Of the vegetation sampled, lichen had the greatest variability (17 parameters), followed by sedges (13 parameters in 2007 and 15 parameters in 2008), birch (11 parameters), alder (10 parameters), willow (7 parameters), and submergent macrophytes (7 parameters).

There were no differentiating features of sample locations to explain the variability in the data obtained. Soil types were relatively consistent and there was no obvious trend in locations of samples with higher concentrations (e.g., around Grid Pond). There also was no trend in sample locations that had multiple parameters with maximum concentrations in all types of samples collected (i.e., soil, lichen, sedge, birch, alder, willow, and submergent macrophytes). It is expected that localized geological conditions may be the reason for the high variability in data.

The chemistry data also indicated that plants are not substantially taking up metals from soil. The majority of plant concentrations are less than soil concentrations indicating that plants are not accumulating metals. Manganese and zinc concentrations were higher in some plants than found in soil; however, both manganese and zinc are required nutrients for plant growth.

5 REFERENCES

CCME (Canadian Council of Ministers of the Environment). 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Update 7.0, September, 2007.

6 GLOSSARY OF TERMS

6.1 ABBREVIATIONS AND ACRONYMS

ARC	Alberta Research Council
CCME	Canadian Council of Ministers of the Environment
e.g.	for example
ELC	ecological land cover classification
Fortune	Fortune Minerals Limited
Golder	Golder Associates Ltd.
GPS	global positioning system
i.e.	that is
Project	NICO Cobalt-Gold-Bismuth-Copper Project
spp.	multiple species
UTM	universal transverse mercator

6.2 UNITS OF MEASURE

<	less than
cm	centimetre
km	kilometre
m	metre
mg/kg	milligrams per kilogram