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SITE CHARACTERIZATION, *EX SITU* BIOPILES AND *IN SITU* PILOT SCALE BIOREMEDIATION STUDIES AT CFS-ALERT, NUNAVUT

Final Report 2008-2009

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EXECUTIVE SUMMARY

This report presents the results of the 2008/09 field and laboratory work performed by the Biotechnology Research Institute (BRI), of the National Research Council of Canada (NRC), with samples collected from Canadian Force Station Alert (CFS-Alert), Nunavut.

The original project had 3 goals: 1) complete the characterization and delineation of 18 previously identified contaminated sites with the goal of developing a remediation plan, 2) implement a pilot scale *in situ* bioremediation system at 2 sites to identify optimal *in situ* bioremediation conditions which can then be scaled up and used at selected sites at CFS-Alert and 3) excavation and *ex situ* biopile bioremediation of selected petroleum hydrocarbon (PHC) contaminated sites with a goal of site closure.

Summary of Progress

1) Site Characterization and Delineation

The objectives of the characterization and delineation were:

- Identification of missing data/sample sites required for complete site characterization;
- Perform field sample and data collection;
- Update classification of each site according to the National Classification System (NCS) for contaminated sites;
- Update Geographic Information System (GIS) documentation for CFS-Alert;
- Entry of required information and NCS scores into the ECONET database.

Sampling was performed as planned at all 18 sites, with 13 sites completely delineated and ready for the development of a remediation plan. A total of 222 soil samples, 12 ground- and surface-water samples were collected and analysed during this sampling campaign. In addition, 11 field blanks and 7 transport blanks were collected and analysed. The remaining 5 sites require a final sampling campaign in specific localized areas to refine contaminant delineation but the characterization work was advanced far enough that bioremediation plans can be developed.

A summary of the site recommendations is presented in Table A.

Table A. Summary of Site Characterization Recommendations

Closure or Long Term Maintenance	***Ex Situ* Bioremediation**
S-146 Alert (Contaminated Sites/Underwater Survey) S-148 Battery Dump S-10529 Lower Dumbell Lake	S-10196 Burn Pit S-10206 TX Site S-10212 Airstrip Met Shack S-10213 Main Station POL Pallet Line S-10218 Burner Project Site S-10220 Barrel cache
***In Situ* Bioremediation (once *in situ* parameters established)**	**Complete Delineation with a Goal to Remediation**
S-10214 Main Station Day Tank S-10195 MSE-17 Vehicle Maintenance Building S-10199 CE-140 MCE Building Fire Hall S-10207 Airstrip Building HIL-124 S-10208 Airstrip Building FH-128 S-10215 Main Station HAPS S-10217 Heated Vehicle Storage S-10522 AES Weather Station Remains S GA	S-10207 Airstrip Building HIL-124 S-10208 Airstrip Building FH-128 S-10214 Main Station Day Tank/ S-354 Alert Old Upper POL Line S-10215 Main Station HAPS S-10217 Building 113, Heated Vehicle Storage S-10522 AES Weather Station Remains-GA

2) *In Situ* Pilot Scale Bioremediation Systems

Two pilot scale *in situ* systems were installed at the S-349 Oxidator Building and S-10216 Baker's Dozen sites to examine the impact of 3 different aeration systems and nutrient amendment on the bioremediation of PHC contamination. Each system consisted of 4 test plots, 1 plot each for the 3 technologies under examination (soil venting, soil turning and a commercial oxygen delivery compound) and 1 control plot with no aeration system. The 3 aerated test plots were also amended with nutrients (250 mg monoammonium phosphate / kg soil).

Field measurements indicated that oxygen concentrations in the sub-surface were higher than expected (i.e. saturated) but that the indigenous microbial activity, based on CO_2 and methane production, was quite low. The addition of nutrients had a positive impact on the biodegradation of PHC surrogates (hexadecane and naphthalene) as observed by lab based microbiological analyses. The increased rate and extent of PHC biodegradation by the indigenous microbial population indicates that nutrient deficiency is the primary consideration in optimizing an *in situ* bioremediation system and that improved aeration may be required once microbial activity increases.

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in the world. It has an average temperature in June, July and August of -0.8°C, 3.3°C and 0.8°C, respectively, and the total average annual precipitation is 153.8 mm (Environment Canada, 2004). Precipitation occurs primarily during the months of July, August, and September. Because of permafrost and the lack of significant surface vegetation, runoff is an important water redistribution process during the snowmelt period.

The closest non-military Canadian community to CFS-Alert is Grise Fiord, located approximately 800 km southeast of the station (Soulière 1997). The Ellesmere Island National Park Reserve is 40 km southwest of CFS-Alert. The CFS-Alert area was not included in the Park Reserve at the request of the Department of National Defence and Canadian Forces (DND/CF).

Built in 1950 as a weather station, Alert became a Canadian Military Communications Research Facility in 1956. At its peak of activity in the 1970's, 200 military staff were stationed year around at CFS-Alert. CSF-Alert is now a remotely operated listening facility, and staffing was reduced to approximately 50 to 100 personnel for year around operation (Figure 2).

The subsurface stratigraphy of the CFS-Alert area is continuous permafrost. Holes drilled during a permafrost study indicated that the permafrost depth reaches a maximum of 480 m (Grey 1997). Recent observations indicated that the depth of the active layer is approximately 1 m (BRI 2007, 2008). The active layer is located above the permafrost and is the portion of the soil that is subjected to seasonal freeze thaw cycles.

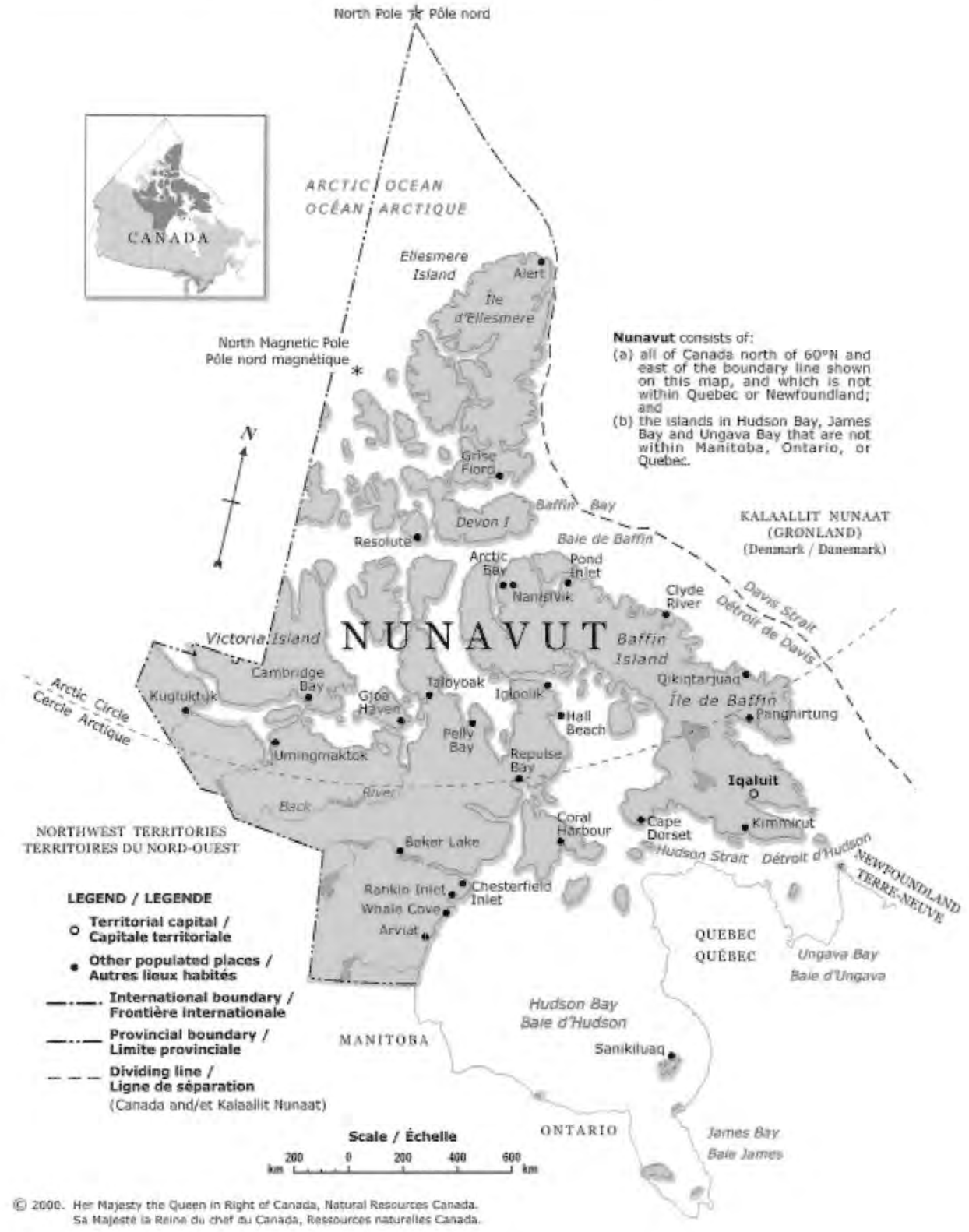

Figure 1. Map of Nunavut, showing CFS-Alert on Ellesmere Island.

Figure 2. Aerial view of CFS-Alert with Alert Inlet in foreground and both Dumbell Lakes in the left mid-ground (BRI 2008).

2.1 ENVIRONMENTAL RECEPTORS

Alert Inlet and Dumbell Bay are important environmental receptors for most CFS-Alert sites. They receive contaminated drainage water coming from the station, whether migrating within the surface water or groundwater. Influenced by tidal cycles, the water in Alert Inlet enters Dumbell Bay and reaches the Arctic Ocean by way of the Lincoln Sea. Therefore, aquatic life is potentially affected by the contamination from CFS-Alert. During the underwater survey, plant and animal life such as seaweed, fish and seals, were observed near the shoreline of Alert Inlet and Dumbell Bay. Lower and Upper Dumbell Lakes are the environmental receptors for the watershed surrounding the lakes. Artic Char fishing at Lower and Upper Dumbell Lakes is an occasional recreational activity for CFS-Alert personnel.

During the 2006-2008 sampling campaigns, animals such as polar bears, reindeer, muskox, wolves, hares, lemmings and birds were observed in or near the vicinity of CFS-Alert. When an animal was not directly observed at a study site, evidence of its presence or passage, such as feces and tracks, were generally recorded. An important quantity of birds was frequently observed at the sewage outfall site.

Various types of vegetation were observed at CFS-Alert during the 2006-2008 sampling campaigns. This vegetation was abundant at the sewage outfall site, and was present to a lesser degree throughout the station area.

Human activity is restricted to the building during the winter, with increased outdoor activities in the vicinity of the station during the summer months.

3 METHODOLOGY

3.1 SITE VISITS

A total of 3 teams composed of BRI staff members worked at CFS-Alert during the 2008 field season. The first team (2 staff) worked at CFS-Alert from July 3rd to July 16th, the second team (1 staff) worked at CFS-Alert from July 16th to July 31st and the third team (2 staff) worked at CFS-Alert from July 31st to August 17th.

A total of 222 soil samples and 12 ground- and surface-water samples were collected during this sampling campaign.

3.2 SAMPLE IDENTIFICATION

The sample identification scheme followed this format: B08-XX-####. The letter B represents the BRI sampling campaign, the first 2 numbers represent the year of the sampling campaign (i.e. 2008), the 2 letters represent the site identification abbreviation and the last 4 numbers represent the sample identification. A list of the site abbreviations with the associated Property Record Identification Number (PRIN) and site name is presented in Table 1.

Bodycote Materials Testing, located in Pointe-Claire, Montreal, and Testmark Laboratories Ltd., located in Garson, Ontario, supplied all sample containers. The sample label was firmly attached to the side of the container, and the following information was legibly and indelibly written on the label:

- Project name;
- Sample identification;
- Sampling date;
- Tests required;
- Preservatives added;
- Sample collector's initials.

Table 1. Sites visited during the 2008 BRI sampling campaign.

PRIN	Name	Abbreviations
Site Characterization/Delineation		
S-146	Alert (Contaminated Sites/Underwater Survey)	SH/MW SH
S-148	Battery Dump	BD
S-354	Old Upper POL Farm	UP
S-10195	MSE-17 Vehicle Maintenance Building	VM
S-10196	Burn Pit	BP
S-10199	CE-140 MCE Building Fire Hall	FH
S-10206	TX Site	TX
S-10207	Airstrip Building HIL-124	HI
S-10208	Airstrip Building FH-128	AS
S-10212	Airstrip Met Shack	ME
S-10213	Main Station POL Pallet Line	SP
S-10214	Main Station Day Tank Area	DT
S-10215	Main Station HAPS	HA
S-10217	Building 113, Heated Vehicle Storage	HV
S-10218	Burner Project Site	BU
S-10220	Barrel Cache	XX
S-10522	AES Weather Station Remains-GA	WS
S-10529	Lower Dumbell Lake	LL
In Situ Pilot Scale Study Areas		
S-349	Oxidator Building	OX
S-10216	Baker's Dozen	BZ

3.3 SURVEYING OF EACH SAMPLE POINT

Each new sample point collected during the 2008 sampling campaign was geo-referenced to update the GIS documentation of the CFS-Alert sites. A post-processing differential CMT-Alto-G12 GPS was used to perform the geo-referencing survey. This differential GPS procedure involved a stationary receiver (base station), which continuously recorded satellite measurements at a fixed and known location, and a mobile receiver that recorded the location of each sampling point. The base station was located in the same place as in 2007. The geo-reference of each sampling point recorded with the mobile receiver was corrected using the information recorded by the base station (differential GPS procedure). The reader should note that only sampling points from the 2006-2008 BRI field campaigns are presented on the maps. Please reference previous reports for all previous sampling points.

Geo-reference coordinates were collected using the global geodetic reference system WGS84. This system was established and is maintained by the U.S. Department of Defense to facilitate positioning and navigation worldwide (Kouba and Popelar, 1994), and has an accuracy of approximately 1 m.

3.4 SOIL AND SEDIMENT SAMPLING

Site assessment work performed during the 2008 campaign was based on previous literature reviews and campaign results. The objective of the assessment work was to delineate and characterize contaminated areas in order to obtain the necessary information for updating of the Econet database and prepare potential remediation schemes, where applicable.

Total petroleum hydrocarbon (TPH) fraction analysis (F1 to F4) was carried out by Testmark Laboratories Ltd, accredited by the CCME. All other analyses (heavy metals, volatile organic carbon (VOC), Kjeldahl nitrogen, ammonia nitrogen, and total phosphorus) were performed by Bodycote Materials Testing, also an accredited laboratory.

Soil samples (active layer and suprapermafrost layer) were collected from trenches made with a backhoe, using fresh disposable gloves for each sample and taken from newly exposed soil (i.e. soil not contacted by the backhoe). Some soil samples collected from the surface to approximately 60 cm below ground surface were dug with pick and shovel, which were decontaminated with an Alconox® soap solution between each sample. Samples for organic and inorganic element analyses were collected using glass sample jars with Teflon coated caps and dedicated gloves. For TPH F1 to F4 analyses, one 250 mL jar per sample was completely filled with soil or sediment to avoid contaminant volatilization.

Visual observations and odor descriptions were noted for each sample in the field logs. Samples were stored in coolers at 4°C before and during shipping. A total of 239 soil samples were collected at Alert during the 2008 campaign, 212 for site characterization and delineation and 27 for the pilot scale *in situ* bioremediation study.

3.5 WATER SAMPLING

Site assessment work performed during the 2008 campaign was based on previous literature reviews and campaign results. The objective of the assessment work was to delineate and characterize contaminated areas in order to obtain the necessary information for updating of the Econet database and prepare potential remediation schemes, were applicable.

TPH F1 to F4 analysis was carried out by Testmark Laboratories Ltd, accredited by the CCME. All other analyses (heavy metals and polycyclic aromatic hydrocarbons (PAH)) were performed by Bodycote Materials Testing, also an accredited laboratory.

Samples for TPH analysis were collected in one 1L amber glass bottle per sample, provided by Testmark Laboratories Ltd., paying special attention to eliminate air within the bottles. All other bottles were provided by Bodycote Material Testing. Samples for PAH analyses were collected in one 1L amber glass bottle per sample. Samples analyzed for metals were collected in one 125mL plastic bottle per sample.

Visual observations and odor descriptions were noted for each sample in the field logs. Samples were stored in coolers at 4°C before and during shipping. A total of 17 water (14 surface and 3 groundwater) samples were collected at Alert during the 2008 campaign.

3.6 ASSESSMENT GUIDELINES

3.6.1 Soil Guidelines

Comparison guidelines for the assessment of soil contamination at CFS-Alert are based on the CCME Canada-Wide standards.

Inorganic elements, TPH, PAH, and other contaminant concentrations obtained during the 2008 sampling campaign were compared to CCME commercial/industrial generic levels. The CCME

commercial/industrial land use category is assigned to a site where the primary activity involves the production, manufacture, or storage of materials, and where public access is restricted. Children are not permitted continuous access or occupancy on commercial/industrial sites. This land use category corresponds to the activities occurring at CFS-Alert.

3.6.2 Water Guidelines

Water samples collected from Dumbell Bay and Alert Inlet were compared to the CCME Marine Quality Guidelines for the Protection of Aquatic Life. Water samples collected from isolated standing water pools, Lower Dumbell Lake and drainage channels from both Dumbell lakes were compared to CCME Freshwater Quality Guidelines for the Protection of Aquatic Life.

3.6.3 Sample Replicates and Blanks

Replicate pairs, field blanks and transport blanks were collected and analyzed for collection and transportation quality control. One field blank was generally collected at each site during the sampling procedure. One transport blank was sent with each load shipped from CFS-Alert to the analytical laboratory, via CFB-Trenton. These blanks were 250 mL glass jars filled with silica sand provided by Bodycote Materials Testing. The results of the analyses of the sample replicates are presented within the results of each site and the results of the transport and field blanks are presented in Tables 2 and 3, respectively.

Table 2. Results of transport blank analyses from CFS-Alert.

					Transport blank 2007						
		SOIL			SOIL						
	PARAMETERS	UNITS	GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	TB08-1 8/08/08	TB08-2	TB08-20	TB08-021	TB08-022 14/08/08	TB08-023 22/08/07	TB08-024 1/09/07
	F1 (C6-C10)	mg/kg	310	10.7	<2.6	NA	NA	<2.5	<2.4	<2.6	<2.3
	F2 (C10-C16)	mg/kg	760	3.9	<1.4	NA	NA	7.0	7.8	2.9	<1.5
	F3 (C16-C34)	mg/kg	1700	9.0	<3.3	NA	NA	<5.9	<3	3.0	<3.6
	F4 (C34-C50)	mg/kg	3300	29	<4.7	NA	NA	<8.5	<4.3	<3.7	<5.1
	Arsenic (As)	mg/kg	12	0.27	NA	<0.7	<0.7	NA	NA	NA	NA
	Barium (Ba)	mg/kg	2,000	5	NA	<2	<2	NA	NA	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	NA	<0.9	<0.9	NA	NA	NA	NA
	Chromium (Cr)	mg/kg	87	3	NA	<2	<2	NA	NA	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	NA	<1	<1	NA	NA	NA	NA
	Copper (Cu)	mg/kg	91	2.1	NA	<1	<1	NA	NA	NA	NA
	Lead (Pb)	mg/kg	600	1.2	NA	<10	<10	NA	NA	NA	NA
	Manganese (Mn)	mg/kg	---	1.1	NA	5	6	NA	NA	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	NA	<2	<2	NA	NA	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	NA	<2	<2	NA	NA	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	NA	<0.5	<0.5	NA	NA	NA	NA
	Silver (Ag)	mg/kg	40	0.4	NA	<0.5	<0.5	NA	NA	NA	NA
	Tin (Sn)	mg/kg	300	0.8	NA	<5	<5	NA	NA	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	NA	<4	<4	NA	NA	NA	NA

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL rotection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

Field blank collected at the CFS Alert

SOIL

6	B08-BP-FB0180	B08-BU-FB0193	B08-DT-FB0145	B08-DT-FB0207	B08-HA-FB0127	B08-HV-FB0121	B08-SP-FB0123	B08-BC-FB0152	B08-UP-FB0136	B08-VM-FB0113
	<2.1	NA	<2.5	<2.1	<2.4	<2.3	<2.1	<2.7	<2.5	2.5
	<1.1	NA	<1.8	1.4	1.3	0.81	<1.5	<2.3	<1.7	3.5
	<2.5	NA	<4.2	<2.4	216	152	152	242	<3.9	263
	<3.6	NA	<6.1	<3.5	<3.3	<2.6	<5.1	<7.6	<5.5	<6.5
	NA	<0.7	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<2	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<0.9	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<2	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<1	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<1	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<10	NA	NA	NA	NA	NA	NA	NA	NA
	NA	6	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<2	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<2	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<0.5	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<0.5	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<5	NA	NA	NA	NA	NA	NA	NA	NA
	NA	<4	NA	NA	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.4	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.009	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.02	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.08	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA
	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	NA

3.7 CONTAMINATED SITE CLASSIFICATION

Using the results from the 2006 to 2008 sampling campaigns, the CFS-Alert sites were evaluated with the CCME National System of Classification (NCS) of contaminated sites. This tool was created to help evaluate contaminated sites according to the actual or possible negative impacts of the contamination on the environment or human health. A copy of the Summary Score Sheet for each site is presented in Appendix A.

3.8 BACKGROUND METAL CONCENTRATIONS

Based on a soil survey examining the background concentrations of metals in the CFS-Alert area, conducted in 2007, it is recommended that a higher guideline concentration be adopted for arsenic and nickel. Current CCME industrial (coarse) soil guidelines for these metals are 12 and 50 mg/kg, respectively. The background survey revealed average (n=39) concentrations for arsenic and nickel to be 9.6 and 36.7 mg/kg, respectively, with measured concentrations ranging from 5.4-16.5 mg/kg and 28-52 mg/kg, respectively. The sample locations were chosen to represent the different topographies present in the area and were in areas where there was no evidence of current or past anthropogenic contamination. It is therefore recommended that guideline limits be calculated at twice the average background concentration (referred to as 'alternate' guidelines), which corresponds to 19.2 mg/kg for arsenic and 73.4 mg/kg for nickel.

All results discussed in this report will be based on current CCME guidelines (i.e. 12 and 50 mg/kg for arsenic and nickel, respectively) until the appropriate regulatory bodies agree and approve of the use of the alternate guidelines.

The calculated volumes of contaminated soil are based on alternate metals guidelines.

3.9 CERTIFICATES OF ANALYSIS

Certificates of analysis for all samples collected and analysed, including field and transport blanks, during the 2008 field campaign can be found in Appendix B.

4 CFS-Alert Sites

4.1 S-146 ALERT (CONTAMINATED SITES/UNDERWATER SURVEY)

4.1.1 Location and Site Description

The initial underwater site characterization survey, undertaken in 2007, focused on the benthic zone up to a distance of 40m from the shoreline. The area covered started approximately 250 m north of the airstrip refueling area, in Dumbell Bay, and finished at the southwestern end of Alert Inlet (Figure 3). Samples were collected at regular intervals of approximately 100 m at an average depth of approximately 15 m, and the distance from shore was limited by the movement of pack ice in the bay. Except for the annual Polar Dip event, no human activities are officially occurring within the shoreline area.

The 2008 sampling campaign was focused on the on-shore sites identified as being potential sources of contamination. These are old dump sites where material, most often barrels and waste metals, were buried. The topography of the land approaching the shoreline is generally strongly to moderately sloped, followed by flatland immediately adjacent to the shoreline. Two areas were targeted for detailed sampling; the first was to the west of the Narrows below the main base (Figure 4) and the second area was just inside of the Narrows to just before the sewage outfall in Alert Inlet (Figure 5). In addition, a series of 10 monitoring wells were installed along the shoreline. The wells were installed down to the permafrost and targeted natural drainage areas downstream of potential sources of contamination (eg. Main Station Landfill). The first well was located in a natural drainage area south of the runway and west of the Main Station Landfill and continued to just south of the Sewage outfall in Alert Inlet.

4.1.2 Summary of Previous BRI Investigations

The results from the underwater survey performed during 2007 revealed that hydrocarbon contamination (TPH and PAH) in the sediment was associated with old dump sites and waste

material in the sediments. The contamination is most likely due to residual material in the buried containers being released when the sediment and debris is disturbed. Metals were also detected (As, Cu Zn, Pb and Cr) above CCME guidelines and again were associated with the buried material. Metals were the primary contaminant in the sediments and may be due to long term leaching and/or dissolution of buried metal waste.

4.1.3 Nature and Extent of Contamination

All soil samples from the shoreline were collected at a depth of approximately 40cm using a pick and shovel as backhoe support was not available at the time of sampling. The majority of samples were collected at a distance of approximately 5-10 m from the shoreline, with several collected up to approximately 100 m from the shoreline when potential sources of contamination (eg. buried waste) were observed. A total of 39 soil samples were collected from the 2 targeted areas and only 1 groundwater sample was collected as the remaining wells were dry at the time of sampling.

All soil samples were analyzed for F1-F4 and no sample exhibited hydrocarbon concentrations above CCME guidelines (Table 4). Several samples were observed with elevated concentrations of F2 (B08-SH-0275 and B08-SH-0276) and F3 (B08-SH-0279).

Metals analysis was performed on 8 samples and revealed that 2 samples (B08-SH-0268 and B08-SH-0275) were above CCME guidelines (13.2 and 13.1 mg/kg, respectively) for arsenic and 4 samples (B08-SH-0270, B08-SH-0275, B08-SH-0286 and B08-SH-0290) were above guidelines (51, 58, 50 and 51 mg/kg, respectively) for nickel. There are 2 interesting points regarding the metal results; 1) no samples were above alternate guidelines for either metal and; 2) the remaining samples demonstrated the natural elevated concentrations of these metals (8.7-10.7 mg/kg arsenic and 47-49 mg/kg nickel).

NCS Score/Classification: 58.6/2

The estimated volume of contaminated soil is 3,000 m^3.

4.1.4 Recommendations

It appears that previously observed underwater (i.e. sediment) exceedences were due to submerged material or leaching of material at the immediate shoreline. Characterization of the slopes immediately upgradient of the landfill sites did not reveal any sites exceeding guidelines for F1-F4 (and no heavy metals above alternate guidelines). The most appropriate action at these two sites is to leave the underwater sites undisturbed as any dredging or disturbances would result in liberation of the contaminants into the water column significantly increasing the extent of the contamination. The materials remaining in the landfills should be removed as they are exposed with minimal disturbance to the shoreline for the above mentioned reason. One additional consideration is that the buried material may also be acting to stabilize the shoreline against ice and tide movements.

Alert (Cont Sites/Underwater Survey) (S-148)									
SOIL									
-SH-0268 30 cm 08/2008	B08-SH-0269 30 cm 11/08/2008	B08-SH-0270 40 cm 11/08/2008	B08-SH-0271 30 cm 11/08/2008	B08-SH-0272 30 cm 11/08/2008	B08-SH-0273 30 cm 11/08/2008	B08-SH-0274 30 cm 11/08/2008	B08-SH-0275 30 cm 11/08/2008	B08-SH-0276 30 cm 11/08/2008	B08-SH-0277 30 cm 11/08/2008
<3.7	<3.3	<2.9	<3.3	<3.3	<3	<3.2	125	134	3.4
2.1	3.4	21.5	2.5	2.7	1.5	2	475	538	49
5.3	13	34.5	30	40.8	10	77.8	245	249	300
<5.1	6.2	8.9	15	25	6.6	44.9	110	112	97.9

SOIL									
-SH-0279 30 cm 08/2008	B08-SH-0280 30 cm 11/08/2008	B08-SH-0281 30 cm 11/08/2008	B08-SH-0282 30 cm 11/08/2008	B08-SH-0283 30 cm 11/08/2008	B08-SH-0284 30 cm 11/08/2008	B08-SH-0285 30 cm 11/08/2008	B08-SH-0286 30 cm 11/08/2008	B08-SH-0287 30 cm 11/08/2008	B08-SH-0288 30 cm 11/08/2008
11	<2.8	65.4	4.9	<2.9	<3.1	<3.5	<3.2	<3.3	<3.3
132	5.3	90	28.7	21	13.7	10	17.1	18.1	7.7
1,480	30.5	449	283	602	113	56	510	102	197
589	11	91.9	100	213	28	34	202	35	54.7

SOIL									
-SH-0290 10 cm 08/2008	B08-SH-0291 30 cm 11/08/2008	B08-SH-0292 30 cm Dup. 0291 11/08/2008	B08-SH-0293 30 cm 11/08/2008	B08-SH-0294 10 cm 11/08/2008	B08-SH-0295 30 cm 11/08/2008	B08-SH-0296 30 cm 12/08/2008	B08-SH-0297 10 cm 12/08/2008	B08-SH-0298 30 cm 12/08/2008	B08-SH-0299 10 cm 12/08/2008
<3.4	<2.9	<3.3	<2.6	<2.7	<3.3	<3.3	<2.7	<3.1	<3.4
2.1	3.4	5.8	5.5	3.7	6.1	3.7	6.2	3	4.5
18	48.5	64	54.4	32	52.6	29	34.3	28	26.4
6.3	19	26	25	23	53.5	12	30	25	13

SOIL		WATER	SOIL					
USTRIAL DELINES Coarse)	DETECTION LIMIT	B08-SH-MW1 Groundwater 11/08/2008	B08-SH-0300 30 cm 12/08/2008	B08-SH-0301 25 cm 12/08/2008	B08-SH-0302 30 cm 12/08/2008	B08-SH-0303 30 cm 12/08/2008	B08-SH-0304 30 cm 12/08/2008	B08-SH-0305 30 cm 12/08/2008
310	10.7	<25	<3.1	<2.9	<3.3	<3.2	<3.2	<3.3
760	3.9	NA	5.5	<2.2	4.8	6.9	16.9	8.8
1700	9.0	NA	19	11	13	14	21	18
3300	29	NA	14	<7.3	5.6	6.8	12	8.4

ealth in Industrial land uses, of the CCME. (2006)

il Contact), endorsed by the CCME. (January 2001)

rine Water, of the CCME. (2006)

Table 5. S-146 Alert (Contaminated Sites/Underwater Survey) metal chemistry results

	PARAMETERS	SOIL			Alert (Cont Sites/Underwater Survey) (S-148)							
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-SH-0268 30 cm 11/08/2008	B08-SH-0270 40 cm 11/08/2008	B08-SH-0275 30 cm 11/08/2008	B08-SH-0286 30 cm 11/08/2008	B08-SH-0290 10 cm 11/08/2008	B08-SH-0294 10 cm 11/08/2008	B08-SH-0299 10 cm 11/08/2008	B08-SH-0304 30 cm 11/08/2008
METALS	Arsenic (As)	mg/kg	12	0.27	13.2	8.7	13.1	10.4	10.6	9.6	9.7	10.7
	Barium (Ba)	mg/kg	2,000	5	28	19	27	17	17	18	17	19
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	28	31	30	29	28	27	30	30
	Cobalt (Co)	mg/kg	300	1.9	14	14	18	14	14	13	14	13
	Copper (Cu)	mg/kg	91	2.1	29	24	61	29	20	28	23	20
	Lead (Pb)	mg/kg	600	1.2	16	12	24	15	13	13	14	13
	Manganese (Mn)	mg/kg	---	1.1	405	594	691	643	569	546	548	616
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	47	51	58	50	51	47	49	49
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	79	73	155	95	69	72	76	72

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

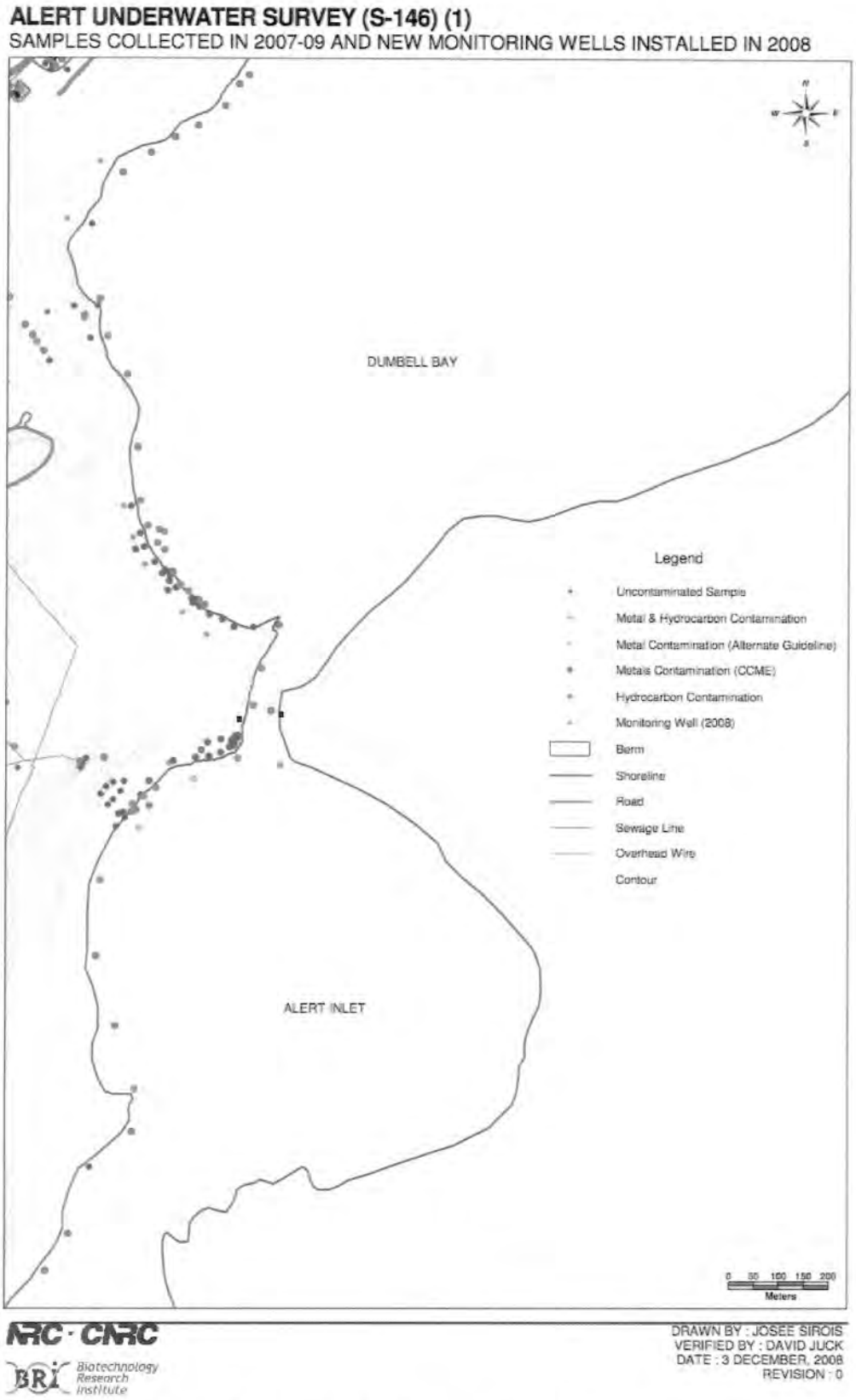

Figure 3. S-146 Alert (Contaminated Sites/Underwater Survey) map 1.

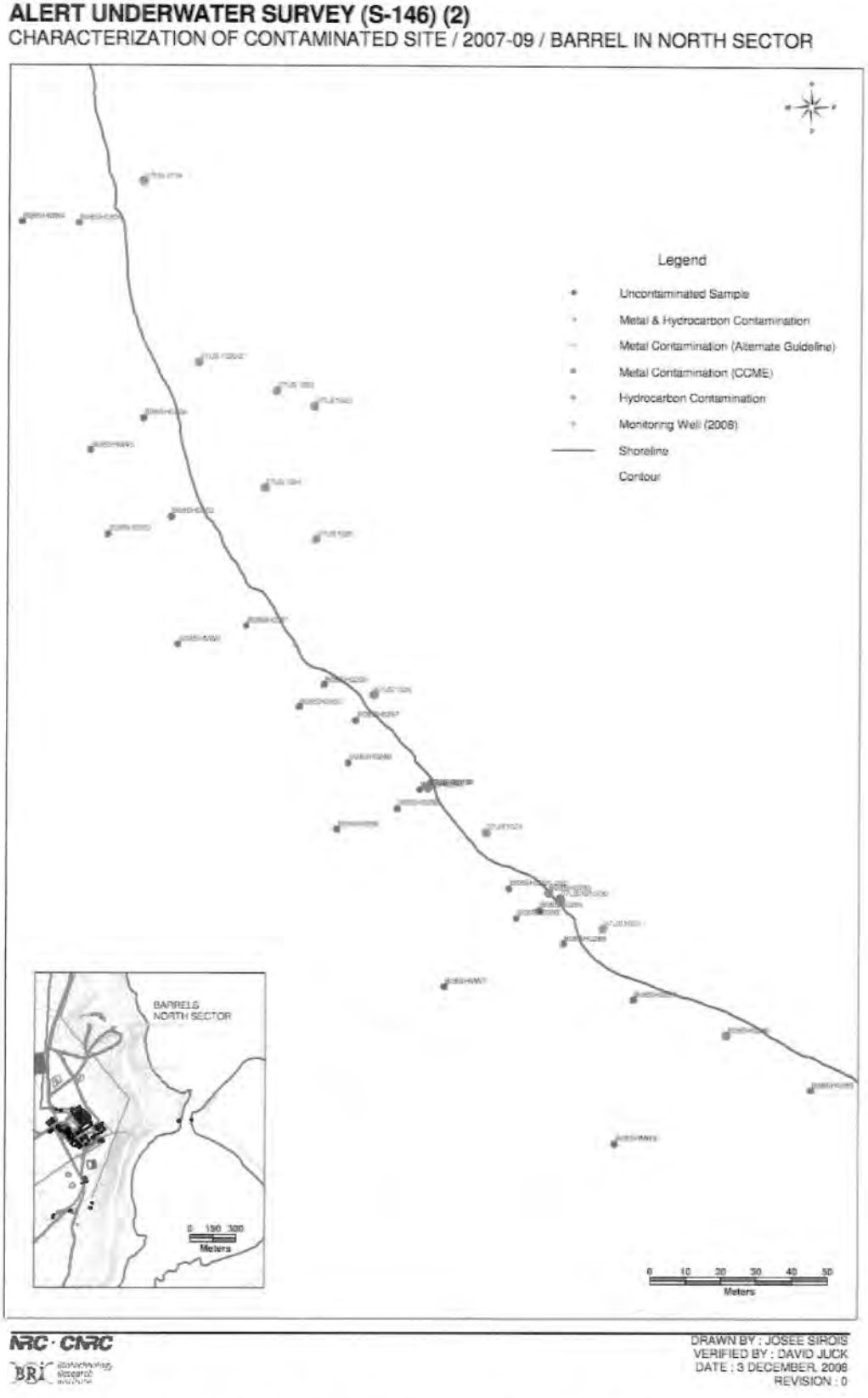

Figure 4. S-146 Alert (Contaminated Sites/Underwater Survey) map 2.

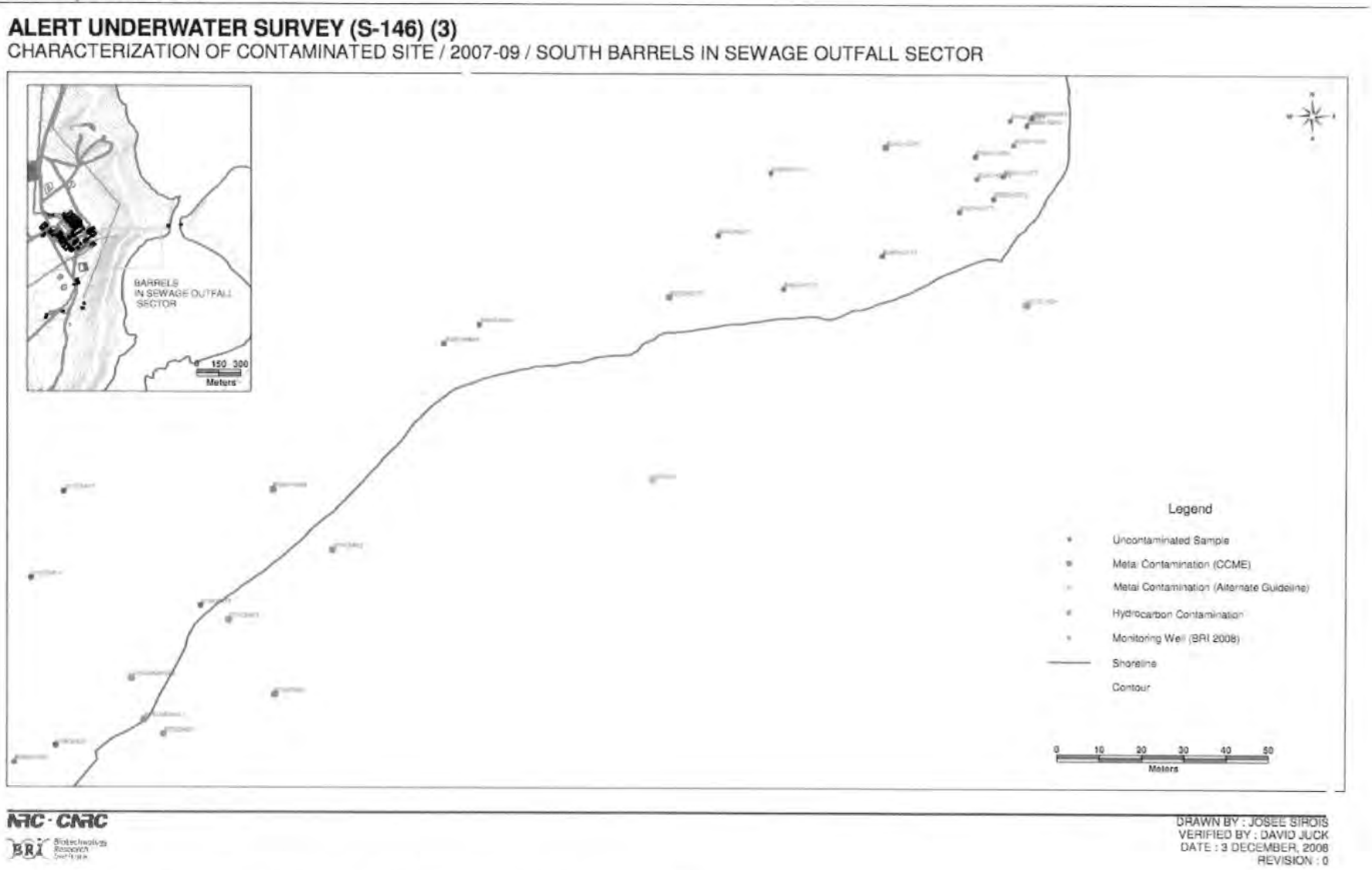

Figure 5. S-146 Alert (Contaminated Sites/Underwater Survey) map 3

4.2 S-148 BATTERY DUMP

4.2.1 Location and Site Description

The Battery Dump site is located southwest of the AES Hydrogen Building between Lower Water Road and Line Road and remains an operational site (Figure 6). The Battery Dump, situated on the side of a north-south slope above Alert Inlet, "has been used for the disposal of various types of batteries, including vehicle and potassium hydroxide batteries, and to a lesser extent, other types of debris such as wooden pallets, electrical wire, metal and cargo strapping", (ESG 2000). The area is surrounded by a circular rope fence and the debris was covered with gravel in 2004. At the time of the field investigation, battery debris and asbestos were exposed.

4.2.2 Summary of Previous BRI Investigations

A series of 5 samples were collected in 2006 (BRI 2006) within a previously (ESG 2000) identified area. Of the 5 samples collected, 3 had arsenic concentrations above CCME guidelines (but below alternate guidelines) and only 1 sample (06BD0026) had zinc above CCME guidelines (7,900 mg/kg vs 360 mg/kg).

4.2.3 Nature and Extent of Contamination

In 2008 a series of 8 samples were collected from the area down-gradient of the Battery Dump (Figure 6) to establish whether movement of contamination, in particular metals, was occurring (Table 6). Of the 8 samples collected, no F1-F4 was detected and only 2 samples had metals above CCME guidelines; B08-BD-0183 (nickel) and B08-BD-0186 (arsenic and nickel). It should be noted that the observed arsenic and nickel concentrations do not exceed the alternate guidelines.

NCS Score/Classification: 36.2/N

The estimated volume of contaminated soil is 0 m^3.

4.2.4 Recommendations

The areas previously identified as being above CCME guidelines are all contained within the built up area of the Battery Dump and no contamination has been identified outside of this area. Based on the location of this site and no evidence of offsite movement of heavy metals (in particular zinc), this site should be left dormant and a regular monitoring program be established based on soil sampling once every 3 years.

Table 6. S-148 Battery Dump metal chemistry results

	PARAMETERS	UNITS	SOIL INDUSTRIAL GUIDELINES (Coarse)	SOIL DETECTION LIMIT	Battery Dump (S-148) SOIL B08-BD-0085 90-100 cm Dup. 0185 23/07/2008	B08-BD-0183 90-100 cm 23/07/2008	B08-BD-0184 90-100 cm 23/07/2008	B08-BD-0185 90-100 cm 23/07/2008	B08-BD-0186 80-90 cm 23/07/2008	B08-BD-0187 90-100 cm 23/07/2008	B08-BD-0188 80-90 cm 23/07/2008	B08-BD-0189 100-100 cm 23/07/2008
TPH	F1 (C6-C10)	mg/kg	310	10.7	<2.9	<3	<2.6	<3.1	<2.6	<2.7	<3.1	<2.5
	F2 (C10-C16)	mg/kg	760	3.9	<1.4	<1.4	<1.2	<1.1	<1.3	<0.87	<1.7	<2
	F3 (C16-C34)	mg/kg	1,700	9.0	<3.3	<3.2	5	<2.6	<3.1	<2	<4	<4.7
	F4 (C34-C50)	mg/kg	3,300	29	<4.7	<4.5	<4.2	<3.8	<4.4	<2.9	<5.7	<6.7
METALS	Arsenic (As)	mg/kg	12	0.27	NA	10.2	NA	NA	12.4	8.2	NA	NA
	Barium (Ba)	mg/kg	2,000	5	NA	11	NA	NA	10	7	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	NA	<0.9	NA	NA	<0.9	<0.9	NA	NA
	Chromium (Cr)	mg/kg	87	3	NA	29	NA	NA	31	21	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	NA	15	NA	NA	15	11	NA	NA
	Copper (Cu)	mg/kg	91	2.1	NA	31	NA	NA	35	16	NA	NA
	Lead (Pb)	mg/kg	600	1.2	NA	14	NA	NA	14	11	NA	NA
	Manganese (Mn)	mg/kg	---	1.1	NA	477	NA	NA	468	436	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	NA	<2	NA	NA	<2	<2	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	NA	54	NA	NA	56	39	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	NA	<0.5	NA	NA	<0.5	0.6	NA	NA
	Silver (Ag)	mg/kg	40	0.4	NA	<0.5	NA	NA	<0.5	<0.5	NA	NA
	Tin (Sn)	mg/kg	300	0.8	NA	<5	NA	NA	<5	<5	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	NA	70	NA	NA	74	52	NA	NA

NA Not available

Higher than the criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

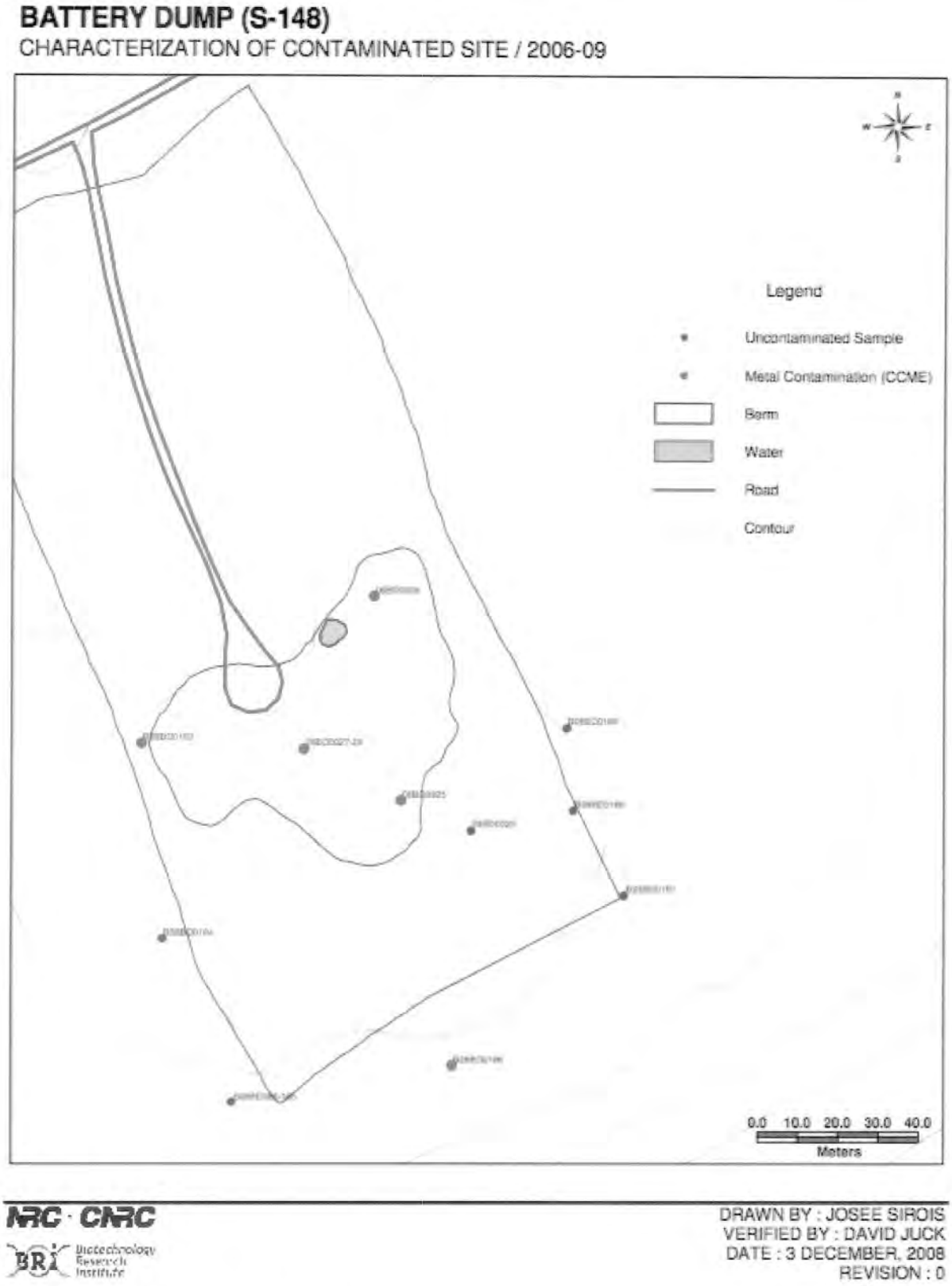

Figure 6. S-148 Battery Dump map

4.3 S-354 ALERT OLD UPPER POL LINE

See section 4.12 S-10214 Main Station Day Tank Area for site recommendations

4.4 S-10195 MSE-17 VEHICLE MAINTENANCE BUILDING

4.4.1 Location and Site Description

The MSE-17 Vehicle Maintenance Building is located at the CFS-Alert main station, southwest of the Construction Engineering Building/Fire Hall (CE-140) and southeast of the Heated Vehicle Storage Building (Bldg 113). The west side of the building complex is used for vehicle maintenance, and offices are located midway along the building. A supply storage area is located at the east end of the building. The Vehicle Maintenance Building is constructed on beams which creates an empty space between the ground and the building. The ground is composed of fill material, mainly coarse to small gravel mixed with some fine material found in low spots.

During the 2006 and 2007 sampling campaigns, a drainage pathway leading from the southwest to the southeast of the site, along a small slope, was observed. The drainage pathway leads to a ditch situated along Herc drive.

4.4.2 Summary of Previous BRI Investigations

A summary of site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

During the 2006 and 2007 field seasons, sampling focused on the area behind the MSE-17 Vehicle Maintenance building and the down slope area between the building and Herc drive (Figure 7). Hydrocarbon contamination (F1-F4) was found exceeding guidelines in samples collected from either the surface (approximately 20 cm depth) or suprapermafrost

(approximately 100 cm depth). Metals (As, Cu, Ni and Zn) were also detected in several samples with concentrations exceeding CCME by small margins. Arsenic and nickel were not in excess of alternate guidelines.

A surface water sample was collected from the drainage area leading away from the building along Herc drive and a groundwater sample was collected from an adjacent area. The ground water sample was found to have concentrations of toluene above CCME guidelines and an elevated concentration of total xylenes, of which there is no current CCME guideline. Concentrations of F1-F3 in the groundwater were highly elevated but no CCME guidelines for F1-F4 exist in groundwater. The surface water samples was found to have an elevated concentration of F2.

4.4.3 Nature and Extent of Contamination

During the 2008 sampling campaign, a total of 9 soil samples (8 samples and 1 duplicate) were collected using a pick and shovel from depths of 30-50 cm. Of these samples, 3 were analyzed for metals, 2 for VOC and all 9 were analyzed for TPH. One sample (B08-VM-0190) was found to be in excess of CCME and alternate guidelines for arsenic (its duplicate only demonstrated an arsenic concentration of 10.8 mg/kg) and all 3 (B08-VM-0108, B08-VM-0190 and its duplicate B08-VM-0013) demonstrated significant concentrations of iron (16,800 – 22,300 mg/kg), although no CCME guidelines for iron in soil exist (Table 7).

In the VOC analysis, both samples (B08-VM-0108 and B08-VM-0113) did not contain measurable concentrations of contaminants (Table 8). In the TPH analysis, 2 samples (B08-VM-0107 and B08-VM-0108) demonstrated concentrations of F1 and F2 above CCME guidelines while B08-VM-0190 was above guidelines for F2 only (Table 7). All other samples were below guidelines or non-detect for F1-F4.

NCS Score/Classification: 62.9/2
The estimated volume of contaminated soil is 2,250 m^3.

4.4.4 Recommendations

The outer limits of the contaminated area remain to be delineated. To complete delineation of the site, one additional sampling campaign, with backhoe support, is required. The focus should be in the area on the opposite side of Herc drive and in particular, the drainage channel leading away from the site. The contamination also appears to overlap the former Ice Shelf Building remains and the two areas should be treated as a single site. Although it remains to be confirmed, an *in situ* approach to treatment of the site would be the most promising approach based on the extent of TPH contamination and the fact that the majority of the contamination is located between Herc drive and the elevated base supporting the building.

Table 7. S-10195 MSE-17 Vehicle Maintenance Building metals and F1-F4 chemistry results

	PARAMETERS	SOIL			MSE 17 - Vehicle Maintenance Bldg (S-10195)								
					SOIL								
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-VM-0013 25-35 cm Dup. 0113 11/07/2008	B08-VM-0107 20-30 cm 11/07/2008	B08-VM-0108 20-30 cm 11/07/2008	B08-VM-0109 30-40 cm 11/07/2008	B08-VM-0110 30-40 cm 11/07/2008	B08-VM-0111 40-50 cm 11/07/2008	B08-VM-0112 30-40 cm 11/07/2008	B08-VM-0113 25-35 cm 11/07/2008	B08-VM-0190 40-50 cm 24/07/2008
METALS	Arsenic (As)	mg/kg	12	0.27	10.8	NA	8.4	NA	NA	NA	NA	27	NA
	Barium (Ba)	mg/kg	2,000	5	23	NA	14	NA	NA	NA	NA	21	NA
	Cadmium (Cd)	mg/kg	22	0.22	1.2	NA	<0.9	NA	NA	NA	NA	<0.9	NA
	Chromium (Cr)	mg/kg	87	3	29	NA	36	NA	NA	NA	NA	26	NA
	Cobalt (Co)	mg/kg	300	1.9	7	NA	8	NA	NA	NA	NA	9	NA
	Copper (Cu)	mg/kg	91	2.1	27	NA	14	NA	NA	NA	NA	66	NA
	Iron (Fe)	mg/kg	---		17,600	NA	23,200	NA	NA	NA	NA	16,800	NA
	Lead (Pb)	mg/kg	600	1.2	32	NA	37	NA	NA	NA	NA	31	NA
	Manganese (Mn)	mg/kg	---	1.1	424	NA	417	NA	NA	NA	NA	424	NA
	Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	<2	NA	NA	NA	NA	<2	NA
	Nickel (Ni)	mg/kg	50	0.6	21	NA	31	NA	NA	NA	NA	21	NA
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	NA	<0.5	NA	NA	NA	NA	<0.5	NA
	Silver (Ag)	mg/kg	40	0.4	<0.5	NA	<0.5	NA	NA	NA	NA	<0.5	NA
	Sodium (Na)	mg/kg	---		137	NA	139	NA	NA	NA	NA	149	NA
	Tin (Sn)	mg/kg	300	0.8	<5	NA	<5	NA	NA	NA	NA	<5	NA
	Zinc (Zn)	mg/kg	360	2.5	43	NA	59	NA	NA	NA	NA	41	NA
TPH	F1 (C6-C10)	mg/kg	310	10.7	22	707	1,420	5.8	3.4	<3.1	<3.5	17	114
	F2 (C10-C16)	mg/kg	760	3.9	269	9,790	10,600	9.7	14	<1.5	<1.9	411	1,240
	F3 (C16-C34)	mg/kg	1,700	9.0	99.9	767	1590	126	226	19	12	149	67
	F4 (C34-C50)	mg/kg	3,300	29	15	97.6	122	57.8	56	<5.1	<6.2	29	6.8

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 8. S-10195 MSE-17 Vehicle Maintenance Building VOC chemistry results

	PARAMETERS	SOIL			MSE 17 - Vehicle Maintenance Bldg (S-10195)								
					SOIL								
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-VM-0013 25-35 cm Dup. 0113 11/07/2008	B08-VM-0107 20-30 cm 11/07/2008	B08-VM-0108 20-30 cm 11/07/2008	B08-VM-0109 30-40 cm 11/07/2008	B08-VM-0110 30-40 cm 11/07/2008	B08-VM-0111 40-50 cm 11/07/2008	B08-VM-0112 30-40 cm 11/07/2008	B08-VM-0113 25-35 cm 11/07/2008	B08-VM-0190 40-50 cm 24/07/2008
VOC	Vinyl chloride	mg/kg	---	0.04	NA	NA	<0.4	NA	NA	NA	NA	<0.4	NA
	1,1-dichloroethene	mg/kg	50	0.04	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Dichloromethane	mg/kg	50	20	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,2-dichloroethene (trans)	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,1-dichloroethane	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,2-dichloroethene (cis)	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Chloroform	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,1,1-trichloroethane	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Carbon tetrachloride	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,2-dichloropropane	mg/kg	50	0.04	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,3-dichloropropene (cis)	mg/kg	50	0.03	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,3-dichloropropene (trans)	mg/kg	50	0.05	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,1,2-trichloroethane	mg/kg	50	0.04	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Tetrachloroethene	mg/kg	50	0.08	NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,1,2,2-tetrachloroethane	mg/kg	50		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Benzene	mg/kg	0.03	0.02	NA	NA	<0.009	NA	NA	NA	NA	<0.009	NA
	Ethylbenzene	mg/kg	0.082	0.02	NA	NA	0.03	NA	NA	NA	NA	<0.02	NA
	Chlorobenzene	mg/kg	10		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	Toluene	mg/kg	0.37	0.02	NA	NA	<0.08	NA	NA	NA	NA	<0.1	NA
	Xylenes	mg/kg	11	0.04	NA	NA	2.4	NA	NA	NA	NA	<0.1	NA
	Styrene	mg/kg	50		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,2-dichlorobenzene	mg/kg	10		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,3-dichlorobenzene	mg/kg	10		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA
	1,4-dichlorobenzene	mg/kg	10		NA	NA	<0.1	NA	NA	NA	NA	<0.1	NA

NA Not available

Higher than the criteria

High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

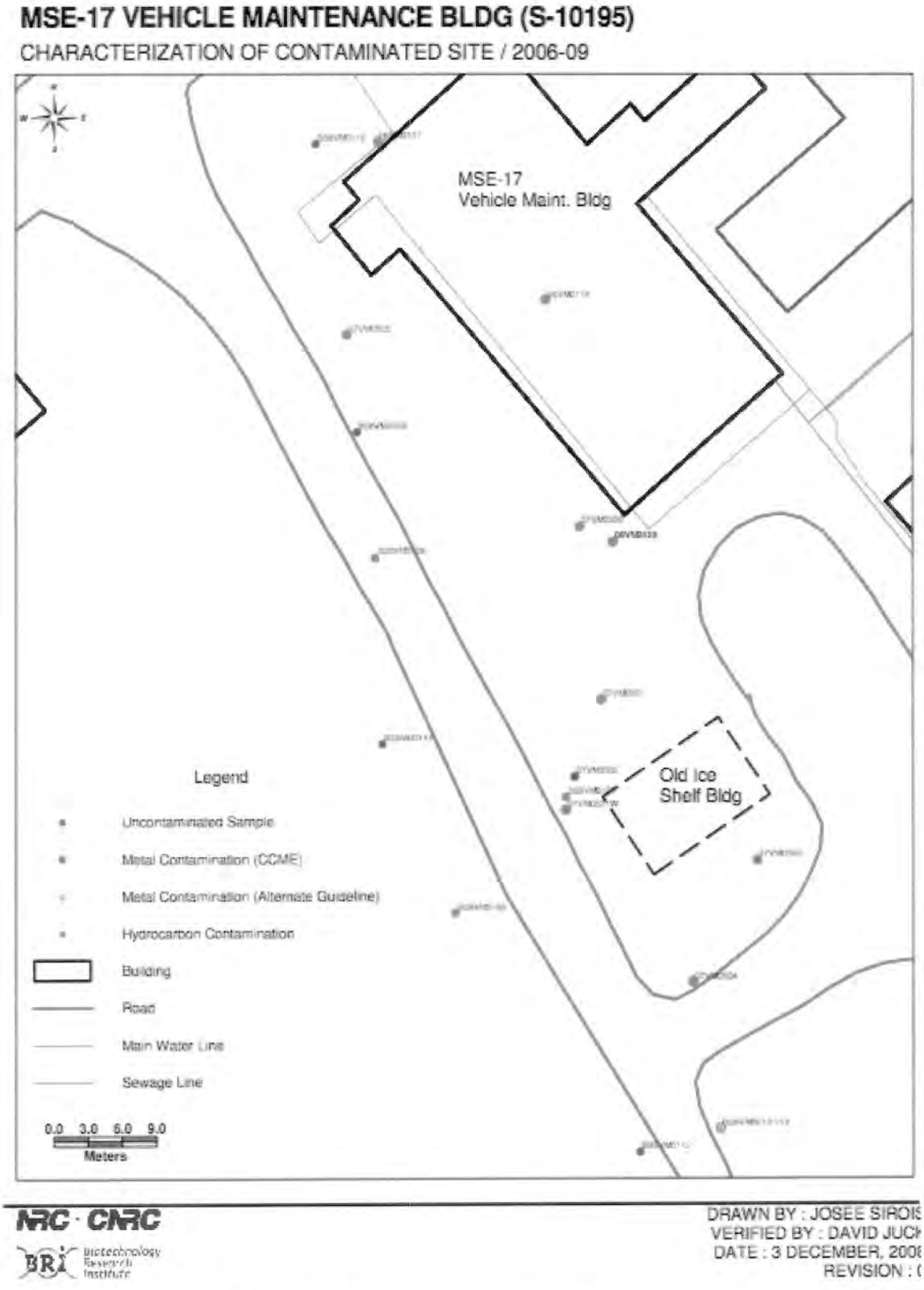

Figure 7. S-10195 MSE-17 Vehicle Maintenance Building map.

4.5 S-10196 BURN PIT

4.5.1 Location and Site Description

The Burn Pit site is situated north of the CFS-Alert main station, at the junction of Tower Way and the road leading to the Main Station Landfill (Figure 8). The site was previously used to burn combustible waste generated by the station before being disposed of in the Main Station Landfill (ESG 1999). The burned waste included paper, tin cans, plastics, wood and Styrofoam, using fuel to ignite the garbage pile. Currently this site is inactive.

The Burn Pit site covers an area of approximately 30 m by 25 m, with the topography generally level. The east side of the site slopes gently towards Dumbell Bay. The Burn Pit site is located less than 500 m from Dumbell Bay. The description of the Burn Pit site from previous reports describes a berm surrounding the site. At the time of the 2006 and 2007 sampling campaigns, the majority of the berm surrounding the site was removed. The only obvious site remnants are situated to the northeast of the site. It was suspected that after the closure of the Burn Pit, the site had been leveled with the soil from the berms.

The soil at the Burn Pit site is composed of fill material mixed with natural soil; coarse to fine gravels mixed with light grey silt and clay and interspersed with shale stones. Drainage ditches are located along the roads near the burn pit. During the 2007 sampling campaign, a drainage pathway was noted on the southeast side of the site, heading towards Dumbell Bay. The drainage ditches and drainage pathway were dry at the time of the 2007 sampling campaign.

4.5.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007/08 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Of the 4 samples collected during the 2006 sampling campaign (Figure 8), all contained arsenic

concentrations exceeding both the CCME and alternate guidelines, one sample contained nickel concentrations above the CCME guidelines but below the alternate guidelines. In 2007 a total of 6 soil samples were collected and all demonstrated arsenic concentrations above CCME guidelines while only 2 were at or above alternate guidelines.

4.5.3 Nature and Extent of Contamination

In 2008, 6 soil samples were collected at a depth of 80-100 cm, and analyzed for both TPH and metals. As in previous sample campaigns, no F1-F4 was detected in any of the samples (Table 9), suggesting that the TPH hotspot detected by ESG in 1999 has not migrated. Metals analysis revealed arsenic in 2 of the 6 samples (B08-BP-0178 and B08-BP-0182) above CCME guideline concentrations while only B08-BP-0178 was above the alternate guideline (Table 9). Nickel was detected above CCME guidelines in B08-BP-0178 (but was below the alternate guideline).

NCS Score/Classification: 32.2/N

The estimated volume of contaminated soil is 1,000 m^3.

4.5.4 Recommendations

The former Burn Pit is situated in an area circumscribed by roads and drainage ditches. The previously detected PHC contamination does not appear to have migrated and could be addressed by using an *ex situ* biopile approach. The heavy metal contamination on site appears to be sporadic in nature with only several sites above alternate guidelines and always less than 2X the alternate guidelines. This contamination could be dealt with using a dig and dump approach once a secure landfill is constructed at CFS-Alert. This would permit closure of the site.

Table 9. S-10196 Burn Pit F1-F4 and metals chemistry results

					Burn Pit (S-10196)					
		SOIL			SOIL					
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-BP-0078 90-100 cm Dup. 0178 22/07/2008	B08-BP-0178 90-100 cm 22/07/2008	B08-BP-0179 80-90 cm 22/07/2008	B08-BP-0180 100-110 cm 22/07/2008	B08-BP-0181 70-80 cm 22/07/2008	B08-BP-0182 80-90 cm 22/07/2008
TPH	F1 (C6-C10)	mg/kg	12	0.27	<2.4	<3	<3	<2.9	<2.7	10
	F2 (C10-C16)	mg/kg	2,000	5	<1.1	<1.4	<1.1	<1.9	2.1	53.9
	F3 (C16-C34)	mg/kg	22	0.22	<2.6	<3.3	<2.5	<4.4	126	235
	F4 (C34-C50)	mg/kg	87	3	<3.7	6.1	<3.6	<6.3	92.6	172
METALS	Arsenic (As)	mg/kg	12	0.27	NA	36.9	NA	NA	NA	18.3
	Barium (Ba)	mg/kg	2,000	5	NA	10	NA	NA	NA	38
	Cadmium (Cd)	mg/kg	22	0.22	NA	<0.9	NA	NA	NA	<0.9
	Chromium (Cr)	mg/kg	87	3	NA	29	NA	NA	NA	29
	Cobalt (Co)	mg/kg	300	1.9	NA	14	NA	NA	NA	12
	Copper (Cu)	mg/kg	91	2.1	NA	31	NA	NA	NA	38
	Lead (Pb)	mg/kg	600	1.2	NA	15	NA	NA	NA	114
	Manganese (Mn)	mg/kg	---	1.1	NA	430	NA	NA	NA	519
	Molybdenum (Mo)	mg/kg	40	1.4	NA	<2	NA	NA	NA	<2
	Nickel (Ni)	mg/kg	50	0.6	NA	51	NA	NA	NA	34
	Selenium (Se)	mg/kg	3.9	0.5	NA	<0.5	NA	NA	NA	<0.5
	Silver (Ag)	mg/kg	40	0.4	NA	<0.5	NA	NA	NA	<0.5
	Tin (Sn)	mg/kg	300	0.8	NA	<5	NA	NA	NA	<5
	Zinc (Zn)	mg/kg	360	2.5	NA	74	NA	NA	NA	159

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

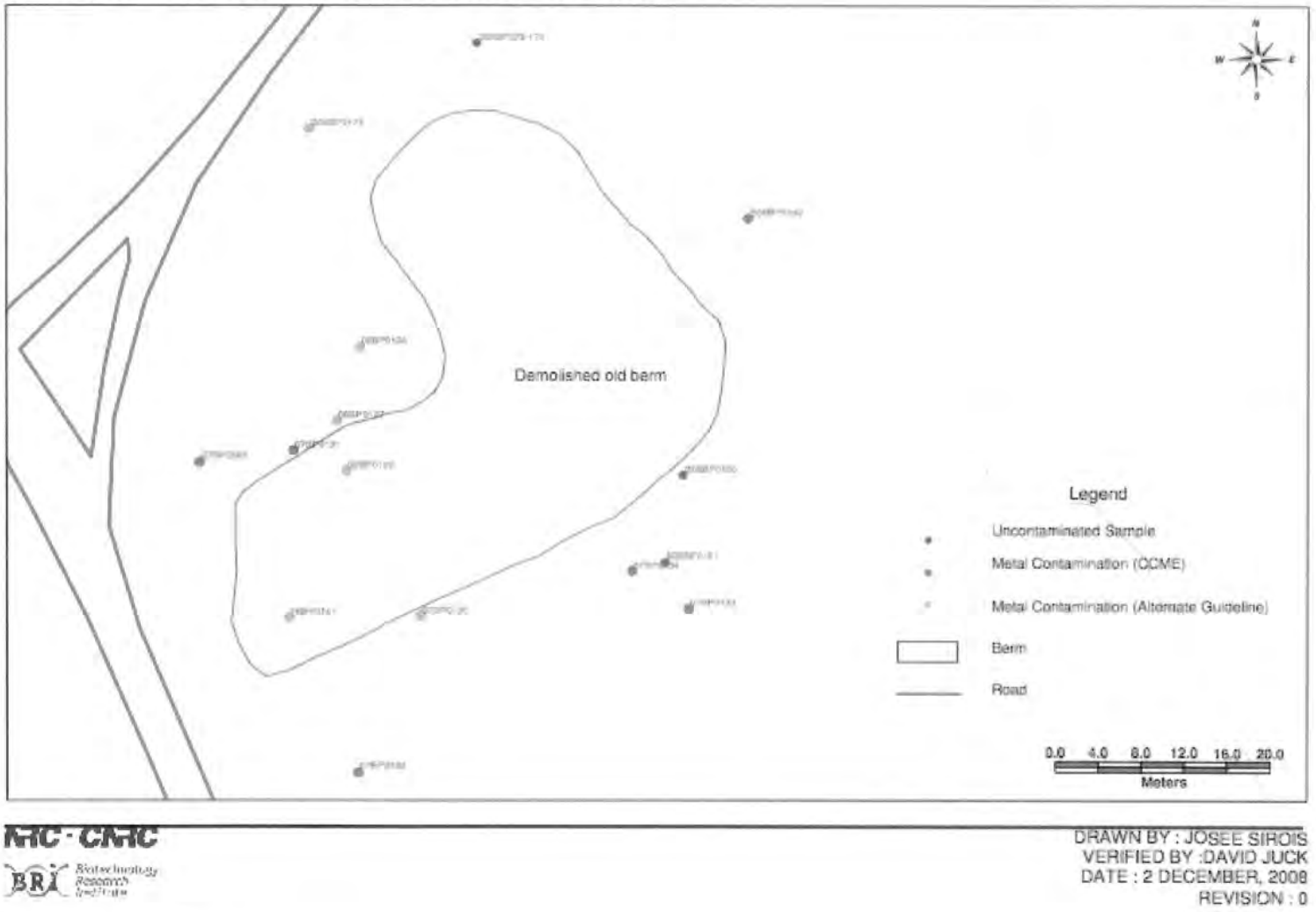

Figure 8. S-10196 Burn Pit map.

4.6 S-10199 CE-140 MCE BUILDING FIRE HALL

4.6.1 Location and Site Description

The main Construction Engineering building, CE-140 MCE Building Fire Hall, is located adjacent to the CFS-Alert main station west of Doe Road. It contains the fire hall, the trash compactor/crusher and the construction engineering offices and facilities. The building is located on a small embankment of coarse gravel and fills material. A vehicle approach that moderately slopes down toward the south is located east of the building, beside Doe Road. A second vehicle approach that slopes down toward the north is located behind the MCE building, starting from Herc Drive, and going towards the Vehicle Maintenance Building.

The topography of the site is generally level, with the exception of the 2 vehicle approaches. During the 2006 sampling campaign, a standing pool of water was located north of the fire hall building, but no pool of water was noted in 2007. Drainage pathways were noted during the 2007 sampling campaign. The drainage pathways generally followed both vehicle approaches. A drainage ditch was located along Herc Drive.

TPH contamination associated with this building has been identified in 2 different areas; in front of the building to the east and behind the building to the southwest.

4.6.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

During the 2006 sampling campaign, a total of 5 soil samples, including 1 duplicate, were collected from around the buildings (Figure 9) and analyzed for metals and TPH. Three soil samples contained arsenic concentrations slightly exceeding the CCME guideline but below the

alternate guideline. TPH F2 concentrations were above the CCME guidelines in two soil samples.

In the 2007 sampling campaign, a total of 21 soil samples were collected from 2 areas; 16 soil samples (including 2 duplicate pairs) were collected from the front of the building and 5 soil samples were collected in the area behind the building on the down-slope towards Herc drive. A groundwater sample was also collected from the front area of the building. From the front of the building, 4 samples had arsenic concentrations above CCME guidelines but below alternate guidelines. TPH analysis of soil samples from the front of the building revealed F2 and F3 concentrations above CCME guidelines in 2 and 1 samples, respectively. TPH F2 and F3 were also observed at elevated concentrations in the groundwater sample, but there are currently no CCME guidelines for TPH in groundwater. In the area behind the building, F1 and F2 were detected in 1 and 3 samples, respectively.

4.6.3 Nature and Extent of Contamination

The goal of the 2008 sampling campaign for this site was to complete delineation of the contaminated areas located to the front and back of the building. A total of 5 soil samples were collected and subjected to TPH analysis (Table 10). Of the samples collected from the front of the building, B08-FH-0114 had F2 and F3 above CCME guidelines, B08-FH-0115 was only above CCME guidelines for F3 and B08-FH-0106 was below CCME guidelines for all TPH fractions. Samples (n=2) collected from the back of the building demonstrated F2 and F3 contamination above CCME guidelines in B08-FH-0104 but no TPH contamination in B08-FH-0105.

NCS Score/Classification: 55.5/2

The estimated volume of contaminated soil is 600 m^3.

4.6.4 Recommendations

The TPH contamination associated with the 2 sites around the CE-140 MCE Building Fire Hall are small in size and do not appear to be moving. The remediate these sites, 2 potential

approaches may be considered. Due to the size of the sites, excavation and *ex situ* biopile treatment would prove to be the most expedient method for site closure. This approach is however not favored for these sites as the area is in active use and the contamination is adjacent to the building foundation. An *in situ* approach would be less disruptive to the site and current activities and is recommended. Optimal conditions for *in situ* site remediation remain to be determined and experiments are currently underway at adjacent CFS-Alert sites to establish an *in situ* bioremediation protocol for the CFS-Alert area (see Section 5).

Table 10. S-10199 CE-140 MCE Building Fire Hall F1-F4 chemistry results

	PARAMETERS	UNITS	SOIL INDUSTRIAL GUIDELINES (Coarse)	SOIL DETECTION LIMIT	CE-140 MCE Building Fire Hall (S-10199) SOIL B08-FH-0104 30-40 cm 11/07/2008	B08-FH-0105 30-40 cm 11/07/2008	B08-FH-0106 20-30 cm 11/07/2008	B08-FH-0114 30-40 cm 12/07/2008	B08-FH-115 40-50 cm 12/07/2008
	F1 (C6-C10)	mg/kg	310	10.7	464	4.6	13	1660	50.7
	F2 (C10-C16)	mg/kg	760	3.9	2500	12	407	3620	823
	F3 (C16-C34)	mg/kg	1,700	9.0	243	29	97.5	172	217
	F4 (C34-C50)	mg/kg	3,300	29	40	7.2	16	9	38

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

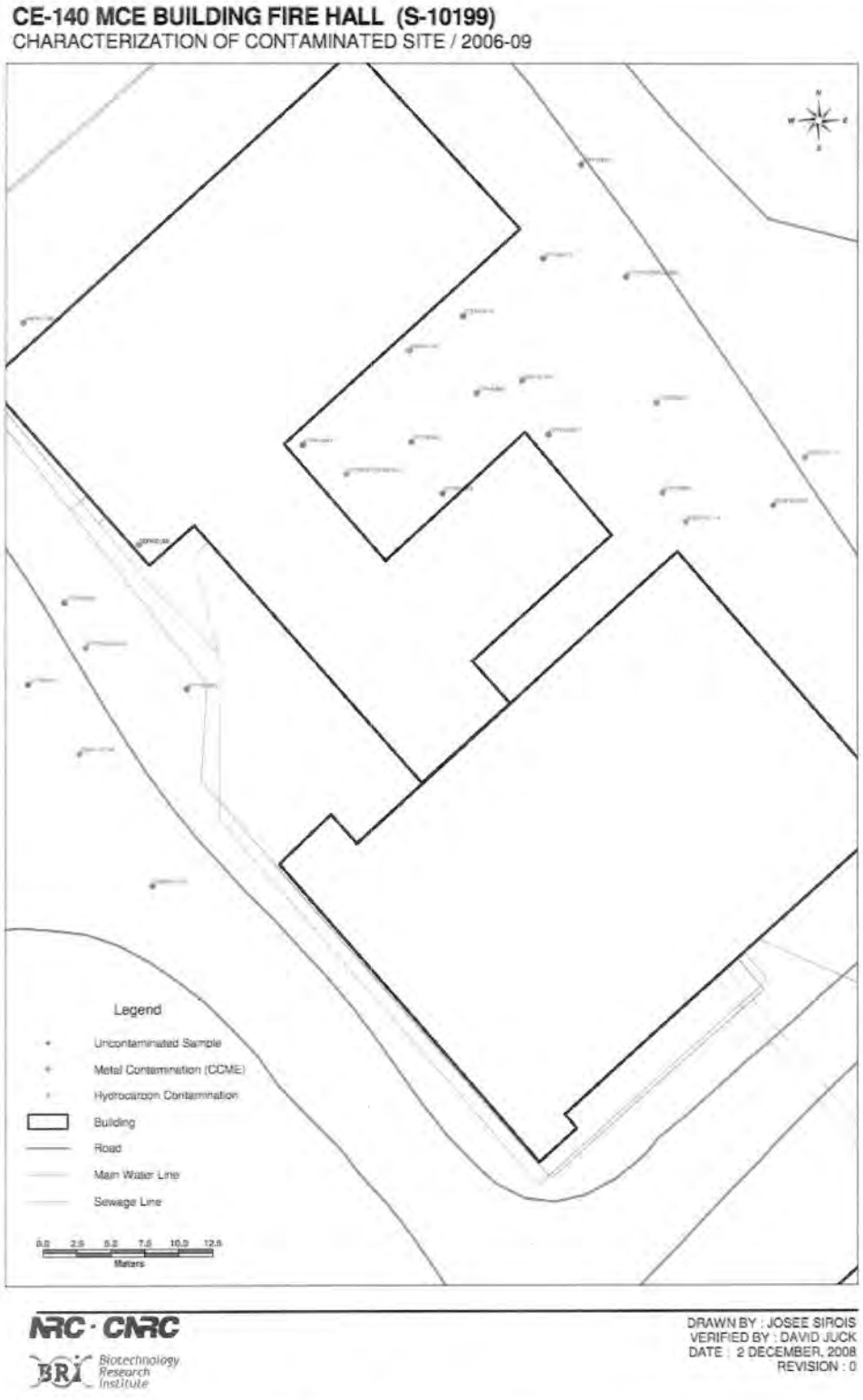

Figure 9. S-10199 CE-140 MCE Building Fire Hall map.

4.7 S-10206 TX SITE

4.7.1 Location and Site Description

The transmitter site (TX) is located roughly 4 km south-southwest of the CFS-Alert main station, on the top of a ridge about 60 m above sea level (ESG 2000). In 1982 the old main building was demolished and a new building was constructed on another part of the site. The new main building hosts working, sleeping and eating areas. The old auxiliary power unit and diesel fuel tank were replaced and the new auxiliary power unit and diesel fuel tank are located at a slightly different location from the old ones. The old transformer building is still standing on the site.

During the previous ESG investigations, the remains and debris of the main station demolished in 1982 were located in an inactive small dump situated southeast of the new main building. During the 2006 and 2007 sampling campaigns, the remains and debris had been relocated to the Millionaire's Dump along with soil excavated from the old small dump.

The topography of the site is gently undulating, with the some small depressions in which standing water accumulates during summer months. Two major pools of standing water were located south of the previous location of the old main building and northwest of the old excavated dump. There was no apparent surface drainage network in the area, and the site is located approximately 3,000 m from Upper Dumbell Lake, 2,800 m from Lower Dumbell Lake, and 3,365 m from Alert Inlet. The soil is saturated with water during snowmelt and the summer months. It is composed mainly of native shaley silt and clay with a few shale stones.

4.7.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

The TX site was snow covered during the 2006 sampling campaign, which made locating the old main building remains and old dump very difficult. Five soil samples were collected around the old main building remains and the dump, including one duplicate pair. These samples were analyzed for metals and PCB and no contaminants were fond above CCME guidelines.

In 2007, 16 subsurface soil samples were collected and analyzed for metals and TPH. Two soil samples and one duplicate pair were analyzed for PCBs, and the duplicate pair was also analyzed for PAHs. The samples were collected in two separate areas associated with the TX site. The area surrounding the old main building remains contained no heavy metal or TPH contamination above CCME guidelines. The lead and cadmium contamination previously detected (ESG 1999) appeared to be localized. In the second area, adjacent to the new auxiliary building, TPH Fraction 2 was detected at concentrations above the CCME guideline in one soil sample. No PAHs or PCBs were detected in the soil samples tested.

4.7.3 Nature and Extent of Contamination

During the 2008 sampling campaign, a total of 10 soil samples were collected; 6 from the old auxiliary power building site (Figure 10) at depths of approximately 50-90 cm and 4 from the old main building site (Figure 11) at depths of approximately 30 cm. The samples from the new auxiliary power building were analysed for TPH and all came back below CCME guidelines for all fractions (Table 11). The 4 samples collected from the old main building were analysed for metals and all came back below CCME guidelines (Table 11). This completes delineation for these 2 sites.

NCS Score/Classification: 32.8/N

The estimated volume of contaminated soil is 600 m^3.

4.7.4 Recommendations

The two separate areas associated with the TX site were sampled. The area surrounding the old

main building remains demonstrated no heavy metal or TPH contamination. The previously detected (1999) lead and cadmium contamination would appear to be very localized. Remediation of this area would entail excavation of the contaminated soil and burial in a secure landfill to prevent further leaching. The second area adjacent to the transformer had a single sample just above CCME guidelines for F2 during the 2007 campaign. No other heavy metal or TPH contamination was detected. This localized contamination can be addressed through excavation and *ex situ* biopile treatment. Once excavation at these sites is completed, the site can be closed.

Table 11. S-10206 TX Site F1-F4 and metals chemistry results

					TX Site (S-10206)									
		SOIL			SOIL									
	PARAMETE	UNITS	INDUSTRIA GUIDELINES (Coarse)	DETECTION LIMIT	B08-TX-0166 40-50 cm 21/07/2008	B08-TX-0167 70-80 cm 21/07/2008	B08-TX-0168 70-80 cm 21/07/2008	B08-TX-0169 60-70 cm 21/07/2008	B08-TX-0170 80-90 cm 21/07/2008	B08-TX-0171 60-70 cm 21/07/2008	B08-TX-0212 30 cm 04/08/2008	B08-TX-0213 30 cm 04/08/2008	B08-TX-0214 30 cm 04/08/2008	B08-TX-02 30 cm 04/08/200
	Arsenic (As)	mg/kg	12	0.27	NA	NA	NA	NA	NA	NA	5.3	5.4	4.1	3.9
	Barium (Ba)	mg/kg	2,000	5	NA	NA	NA	NA	NA	NA	34	34	30	25
	Cadmium (Cd)	mg/kg	22	0.22	NA	NA	NA	NA	NA	NA	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	NA	NA	NA	NA	NA	NA	23	22	24	24
	Cobalt (Co)	mg/kg	300	1.9	NA	NA	NA	NA	NA	NA	12	13	12	13
	Copper (Cu)	mg/kg	91	2.1	NA	NA	NA	NA	NA	NA	18	17	18	18
	Lead (Pb)	mg/kg	600	1.2	NA	NA	NA	NA	NA	NA	14	14	14	13
	Manganese (Mn)	mg/kg	---	1.1	NA	NA	NA	NA	NA	NA	521	488	502	586
	Molybdenum (Mo)	mg/kg	40	1.4	NA	NA	NA	NA	NA	NA	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	NA	NA	NA	NA	NA	NA	38	37	38	39
	Selenium (Se)	mg/kg	3.9	0.5	NA	NA	NA	NA	NA	NA	<0.5	<0.5	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	NA	NA	NA	NA	NA	NA	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	NA	NA	NA	NA	NA	NA	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	NA	NA	NA	NA	NA	NA	51	49	52	50
	F1 (C6-C10)	mg/kg	310	10.7	<3.6	<3.2	<3.6	<2.9	<3.3	<3.6	NA	NA	NA	NA
	F2 (C10-C16	mg/kg	760	3.9	1.2	<1.5	<1.7	<1.4	<1.1	<1.3	NA	NA	NA	NA
	F3 (C16-C34)	mg/kg	1,700	9.0	34.5	5.6	23.0	4.6	24.0	15.0	NA	NA	NA	NA
	F4(C34-C50)	mg/kg	3,300	29	24.0	7.8	19.0	5.7	19.0	14.0	NA	NA	NA	NA

NA Not analysed

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

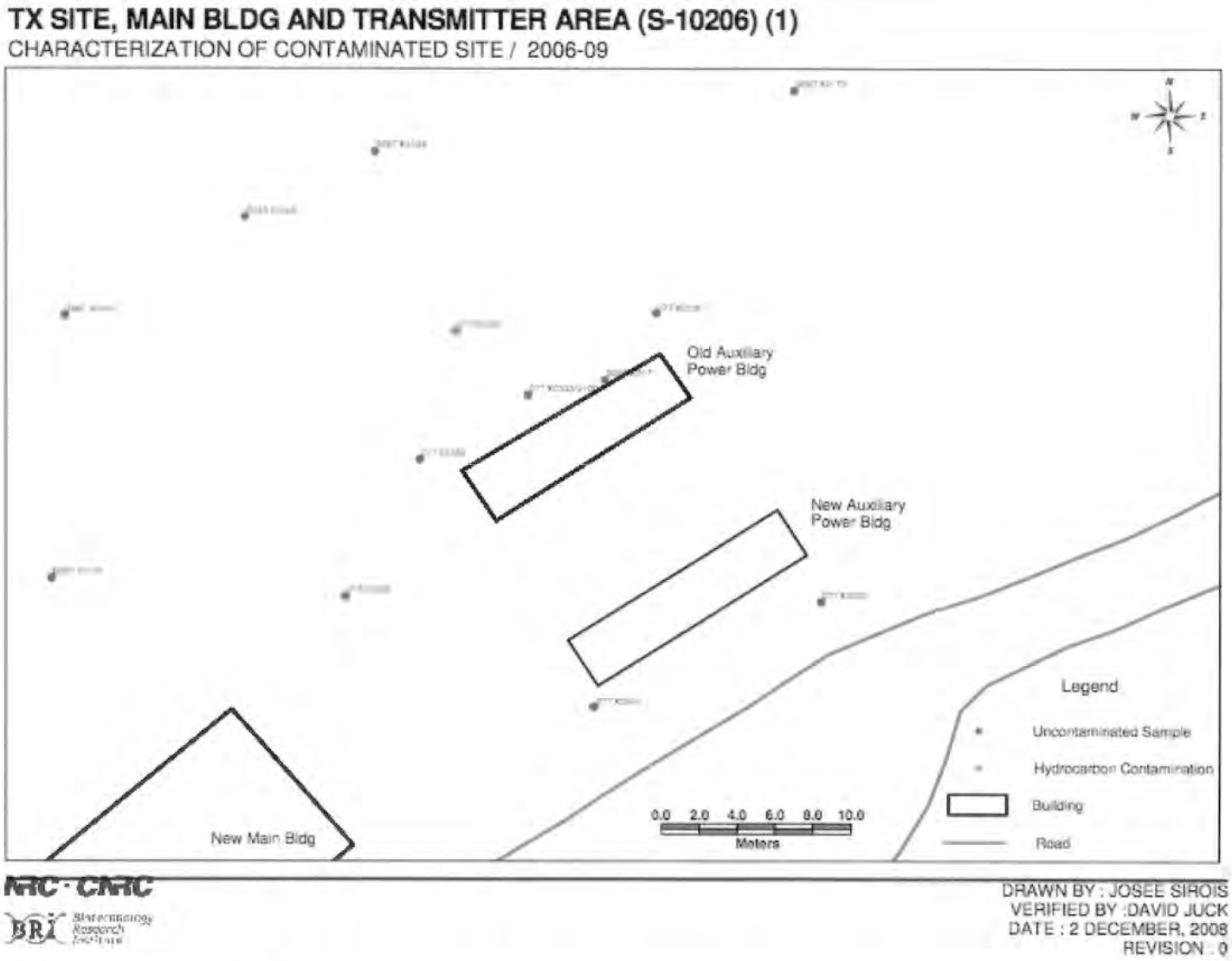

Figure 10. S-10206 TX Site map 1.

Figure 11. S-10206 TX Site map 2.

4.8 S-10207 AIRSTRIP BUILDING HIL-124 "THE HILTON"

4.8.1 Location and Site Description

Airstrip Building HIL-124, commonly known as "The Hilton", is located on the west side of the airstrip entrance northeast of the DREP (Defence Research Establishment Pacific) building. Currently, CFS-Alert traffic personnel use the building for equipment storage. The site is still active and there is one fuel tank situated west of the site, behind the building.

The topography of the site is gently sloping towards the south-southeast in front of the building, and gently sloping west-northwest behind the building. On the west side, behind the building, the site slopes into a drainage area and ditch. The ditch comes from deicing areas 2 and 3, on the western part of the airstrip, and proceeds on the east side of the airstrip towards Dumbell Bay. During the 2006 and 2007 sampling campaigns, a pool of standing water was observed in the drainage area and there was water in the ditch. The site is composed of fill materials with silt and clay and a few shale stones as underlying material in the drainage area. The site is less than 400 m from Dumbell Bay.

4.8.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

In 2006, 3 surface soil samples were collected and analysed for metals, PAHs and TPH. Cadmium was the only compound that showed a concentration above the CCME guideline. No PAH or TPH was detected above the CCME guidelines. During the 2007 sampling campaign a total of 13 soil (10 – 40 cm depth) and 1 surface water samples were collected. Four soil samples were tested for metals, 8 soil samples were tested for TPH, 1 soil sample (from a drainage pathway) and 1 surface water sample were tested for metals and TPH. No metals were

detected above the CCME guidelines for soil. However, copper and lead concentrations in the surface water sample were above the CCME guidelines for aquatic life. TPH Fractions 1 and 2 were also above the CCME guideline concentrations in 1 soil sample collected from the east side in front of the building.

4.8.3 Nature and Extent of Contamination

A total of 6 soil samples were collected during the 2008 campaign from depths of 10-50 cm using a pick and shovel, and analysed for TPH and metals. Of these, 2 adjacent samples (B08-HI-0158 and B08-HI-0159) demonstrated concentrations of F1 and F2 above CCME guidelines (Table 12). In both samples, F2 was significantly above guidelines (11,100 and 15,500 mg/kg, respectively). Due to the active nature of the site (adjacent to runway access), the sample identification tags for these sites were removed by heavy equipment before the precise GPS coordinates could be established. It is known that these samples were collected from the northwest of Airstrip Building HIL-124 (the locations of these sites are approximate in (Figure 12). Metals analysis revealed the presence, in 1 sample, of arsenic just above CCME guidelines (12.7 mg/kg) which is below the alternate guidelines.

NCS Score/Classification: 56.6/2
The estimated volume of contaminated soil is 625 m^3.

4.8.4 Recommendations

Several TPH contamination hot spots have been identified, although precise localization of one area remains to be completed. Delineation of the TPH contaminated area to the northwest of Airstrip Building HIL-124 needs to be completed before remediation work can start. Due to the active and critical nature of the site (active plane staging area), an *in situ* is the only remediation option. *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5). The source of the previously observed copper and lead contamination in the surface water has not been established and is not evident. The average soil background

concentrations for copper and lead were 19.3 and 13.5 mg/kg, respectively, and may be the source of the observed contamination.

Table 12. S-10207 Airstrip Building HIL-124 metals and F1-F4 chemistry results

	PARAMETERS	SOIL			Airstrip Bldg HIL-124 (S-10207) SOIL					
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-HI-0100 40-50 cm 10/07/2008	B08-HI-0101 30-40 cm 10/07/2008	B08-HI-0102 10-20 cm 11/07/2008	B08-HI-0103 10-20 cm 11/07/2008	B08-HI-0158 20-40 cm 14/07/2008	B08-HI-0159 20-40 cm 14/07/2008
	Arsenic (As)	mg/kg	12	0.27	9.5	12.7	NA	NA	NA	NA
	Barium (Ba)	mg/kg	2000	5	19	20	NA	NA	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	NA	NA	NA	NA
	Chromium (Cr)	mg/kg	87	3	32	35	NA	NA	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	8	10	NA	NA	NA	NA
	Copper (Cu)	mg/kg	91	2.1	15	17	NA	NA	NA	NA
	Iron (Fe)	mg/kg	---		20,400	23,300	NA	NA	NA	NA
	Lead (Pb)	mg/kg	600	1.2	32	40	NA	NA	NA	NA
	Manganese (Mn)	mg/kg	---	1.1	402	424	NA	NA	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	NA	NA	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	25	31	NA	NA	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	NA	NA	NA	NA
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	NA	NA	NA	NA
	Sodium (Na)	mg/kg	---		162	126	NA	NA	NA	NA
	Tin (Sn)	mg/kg	300	0.8	<5	<5	NA	NA	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	45	55	NA	NA	NA	NA
TPH	F1 (C6-C10)	mg/kg	310	10.7	<3.4	<2.9	<2.2	<2.4	820	1,020
TPH	F2 (C10-C16)	mg/kg	760	3.9	2.5	5.6	28.8	3	11,100	15,500
TPH	F3 (C16-C34)	mg/kg	1700	9.0	19	46.3	37	50.3	582	1,120
TPH	F4 (C34-C50)	mg/kg	3300	29	10	19	13	15	15	41

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

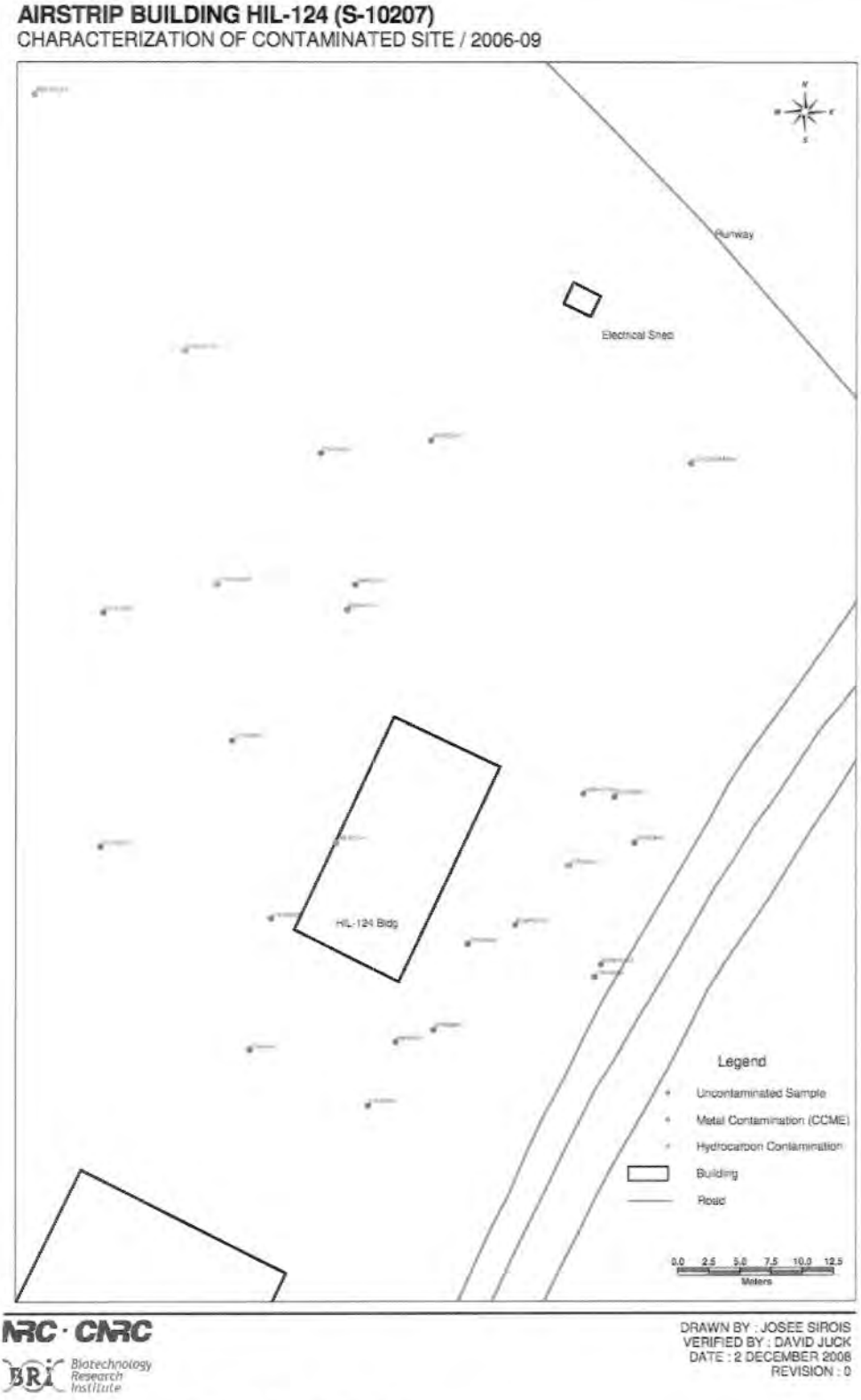

Figure 12. S-10207 Airstrip Building HIL-124 map.

4.9 S-10208 AIRSTRIP BUILDING FH-128

4.9.1 Location and Site Description

The Airstrip Building FH-128 (Airstrip Garage) is located at the southeastern end of the airstrip apron, approximately 80 m west of the apron refueling area. The building sits on a raised gravel embankment. The raised gravel pad extends 8 m from the end of the building towards the southeast. The platform subsequently drops 3 m. The airstrip garage was apparently slated for demolition in the next few years (ESG 2000), although was still standing during the 2008 sampling campaign. Currently, the garage is used for storing deicing equipment. There is a fuel tank located behind the building, on the southeast side of the site which is still in use. A bay door is situated at the northwestern side of the building and there is a regular doorway on the southeastern side of the building.

Active drainage pathways flow from the gravel embankment downhill towards Dumbell Bay. which is situated approximately 320 m from the site. There are two important drainage pathways surrounding FH-128, one each on the north and south sides of the site. A diesel pipeline and several high tension wires pass within and near the south side of the site, at the foot of the talus.

4.9.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Previous sampling campaigns have focused on the area immediately adjacent to the building where the external oil tank is located and the downgradient area, approximately 2 m lower than the elevated building pad. Samples collected during the 2006 and 2007 sampling campaigns have demonstrated F1-F3 contamination above CCME guidelines immediately adjacent to the building beside the oil tank and the area south-southeast of the building pad following the natural

slope of the terrain. No BTEX or metals were detected above CCME guidelines at this site.

4.9.3 Nature and Extent of Contamination

The 2008 sampling campaign focused on completing delineation of the PHC contamination to the area south-southeast of the elevated building pad. A total of 11 soil samples (including 1 duplicate) and one groundwater sample were collected (Figure 13) and analysed for TPH. In the soil samples, 3 were above CCME guidelines for F1 (B08-AS-0235, B08-AS-0238 and B08-AS-0241) and 7 were above CCME guidelines for F2 (B08-AS-0235, B08-AS-0236, B08-AS-0237 (duplicate of B08-AS-0236), B08-AS-0238, B08-AS-0239, B08-AS-0241 and B08-AS-0242) (Table 13). The groundwater sample was collected from the bottom of B08-AS-0239 during sampling and had highly elevated concentrations of F2 (213,000 µg/L) (Table 14) although no CCME guidelines exist for TPH in groundwater.

The site was not completely delineated to the southeast as a rigid elevated diesel pipeline from the airstrip to the main tank farm crossed the site and the other side of the pipeline was designated as the "12 Pack" site. The drainage channel passing to the south-southwest of the site was not sampled either as it consisted of very large stones and the available backhoe support was not able to adequately excavate the material. The area on the opposite side of the drainage channel was crisscrossed with power and communications cables preventing sampling of this area, although contamination is unlikely as it was slightly higher in elevation and upgradient of the principal contamination.

NCS Score/Classification: 50.9/2
The estimated volume of contaminated soil is 2,025 m^3.

4.9.4 Recommendations

Completion of site delineation remains to accomplished before a remediation plan can be established. It is recommended that this site be combined with the "12 Pack" site as they are adjacent and the contamination appears to have migrated from the Airstrip Building FH-128 site.

The drainage channel on the other side of the elevated diesel pipeline should also be sampled to determine if runoff from the area is contaminated with PHC.

Despite the need to complete delineation, this site may be a potential candidate for *in situ* bioremediation due to the existing on-site infrastructure (eg. elevated diesel pipeline). *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5).

Table 13. S-10208 Airstrip Building FH-128 F1-F4 chemistry results

					Airstrip Building FH-128 (S-10208)										
		SOIL			SOIL										
	PARAMETER	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-AS-0233 80 cm 8/08/2007	B08-AS-0234 80 cm 8/08/2008	B08-AS-0235 70 cm 8/08/2008	B08-AS-0236 70 cm 8/08/2008	B08-AS-0237 70 cm Dup. 0236 8/08/2008	B08-AS-0238 50 cm 8/08/2008	B08-AS-0239 70 cm 8/08/2008	B08-AS-0240 70 cm 8/08/2008	B08-AS-0241 80 cm 8/08/2008	B08-AS-0242 110 cm 8/08/2008	B08-AS-02 110 cm 8/08/2008
TPH	F1 (C6-C10)	mg/kg	310	10.7	27	<3.3	359	220	249	1,290	237	<3.2	407	74.9	<3.3
	F2 (C10-C16)	mg/kg	760	3.9	19.2	8.5	2,190	1,130	1,070	4,190	2,970	<1.5	8,030	1,230	<1.4
	F3 (C16-C34)	mg/kg	1,700	9.0	36	24	36.5	104	87.7	239	147.0	8.4	639.0	74.7	18.0
	F4 (C34-C50)	mg/kg	3,300	29	9.4	13	17	26	24	51.3	<4	6.7	14.0	13.0	13.0

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 14. S-10208 Airstrip Building FH-128 F1-F4 surface water chemistry results

	PARAMETERS	FRESHWATER			WATER
		UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B08-AS-0239W Groundwater 20/08/2008
	F1 (C6-C10)	ug/L	---	100	550
	F2 (C10-C16)	ug/L	---	100	213,000
	F3 (C16-C34)	ug/L	---	100	9,410
	F4 (C34-C50)	ug/L	---	100	54

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

High concentration / No CCME guideline

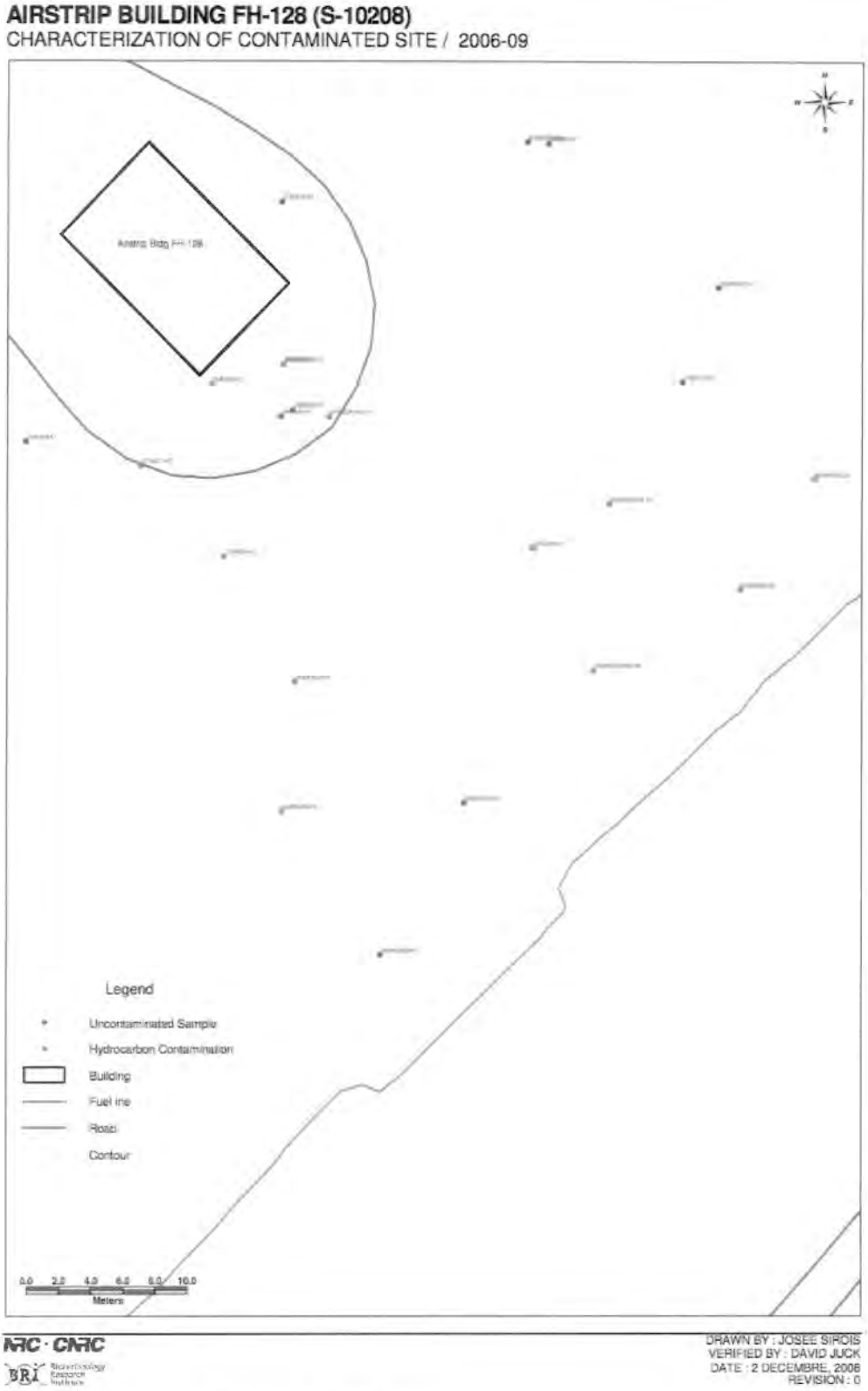

Figure 13. S-10208 Airstrip Building FH-128 map.

4.10 S-10212 AIRSTRIP MET SHACK

4.10.1 Location and Site Description

The Airstrip Meteorological Shack (Met Shack) is located approximately halfway down the west side of the airstrip. This building hosts the airport control tower and the airport meteorological station. The meteorological instruments are installed to the southwest of the Met Shack building. There are three small sheds situated northeast of the site: an electrical storage shed and 2 electrical generator sheds. The electrical storage shed was marked for demolition in 2005, but was still standing during the 2008 sampling campaign. Two fuel tanks located beside the north corner of the Met Shack were noted during a previous campaign. During the 2007 sampling campaign, one tank was relocated beside one of the electrical generator sheds and one tank was left standing beside the Met Shack.

The Met Shack is built on a compacted gravel pad. This pad is extended on the each side of the Met Shack allowing for parking. The area west of the Met Shack is composed of a native mix of shaley silt and clay. This area is a drainage discharge for the surrounding lands, and is important in preventing flooding of the airstrip during snowmelt. The soil is saturated with water during snowmelt and summer, and the cryoturbations within the soil are important. There is a large swampy area located on the northeast side of the site that measures approximately 12 m by 15 m. The southeast part of the site was still frozen during the 2006 sampling campaign, but was completely thawed during the 2007 and 2008 sampling campaigns.

The topography is generally level with a few very gentle slopes toward the west end of the site. Two main drainage pathways were noted in 2007 and 2008. The first one goes westward from the Met Shack to the second drainage pathway. The second drainage pathway goes from the southwestern end of the site to the northwestern end of the site, towards the Lincoln Sea. The site is approximately 602 m upgradient of the Lincoln Sea.

4.10.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2007/08 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Previous sampling campaigns have identified areas of localized PHC and metals contamination. The PHC contamination is limited to a very small area immediately adjacent to the main building and is composed of low levels of toluene, ethylbenzene and total xylenes. The areas identified as being contaminated (soil) with metals are scattered and represent concentrations of arsenic and nickel at or just above CCME guidelines, but below alternate guidelines. Two surface water samples collected in 2006 were at or moderately above CCME guidelines for several metals (As, Cu, Pb and Zn). Surface water samples (n=2) collected in 2007 demonstrated concentrations of copper, lead and selenium at CCME guidelines with one having elevated concentrations of zinc (B07-ME-0566W, 100 µg/L vs. 30 µg/L).

4.10.3 Nature and Extent of Contamination

In 2008, a total of 4 soil samples were collected (Figure 14) from depths of 35-50 cm from the area north of the Met Shack. The samples were analyzed for metals and TPH (Table 15). None of the soil samples were above CCME guidelines for either metals or TPH.

NCS Score/Classification: 51.2/2
The estimated volume of contaminated soil is 25 m^3.

4.10.4 Recommendations

The only TPH contamination detected on site was localized to a single area just adjacent to the main building. Two potential options exist for remediating the PHC contamination found on site; excavation and *ex situ* biopile treatment (quicker closure of site) or *in situ* bioremediation (less site perturbation). Due to the close proximity of the PHC contamination to the Met Shack, excavation and *ex situ* biopile treatment may not be a viable option. *In situ* bioremediation is the

least disruptive approach but would require a longer time frame before site closure could be achieved. *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5).

Metal contamination in soil samples for lead, nickel and selenium were all found to be at CCME guidelines and arsenic was above CCME guidelines but below alternate guidelines. Zinc, detected in surface drainage waters, was the only metal detected at concentrations above the CCME guidelines and is the primary concern although the on-site source of zinc was not identified. Excavation and disposal in a secure landfill of the soil form the area possessing elevated zinc concentrations would permit closure of the site once upgradient areas are sampled to confirm the localized nature of the contamination.

Table 15. S-10212 Airstrip Met Shack metals and F1-F4 chemistry results

					Airstrip MET Shack (S-10212)			
			SOIL		SOIL			
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-ME-0160 40-50 cm 20/07/2008	B08-ME-0161 40-50 cm 20/07/2008	B08-ME-0162 40-50 cm 20/07/2008	B08-ME-0163 25-35 cm 20/07/2008
METALS	Arsenic (As)	mg/kg	12	0.27	6.2	NA	NA	5.8
	Barium (Ba)	mg/kg	2,000	5	20	NA	NA	25
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	NA	NA	<0.9
	Chromium (Cr)	mg/kg	87	3	29	NA	NA	31
	Cobalt (Co)	mg/kg	300	1.9	11	NA	NA	9
	Copper (Cu)	mg/kg	91	2.1	23	NA	NA	25
	Lead (Pb)	mg/kg	600	1.2	12	NA	NA	11
	Manganese (Mn)	mg/kg	---	1.1	398	NA	NA	252
	Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	NA	<2
	Nickel (Ni)	mg/kg	50	0.6	43	NA	NA	41
	Selenium (Se)	mg/kg	3.9	0.5	0.6	NA	NA	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	NA	NA	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	NA	NA	<5
	Zinc (Zn)	mg/kg	360	2.5	73	NA	NA	79
TPH	F1 (C6-C10)	mg/kg	310	10.7	4.2	<4	<3.7	<3
	F2 (C10-C16)	mg/kg	760	3.9	2.3	2.3	<1.7	<1.3
	F3 (C16-C34)	mg/kg	1700	9.0	30	70.3	42.7	37.2
	F4 (C34-C50)	mg/kg	3300	29	18	46.9	33	28

NA Not analysed

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by

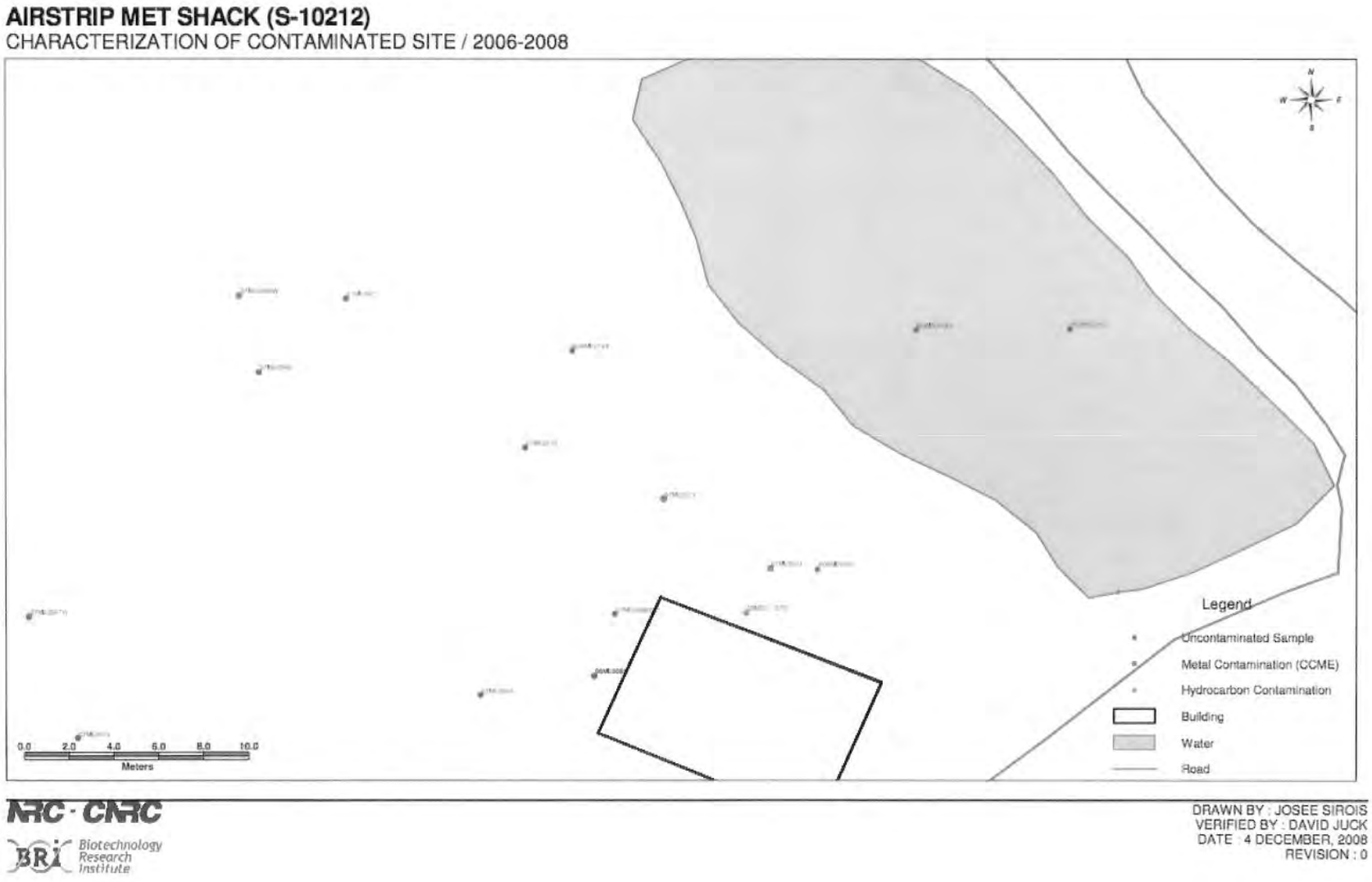

Figure 14. S-10212 Airstrip Met Shack map.

4.11 S-10213 MAIN STATION POL PALLET LINE

4.11.1 Location and Site Description

The Main Station POL Pallet Line is located to the north of the main station, just north of the day tank area on the south side of Lancaster Drive. The site is characterized by uniformly flat land with a very gentle slope to the east toward Alert Inlet in the distance. The area is enclosed by a metal fence. This is an active site that is still used for storing barrels on 6 raised metal pallets. The barrels stored on site contain such substances as POL, chemical products and waste oil. Lubricating oil, deicing fluid, and acids are also stored in this area. The soil composition is mainly rocky sandy soils.

4.11.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

During the 2006 sampling campaign, a series of 3 test pits (approximately 1.0 m wide, 3.0 to 4.5 m long and depths of 80 cm to 1.4 m) were dug and composite samples were collected from each trench. Samples were analyzed for TPH and metals and only arsenic was above CCME guidelines but below alternate guidelines. Samples collected from 2 areas in which high TPH concentrations had been previously noted (ESG, 1999), were found to be below CCME guidelines.

4.11.3 Nature and Extent of Contamination

A total of 5 soil samples (including 1 duplicate) were collected (Figure 15) at depths of 20-30 cm during the 2008 sampling campaign. All samples were analysed for TPH (Table 16). None of the samples were above CCME guideline concentrations.

NCS Score/Classification: 35.1/N

The estimated volume of contaminated soil is 0 m^3.

4.11.4 Recommendations

The previously (1999) observed TPH contamination exceeding CCME guidelines is now at concentrations below guidelines. The only metal contamination observed on site was arsenic at levels just above CCME guidelines but below alternate guidelines. If it is established that the alternate guideline for arsenic is approved for the CFS-Alert area, this site can be closed.

Table 16. S-10213 Main Station POL Pallet Line F1-F4 chemistry results

					Main Station POL Pallet Line (S-10213)				
		SOIL			SOIL				
	PARAMETERS	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-SP-0022 20-30 cm Dup. 0122 13/07/2008	B08-SP-0122 20-30 cm 13/07/2008	B08-SP-0123 20-30 cm 13/07/2008	B08-SP-0124 20-30 cm 13/07/2008	B08-SP-0125 20-30 cm 13/07/2008
	F1 (C6-C10)	mg/kg	310	10.7	191	268	<2.8	<2.8	<3.1
	F2 (C10-C16)	mg/kg	760	3.9	246	364	2.6	<1.2	<2.2
	F3 (C16-C34)	mg/kg	1,700	9.0	87.4	97.3	10	157	25
	F4 (C34-C50)	mg/kg	3,300	29	33	36	6.1	56.7	16

NA Not analysed

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

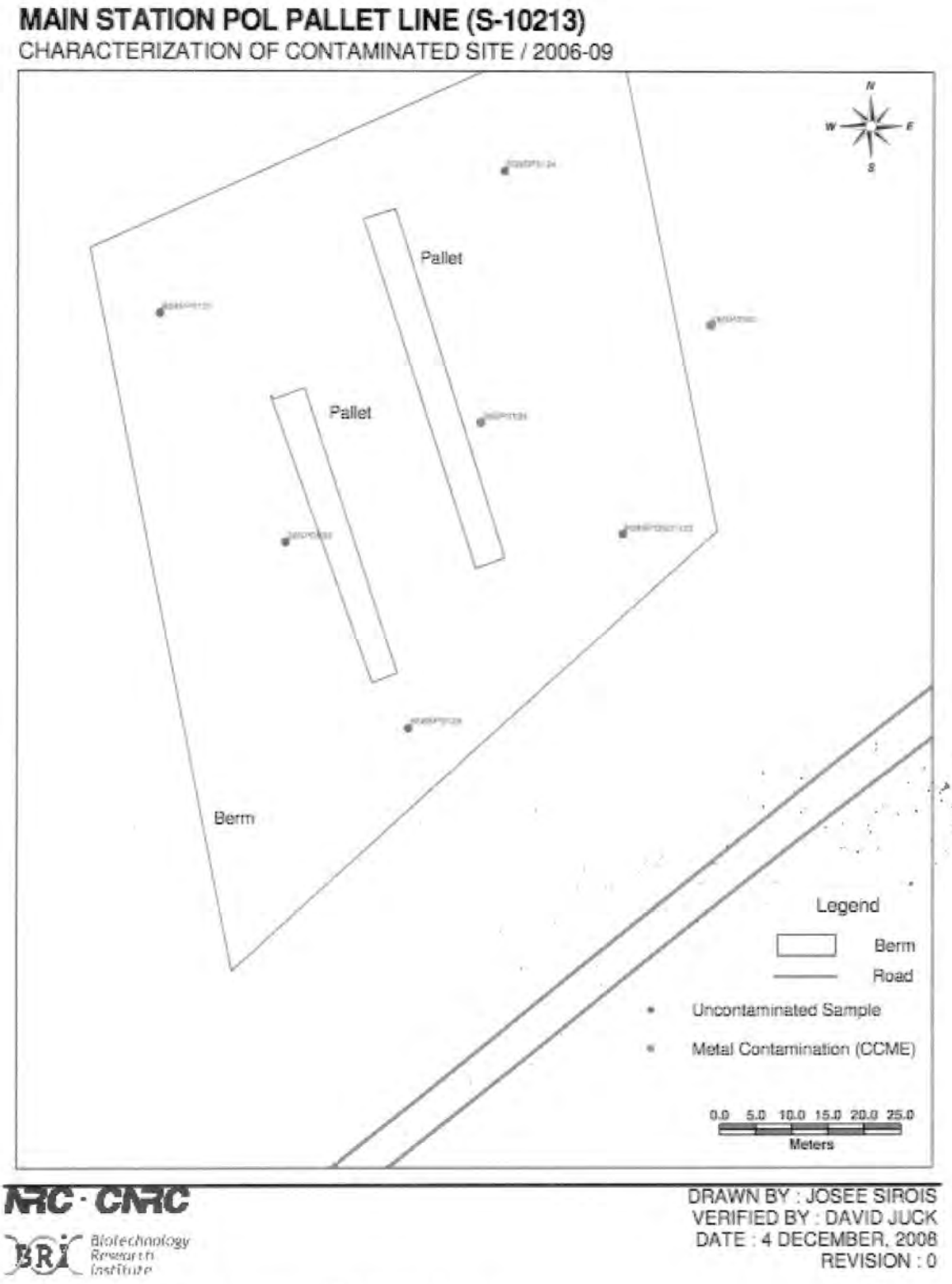

Figure 15. S-10213 Main Station POL Pallet Line map

4.12 S-10214 MAIN STATION DAY TANK AREA

4.12.1 Location and Site Description

The Main Station Day Tank area is located at the north end of the CFS-Alert main station, west of the Operations Building and beside the Old Upper POL line areas (S-354). Based on the proximity of the Main Station Day Tank area to the Old Upper POL Line, the 2 sites should be treated as one area. The site consists of one diesel day tank for vehicle refueling, a pump house, a fuel-dispensing shed and a refueling building. The refueling building hosts the pumping system that fills the station day tank from the airstrip tank farm. A couple of storage trailers are located on the east side of the site and many utilidors carrying power and other utility lines pass through the site (ESG 1999). The site is surrounded by three gravel berms which contain any fuel spills. One berm surrounds the pump house and the day tank, a second berm surrounds a diesel pipeline valve situated north of the pump house and a third berm surrounds the refueling building area east of the 2 other berms. In 2006, a fuel additive building was placed beside the fuel-dispensing shed. This building was the old refueling building and was replaced by the new building situated inside the third bermed area. In 2007, the fuel additive building was not observed on site. The current Main Station Day Tank is slated for replacement in the near future.

The topography of the site is generally level, with a gentle slope on the east side of the site. The buildings are constructed on elevated gravel pads and the soil in the area is mainly native shaley silts and clays with a few shale stone. The bermed areas occasionally fill with water. The water appears to drain out of the berms from holes in the berm structures. A drainage pathway was noted during the 2006 and 2007 sampling campaigns, starting from the second bermed area, passing through the third bermed area to a drainage channel located east of the site alongside the Operations Building. The drainage channel eventually reaches a drainage ditch situated along Tower Way road. The site is approximately 650 m from Dumbell Bay.

4.12.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

In 2006, 5 soil samples were collected around the fuel dispensing shed and the day tank area. Three soil samples exceeded CCME guidelines for F1 and all samples exceeded CCME guidelines for F2. Toluene, ethylbenzene and total xylene exceeded the CCME guidelines in two soil samples.

In 2007, sample collection focused on the drainage network of the Station Day Tank area, with 3 soil samples and 2 surface water samples collected. No BTEX or PAHs were detected in any sample and only 1 sample was above CCME guidelines for F2. TPH F1 and F3 were detected at elevated concentrations in both surface water samples while F2 was detected in only one. There are currently no CCME guidelines for F1-F4 in surface waters.

BRI has not previously sampled the area designated as S-354 Old Upper POL Line.

4.12.3 Nature and Extent of Contamination

In 2008, these sites were treated as 1 and a total of 35 soil samples were collected, 3 of which were duplicates (Figure 16). All samples were analyzed for F1-F4 and 4 (assigned to the Alert Old Upper POL Line area) were analyzed for VOC.

TPH contamination was found to be widespread at this site (Tables 17 and 18). A total of 6 samples were above CCME guideline concentrations for F1 (B08-DT-142, B08-DT-142, B08-DT-206, B08-DT-211, B08-UP-0136 and B08-UP-0137), a total of 25 (including 3 duplicates) were above CCME guideline concentrations for F2 (B08-DT-0010, B08-DT-0045, B08-DT-142, B08-DT-143, B08-DT-144, B08-DT-145, B08-DT-146, B08-DT-206, B08-DT-207, B08-DT-209, B08-DT-210, B08-DT-211, B08-UP-0033, B08-UP-0133, B08-UP-0136, B08-UP-0137,

B08-UP-0138, B08-UP-0156, B08-UP-0157, B08-DT-164, B08-DT-165, B08-UP-0172, B08-UP-0173, B08-UP-0174 and B08-UP-0177) and 3 samples were above CCME guideline concentrations for F3 (B08-DT-206, B08-DT-209 and B08-DT-211).

VOC analysis revealed only 1 sample (B08-UP-0136) slightly above CCME guideline concentrations for ethylbenzene (0.15 mg/kg vs 0.082 mg/kg) (Table 19). No other VOC contaminated samples were observed.

NCS Score/Classification for Main Station Day Tank Area: 59.6/2
NCS Score/Classification for Alert Old Upper POL Farm: 59.2/2
The estimated volume of contaminated soil is 10,000 m^3.

4.12.4 Recommendations

TPH contamination is widespread in this area. It has been detected in front of the day tank vehicle refueling area, throughout the large bermed area behind the day tanks and in the drainage channel located leading away from the day tank area.

The current Main Station Day Tank is slated for replacement in the near future. Due to the widespread nature of TPH contamination and the potential for additional spills during tank the replacement and disposal no further characterization work should be performed until the new system is in place and operational.

The area in front of the current Day Tank is in continual use due to vehicle refueling and vehicle traffic in general. The bermed area behind the day tank, while not in active use, is significantly contaminated, with respect to the volume of soil. An *in situ* bioremediation system is the most appropriate approach to remediating this site. *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5).

Table 17. S-10214 Main Station Day Tank Area F1-F4 chemistry results

					Main station day tank (S-10214)								
	PARAMETER	UNITS	SOIL GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	SOIL B08-DT-0010 80-100 cm Dup. 0210 13/07/2008	B08-DT-0045 25-35 cm Dup. 0145 13/07/2008	B08-DT-142 15-25 cm 13/07/2008	B08-DT-143 25-30 cm 13/07/2008	B08-DT-144 25-35 cm 13/07/2008	B08-DT-145 25-35 cm 13/07/2008	B08-DT-146 30-40 cm 13/07/2008	B08-DT-147 30-40 cm 13/07/2008	B08-DT-164* 5-15 cm 20/07/2008
	F1 (C6-C10)	mg/kg	310	10.7	52	187	834	1,210	239	206	241	<3.3	967
	F2 (C10-C16)	mg/kg	760	3.9	3,370	3,970	3,730	10,200	4,770	4,500	3,580	<2.4	4690
	F3 (C16-C34)	mg/kg	1,700	9.0	445	473	255	700	1,110	548	196	13	388
	F4 (C34-C50)	mg/kg	3,300	29	7.1	37	22	15	156	33	35	<8	29

	PARAMETER	UNITS	SOIL GUIDELINES INDUSTRIAL (Coarse)	DETECTION LIMIT	SOIL B08-DT-165* 5-15 cm 20/07/2008	B08-DT-205 100-120 cm 27/07/2008	B08-DT-206 100-120 cm 27/07/2008	B08-DT-207 90-100 cm 27/07/2008	B08-DT-208 70-90 cm 27/07/2008	B08-DT-209 20-30 cm 27/07/2008	B08-DT-210 80-100 cm 27/07/2008	B08-DT-211 80-100 cm 27/08/2008
	F1 (C6-C10)	mg/kg	310	10.7	531	<2.8	681	41.4	<2.9	110	77	589
	F2 (C10-C16)	mg/kg	760	3.9	7410	2.4	14,000	1,960	5.2	4,600	3,060	18,100
	F3 (C16-C34)	mg/kg	1,700	9.0	1210	5.1	3,070	289	88.5	2,170	473	8,000
	F4 (C34-C50)	mg/kg	3,300	29	71.2	<4.9	34	8.8	36	30	<4.6	7.4

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

* New planned Day Tank location outside of the current Day Tank Area.

Table 18. S-354 Alert Old Upper POL Line F1-F4 chemistry results

					Old Upper POL Farm (S-354)								
	PARAMETE	SOIL			SOIL								
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-UP-0033 25-35 cm Dup. 0133 13/07/2008	B08-UP-0133 25-35 cm 13/07/2008	B08-UP-0134 35-45 cm 13/07/2008	B08-UP-0135 20-30 cm 13/07/2008	B08-UP-0136 30-40 cm 13/07/2008	B08-UP-0137 20-30 cm 13/07/2008	B08-UP-0138 35-45 cm 13/07/2008	B08-UP-0139 30-40 cm 14/07/2008	B08-UP-01 30-40 cm 14/07/2008
TPH	F1 (C6-C10)	mg/kg	310	10.7	28	16	<3.6	<3.3	637	336	206	<3.4	<3.2
	F2 (C10-C16)	mg/kg	760	3.9	2,000	1,850	<2.6	<2.5	3,560	2,190	7,860	<1.9	98.3
	F3 (C16-C34)	mg/kg	1,700	9.0	183	181	<6	<5.9	215	45	507	<4.5	145
	F4 (C34-C50)	mg/kg	3,300	29	<4.3	<5.5	<8.5	<8.5	<6.9	<5.7	9.6	<6.4	55

	PARAMETE	SOIL			SOIL								
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-UP-0141 10-20 cm 14/07/2008	B08-UP-0156 30-40 cm 14/07/2008	B08-UP-0157 30-40 cm 14/07/2008	B08-UP-0172 70-80 cm 22/07/2008	B08-UP-0173 70-80 cm 22/07/2008	B08-UP-0174 90-100 cm 22/07/2008	B08-UP-0175 90-100 cm 22/07/2008	B08-UP-0176 90-100 cm 22/07/2008	B08-UP-01 90-100 cm 22/07/2008
	F1 (C6-C10)	mg/kg	310	10.7	4.1	147	24	176	160	37.9	36.8	<3	143
	F2 (C10-C16)	mg/kg	760	3.9	<1.4	1,510	783	787	3,620	2,620	692	34.9	2,590
	F3 (C16-C34)	mg/kg	1,700	9.0	<3.2	46	57.2	55.3	622	839	96.7	3.4	287
	F4 (C34-C50)	mg/kg	3,300	29	<4.6	<7.2	<8	7.8	<4	34	<4.9	<4.6	<4.3

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 19. S-354 Alert Old Upper POL Line VOC chemistry results

					Old Upper POL Farm (S-354)			
	PARAMETERS	SOIL			SOIL			
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-UP-0033 25-35 cm Dup. 0133 13/07/2008	B08-UP-0133 25-35 cm 13/07/2008	B08-UP-0136 30-40 cm 13/07/2008	B08-UP-0156 30-40 cm 14/07/2008
VOC	Vinyl chloride	mg/kg	---	0.04	<0.4	<0.4	<0.4	<0.4
	1,1-dichloroethene	mg/kg	50	0.04	<0.1	<0.1	<0.1	<0.1
	Dichloromethane	mg/kg	50	20	<0.1	<0.1	<0.1	<0.1
	1,2-dichloroethene (trans)	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	1,1-dichloroethane	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	1,2-dichloroethene (cis)	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	Chloroform	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	1,1,1-trichloroethane	mg/kg	50	0.03	<0.1	<0.1	0.2	<0.1
	Carbon tetrachloride	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	1,2-dichloropropane	mg/kg	50	0.04	<0.1	<0.1	<0.1	<0.1
	1,3-dichloropropene (cis)	mg/kg	50	0.03	<0.1	<0.1	<0.1	<0.1
	1,3-dichloropropene (trans)	mg/kg	50	0.05	<0.1	<0.1	<0.1	<0.1
	1,1,2-trichloroethane	mg/kg	50	0.04	<0.1	<0.1	<0.1	<0.1
	Tetrachloroethene	mg/kg	50	0.08	<0.1	<0.1	<0.1	<0.1
	1,1,2,2-tetrachloroethane	mg/kg	50		<0.1	<0.1	<0.1	<0.1
	Benzene	mg/kg	0.03	0.02	<0.009	<0.009	<0.009	<0.009
	Ethylbenzene	mg/kg	0.082	0.02	<0.02	<0.02	0.15	<0.02
	Chlorobenzene	mg/kg	10		<0.1	<0.1	<0.1	<0.1
	Toluene	mg/kg	0.37	0.02	<0.08	<0.08	0.23	<0.08
	Xylenes	mg/kg	11	0.04	<0.1	<0.1	4	0.1
	Styrene	mg/kg	50		<0.1	<0.1	<0.1	<0.1
	1,2-dichlorobenzene	mg/kg	10		<0.1	<0.1	<0.1	<0.1
	1,3-dichlorobenzene	mg/kg	10		<0.1	<0.1	<0.1	<0.1
	1,4-dichlorobenzene	mg/kg	10		<0.1	<0.1	<0.1	<0.1

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

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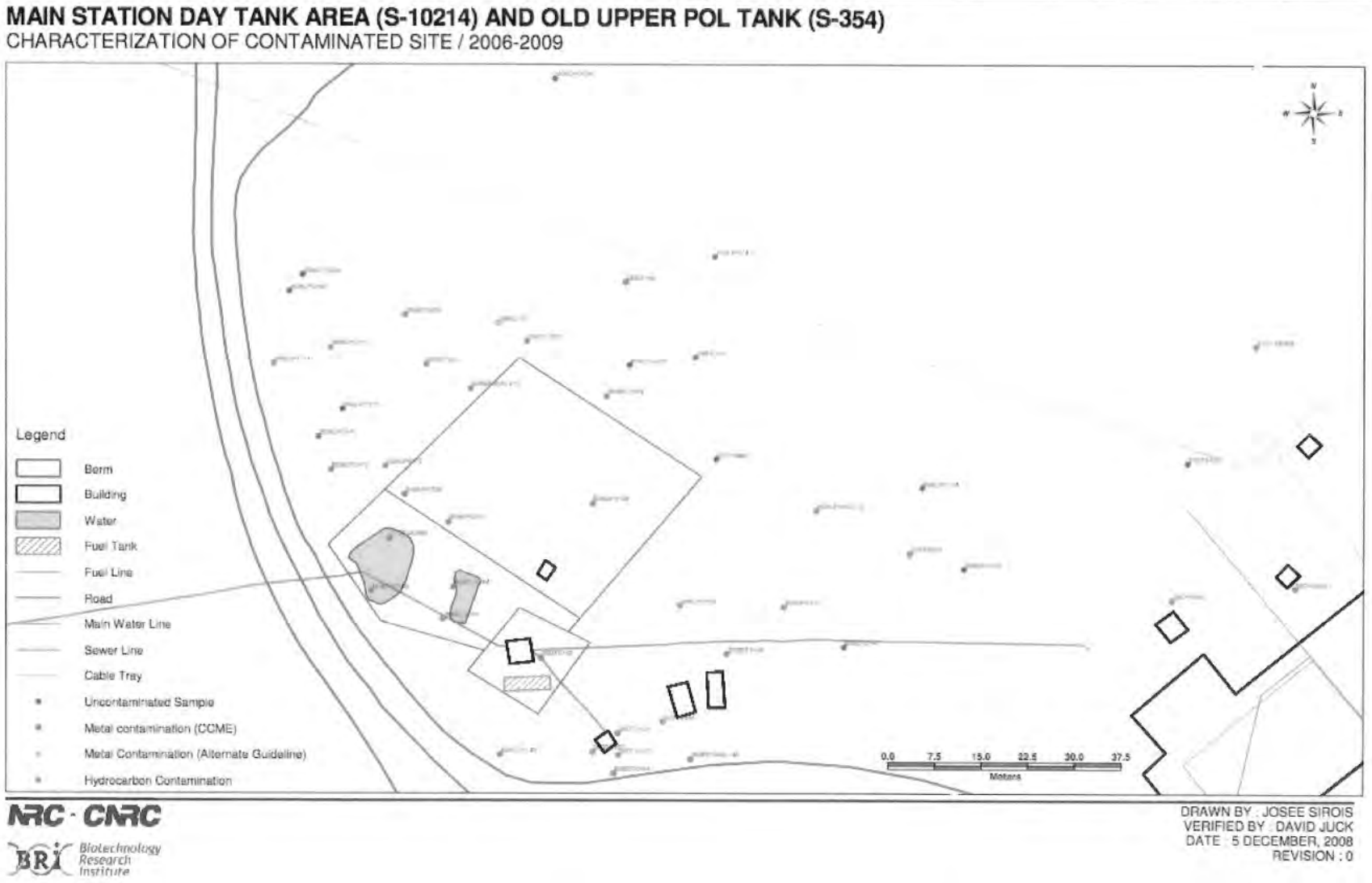

Figure 16. S-10214 Main Station Day Tank Area and S-354 Alert Old Upper POL Line map.

4.13 S-10215 MAIN STATION HAPS

4.13.1 Location and Site Description

"The [Main Station] HAPS building was constructed between 1982 and 1984, replacing the original GP hut style buildings that contained offices and personnel services." (ESG 2000). The present building contains the kitchen and dining room, administrative offices, theatre, barbershop, an all-ranks mess, library, TV and radio stations and games and activity rooms. The building itself is located in the center of the site, west-northwest of the gym and curling club. Like many of the buildings on site, the Main Station HAPS is constructed on supports providing for a gap of approximately 1 m between the bottom of the building and the ground. There are also 2 tanks inside the building and the site remains active. The topography of the site features a gentle slope underneath the building toward the southeast and Dumbell Bay. The surface soil is mainly rocks with clayey soil beneath.

4.13.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

PHC contamination was initially identified under boiler room vents by ESG in 1999 and 2000 and this was confirmed during the 2006 sampling campaign by BRI. One of two surface soil samples, collected from underneath the boiler vents, exceeded CCME guidelines for F1. No sampling was performed in 2007 due to time constraints.

4.13.3 Nature and Extent of Contamination

The goal of the sampling campaign in 2008 was to delineate the extent of PHC contamination around and under the Main Station HAPS building. A total of 8 (including 1 duplicate) surface (20-50 cm depth) soil samples were collected from under the boiler vents and beneath the Main

Station HAPS building (Figure 17) and all were analyzed for TPH (Table 20). The contamination beneath the boiler vents is relatively localized and only 1 sample (including its duplicate) from this area was above CCME guidelines for F1 and F2 (B08-HA-0127 and B08-HA-0027). The 2 samples collected from underneath the building, B08-HA-0129 and B08-HA-0131, were above CCME guidelines for F1 and F1-F2, respectively. Due to the sheltering of the building, the soil is protected from direct exposure to sunlight and the permafrost layer under the building is quite shallow with ice being present on the soil surface in some areas all year long.

NCS Score/Classification: 49.8/3

The estimated volume of contaminated soil is 300 m^3.

4.13.4 Recommendations

Delineation of the area under the building and the area to the southeast of the building remains to be completed to determine the total extent of PHC contamination. As this is an active area and excavation is not a possibility, an *in situ* bioremediation system is the only practical approach to remediating this area. *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5).

Table 20. S-10215 Main Station HAPS F1-F4 chemistry results

					Main Station HAPS (S-10215)							
		SOIL			SOIL							
	PARAMETE	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-HA-0027 30-40 cm Dup. 0127 13/07/2008	B08-HA-0126 30-40 cm 13/07/2008	B08-HA-0127 30-40 cm 13/07/2008	B08-HA-0128 30-40 cm 13/07/2008	B08-HA-0129 10-20 cm 13/07/2008	B08-HA-0130 30-40 cm 13/07/2008	B08-HA-0131 15-25 cm 13/07/2008	B08-HA-013 40-50 cm 13/07/2008
	F1 (C6-C10)	mg/kg	310	10.7	845	<2.4	827	3.9	253	<3.5	969	4.2
	F2 (C10-C16)	mg/kg	760	3.9	2,760	1.7	3,020	4.2	3,410	6.7	2,080	2.8
	F3 (C16-C34)	mg/kg	1,700	9.0	56.3	71.4	54.7	185	89.3	61.3	63.9	48.5
	F4 (C34-C50)	mg/kg	3,300	29	9.1	17	10	65.9	13	23	8	23

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

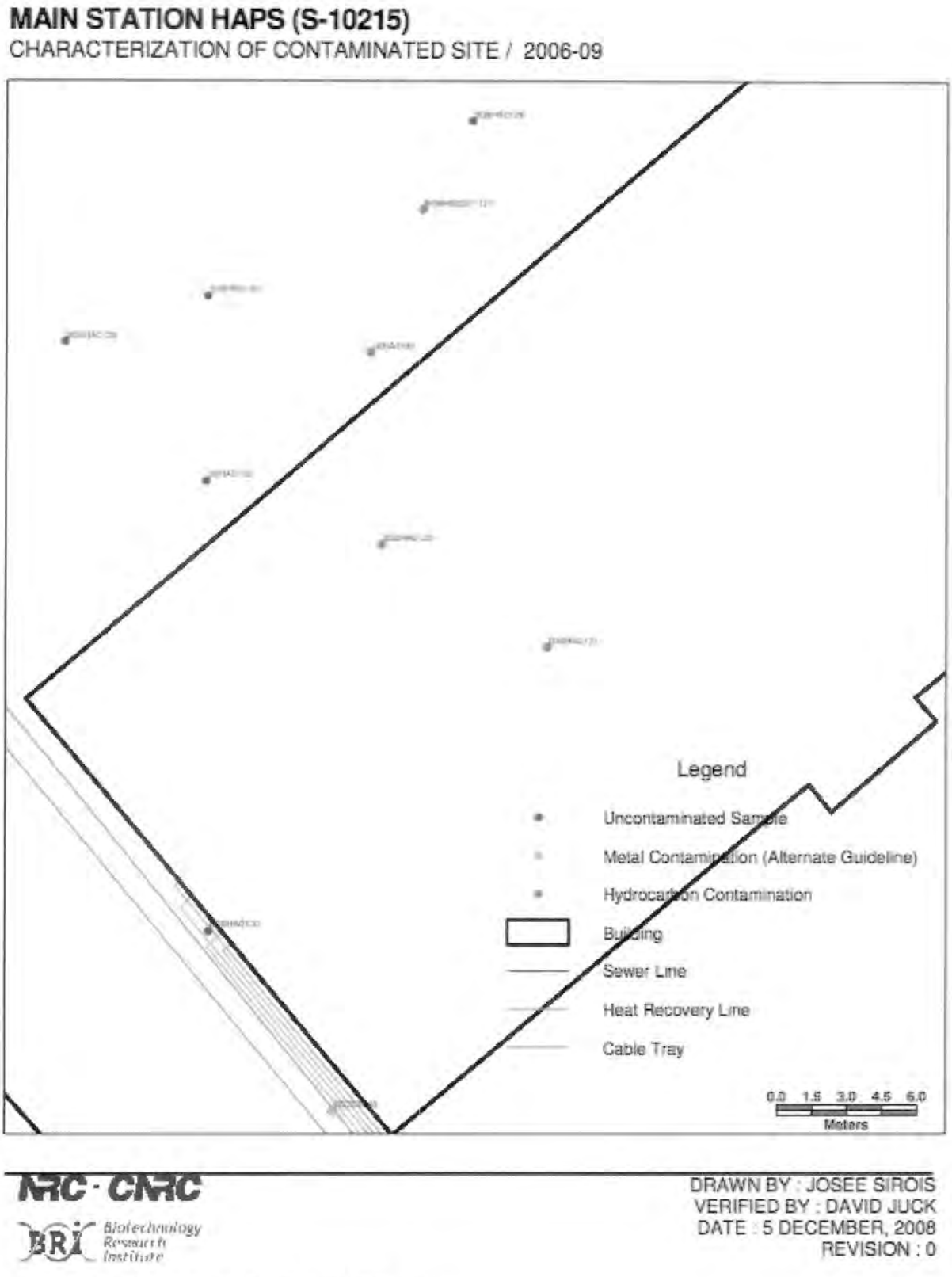

Figure 17. S-10215 Main Station HAPS map.

4.14 S-10217 BUILDING 113, HEATED VEHICLE STORAGE

4.14.1 Location and Site Description

Building 113, Heated Vehicle Storage, is located at the northwest end of the CFS-Alert main station, north of the Vehicle Maintenance building. This building is sheathed in corrugated steel and has a gravel floor. Station vehicles are stored in this building during the winter and periods of inclement weather. One fuel tank covered by a metal hut and a small pipeline are located in the northeast corner of the building. A fuel tank was located west of the building but was removed prior to the 2006 sampling campaign. A Cold Storage building (Building 110) was located north of the Building 113 and was demolished prior to the 2006 sampling campaign. During the 2006, 2007 and 2008 sampling campaigns, a pool of standing water was noted at the old location of Building 110. Several pools of standing water were present on the west side of the site, behind the Heated Vehicle Storage building.

The topography is level. Clayey, silty soils with some gravel and shale stones are predominant in the surrounding area. No drainage channels were noted around Building 113, but a drainage ditch is located at the west end of the site. This drainage ditch leads downhill to the south and links to the drainage ditch adjacent to Herc Drive. The site is located roughly 650 m from Dumbell Bay.

4.14.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Previous investigations on this site have targeted obvious contamination in and around the building. Contaminated areas within the building, while of concern, cannot adequately be addressed until the building is removed from active use and equipment is removed. The PHC

contamination exterior to the Heated Vehicle Storage Building is found to the southwest behind the building. In 2006 and 2007, soil samples were collected which were above CCME guidelines for BTEX, F1 and F2. Arsenic was also detected above CCME guidelines in 1 sample, but the concentration was below the proposed alternate guideline. One surface water sample was collected in 2007 which was found to have copper, lead, selenium and naphthalene be at or above CCME guideline concentrations.

4.14.3 Nature and Extent of Contamination

In 2008, a series of 7 soil samples (including 1 duplicate) were collected from the behind the building to the southwest (Figure 18) at depths of 30-50 cm. A buried high tension cable prevents the sampling of the area to the south southeast of the building. Of the soil samples collected, all but 1 were demonstrated concentrations of F2 above CCME guidelines (B08-HV-0119 was the exception) (Table 21). F1 was also observed above CCME guidelines in B08-HV-0120 (its duplicate B08-HV-0020) and B08-HV-0121.

NCS Score/Classification: 58.5/2
The estimated volume of contaminated soil is 3,600 m^3.

4.14.4 Recommendations

The majority of the TPH contamination at this site is located to the south-west of the building and follows a shallow drainage channel away from the building. Complete delineation of the drainage ditch needs to be completed to establish the total extent of contamination originating from this site. Once this is completed and optimized *in situ* conditions have been established for the CFS-Alert area (see Section 5), an active *in situ* bioremediation plan can be implemented.

Table 21. S-10217 Heated Vehicle Storage, Building 113 F1-F4 chemistry results

					Bldg 113, Heated Vehicle Storage (S-10217)						
		SOIL			SOIL						
	PARAMETE	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-HV-002 30-40 cm Dup. 0120 12/07/2008	B08-HV-011 40-50 cm 12/07/2008	B08-HV-011 30-40 cm 12/07/2008	B08-HV-011 40-50 cm 12/07/2008	B08-HV-011 40-50 cm 12/07/2008	B08-HV-012 30-40 cm 12/07/2008	B08-HV-0 30-40 cm 12/07/200
TPH	F1 (C6-C10)	mg/kg	310	10.7	565	176	153	57.9	3.3	456	645
	F2 (C10-C16)	mg/kg	760	3.9	2,260	2,070	1,990	1,080	4.3	2,470	2,890
	F3 (C16-C34)	mg/kg	1,700	9.0	1,260	562	335	104	28	1,380	668
	F4 (C34-C50)	mg/kg	3,300	29	204	94.9	76.1	34	11	242	220

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME

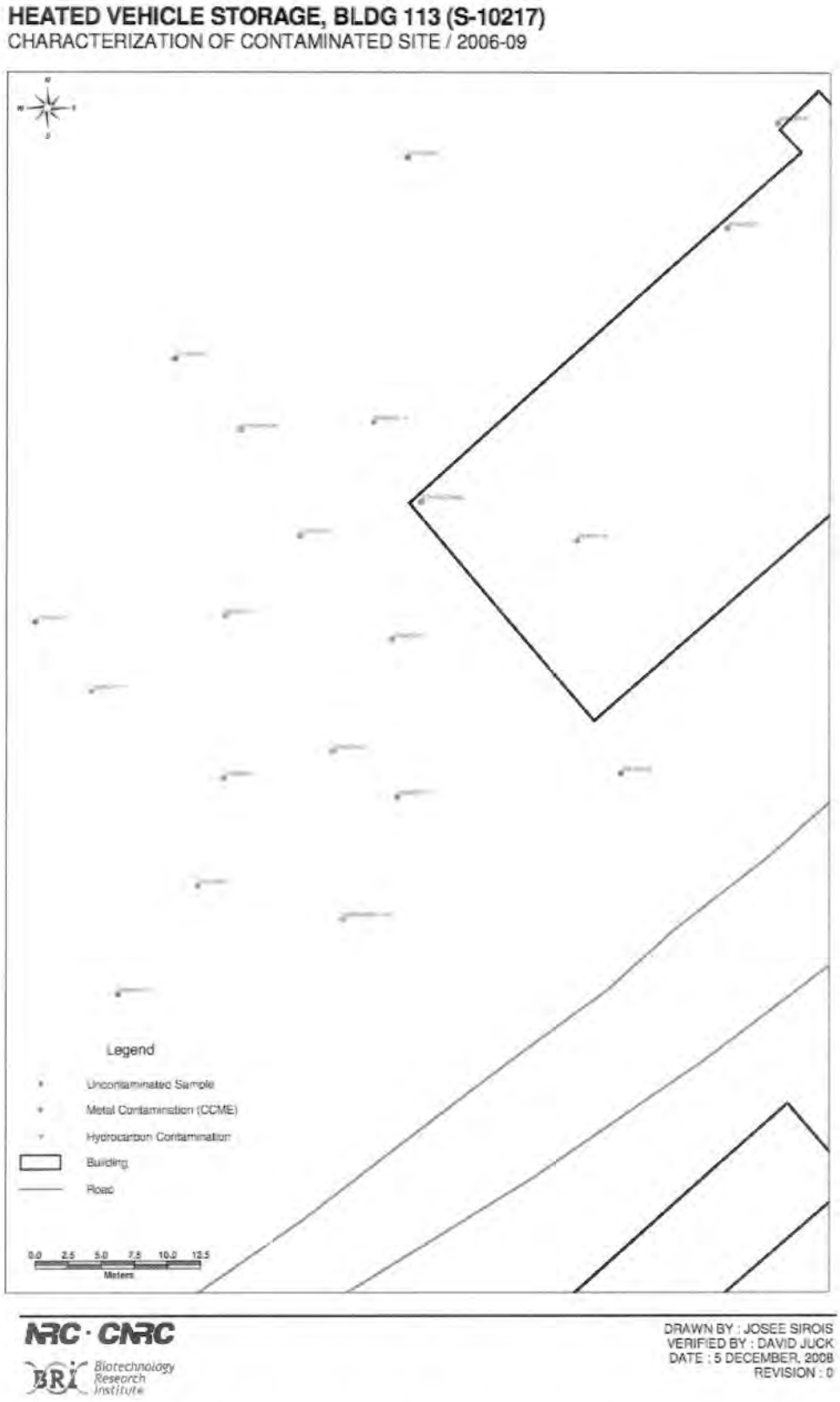

Figure 18. S-10217 Building 113, Heated Vehicle Storage map.

4.15 S-10218 BURNER PROJECT SITE (Old Hazmat Storage Site)

4.15.1 Location and Site Description

The Burner Project site is situated in the area northwest of the CFS-Alert main station, on the west side of Pusher Road. In 1998 this site was set aside for the burning of hydrocarbon wastes. The burner site was used until 2000 to reduce the inventory of hydrocarbon waste. During the three years of operation, it was estimated that thousands of liters of fuel and oil were disposed of (ESG 2000). A burner, mixer and diesel tank were removed from the site when it was decommissioned. The Burner Project site is currently inactive and human activities no longer occur on site. Soil was excavated from the site to construct a berm on the northeast and southeast sides of the site.

The topography is level with a gentle southwest slope. During the 2006 and 2007 sampling campaigns, one large pool of standing water was observed on site, contained on one side by the southeast berm. This indicates that the underlying material is highly impermeable to water. No drainage channel was observed on site. The soil is mainly composed of natural coarse shaley material mixed with silt and shale stones.

During the 2008 sampling campaign it was noted that material from the south of the site, adjacent to the previously described pools of water, was being removed and used for fill material around the base. This was due to equipment failure in the quarry, and resulted in the removal of several sample tags before GPS locations could be determined.

4.15.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Results from the 2006 and 2007 sampling campaigns has revealed the presence of 2 types of contamination at the site. PHC contamination above CCME guidelines was noted in 2 localized and relatively small areas, the first being the previous location of the burner and the second was a single hotspot within the bermed area used to store material before burning. BTEX and PAH analyses were also performed and only toluene and ethylbenzene were detected in a single 2006 sample at low to moderate concentrations.

The second type of contamination is by metals, predominantly arsenic and nickel, and was found to be relatively widespread throughout the northern portion of the site. A single 2006 sample, below CCME guideline concentrations for arsenic and nickel, was found to be significantly contaminated with chromium, copper, nickel and zinc while 1 2007 sample was found to have highly elevated concentrations of nickel. Both of these samples suggest that the metals detected were from anthropogenic sources. Visual inspection of the site also determined that some material was buried (eg. old rusty cans), but this was limited to several small areas and it did not appear to be an old buried dump. The relatively consistent nature of the arsenic and nickel concentrations seen through the north of the site suggests that these may be natural concentrations, although some areas are above recommended alternate guidelines.

4.15.3 Nature and Extent of Contamination

The soil sampling performed in 2008 focused primarily on determining the whether the arsenic and nickel concentrations previously observed were consistent throughout the downgradient area of the site and whether localized hotspots might exist elsewhere. TPH analysis was also performed to determine if any PHC contamination migrated downgradient of the former burner area. Groundwater was also sampled in 3 test pits adjacent to the standing pools of water found at the south of the site.

A total of 19 subsurface soil samples (including 2 duplicates) and 3 groundwater samples were collected from the area to the south of the elevated former burner area (Figure 19). All but 2 soil samples were analysed for metals and 4 soil samples (including 1 duplicate) were analysed for TPH in the areas previously flooded in the former barrel storage area.

A total of 15 soil samples (including 2 duplicates) were above CCME guidelines for arsenic (B08-BU-0191, B08-BU-0192, B08-BU-0193, B08-BU-0194, B08-BU-0195, B08-BU-0196, B08-BU-0197, B08-BU-0198, B08-BU-0201, B08-BU-0202, B08-BU-0002 (duplicate of B08-BU-0202), B08-BU-0203, B08-BU-0204, B08-BU-0216 and B08-BU-0217 (duplicate of B08-BU-0216)), of which 12 were above alternate guidelines (B08-BU-0191, B08-BU-0192, B08-BU-0193, B08-BU-0194, B08-BU-0195, B08-BU-0197, B08-BU-0198, B08-BU-0201, B08-BU-0202, B08-BU-0002 (duplicate of B08-BU-0202), B08-BU-0203 and B08-BU-0216) (Table 22). The arsenic concentration average for the 17 soil samples was 26.4 mg/kg, which is above the alternate guideline but not significantly above.

Nickel was found in excess of CCME guideline concentrations in 14 soil samples (including 2 duplicates) (B08-BU-0191, B08-BU-0192, B08-BU-0193, B08-BU-0194, B08-BU-0195, B08-BU-0196, B08-BU-0197, B08-BU-0198, B08-BU-0201, B08-BU-0202, B08-BU-0002 (duplicate of B08-BU-0202), B08-BU-0203, B08-BU-0204 and B08-BU-0216) and 5 of those also exceeded alternate guideline concentrations (B08-BU-0193, B08-BU-0196, B08-BU-0197, B08-BU-0202 and B08-BU-0204) (Table 22). The nickel concentration average for the 17 soil samples was 82.7 mg/kg, which is above the alternate guideline but not significantly above.

These soil samples are somewhat similar to each with respect to arsenic and nickel concentrations and suggest that the observed concentrations are naturally occurring. Only 1 sample, B08-BU-0196, appears to have anthropogenic metal contamination in the form of copper and nickel (371 mg/kg and 390 mg/kg, respectively). No apparent source of this contamination was noted in the area of the test pit although metal debris may have been removed prior to sampling due to the use of gravel from this area as fill or for road repairs.

Metal analysis of the groundwater samples identified concentrations of arsenic in 1 sample (B08-BU-0195W) above CCME guidelines and all 3 samples had concentrations of selenium above CCME guidelines (Table 23). The selenium concentrations in samples B08-BU-0197W and B08-BU-0202W were elevated (9 µg/L and 8 µg/L vs 1 µg/L CCME) but the concentration in

sample B08-BU-0195W was significantly elevated (144 µg/L). Again, no apparent source of this contamination was noted in the area of the test pit.

TPH analysis of the collected soil samples revealed no further TPH contamination indicating that the previously identified contaminated areas are well defined and that the PHCs have not migrated.

NCS Score/Classification: 54.1/2
The estimated volume of contaminated soil is 38,000 m^3.

4.15.4 Recommendations

The TPH contamination in the area of the former burner is most easily dealt with by excavation and *ex situ* biopile bioremediation. The volumes are relatively small and the areas well defined.

The elevated concentrations of arsenic and nickel appear to be due to the natural presence of these metals in this area, although they are somewhat elevated when compared to the previous background study (BRI, 2008). This may be due to the specific geological formations in this localized area or the fact that this material has recently been uncovered due to the requirement for fill material on base and the metals have not leached away to the same extent as in other areas. As with the recommended alternate guidelines for arsenic and nickel at the rest of the CFS-Alert sites, an alternate guideline for this site should be discussed with, and approved by, the appropriate regulatory authorities. In either case, there are only several identified metal hot spots of concern in this area which can be dealt with by excavation and burial in a secure landfill.

Table 22. S-10218 Burner Project Site metals and F1-F4 soil chemistry results.

	PARAMETERS	UNITS	SOIL: INDUSTRIAL GUIDELINES (Coarse)	SOIL: DETECTION LIMIT	Burner Project Site (S-10218) SOIL: B08-BU-0002 90-100 cm Dup. 0202 25/07/2008	B08-BU-0191 70-80 cm 25/07/2008	B08-BU-0192 60-70 cm 25/07/2008	B08-BU-0193 70-80 cm 25/07/2008	B08-BU-0194 20-30 cm 25/07/2008	B08-BU-0195 80-100 cm 25/07/2008	B08-BU-0196 80-90 cm 25/07/2008	B08-BU-0197 70-80 cm 25/07/2008	B08-BU-0198 50-60 cm 25/07/2008	B08-BU-0199 80-100 cm 25/07/2008
	Arsenic (As)	mg/kg	12	0.27	27.6	53.1	58.4	40.8	23.8	22.4	14	19.5	29.8	9.4
	Barium (Ba)	mg/kg	2000	5	33	20	21	14	22	16	12	32	31	23
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	32	28	29	25	27	19	26	30	29	24
	Cobalt (Co)	mg/kg	300	1.9	27	30	23	45	18	14	34	21	28	12
	Copper (Cu)	mg/kg	91	2.1	51	49	51	43	28	37	371	36	37	20
	Lead (Pb)	mg/kg	600	1.2	22	18	29	14	17	12	26	19	22	15
	Manganese (Mn)	mg/kg	—	1.1	927	1110	660	857	757	286	179	818	707	478
	Mercury (Hg)	mg/kg	50		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	72	67	68	55	56	54	390	80	67	41
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	0.7	0.6	<0.5	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	80	80	85	73	72	75	107	79	83	60
	F1 (C6-C10)	mg/kg	310	10.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	F2 (C10-C16)	mg/kg	760	3.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	F3 (C16-C34)	mg/kg	1700	9.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	F4 (C34-C50)	mg/kg	3300	29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

	PARAMETERS	UNITS	SOIL: INDUSTRIAL GUIDELINES (Coarse)	SOIL: DETECTION LIMIT	SOIL: B08-BU-0200 90-100 cm 25/07/2008	B08-BU-0201 90-100 cm 25/07/2008	B08-BU-0202 90-100 cm 25/07/2008	B08-BU-0203 80-90 cm 25/07/2008	B08-BU-0204 90-100 cm 25/07/2008	B08-BU-0216 50 cm 25/07/2008	B08-BU-0217 50 cm Dup. 0216 25/07/2008	B08-BU-0218 80 cm 25/07/2008	B08-BU-0219 100 cm 25/07/2008
	Arsenic (As)	mg/kg	12	0.27	7	20.4	37.4	26.1	13.6	29.3	16.1	NA	NA
	Barium (Ba)	mg/kg	2000	5	18	29	32	35	26	26	17	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	NA	NA
	Chromium (Cr)	mg/kg	87	3	23	29	31	31	26	28	28	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	12	23	42	27	17	21	15	NA	NA
	Copper (Cu)	mg/kg	91	2.1	19	33	69	48	33	31	19	NA	NA
	Lead (Pb)	mg/kg	600	1.2	14	20	20	26	16	19	12	NA	NA
	Manganese (Mn)	mg/kg	—	1.1	418	766	1340	964	892	646	518	NA	NA
	Mercury (Hg)	mg/kg	50		NA	NA	NA	NA	NA	NA	NA	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	<2	<2	<2	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	36	62	87	79	79	56	36	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	NA	NA
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA	NA
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	<5	<5	<5	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	53	73	83	78	72	65	50	NA	NA
TPH	F1 (C6-C10)	mg/kg	310	10.7	NA	NA	NA	NA	NA	<2.8	<3.2	<2.9	13
TPH	F2 (C10-C16)	mg/kg	760	3.9	NA	NA	NA	NA	NA	5	9	4.6	81
TPH	F3 (C16-C34)	mg/kg	1700	9.0	NA	NA	NA	NA	NA	4.4	5.7	<2.4	<5.5
TPH	F4 (C34-C50)	mg/kg	3300	29	NA	NA	NA	NA	NA	<4.3	<5.5	<3.4	<7.9

NA Not analysed
Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME) CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 23. S-10218 Burner Project Site metals and F1-F4 groundwater chemistry results.

PARAMETERS	WATER			Burner Project Site (S-10218) FRESHWATER		
	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B08-BU-0195W Groundwater 25/07/2008	B08-BU-0197W Groundwater 25/07/2008	B08-BU-0202W Groundwater 25/07/2008
Arsenic (As)	mg/L	5	0.0001	9	3	4
Barium (Ba)	mg/L	—	0.001	<10	<10	<10
Cadmium (Cd)	mg/L	0.017	0.0001	<1	<1	<1
Chromium (Cr)	mg/L	---	0.0007	1	1	1
Cobalt (Co)	mg/L	---	0.0006	<1	<1	<1
Copper (Cu)	mg/L	2-4	0.0012	1	1	1
Lead (Pb)	mg/L	1-7	0.0011	<1	<1	<1
Manganese (Mn)	mg/L	---	0.0003	<5	<5	<5
Mercury (Hg)	mg/L	26		<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/L	73	0.0078	65	19	20
Nickel (Ni)	mg/L	25-150	0.0005	<1	1	<1
Selenium (Se)	mg/L	1	0.0006	144	9	8
Silver (Ag)	mg/L	---	0.0008	<6	<6	<6
Tin (Sn)	mg/L	—	0.011	<1	<1	<1
Zinc (Zn)	mg/L	30	0.006	<10	<10	<10

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the ccme. (2006)

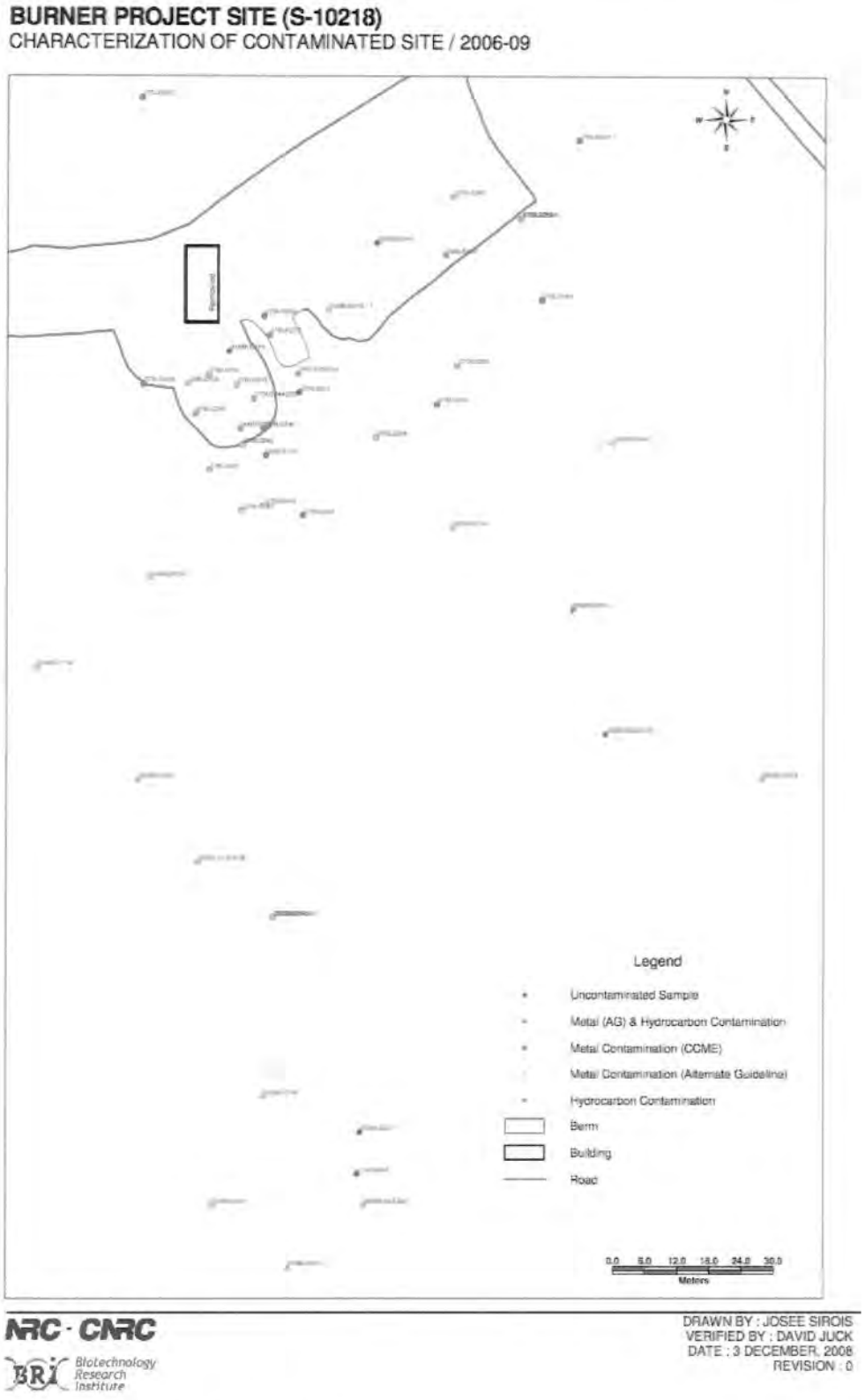

Figure 19. S-10218 Burner Project Site map.

4.16 S-10220 BARREL CACHE

4.16.1 Location and Site Description

The Barrel Cache site is a former storage area for fuel and oil barrels. The site is located to the southeast of the 4 orange fuel storage tanks adjacent to the runway refueling area, towards Dumbell Bay. The area slopes from the base of the bermed area surrounding the large fuel storage tanks towards Dumbell Bay, approximately 300 m to the southeast. A portion of the site, towards Dumbell Bay, was covered in 2007 due to the construction of a large bermed area created for the decontamination of PHC contaminated soils using an *ex situ* biopile bioremediation approach. The southeastern extent of the original site is located in the approximate middle of the newly constructed bermed area.

4.16.2 Summary of Previous BRI Investigations

This is the first characterization work to be performed by BRI at this site.

4.16.3 Nature and Extent of Contamination

A series of 15 subsurface soil samples (50-100 cm depth) were collected (Figure 20) and analysed for metals and TPH (Table 24). Metals analysis revealed the presence of arsenic above CCME guideline concentrations in 5 samples (B08-XX-0245, B08-XX-0247, B08-XX-0250, B08-XX-0251, B08-XX-0252), (only B08-XX-0250 was just above the alternate guideline) and 7 samples at or above nickel CCME guideline concentrations (B08-XX-0244, B08-XX-0245, B08-XX-0247, B08-XX-0250, B08-XX-0251, B08-XX-0252 and B08-XX-0256). No samples were above alternate guidelines for nickel.

TPH analysis revealed that 2 samples were above CCME guidelines for F1 (B08-XX-0251 and B08-XX-0252) and 3 samples above CCME guidelines for F2 (B08-XX-0246, B08-XX-0251 and B08-XX-0252). The TPH contaminated sites were small, well defined hotspots.

NCS Score/Classification: 49.9/3

The estimated volume of contaminated soil is 900 m^3.

4.16.4 Recommendations

The metal arsenic and nickel observed on site is not of concern as all but 1 sample were below the alternate guidelines. The observed TPH contamination is well defined and can be easily addressed by excavation and *ex situ* biopile bioremediation. Once the TPH contamination is addressed, the site can be closed.

Table 24. S-10220 Barrel Cache metals and F1-F4 chemistry results

	PARAMETERS	SOIL			Barrel Cache (S-10220) SOIL							
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-XX-0244 80 cm 08/08/2008	B08-XX-0245 70 cm 08/08/2008	B08-XX-0246 80cm 08/08/2008	B08-XX-0247 90 cm 08/08/2008	B08-XX-0248 100 cm 08/08/2008	B08-XX-0249 110 cm 09/08/2008	B08-XX-0250 100 cm 09/08/2008	B08-XX-0251 80 cm 09/08/2008
	Arsenic (As)	mg/kg	12	0.27	10.7	13.5	7.2	12.5	NA	9.6	19.7	14.1
	Barium (Ba)	mg/kg	2,000	5	19	26	18	22	NA	21	35	33
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9	NA	<0.9	<0.9	<0.9
	Chromium (Cr)	mg/kg	87	3	35	35	23	33	NA	29	35	30
	Cobalt (Co)	mg/kg	300	1.9	17	17	12	18	NA	15	17	15
	Copper (Cu)	mg/kg	91	2.1	34	37	23	43	NA	33	41	32
	Lead (Pb)	mg/kg	600	1.2	15	16	11	17	NA	15	18	14
	Manganese (Mn)	mg/kg	---	1.1	540	510	421	516	NA	498	561	452
	Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2	NA	<2	<2	<2
	Nickel (Ni)	mg/kg	50	0.6	58	58	38	60	NA	48	60	52
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	<0.5	<0.5	NA	<0.5	0.7	<0.5
	Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5	NA	<0.5	<0.5	<0.5
	Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5	NA	<5	<5	<5
	Zinc (Zn)	mg/kg	360	2.5	92	94	56	87	NA	75	102	89
	F1 (C6-C10)	mg/kg	310	10.7	<3.7	51.9	160	3.3	4	<6.2	<3.4	432
	F2 (C10-C16)	mg/kg	760	3.9	<2	169	765	<1.4	49.6	<1.7	<1.6	1,760
	F3 (C16-C34)	mg/kg	1,700	9.0	20	17	48.4	250	124	29	23	31
	F4 (C34-C50)	mg/kg	3,300	29	15	10	22	130	47	19	13	10

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 24 (cont). S-10220 Barrel Cache metals and F1-F4 chemistry results

	PARAMETERS	SOIL			SOIL						
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-XX-0252 50 cm 09/08/2008	B08-XX-0253 80 cm 09/08/2008	B08-XX-0254 90 cm 09/08/2008	B08-XX-0255 80 cm 09/08/2008	B08-XX-0256 80 cm 09/08/2008	B08-XX-0257 90 cm 09/08/2008	B08-XX-0258 100 cm 09/08/2008
	Arsenic (As)	mg/kg	12	0.27	15.1	NA	NA	NA	8.7	NA	NA
	Barium (Ba)	mg/kg	2,000	5	33	NA	NA	NA	20	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	<0.9	NA	NA	NA	<0.9	NA	NA
	Chromium (Cr)	mg/kg	87	3	38	NA	NA	NA	31	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	18	NA	NA	NA	17	NA	NA
	Copper (Cu)	mg/kg	91	2.1	39	NA	NA	NA	29	NA	NA
	Lead (Pb)	mg/kg	600	1.2	17	NA	NA	NA	14	NA	NA
	Manganese (Mn)	mg/kg	---	1.1	558	NA	NA	NA	518	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	NA	NA	<2	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	64	NA	NA	NA	52	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	<0.5	NA	NA	NA	<0.5	NA	NA
	Silver (Ag)	mg/kg	40	0.4	<0.5	NA	NA	NA	<0.5	NA	NA
	Tin (Sn)	mg/kg	300	0.8	<5	NA	NA	NA	<5	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	106	NA	NA	NA	72	NA	NA
	F1 (C6-C10)	mg/kg	310	10.7	505	4.8	.	<3.3	<3.0	12	<3.4
	F2 (C10-C16)	mg/kg	760	3.9	1,660	<2.1	<1.6	<1.5	<1.0	238	<1.4
	F3 (C16-C34)	mg/kg	1,700	9.0	20	46	18	14	14	43.7	16
	F4 (C34-C50)	mg/kg	3,300	29	8.2	23	11	8.9	8.1	9.1	8.5

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

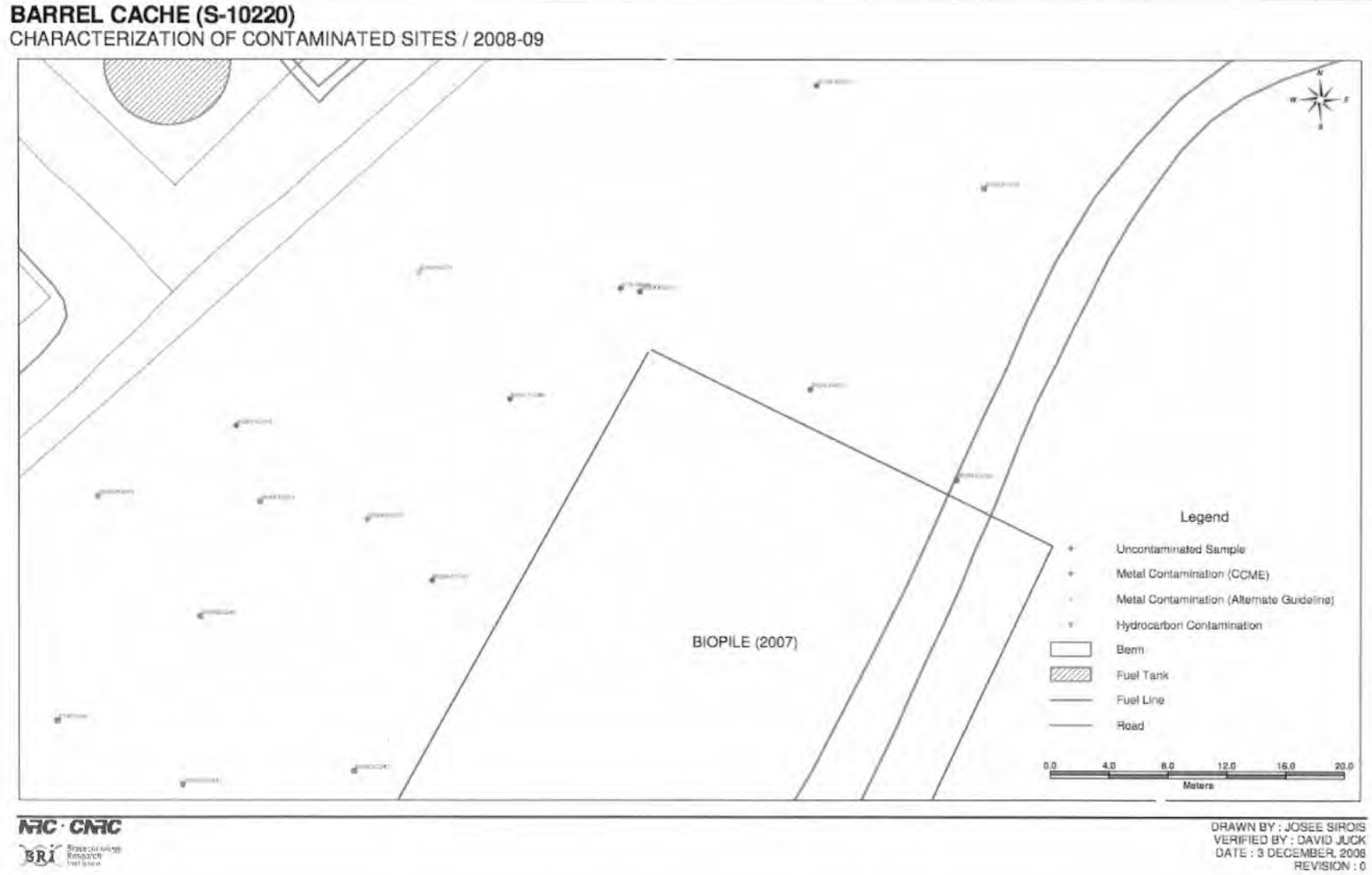

Figure 20. S-10220 Barrel Cache map

4.17 S-10522 AES WEATHER STATION REMAINS-GA

4.17.1 Location and Site Description

The AES Weather Station Remains-GA site is located in an area southeast of the CFS-Alert main station and east of the C-Span building. The Weather Station buildings were demolished in 1995 and all that remains are two concrete foundations; the first one (weather station building) is located directly east of the C-Span building and the second one (weather station storage) is 200 m east of the first one. Debris from old burn piles was found south of the Weather Station Remains site.

The area south of the Weather Station Remains is used as storage for material such as wood pallets, antenna, machinery, new wire spools, gas cylinders, construction materials, etc. Heavy road equipment is also stored at the site, near the C-Span building. During the 2007 sampling campaign, four new tanks were stored at the east end of the site.

The topography of the site is flat with a strong slope at the east end of the site heading towards Alert Inlet. The Inlet is located approximately 300 m downhill from the site. The soil in the area consists of native clay and silt, with some gravel from the fill material of the old foundation. All drainage pathways lead into a main drainage pathway located southeast of the site leading into Alert Inlet.

4.17.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

During the 2006 and 2007 sampling campaigns, a total of 20 soil samples were collected from the area east of the ESG C-Span Building around the remains of the concrete foundations.

Samples were analysed for metals, BTEX, TPH and PAHs. It should be noted that a significant amount of buried debris, including wire, metal, wood and organic matter was observed in a lot of the sampling sites.

Toluene, ethylbenzene and total xylenes were found in excess of CCME guidelines in 6, 6 and 3 samples, respectively, while naphthalene was detected above CCME guidelines in 3 samples. TPH fractions F1 ad F2 were also detected above CCME guidelines in 7 and 12 samples, respectively. Metal analysis revealed little contamination, with 1 site each possessing copper and nickel concentrations slightly above CCME guidelines (nickel was below the alternate guideline).

4.17.3 Nature and Extent of Contamination

A total of 21 subsurface soil samples (including 2 duplciates) were collected during the 2008 sampling campaign in the area south southeast of the ESG C-Span building (Figure 21). Physical constraints to sampling included material stored on site (pallets, rolls of high tension cable, other large materials) buried active high tension electrical cables and the presence of active overhead wires running along the east of the site.

All samples were analysed for TPH and 10 samples were analysed for metals (Table 25). A significant portion of the site was found to have TPH contamination; 8 samples were above CCME guideline concentrations for F1 (including 1 duplicate) (B09-WS-0220, B09-WS-0221, B09-WS-0222, B09-WS-0223, B09-WS-0224, B09-WS-0228, B09-WS-0229 (duplicate of B09-WS-0228) and B09-WS-0232). F2 was detected above CCME guideline concentrations in 9 samples (B09-WS-0220, B09-WS-0221, B09-WS-0222, B09-WS-0224, B09-WS-0226 (duplicate of B08-WS-0225 which was just below guidelines), B09-WS-0227, B09-WS-0228, B09-WS-0229 (duplicate of B09-WS-0228) and B09-WS-0232). Only 1 sample, B09-WS-0221, was above CCME guideline concentrations.

Nickel was the only metal detected above CCME guidelines in 9 samples (B09-WS-0220, B09-WS-0223, B09-WS-0230, B09-WS-0231, B09-WS-0232, B09-WS-0259, B09-WS-0261, B09-

WS-0263 and B08-WS-0264), but the measured concentration of nickel in these samples did not exceed the alternate guidelines.

The extent of TPH contamination is well defined on 3 sides, with the area to the east as delineated by the overhead wires, remaining to be completed. It is not expected that significant contamination will be found there as the overhead wires follow along the cusp of the slope leading to Alert Inlet and it is unlikely that any infrastructure was placed in this area.

NCS Score/Classification: 59.8/2
The estimated volume of contaminated soil is 4,900 m^3.

4.17.4 Recommendations

The nickel contamination detected on site is present at concentrations below alternate guidelines and as such is not of concern. The TPH contamination detected on site is located to the east southeast of the ESG C-Span building, with the northern limit being the northern end of the C-Span. Completion of delineation is required in the area north and northeast of the storage pallets. Due to the size of the site and its location, the most appropriate approach to remediation of the site once delineation is completed is an *in situ* system. *In situ* optimization studies and currently underway at other sites around CFS-Alert and the results from this work will be used to develop an appropriate bioremediation strategy for this site (see Section 5).

Table 25. S-10522 AES Weather Station Remains-GA F1-F4 and metal chemistry results

PARAMETERS	SOIL			AES Weather Station Remains-GA (S-10522) SOIL						
	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-WS-0220 50 cm 08/08/2008	B08-WS-0221 60 cm 08/08/2008	B08-WS-0222 80 cm 08/08/2008	B08-WS-0223 80 cm 08/08/2008	B08-WS-0224 90 cm 08/08/2008	B08-WS-0225 80-100 cm 08/08/2008	B08-WS-0226 80-100 cm Dup. 0225 08/08/2008
F1 (C6-C10)	mg/kg	310	10.7	1,160	1,090	1,490	472	667	49.5	68.4
F2 (C10-C16)	mg/kg	760	3.9	5,740	6,680	7,020	1,390	3,060	752	1,820
F3 (C16-C34)	mg/kg	1,700	9.0	533	1,830	449	591	453	37	46
F4 (C34-C50)	mg/kg	3,300	29	79.4	158	45	99.1	<6.0	<6.0	<8.5
Arsenic (As)	mg/kg	12	0.27	8.3	NA	NA	7.6	NA	NA	NA
Barium (Ba)	mg/kg	2,000	5	18	NA	NA	23	NA	NA	NA
Cadmium (Cd)	mg/kg	22	0.22	<0.9	NA	NA	<0.9	NA	NA	NA
Chromium (Cr)	mg/kg	87	3	34	NA	NA	33	NA	NA	NA
Cobalt (Co)	mg/kg	300	1.9	17	NA	NA	16	NA	NA	NA
Copper (Cu)	mg/kg	91	2.1	28	NA	NA	36	NA	NA	NA
Lead (Pb)	mg/kg	600	1.2	17	NA	NA	22	NA	NA	NA
Manganese (Mn)	mg/kg	---	1.1	674	NA	NA	645	NA	NA	NA
Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	NA	<2	NA	NA	NA
Nickel (Ni)	mg/kg	50	0.6	58	NA	NA	55	NA	NA	NA
Selenium (Se)	mg/kg	3.9	0.5	<0.5	NA	NA	<0.5	NA	NA	NA
Silver (Ag)	mg/kg	40	0.4	<0.5	NA	NA	<0.5	NA	NA	NA
Tin (Sn)	mg/kg	300	0.8	<5	NA	NA	<5	NA	NA	NA
Zinc (Zn)	mg/kg	360	2.5	72	NA	NA	76	NA	NA	NA

PARAMETERS	SOIL			SOIL						
	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-WS-0227 40 cm 08/08/2008	B08-WS-0228 70 cm 08/08/2008	B08-WS-0229 70 cm Dup. 0228 08/08/2008	B08-WS-0230 130 cm 08/08/2008	B08-WS-0231 130 cm 08/08/2008	B08-WS-0232 100 cm 08/08/2008	B08-WS-0259 50 cm 09/08/2008
F1 (C6-C10)	mg/kg	310	10.7	107	1,160	784	40.7	5	644	<2.9
F2 (C10-C16)	mg/kg	760	3.9	2,630	13,500	6,380	687	313	2,270	67.3
F3 (C16-C34)	mg/kg	1,700	9.0	614	1,550	884	78.4	276	441	16
F4 (C34-C50)	mg/kg	3,300	29	61.7	130	83	19	23	22	<4.1
Arsenic (As)	mg/kg	12	0.27	7.6	NA	NA	9.4	11.5	6.7	2.5
Barium (Ba)	mg/kg	2,000	5	17	NA	NA	15	20	12	9
Cadmium (Cd)	mg/kg	22	0.22	<0.9	NA	NA	<0.9	<0.9	<0.9	<0.9
Chromium (Cr)	mg/kg	87	3	28	NA	NA	30	33	29	29
Cobalt (Co)	mg/kg	300	1.9	14	NA	NA	19	15	19	14
Copper (Cu)	mg/kg	91	2.1	24	NA	NA	30	33	31	20
Lead (Pb)	mg/kg	600	1.2	15	NA	NA	16	20	17	<10
Manganese (Mn)	mg/kg	---	1.1	542	NA	NA	500	560	602	923
Molybdenum (Mo)	mg/kg	40	1.4	<2	NA	NA	<2	<2	<2	<2
Nickel (Ni)	mg/kg	50	0.6	46	NA	NA	59	56	55	55
Selenium (Se)	mg/kg	3.9	0.5	<0.5	NA	NA	<0.5	<0.5	<0.5	<0.5
Silver (Ag)	mg/kg	40	0.4	<0.5	NA	NA	<0.5	<0.5	<0.5	<0.5
Tin (Sn)	mg/kg	300	0.8	<5	NA	NA	<5	<5	<5	<5
Zinc (Zn)	mg/kg	360	2.5	61	NA	NA	68	80	63	55

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

Table 25 (cont). S-10522 AES Weather Station Remains-GA F1-F4 and metal chemistry results

	PARAMETERS	SOIL			AES Weather Station Remains-GA (S-10522) SOIL						
		UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-WS-0260 70 cm 09/08/2008	B08-WS-0261 90 cm 09/08/2008	B08-WS-0262 70 cm 09/08/2008	B08-WS-0263 80 cm 09/08/2008	B08-WS-0264 50 cm 09/08/2008	B08-WS-0265 70 cm 09/08/2008	B08-WS-0266 50 cm 09/08/2008
	F1 (C6-C10)	mg/kg	310	10.7	<2.8	<2.8	<3.0	<2.9	62.7	157	<3.3
	F2 (C10-C16)	mg/kg	760	3.9	5	2.7	6	4.9	1,430	18,500	8.5
	F3 (C16-C34)	mg/kg	1,700	9.0	13	12	31	50.6	76.5	1620	40.3
	F4 (C34-C50)	mg/kg	3,300	29	5.7	6.4	12	16	14	29	17
	Arsenic (As)	mg/kg	12	0.27	NA	7.8	NA	11.3	10.0	NA	NA
	Barium (Ba)	mg/kg	2,000	5	NA	13	NA	18	18	NA	NA
	Cadmium (Cd)	mg/kg	22	0.22	NA	<0.9	NA	<0.9	<0.9	NA	NA
	Chromium (Cr)	mg/kg	87	3	NA	30	NA	33	34	NA	NA
	Cobalt (Co)	mg/kg	300	1.9	NA	17	NA	18	17	NA	NA
	Copper (Cu)	mg/kg	91	2.1	NA	31	NA	35	43	NA	NA
	Lead (Pb)	mg/kg	600	1.2	NA	16	NA	19	25	NA	NA
	Manganese (Mn)	mg/kg	—	1.1	NA	490	NA	663	639	NA	NA
	Molybdenum (Mo)	mg/kg	40	1.4	NA	<2	NA	<2	<2	NA	NA
	Nickel (Ni)	mg/kg	50	0.6	NA	53	NA	58	60	NA	NA
	Selenium (Se)	mg/kg	3.9	0.5	NA	<0.5	NA	<0.5	<0.5	NA	NA
	Silver (Ag)	mg/kg	40	0.4	NA	<0.5	NA	<0.5	<0.5	NA	NA
	Tin (Sn)	mg/kg	300	0.8	NA	<5	NA	<5	<5	NA	NA
	Zinc (Zn)	mg/kg	360	2.5	NA	69	NA	71	71	NA	NA

NA Not analysed

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

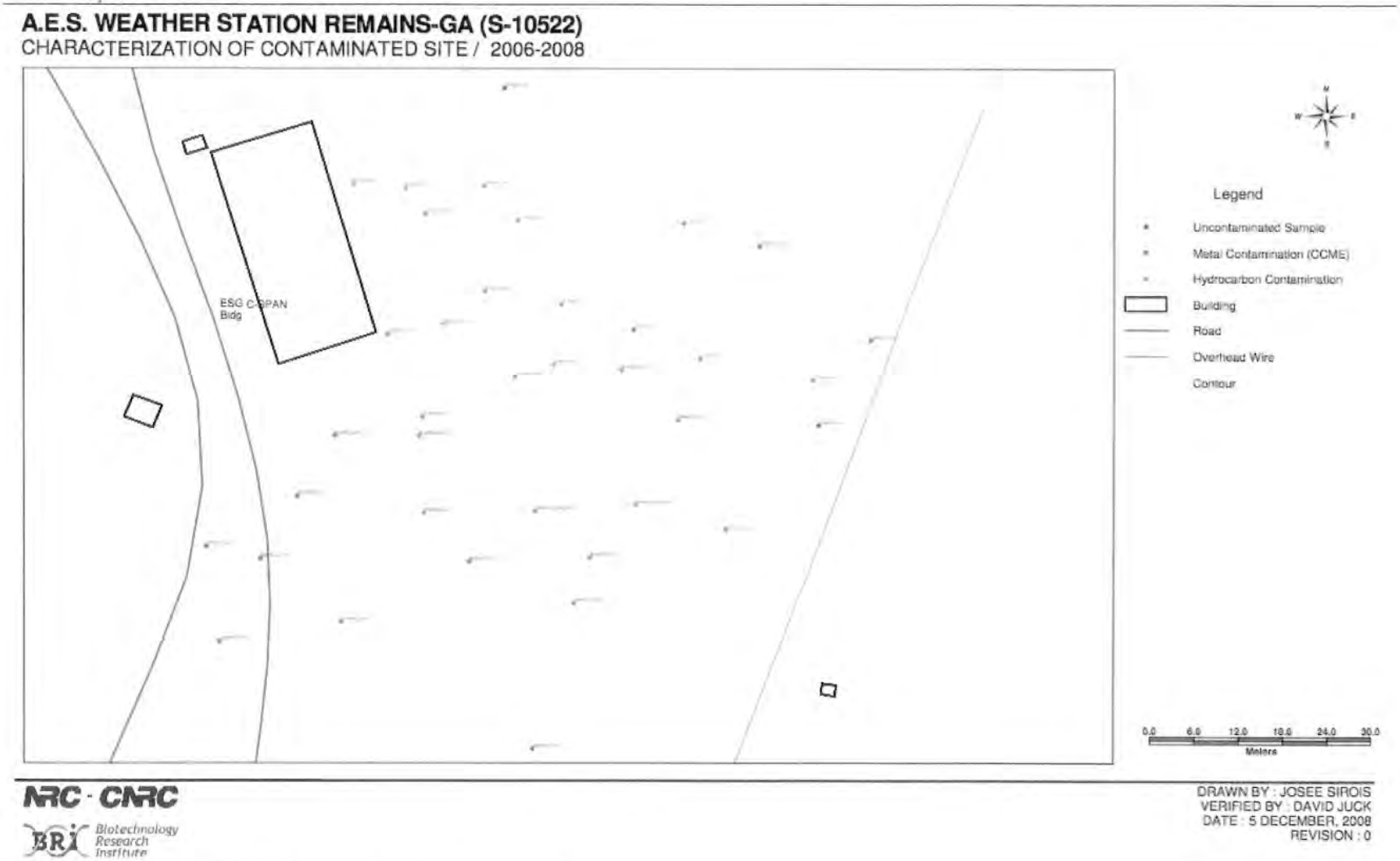

Figure 21 S-10522 AES Weather Station Remains-GA map.

4.18 S-10529 LOWER DUMBELL LAKE

4.18.1 Location and Site Description

Lower Dumbell Lake is located approximately 2 km southeast of the CFS-Alert main station, west of Upper Dumbell Lake. The part of the lake under initial investigation was located on the northwest side of the lake in a small bay. Access to the site is difficult as there is no established route after the Pumphouse Station at Upper Dumbell Lake.

Several years ago the study area were used for fishing with a hut built near the shore. Later on, the hut was demolished when the fishing spot was moved. The floor of the old hut was pushed directly into the lake and was still underwater during the 2006 and 2007 sampling campaigns. Two barrels were previously pulled out of the lake; the contents of the barrels was unknown, and there was no information on whether the barrels were full or empty when disposed of in the lake. One theory is that they contained fuel for the generator of the old hut. Debris from the old hut foundation such as old barrels, wood pallets, and other construction debris was still lying along the shoreline during the 2006 and 2007 investigations, but was removed before the 2008 sampling campaign.

The topography of the study area slopes gently towards the lake. A peak on the northwest side rises approximately 125 m above sea level and a second peak on the southwest side rises approximately 165 m above sea level. The soil in this area is dominated by sand with a few shale stones on the shoreline and shaley silt with clay in the lake.

4.18.2 Summary of Previous BRI Investigations

A summary of the site investigations performed prior to the involvement of BRI can be found in the 2006/07 report entitled "*Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut*".

Previous sampling campaigns in the area where the old fishing shack was located have identified low levels of F1-F4 in sediment samples and F3 and naphthalene in single water samples, but as these concentrations were low and no guidelines currently exist, this is not of major concern. Metals analysis has revealed the presence of only arsenic in 6 of 7 sediment samples above CCME guidelines for aquatic life. Water samples had concentrations of copper, selenium and zinc above CCME guidelines for aquatic life, but the real concern was zinc as it was 10 higher than the guidelines.

4.18.3 Nature and Extent of Contamination

During the 2008 sampling campaign, 8 surface water samples (including 1 duplicate) and 4 shallow soil samples (including 1 duplicate), were collected (Figure 22). The water samples were collected from the stream connecting Upper Dumbell to Lower Dumbell Lakes (B08-LL-0306W), the area where the fishing shack was located (B08-LL-0307W, B08-LL-0308W, B08-LL-0314W (B08-LL-0314W is a duplicate for B08-LL-0308W) and B08-LL-0309W), the western side of Lower Dumbell Lake (B08-LL-0315W), the outlet to Lower Dumbell Lake (B08-LL-0316W) and an area just to the east of the outlet to Lower Dumbell Lake (B08-LL-0317W). All soil samples were collected from the area just upgradient of the fishing shack location.

Metals analysis revealed that all surface waters except for the connecting stream between Upper and Lower Dumbell Lake had concentrations of zinc above CCME guidelines for aquatic life. The concentrations ranged from 40 µg/L to 150 µg/L (as compared to the CCME guideline of 30 µg/L). No metals were detected in the soil samples exceeding the CCME guidelines. This would indicate that the observed elevated dissolved zinc concentrations are natural to Lower Dumbell Lake and that the arsenic found in the sediments is due to its natural presence.

NCS Score/Classification: 53.2/2

The estimated volume of contaminated soil is 0 m^3.

Table 26. S-10529 Lower Dumbell Lake metals chemistry results

PARAMETERS	WATER			Lower Dumbell Lake (S-10529) FRESHWATER							
	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	B08-LL-0306W Surface 13/08/2008	B08-LL-0307W Surface 13/08/2008	B08-LL-0308W Surface 13/08/2008	B08-LL-0309W Surface 13/08/2008	B08-LL-0314W Surface Dup. 0308 13/08/2008	B08-LL-0315W Surface 13/08/2008	B08-LL-0316W Surface 13/08/2008	B08-LL-0317W Surface 13/08/2008
Arsenic (As)	ug/L	5	0.0001	<1	<1	<1	1	<1	<1	1	<1
Barium (Ba)	ug/L	---	0.001	<10	<10	<10	10	10	<10	<10	<10
Cadmium (Cd)	ug/L	0.017	0.0001	<1	<1	<1	<1	<1	<1	<1	<1
Chromium (Cr)	ug/L	---	0.0007	2	2	2	3	1	2	2	2
Cobalt (Co)	ug/L	---	0.0006	<1	<1	<1	<1	<1	<1	<1	<1
Copper (Cu)	ug/L	2-4	0.0012	2	2	2	3	2	3	2	2
Lead (Pb)	ug/L	1-7	0.0011	<1	1	<1	1	1	1	1	<1
Manganese (Mn)	ug/L	---	0.0003	<5	<5	<5	22	<5	6	<5	10
Molybdenum (Mo)	ug/L	73	0.0078	<1	<1	<1	<1	1	<1	<1	<1
Nickel (Ni)	ug/L	25-150	0.0005	<1	<1	<1	2	<1	1	<1	1
Selenium (Se)	ug/L	1	0.0006	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	ug/L	---	0.0008	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Tin (Sn)	ug/L	---	0.011	<1	<1	<1	<1	2	1	1	<1
Zinc (Zn)	ug/L	30	0.006	20	40	90	80	140	150	40	110

PARAMETERS	SOIL			SOIL			
	UNITS	INDUSTRIAL GUIDELINES (Coarse)	DETECTION LIMIT	B08-LL-0310 0-10 cm 13/08/2008	B08-LL-0311 0-10 cm 13/08/08	B08-LL-0312 0-10 cm 13/08/08	B08-LL-0313 0-10 cm Dup. 0312 13/08/08
Arsenic (As)	mg/kg	12	0.27	9.6	7.5	8.9	9.5
Barium (Ba)	mg/kg	2000	5	25	18	19	20
Cadmium (Cd)	mg/kg	22	0.22	<0.9	<0.9	<0.9	<0.9
Chromium (Cr)	mg/kg	87	3	30	22	24	26
Cobalt (Co)	mg/kg	300	1.9	16	12	14	14
Copper (Cu)	mg/kg	91	2.1	26	20	23	22
Lead (Pb)	mg/kg	600	1.2	15	12	13	13
Manganese (Mn)	mg/kg	---	1.1	792	654	719	700
Molybdenum (Mo)	mg/kg	40	1.4	<2	<2	<2	<2
Nickel (Ni)	mg/kg	50	0.6	47	36	40	40
Selenium (Se)	mg/kg	3.9	0.5	<0.5	<0.5	<0.5	<0.5
Silver (Ag)	mg/kg	40	0.4	<0.5	<0.5	<0.5	<0.5
Tin (Sn)	mg/kg	300	0.8	<5	<5	<5	<5
Zinc (Zn)	mg/kg	360	2.5	69	52	56	59

Higher than CCME criteria

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the CCME. (2006)

SOIL Following the Canadian Soil Quality Guidelines for the Protection of Human and/or Environmental Health in Industrial land uses, of the CCME. (2006)

F1-F4 Following the Technical Supplement of the Petroleum Hydrocarbons (PHCs) in soil (Industrial/Eco Soil Contact), endorsed by the CCME. (January 2001)

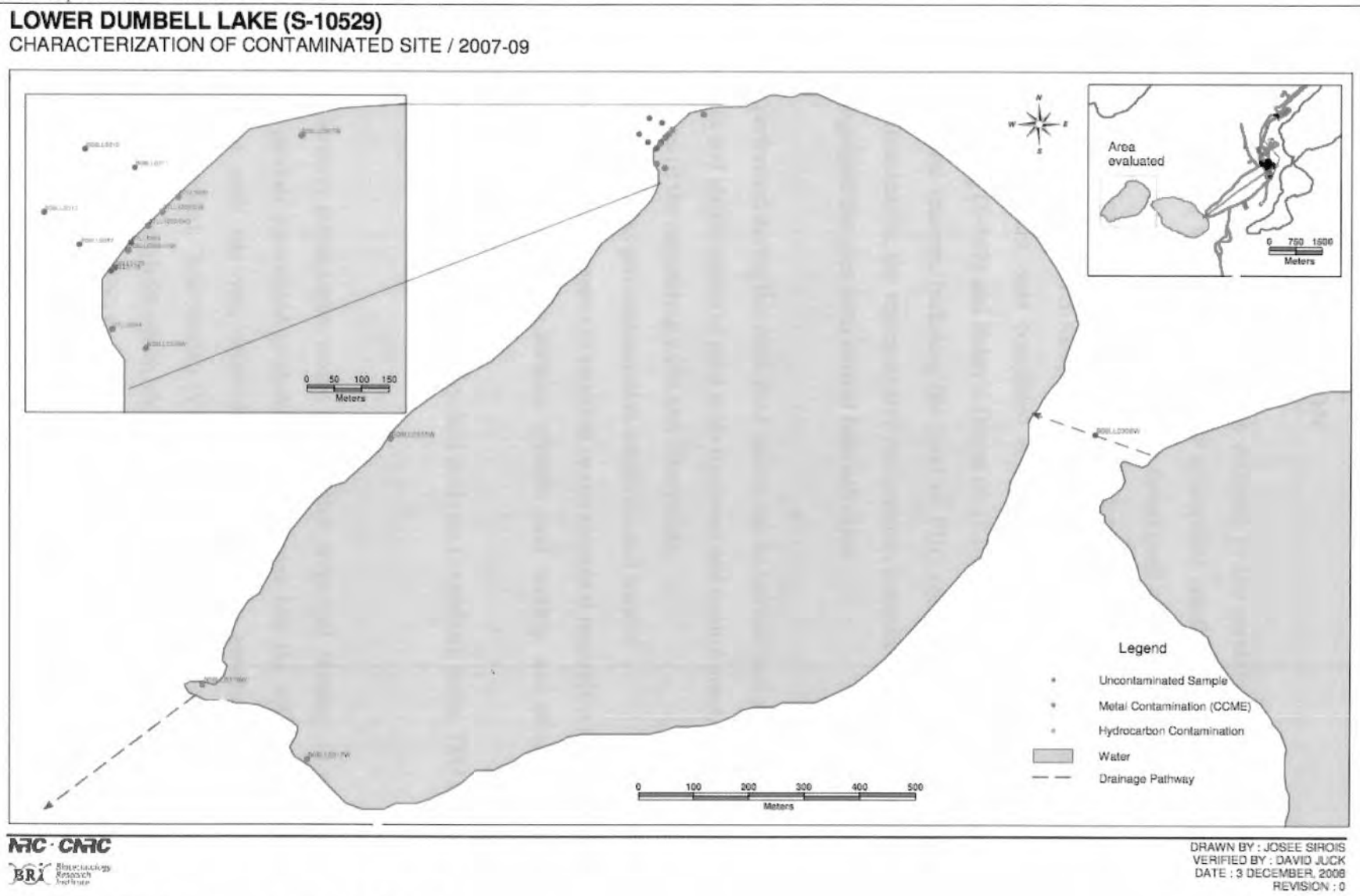

Figure 22. S-10529 Lower Dumbell Lake map.

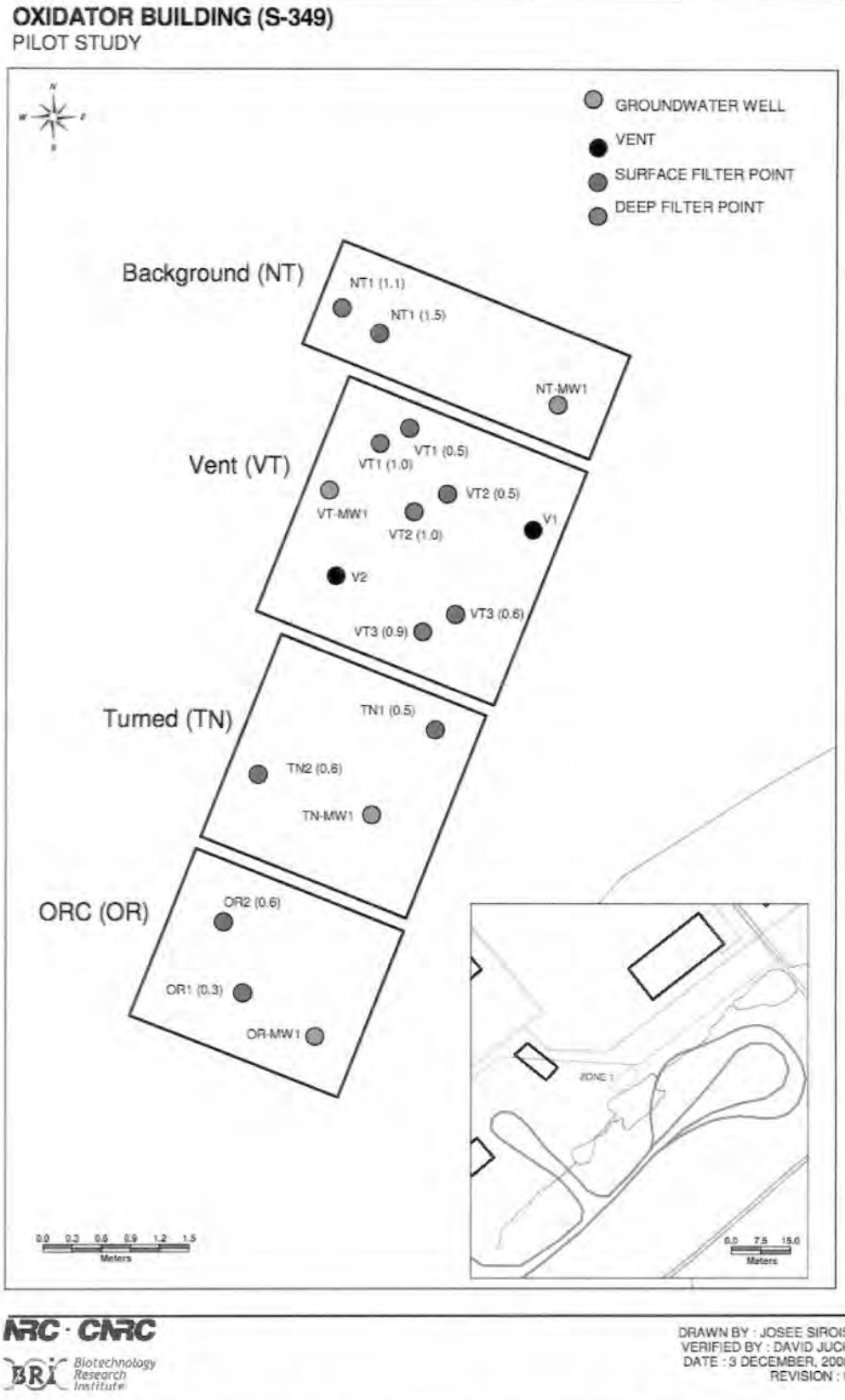

Figure 23. S-349 Oxidator Building *in situ* pilot scale system layout and location.

5.1.2 Site Work

The installation of subsurface infrastructure was accomplished as planned. This included 1 groundwater sampling well per test plot, 1, 3, 2 and 2 surface filter points (approximately 0.5 m) in the NT, VT, TN and OX plots, respectively, and a total of 4 deep filter points (approximately 1.0 m) were installed (1 in NT and 3 in VT). Two soil vents were installed to the permafrost in the VT plot and ORC was successfully applied to the OR plot.

Respirometry assays were performed using the installed filter points and it was noted that subsurface aeration was much better than expected. In fact, the oxygen concentrations measured in both the surface and deep filter points were at or near saturation (Table 27). The results presented in Table 27 are representative of all the results obtained for the Oxidator Building filter points. It was also observed that little or no CO_2 or methane was detected, indicating that the microbial activity in the subsurface was very low.

MAP was applied to the surface of the VT, TN and OR plots on August 14, 2008 at an estimated concentration of 250 mg MAP/kg soil resulting in a total application of 10 kg.

5.1.3 Chemistry Results

Soil (n=15) and groundwater (n=4) (where available) samples for chemistry were collected and analysed for metals, TPH and selected parameters (total ammoniacal nitrogen, total Kjeldahl nitrogen, pH and total phosphorous). All soil samples exceeded CCME guidelines for F1 and F2, and the 3 groundwater samples analysed for TPH had significantly elevated concentrations of F1-F3 (Tables 28 and 29). A total of 5 soil samples and 2 of 4 groundwater samples were in excess of CCME guidelines concentrations for zinc, which is expected as the previously used battery neutralization process, based on acidification with citrate, solubilized and transported significant quantities of zinc into this area. The presence of other metals in excess of CCME guidelines concentrations in the groundwater (As, Cd, Cu, Pb, Mo, Ni and Se) and in elevated concentrations (Mn has no CCME guideline for groundwater) may be due to the battery neutralization and washing process and/or the release of metal particulates related to the incineration process.

Table 27. Respirometry results for Oxidator Building *in situ* pilot scale system

AMBIENT AIR

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	5/07/08	2:45 PM	18.8	0.0	0.0
3.25	5/07/08	6:00 PM	18.2	0.0	0.0
17.5	6/07/08	8:15 AM	18.7	0.0	0.0
41.75	7/07/08	8:00 AM	18.8	0.0	0.0
114.25	10/07/08	8:30 AM	20.4	0.0	0.0

OX-TN1 (0.5 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	5/07/08	2:45 PM	17.5	0.9	0.0
3.25	5/07/08	6:00 PM	16.8	1.2	0.0
17.5	6/07/08	8:15 AM	16.9	1.2	0.0
41.75	7/07/08	8:00 AM	17.2	1.3	0.0
115.25	10/07/08	9:30 AM	18.9	2.0	0.4
149.75	11/07/08	7:00 PM	18.3	1.5	0.5
281.75	17/07/08	7:00 AM	20.6	1.0	0.9
762.75	6/08/08	8:00 AM	20.6	0.0	0.0

OX-OR1 (0.6 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	5/07/08	2:45 PM	17.6	1.0	0.0
3.25	5/07/08	6:00 PM	15.3	1.4	0.0
17.5	6/07/08	8:15 AM	16.0	1.3	0.0
41.75	7/07/08	8:00 AM	16.3	1.3	0.0
149.75	11/07/08	7:00 PM	15.9	2.1	0.5
281.75	17/07/08	7:00 AM	19.7	1.9	1.0
762.75	6/08/08	8:00 AM	20.5	0.0	0.0

OX-VT1 (0.5 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	7/07/08	8:00 AM	18.4	0.4	0.0
74.5	10/07/08	9:30 AM	19.7	1.2	0.6
109	11/07/08	7:00 PM	19.0	1.2	0.5
241	17/07/08	7:00 AM	20.2	0.9	0.9
722.00	6/08/08	8:00 AM	19.8	0.9	0.2

OX-NT1 (0.5 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	10/07/08	9:30 AM	19.5	0.9	0.5
35.5	11/07/08	7:00 PM	18.9	0.8	0.2
167.5	17/07/08	7:00 AM	20.1	0.7	0.7
648.50	6/08/08	8:00 AM	19.3	1.0	0.1

Selected parameters chemistry results

Oxidator building (S-349)										
SOIL										
OX-OR2 0 / 100 cm 7/05/2008	OX-OR3 0 / 100 cm 7/05/2008	OX-NT1 30 / 40 cm 7/05/2010	OX-NT2 30 / 40 cm 7/05/2009	OX-NT3 30 / 40 cm 7/05/2008	OX-VT1 30 / 40 cm 7/05/2008	OX-VT2 30 / 40 cm 7/05/2012	OX-VT3 30 / 40 cm 7/05/2011	OX-VT1 60 / 70 cm 7/05/2008	OX-VT2 60 / 70 cm 7/05/2008	OX-VT3 60 / 70 cm 7/05/2008
7.7	7.9	7.2	6.6	7.9	7.5	7.5	7.0	6.1	6.7	6.6
12	15	15	14	16	13	12	11	10	11	9
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
45	48	46	44	45	45	44	42	44	45	44
11	13	11	10	10	11	11	11	12	13	13
23	25	21	19	19	20	22	20	22	23	24
26,300	27,800	27,200	25,800	26,700	26,500	26,100	25,400	25,900	26,500	25,800
<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
389	356	371	388	367	373	388	399	476	420	464
<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
39	43	39	37	38	38	38	36	42	42	44
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
167	146	164	163	159	159	153	150	116	109	128
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
673	229	224	106	67	362	298	319	370	351	436
N/A	N/A	<5	N/A	N/A	<5	N/A	N/A	19	N/A	N/A
N/A	N/A	702	N/A	N/A	472	N/A	N/A	373	N/A	N/A
N/A	N/A	8.4	N/A	N/A	8.4	N/A	N/A	8.3	N/A	N/A
N/A	N/A	630	N/A	N/A	587	N/A	N/A	520	N/A	N/A
815	753	883	732	875	655	530	699	943	1,100	1,040
4,050	4,900	3,650	3,680	4,460	4,380	2,850	3,340	4,130	4,430	4,480
147	189	117	130	125	159	125	111	140	137	146
11	14	11	11	12	19	17	14	10	10	11

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Table 29. S-349 Oxidator Building *in situ* pilot scale system metals and F1-F4 chemistry results

					Oxidator Building (S-349)			
		WATER			FRESH WATER			
	PARAMETERS	UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	OX-NT-MW1 Groundwater 07/08/2008	OX-NT-MW2 Groundwater 07/08/2008	OX-TN-MW1 Groundwater 07/08/2008	OX-OR-MW1 Groundwater 07/08/2008
	F1 (C6-C10)	ug/L	---	100	4,570	NA	4,840	2,440
	F2 (C10-C16)	ug/L	---	100	85,600	NA	18,500	17,200
	F3 (C16-C34)	ug/L	---	100	7,750	NA	3,950	3,470
	F4 (C34-C50)	ug/L	---	100	130	NA	45	49
	Arsenic (As)	ug/L	5	0.0001	NA	35	6	47
	Barium (Ba)	ug/L	---	0.001	NA	110	<10	320
	Cadmium (Cd)	ug/L	0.017	0.0001	NA	2	<1	3
	Chromium (Cr)	ug/L	---	0.0007	NA	174	5	151
	Cobalt (Co)	ug/L	---	0.0006	NA	3,510	<1	2,900
	Copper (Cu)	ug/L	2-4	0.0012	NA	240	11	264
	Lead (Pb)	ug/L	1-7	0.0011	NA	4	<1	7
	Manganese (Mn)	ug/L	---	0.0003	NA	40,300	36,000	26,100
	Mercury (Hg)	ug/L	26		<0.1	<0.1	<0.1	<0.1
	Molybdenum (Mo)	ug/L	73	0.0078	NA	641	154	320
	Nickel (Ni)	ug/L	25-150	0.0005	NA	1,820	<2	2,410
	Selenium (Se)	ug/L	1	0.0006	NA	28	<11	24
	Silver (Ag)	ug/L	---	0.0008	NA	3	<0.6	3
	Tin (Sn)	ug/L	---	0.011	NA	1	<1	8
	Zinc (Zn)	ug/L	30	0.006	NA	423,000	<10	852,000

NA Not analysed

Higher than CCME criteria

High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the ccme. (2006)

5.2 S-10216 BAKER'S DOZEN

5.2.1 Location and Site Description

The Baker's Dozen site is located at the southeast end of the CFS-Alert main station, downhill from the Cat House and the Auxiliary Power Plant Building. The 'V' shaped site is approximately 6,800 m² and is located between Herc Drive and Doe Road. Thirteen POL tanks were previously located in this area. The tanks were removed and replaced by the 8 diesel fuel storage tanks located north of the CFS-Alert main station.

The petroleum hydrocarbon contamination found at the Baker's Dozen site is most likely due to spills that occurred during the active life of the site and/or during demolition of the tanks. Also, the site is located southwest and downgradient of the Oxidator and the Cold Storage Dog House buildings which are 2 areas significantly contaminated with TPH and metals.

The topography of the Baker's Dozen site slopes gently from the northeast towards the southwest. A large drainage ditch which collects water from the CFS-Alert main station enters Baker's Dozen at the northeast corner of the site. Drainage pathways cross the entire Baker's Dozen site and the drainage water exits the site in a culvert situated at the southern point of the site. The drainage water goes directly into the Runoff Collection Basin. The site is located approximately 370 m from Alert Inlet and 2,250 m from Upper Dumbell Lake. The southern part of the Baker's Dozen site is often saturated during snowmelt and the summer months. The soil is mainly composed of natural shaley silt and clay, with a few shale stones.

The *in situ* pilot scale system was established in the southern part of the site (Figure 24).

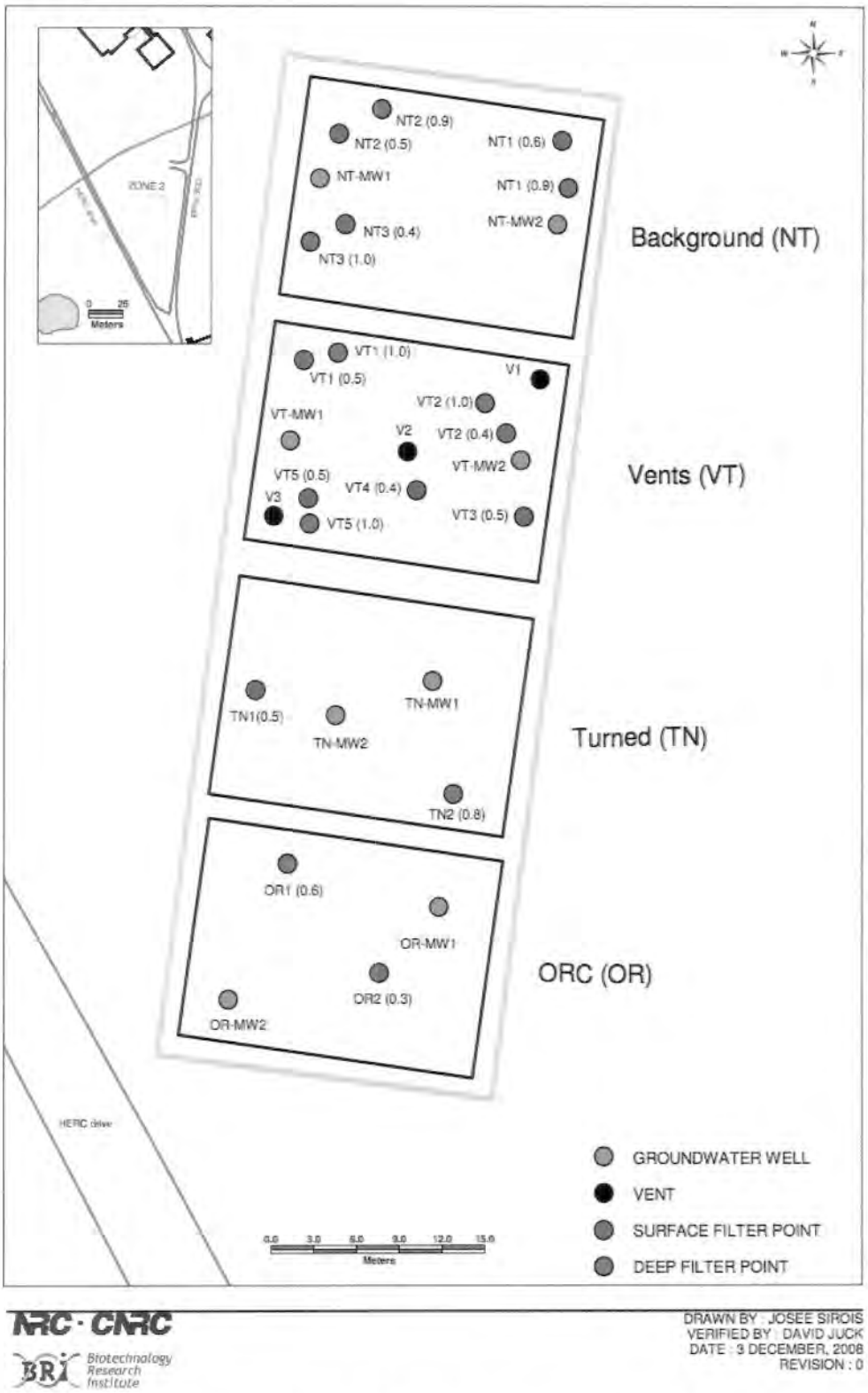

Figure 24. S-10216 Baker's Dozen *in situ* pilot scale system layout and location.

5.2.2 Site Work

The installation of subsurface infrastructure was accomplished as planned. This included 2 groundwater sampling wells per test plot, 3, 5, 1 and 2 surface filter points (approximately 0.5 m) in the NT, VT, TN and OX plots, respectively, and 3, 5, 1 and 0 deep filter points (approximately 1.0 m) in the NT, VT, TN and OX plots, respectively. Three soil vents were installed to the permafrost in the VT plot and ORC was successfully applied to the OR plot.

Respirometry assays were performed using the installed filter points and it was noted that subsurface aeration was much better than expected. In fact, the oxygen concentrations measured in both the surface and deep filter points were at or near saturation (Table 30). The results presented in Table 30 are representative of all the results obtained for the Baker's Dozen filter points. It was also observed that little or no CO_2 or methane was detected, indicating that the microbial activity in the subsurface was very low.

MAP was applied to the surface of the VT, TN and OR plots on August 14, 2008 at an estimated concentration of 250 mg MAP/kg soil resulting in a total application of 10 kg.

5.2.3 Chemistry Results

Soil (n=12) and groundwater (n=4) (where available) samples for chemistry were collected and analysed for metals, TPH and selected parameters (total ammoniacal nitrogen, total Kjeldahl nitrogen, pH and total phosphorous). All soil samples exceeded CCME guidelines for F1 and F2, and 2 soil samples in the NT plot exceeded F3 CCME guideline concentrations (Table 31). All 4 groundwater samples analysed for TPH had significantly elevated concentrations of F1-F3 (Table 32). All groundwater samples were in excess of CCME guidelines concentrations for zinc, which is not unexpected as the previously used battery neutralization process, based on acidification with citrate, solubilized and transported significant quantities of zinc into this area from the Oxidator Building site. The presence of other metals in excess of CCME guidelines concentrations in the groundwater (As, Cd, Cu, Pb, Mo, Ni and Se) and in elevated concentrations (Mn has no CCME guideline for groundwater) may be due to the battery neutralization and washing process followed by transport from the Oxidator Building site.

Table 30. Respirometry results for Baker's Dozen *in situ* pilot scale system

AMBIENT AIR

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	5/07/08	2:45 PM	18.8	0.0	0.0
3.25	5/07/08	6:00 PM	18.2	0.0	0.0
17.5	6/07/08	8:15 AM	18.7	0.0	0.0
41.75	7/07/08	8:00 AM	18.8	0.0	0.0
114.25	10/07/08	8:30 AM	20.4	0.0	0.0

BZ-NT1 (0.6 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	10/07/08	8:30 AM	20.3	0.2	0.2
586.95	3/08/08	6:00 PM	20.8	0.0	0.7
652.95	6/08/08	8:00 AM	20.7	0.0	0.0

BZ-VT1 (0.5 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	10/07/08	8:30 AM	17.7	1.1	0.0
72.95	13/07/08	8:00 AM	19.1	1.5	0.7
586.95	3/08/08	6:00 PM	20.5	0.3	0.0
652.95	6/08/08	8:00 AM	20.8	0.0	0.0

BZ-TN1 (0.5 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	10/07/08	8:30 AM	19.9	0.8	0.1
72.95	13/07/08	8:00 AM	21.0	0.6	1.0
586.95	3/08/08	6:00 PM	19.8	0.4	0.0
652.95	6/08/08	8:00 AM	20.3	0.3	0.0

BZ-OR1 (0.8 m)

CUMULATIVE TIME (H)	DATE	TIME	O2 (%)	CO2 (%)	CH4 (%)
1	10/07/08	8:30 AM	18.7	0.0	0.3
72.95	13/07/08	8:00 AM	18.6	0.3	1.0
586.95	3/08/08	6:00 PM	17.8	0.7	0.0
652.95	6/08/08	8:00 AM	17.2	0.8	0.3

Selected parameters chemistry results

Baker's Dozen (S-10216)								
SOIL								
BZ-OR1 0 / 100 cm 05/07/2008	BZ-OR2 0 / 100 cm 05/07/2008	BZ-OR3 0 / 100 cm 05/07/2008	BZ-NT1 30 / 40 cm 05/07/2008	BZ-NT2 30 / 40 cm 06/07/2008	BZ-NT3 30 / 40 cm 06/07/2008	BZ-VT1 30 / 40 cm 06/07/2008	BZ-VT2 30 / 40 cm 06/07/2008	BZ-VT3 30 / 40 cm 06/07/2008
8.9	8.4	7.9	8.1	7.5	7.7	8.1	8.1	7.8
19	17	17	14	12	12	15	15	16
<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
47	47	46	43	42	44	43	47	46
12	12	11	10	10	10	10	10	10
22	22	21	19	19	21	29	19	19
27,600	27,500	26,800	25,600	25,000	26,000	25,700	25,500	26,000
<10	<10	<10	<10	<10	<10	<10	<10	<10
362	371	358	422	397	390	388	408	379
<2	<2	<2	<2	<2	<2	<2	<2	<2
40	40	39	38	37	39	38	37	37
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
460	318	318	130	131	143	175	125	148
<5	<5	<5	<5	<5	<5	<5	<5	<5
77	80	79	61	66	63	63	76	70
<5	N/A	N/A	<5	N/A	N/A	160	N/A	N/A
595	N/A	N/A	292	N/A	N/A	372	N/A	N/A
7.8	N/A	N/A	8.7	N/A	N/A	8.5	N/A	N/A
616	N/A	N/A	547	N/A	N/A	578	N/A	N/A
742	693	925	1,150	1,190	1,260	1,100	786	771
9,710	8,130	4,940	30,600	19,900	31,200	17,700	7,860	8,580
567	378	251	4,170	541	2,850	972	333	413
38	32	25	34	34	39	25	13	19

uses, of the CCME. (2006)

the CCME. (January 2001)

Table 32. S-10216 Baker's Dozen *in situ* pilot scale system metals and F1-F4 chemistry results

	PARAMETERS	WATER			Baker's Dozen (S-10216) FRESH WATER			
		UNITS	GUIDELINES AQUATIC LIFE FRESH	DETECTION LIMIT	BZ-VT-MW1 07/08/2008	BZ-NT-MW1 07/08/2008	BZ-VT-MW2 07/08/2008	BZ-NT-MW2 07/08/2008
	F1 (C6-C10)	ug/L	—	100	2,530	5,270	5,110	4,720
	F2 (C10-C16)	ug/L	—	100	16,300	46,300	25,600	79,700
	F3 (C16-C34)	ug/L	—	100	3,870	22,100	14,400	84,200
	F4 (C34-C50)	ug/L	—	100	76	240	54	609
	Arsenic (As)	ug/L	5	0.0001	7	5	4	6
	Barium (Ba)	ug/L	—	0.001	60	20	30	30
	Cadmium (Cd)	ug/L	0.017	0.0001	1	<1	<1	<1
	Chromium (Cr)	ug/L	—	0.0007	3	10	17	2
	Cobalt (Co)	ug/L	—	0.0006	19	259	18	12
	Copper (Cu)	ug/L	2-4	0.0012	9	74	15	15
	Lead (Pb)	ug/L	1-7	0.0011	13	4	6	<1
	Manganese (Mn)	ug/L	—	0.0003	1,350	5,130	911	940
	Mercury (Hg)	ug/L	26		<0.1	<0.1	<0.1	<0.1
	Molybdenum (Mo)	ug/L	73	0.0078	97	74	3	14
	Nickel (Ni)	ug/L	25-150	0.0005	24	529	32	29
	Selenium (Se)	ug/L	1	0.0006	45	8	11	9
	Silver (Ag)	ug/L	—	0.0008	<0.6	<0.6	<0.6	<6
	Tin (Sn)	ug/L	—	0.011	<1	<1	1	1
	Zinc (Zn)	ug/L	30	0.006	18,200	3,690	8,470	8,250

Higher than CCME criteria
High concentration / No guideline

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

FRESHWATER Following the Canadian Water Quality Guidelines for the Protection of Aquatic Life in Fresh Water, of the ccme. (2006)

5.3 *IN SITU* MINERALIZATION ASSAYS

Soil samples collected in July, 2008 were subjected to mineralization assays to establish the biodegradation activity of the indigenous microbial populations before nutrient application. The NT and OR plots were used as representative and samples were collected from the active layer at depth of approximately 50 cm. Two representative hydrocarbons were used: hexadecane (straight chain alkanes) and naphthalene (aromatics) at total concentrations of 100 mg/kg and 10 mg/kg, respectively. Soil microcosms (20 g per bottle) were either unamended or amended with MAP at a concentration of 250 mg/kg and all were incubated at 4˚C. Sterile control microcosms were created by filling and sealing microcosms bottles and then autoclaving twice with a period of at least 24 hours between autoclaving. All microcosm conditions were tested in triplicate.

The microbial communities in both sites responded in a similar fashion to the mineralization of hexadecane and naphthalene (Figure 25). In general, the addition of MAP increased the rate and extent of mineralization, although there were some notable differences. Hexadecane mineralization increased with the addition of MAP in both Oxidator Buidling samples, but only the Baker's Dozen NT sample responded positively (Figure 25 A). The overall mineralization of hexadecane was low, with a maximum of approximately 15% after 119 days of incubation.

Naphthalene mineralization was much higher overall, with maxima approaching 60% after only 14 days of incubation in amended Baker's Dozen samples (Figure 25 B). Oxidator Building samples reached 55-60% in amended microcosms after 49-63 days of incubation. In the Baker's Dozen unamended OR sample, there was almost no difference in the rate or mineralization maxima, while the unamended NT sample reached a maxima of approximately 50% after 63 days. Both of the Oxidator Building unamended samples performed in a similar fashion, with relatively slow but steady naphthalene mineralization reaching a maxima of approximately 45% after 119 days of incubation.

All of these results represent pre-treatment microbial activities and will be used as the starting

point for treatment comparisons and establishing the overall effectiveness of the pilot scale bioremediation systems.

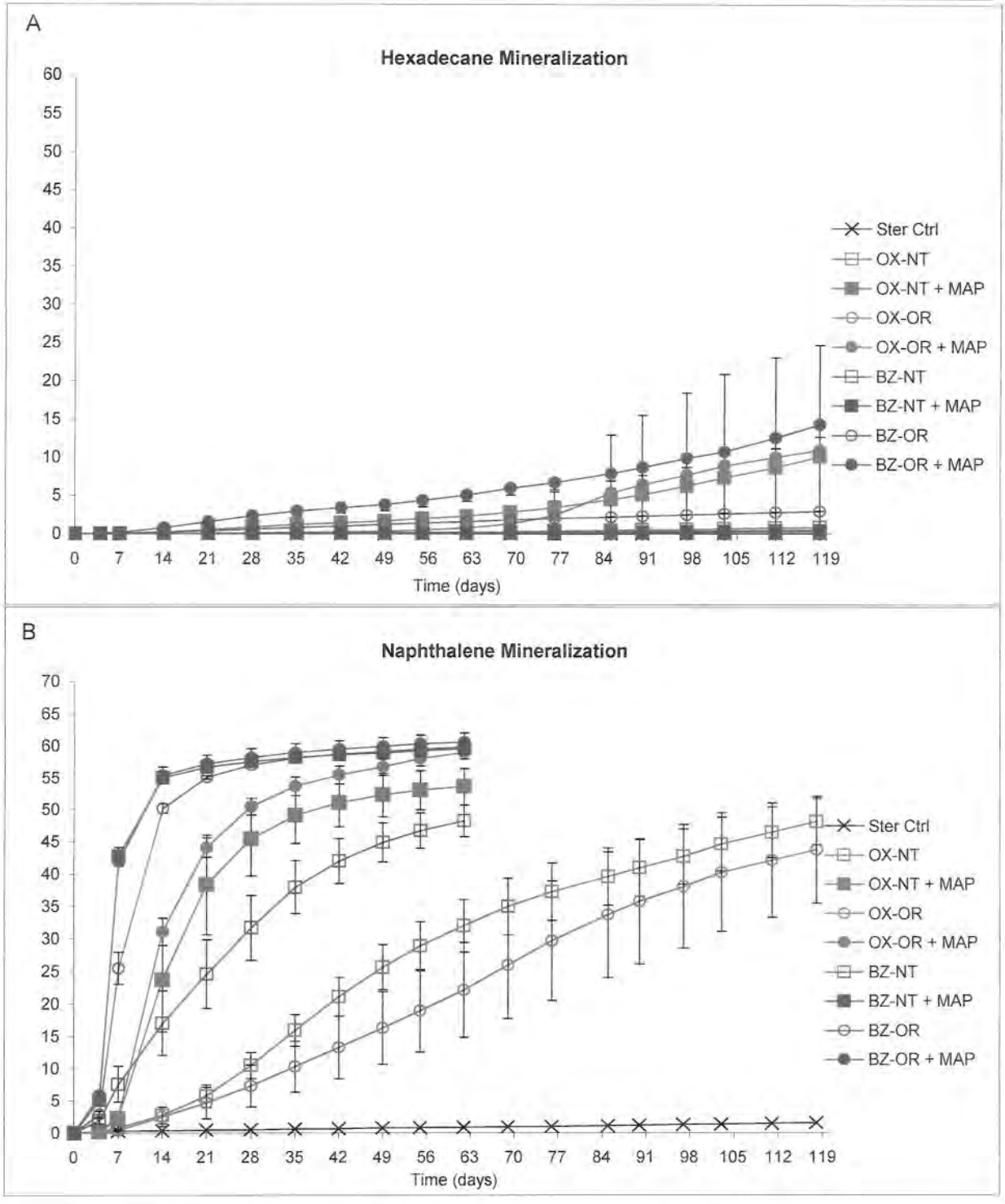

Figure 25. Mineralization assays for Oxidator Building and Baker's Dozen soils.

6 CFS-ALERT CONCLUSIONS

6.1 Site Characterization/Delineation Summary

6.1.1 Site Recommendations

All of the sites slated for characterization and delineation at CFS-Alert were visited and work performed during the 2008 field campaign. Detailed recommendations for each site are included in their respective section and a summary of all site recommendations is presented below:

Closure or Long Term Maintenance

S-146 Alert (Contaminated Sites/Underwater Survey)

S-148 Battery Dump

S-10529 Lower Dumbell Lake

Ex Situ Bioremediation

S-10196 Burn Pit

S-10206 TX Site

S-10212 Airstrip Met Shack

S-10213 Main Station POL Pallet Line

S-10218 Burner Project Site

S-10220 Barrel cache

Complete Delineation with a Goal to Remediation

S-10195 MSE-17 Vehicle Maintenance Building

S-10207 Airstrip Building HIL-124

S-10208 Airstrip Building FH-128

S-10214 Main Station Day Tank/ S-354 Alert Old Upper POL Line

S-10215 Main Station HAPS

S-10217 Building 113, Heated Vehicle Storage

S-10522 AES Weather Station Remains-GA

In Situ Bioremediation (once *in situ* parameters established)

S-10195 MSE-17 Vehicle Maintenance Building

S-10199 CE-140 MCE Building Fire Hall

S-10207 Airstrip Building HIL-124

S-10208 Airstrip Building FH-128

S-10214 Main Station Day Tank/ S-354 Aler Old Upper POL Line

S-10215 Main Station HAPS

S-10217 Heated Vehicle Storage

S-10522 AES Weather Station Remains – GA

6.1.2 NCS Classifications

There were no NCS Class 1 sites at CFS-Alert. The NCS classifications for the sites under study during the 2008 campaign are as follows:

Class 2 Sites:

- Alert Contaminated Sites/Underwater Survey (S-146)
- Vehicle Maintenance (S-10195)
- CE-140 MCE Building Fire Hall (S-10199)
- Airstrip Building HIL-124 (S-10207)
- Airstrip Building FH-128 (S-10208)
- Met Shack (S-10212)
- Main Station Day Tank (S-10214) and Old Upper POL Line (S-354)
- Heated Vehicle Storage (S-10217)
- Burner Project Site (S-10218)
- Weather Station Remains (S-10522)
- Lower Dumbell Lake (S-10529)

Class 3 Sites:

- Main Station HAPS (S-10215)
- Barrel Cache (S-10220)

Class N Sites:

- Battery Dump (S-148)
- Burn Pit (S-10196)
- TX Site (S-10206)
- Main Station POL Pallet Line (S-10213)

6.1.3 Alternate Guidelines for Arsenic and Nickel

Closure and/or proper management of several sites identified in this and previous reports are predicated on the acceptance, by appropriate regulatory agencies, of the alternate guidelines proposed for arsenic and nickel in soil at CFS-Alert. These alternate guidelines (19.2 mg/kg and 73.4 mg/kg, respectively) reflect the natural background concentrations of these metals in the area and are based on a doubling of average concentrations measured from 39 different soil samples collected in the area. The Wing Environment Office of 8 Wing Trenton is recommended to enter into communications with regulatory authorities to establish these alternate guidelines for CFS-Alert, thereby permitting the closure of several sites and clarifying the management of other sites in the area.

6.1.4 Site Work Not Performed

An original component the 2008 field campaign was the excavation and ex situ biopile bioremediation of PHC contaminated soils from 3 sites: Apron Refueling Area (S-10194), B145-Cat House (S-10200) and Curling Club/Gym Complex (S-10203). Although planning for the work was carried out, the excavation of these sites was not performed due to a lack of space in the current biopiles treatment areas. These sites will be addressed when sufficient space is created in the treatment areas.

6.1.5 Projected Work for the Next Sampling Campaign

The recommended work for the next field campaign can be divided into 2 groups: completion of site delineation and *ex situ* biopile remediation of smaller sites. The delineation work remaining to be completed would be relatively easy to perform as the areas are well identified and would not require extensive investigation. The *ex situ* biopile bioremediation of PHC contaminated sites is limited by the free space in the two large bermed and membrane lined areas. Current biopile bioremediation projects in the bermed areas are progressing and space is expected to be freed up in the upcoming years.

The sites recommended for *in situ* bioremediation should be placed on temporary hold (if delineation is complete) until results from years 2 and 3 of the current *in situ* pilot scale bioremediation studies (see Section 5 for details) are analysed and conclusions drawn. Once optimized conditions and approaches have been identified, wide scale implementation of *in situ* bioremediation is recommended.

6.2 *In Situ* Pilot Scale Bioremediation Studies

The field and laboratory work performed in 2008 represent the current contamination levels and microbial activities and are the baselines which will be used to compare the 3 aeration technologies currently installed, ie. active venting of the subsurface soil with vanes, regular mixing of the soil or the commercial oxygen releaseing compound ORC. At this point, there is no information as to which aeration approach is the most effective or even if the use of one of these methods is required at the site. Although the issue of adequate subsurface aeration appears to be less of a concern, continued monitoring will be performed as the microbial activities on site are expected to increase significantly based on the mineralization studies carried out in this project (see Section 5.3 for results).

It is recommended that during the next field season, application of the same type and

concentration of nutrient amendment be performed on areas adjacent to the study sites be performed. This will permit the determination of whether the increase in microbial activities due to nutrient amendment will prevent proper sub-surface aeration from occurring as controls of this nature (nutrient amendment but no disruption of soil structure through excavation) were implemented last year.

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7 REFERENCES

- Biotechnology Research Institute (BRI). 2005. *Bioremediation Feasibility Study for Hydrocarbon Contaminated soil at Alert, Nunavut, and Performance Monitoring of an On Site Biopile*. National Research Council Canada
- Biotechnology Research Institute (BRI). 2007. *Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut. Final Report, Volume I: CFS-Alert*. National Research Council Canada
- Biotechnology Research Institute (BRI). 2008. *Detailed Characterization and ECONET Update of Multiple Sites at CFS-Alert and CFS-Eureka, Nunavut. Final Report, Volume II: CFS-Alert*. National Research Council Canada
- Canadian Council of Resource and Environment Ministers (CCREM). 1993. *Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volume 1: Main Report.*
- Canadian Council of Ministers of the Environment (CCME). 1996. *Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada.*
- Canadian Council of Ministers of the Environment (CCME). 2006. *Canadian Environmental Quality Guidelines*.
- Environmental Services, Western Region. 2000. *Follow-Up Monitoring Report: Contaminated Site Assessment and Remediation, Eureka High Arctic Weather Station, Eureka, Nunavut.* Public Works and Government Services Canada (PWGSC)
- Environmental Sciences Group Royal Military College (ESG). 1999. *CFS-Alert, Delineation of Hydrocarbon Contaminated Soils*. Department of National Defence Canada.
- Environmental Sciences Group Royal Military College (ESG). 2000. *CFS-Alert, Environmental study of Station facilities 1999*. Department of National Defence Canada.
- Environmental Sciences Group Royal Military College (ESG). 2001. *CFS-Alert, Baseline Environmental Report, August 2000*. Department of National Defence Canada.
- Environmental Sciences Group Royal Military College (ESG). 2003. *CFS-Alert, A summary of Environmental Projects 1998-2002*. Department of National Defence Canada.
- Environment Canada. 1976. *Guidelines for Effluent Quality and Wastewater Treatment at*

Federal Establishments.

- Environment Canada. 2003. *FCSAP Contaminated Site Classification, Guidance Document, Version 1.5.*
- Environment Canada. 2004. *Canadian Climate Normals 1971-2000, Alert, Nunavut.* http://climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html
- Environment Canada. 2004. *Canadian Climate Normals 1971-2000, Eureka, Nunavut.* http://climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html
- Environment Canada. 2005. *The Inspector's Field Sampling Manual.* http://dsp-psd.pwgsc.gc.ca/Collection-R/En40-498-2005-1E.pdf
- Federal Activities Environmental Branch and Environmental Conservation Directorate. 1976. *Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments.* Environment Canada. http://www.ec.gc.ca/etad/023194F5-4BED-49AE-BEEB-384A2FD36348/1976_Guidelines_e.pdf
- Gaudet C. et al. 1994. *Review and Recommendation for a Framework for Ecological Assessment at Contaminated Sites in Canada.* Environment Canada
- Goalen, B (Environment Canada). 1998. *Detailed Environmental Site Characterization and Remediation of the Eureka High Arctic Weather Station, NWT.* Public Works and Government Services Canada (PWGSC).
- Grey, D.R. 1997. *Alert, Beyond the Inuit Lands: The Story of Canadian Forces Station Alert.* Department of National Defence Canada.
- Kouba, J. and Popelar, J. 1994. *Modern Geodetic Reference Frames for Precise Satellite Positioning and Navigation.* Natural Resources Canada.
- Ministère du Développement Durable, de l'Environnement et des Parcs du Quebec. 2004. *Centre d'expertise en analyse environnementale du Québec (CEAEQ).* http://www.ceaeq.gouv.qc.ca/
- Soulière, M, 1997. *The 1998 Nunvavut Handbook: Travelling in Canada's Arctic.* Northext Multimedia Inc.
- Whyte, L.G. Goalen, B. Hawari, J. Labbé,D. Greer, C.W. Nahir, M. 2001. *Bioremediation Treatability assessment of hydrocarbon-contaminated soils from Eureka, Nunavut.* Cold Regions Science and Technology 32, p. 121-132.

APPENDIX A

NCS Classification Summary Score Sheets

CCME National Classification System (2008/09)
Score Summary - S-146 Alert (Contaminated Sites/Underwater Survey)

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	6	---
5. Modifying Factors	4	---
Raw Total Score	26	1
Raw Total Score (Known + Potential)	27	
Adjusted Total Score (Raw Total / 40 *33)	22.3	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	12	---
3. Soil	9	---
4. Vapour	0	---
5. Sediment Movement	9	---
6. Modifying Factors	0	0
Raw Total Score	39	0
Raw Total Score (Known + Potential)	39	
Adjusted Total Score (Raw Total / 64 * 33)	20.1	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		0
iii. Ingestion		1.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	4
Raw Total Human Score (Known + Potential)	4	
Adjusted Total Human Score	4.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	4	---
Raw Total Ecological Score	16	0
Raw Total Ecological Score (Known + Potential)	16	
Adjusted Total Ecological Score	16.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	22.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	16.3	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	94%
% Responses that are "Do Not Know"	-45%
Total NCSCS Score for site	58.6
Site Classification Category	2

Site Classification Categories*:

Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-148 Battery Dump

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	2	---
Raw Total Score	18	2
Raw Total Score (Known + Potential)	20	
Adjusted Total Score (Raw Total / 40 *33)	16.5	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	---	2.7
2. Surface Water Movement	---	3.4
3. Soil	12	---
4. Vapour	0	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	12	6.1
Raw Total Score (Known + Potential)	18.1	
Adjusted Total Score (Raw Total / 64 * 33)	9.3	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	12	0
Raw Total Ecological Score (Known + Potential)	12	
Adjusted Total Ecological Score	12.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	14.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	10.3	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-33%
Total NCSCS Score for site	36.2
Site Classification Category	N

Site Classification Categories*:

Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection

CCME National Classification System (2008/09)
Score Summary S-10195 MSE-17 Vehicle Maintenance Building

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	6	---
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	5	---
Raw Total Score	25	0
Raw Total Score (Known + Potential)	25	
Adjusted Total Score (Raw Total / 40 *33)	20.6	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	12	---
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	4	0
Raw Total Score	49	0
Raw Total Score (Known + Potential)	49	
Adjusted Total Score (Raw Total / 64 * 33)	25.3	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	6
Raw Total Human Score (Known + Potential)	6	
Adjusted Total Human Score	6.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		5.5
b. Aquatic		3.5
4. Ecological Receptors Modifying Factors	2	---
Raw Total Ecological Score	2	9
Raw Total Ecological Score (Known + Potential)	11	
Adjusted Total Ecological Score	11.0	(maximum 18)
5. Other Receptors	6	0
Total Other Receptors Score (Known + Potential)	6	
Total Exposure Score (Human + Ecological + Other)	23.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	17.0	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-26%
Total NCSCS Score for site	62.9
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10196 Burn Pit

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	2	---
Raw Total Score	16	2
Raw Total Score (Known + Potential)	18	
Adjusted Total Score (Raw Total / 40 *33)	14.9	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	0	---
2. Surface Water Movement	---	5.9
3. Soil	12	---
4. Vapour	0	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	12	5.9
Raw Total Score (Known + Potential)	17.9	
Adjusted Total Score (Raw Total / 64 * 33)	9.2	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		5.5
b. Aquatic		3.5
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	9
Raw Total Ecological Score (Known + Potential)	9	
Adjusted Total Ecological Score	9.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	11.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	8.1	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-28%
Total NCSCS Score for site	32.2
Site Classification Category	N

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10199 CE-140 MCE Building Fire Hall

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	6	---
Raw Total Score	22	1
Raw Total Score (Known + Potential)	23	
Adjusted Total Score (Raw Total / 40 *33)	19.0	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	8	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	---	2
Raw Total Score	38	2
Raw Total Score (Known + Potential)	40	
Adjusted Total Score (Raw Total / 64 * 33)	20.6	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	6
Raw Total Human Score (Known + Potential)	6	
Adjusted Total Human Score	6.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		5.5
b. Aquatic		4
4. Ecological Receptors Modifying Factors	2	---
Raw Total Ecological Score	2	9.5
Raw Total Ecological Score (Known + Potential)	11.5	
Adjusted Total Ecological Score	11.5	(maximum 18)
5. Other Receptors	4	0
Total Other Receptors Score (Known + Potential)	4	
Total Exposure Score (Human + Ecological + Other)	21.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	15.9	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	81%
% Responses that are "Do Not Know"	-24%
Total NCSCS Score for site	55.5
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10206 TX Site

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	3
2. Chemical Hazard	4	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	2	---
Raw Total Score	12	3
Raw Total Score (Known + Potential)	15	
Adjusted Total Score (Raw Total / 40 *33)	12.4	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	0	---
3. Soil	12	---
4. Vapour	0	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	21	0
Raw Total Score (Known + Potential)	21	
Adjusted Total Score (Raw Total / 64 * 33)	10.8	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		4.5
b. Aquatic		2.5
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	7
Raw Total Ecological Score (Known + Potential)	7	
Adjusted Total Ecological Score	7.0	(maximum 18)
5. Other Receptors	6	0
Total Other Receptors Score (Known + Potential)	6	
Total Exposure Score (Human + Ecological + Other)	13.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	9.6	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	94%
% Responses that are "Do Not Know"	-36%
Total NCSCS Score for site	32.8
Site Classification Category	N

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10207 Airstrip Building HIL-124 "The Hilton"

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	4	---
Raw Total Score	22	2
Raw Total Score (Known + Potential)	24	
Adjusted Total Score (Raw Total / 40 *33)	19.8	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	42	0
Raw Total Score (Known + Potential)	42	
Adjusted Total Score (Raw Total / 64 * 33)	21.7	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		1
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	5
Raw Total Human Score (Known + Potential)	5	
Adjusted Total Human Score	5.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		5.5
b. Aquatic		4
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	9.5
Raw Total Ecological Score (Known + Potential)	9.5	
Adjusted Total Ecological Score	9.5	(maximum 18)
5. Other Receptors	6	0
Total Other Receptors Score (Known + Potential)	6	
Total Exposure Score (Human + Ecological + Other)	20.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	15.2	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-24%
Total NCSCS Score for site	56.6
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)
Score Summary S-10208 Airstrip Building FH-128

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	3
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	6	---
Raw Total Score	22	3
Raw Total Score (Known + Potential)	25	
Adjusted Total Score (Raw Total / 40 *33)	20.6	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	8	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	38	0
Raw Total Score (Known + Potential)	38	
Adjusted Total Score (Raw Total / 64 * 33)	19.6	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		6.5
b. Aquatic		4
4. Ecological Receptors Modifying Factors	2	---
Raw Total Ecological Score	2	10.5
Raw Total Ecological Score (Known + Potential)	12.5	
Adjusted Total Ecological Score	12.5	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	14.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	10.7	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	94%
% Responses that are "Do Not Know"	-38%
Total NCSCS Score for site	50.9
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)/09
Score Summary S-10212 Airstrip Met Shack

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	4	---
Raw Total Score	22	2
Raw Total Score (Known + Potential)	24	
Adjusted Total Score (Raw Total / 40 *33)	19.8	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	0	---
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	33	0
Raw Total Score (Known + Potential)	33	
Adjusted Total Score (Raw Total / 64 * 33)	17.0	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		1
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		3
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	7
Raw Total Human Score (Known + Potential)	7	
Adjusted Total Human Score	7.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		6.5
b. Aquatic		4
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	10.5
Raw Total Ecological Score (Known + Potential)	10.5	
Adjusted Total Ecological Score	10.5	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	19.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	14.4	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-24%
Total NCSCS Score for site	51.2
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10213 Main Station POL Pallet Line

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	2
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	2	---
Raw Total Score	16	2
Raw Total Score (Known + Potential)	18	
Adjusted Total Score (Raw Total / 40 *33)	14.9	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	---	4.2
2. Surface Water Movement	---	7.4
3. Soil	12	---
4. Vapour	0	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	12	11.6
Raw Total Score (Known + Potential)	23.6	
Adjusted Total Score (Raw Total / 64 * 33)	12.2	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		6.5
b. Aquatic		2.5
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	9
Raw Total Ecological Score (Known + Potential)	9	
Adjusted Total Ecological Score	9.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	11.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	8.1	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	81%
% Responses that are "Do Not Know"	-17%
Total NCSCS Score for site	35.1
Site Classification Category	N

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10214 Main Station Day Tank Area

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	6	---
5. Modifying Factors	6	---
Raw Total Score	28	1
Raw Total Score (Known + Potential)	29	
Adjusted Total Score (Raw Total / 40 *33)	23.9	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	12	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	42	0
Raw Total Score (Known + Potential)	42	
Adjusted Total Score (Raw Total / 64 * 33)	21.7	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	6
Raw Total Human Score (Known + Potential)	6	
Adjusted Total Human Score	6.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		5.5
b. Aquatic		3.5
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	9
Raw Total Ecological Score (Known + Potential)	9	
Adjusted Total Ecological Score	9.0	(maximum 18)
5. Other Receptors	4	0
Total Other Receptors Score (Known + Potential)	4	
Total Exposure Score (Human + Ecological + Other)	19.0	
Adjusted Total Exposure Score (Total Exposure / 45 * 34)	14.0	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-26%
Total NCSCS Score for site	59.6
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008/09)
Score Summary S-10215 Main Station HAPS

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	6	---
Raw Total Score	20	1
Raw Total Score (Known + Potential)	21	
Adjusted Total Score (Raw Total / 40 *33)	17.3	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	---	7.4
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	---	2
Raw Total Score	30	9.4
Raw Total Score (Known + Potential)	39.4	
Adjusted Total Score (Raw Total / 64 * 33)	20.3	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		1
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	5
Raw Total Human Score (Known + Potential)	5	
Adjusted Total Human Score	5.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		3.5
b. Aquatic		4
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	7.5
Raw Total Ecological Score (Known + Potential)	7.5	
Adjusted Total Ecological Score	7.5	(maximum 18)
5. Other Receptors	4	0
Total Other Receptors Score (Known + Potential)	4	
Total Exposure Score (Human + Ecological + Other)	16.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	12.2	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	75%
% Responses that are "Do Not Know"	-16%
Total NCSCS Score for site	49.8
Site Classification Category	3

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection

CCME National Classification System (2008)
Score Summary S-10217 Building 113, Heated Vehicle Storage

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	2	---
5. Modifying Factors	7	---
Raw Total Score	25	1
Raw Total Score (Known + Potential)	26	
Adjusted Total Score (Raw Total / 40 *33)	21.5	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	12	---
2. Surface Water Movement	8	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	41	0
Raw Total Score (Known + Potential)	41	
Adjusted Total Score (Raw Total / 64 * 33)	21.1	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		1
iii. Ingestion		2.5
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	6
Raw Total Human Score (Known + Potential)	6	
Adjusted Total Human Score	6.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		6.5
b. Aquatic		3
4. Ecological Receptors Modifying Factors	2	---
Raw Total Ecological Score	2	9.5
Raw Total Ecological Score (Known + Potential)	11.5	
Adjusted Total Ecological Score	11.5	(maximum 18)
5. Other Receptors	4	0
Total Other Receptors Score (Known + Potential)	4	
Total Exposure Score (Human + Ecological + Other)	21.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	15.9	(max 34)

Site Score

Test Site	
Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-26%
Total NCSCS Score for site	58.5
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)
Score Summary S-10218 Burner Project (Old Hazmat Storage Site)

Scores from individual worksheets are tallied in this worksheet
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	6	---
5. Modifying Factors	4	---
Raw Total Score	26	1
Raw Total Score (Known + Potential)	27	
Adjusted Total Score (Raw Total / 40 *33)	22.3	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	12	---
2. Surface Water Movement	8	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	41	0
Raw Total Score (Known + Potential)	41	
Adjusted Total Score (Raw Total / 64 * 33)	21.1	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	---	
B. Potential		
a. Terrestrial		7.5
b. Aquatic		3
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	0	10.5
Raw Total Ecological Score (Known + Potential)	10.5	
Adjusted Total Ecological Score	10.5	(maximum 18)
5. Other Receptors	4	0
Total Other Receptors Score (Known + Potential)	4	
Total Exposure Score (Human + Ecological + Other)	14.5	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	10.7	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	94%
% Responses that are "Do Not Know"	-41%
Total NCSCS Score for site	54.1
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)
Score Summary S-10220 Barrel Cache

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	3
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	---	4
5. Modifying Factors	4	---
Raw Total Score	16	7
Raw Total Score (Known + Potential)	23	
Adjusted Total Score (Raw Total / 40 *33)	19.0	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	---	9.9
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	30	9.9
Raw Total Score (Known + Potential)	39.9	
Adjusted Total Score (Raw Total / 64 * 33)	20.6	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	12	0
Raw Total Ecological Score (Known + Potential)	12	
Adjusted Total Ecological Score	12.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	14.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	10.3	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	88%
% Responses that are "Do Not Know"	-43%
Total NCSCS Score for site	49.9
Site Classification Category	3

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)
Score Summary S-10522 AES Weather Station Remians-GA

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	2	3
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	4	---
4. Contaminant Quantity	6	---
5. Modifying Factors	7	---
Raw Total Score	27	3
Raw Total Score (Known + Potential)	30	
Adjusted Total Score (Raw Total / 40 *33)	24.8	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	9	---
2. Surface Water Movement	8	---
3. Soil	12	---
4. Vapour	9	---
5. Sediment Movement	0	---
6. Modifying Factors	0	0
Raw Total Score	38	0
Raw Total Score (Known + Potential)	38	
Adjusted Total Score (Raw Total / 64 * 33)	19.6	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	0	
B. Potential		
a. Land Use		---
b. Accessibility		---
c. Exposure Route		
i. Direct Contact		---
ii. Inhalation		---
iii. Ingestion		---
2. Human Receptors Modifying Factors	0	---
Raw Total Human Score	0	0
Raw Total Human Score (Known + Potential)	0	
Adjusted Total Human Score	0.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	0	---
Raw Total Ecological Score	12	0
Raw Total Ecological Score (Known + Potential)	12	
Adjusted Total Ecological Score	12.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	14.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	10.3	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	100%
% Responses that are "Do Not Know"	-53%
Total NCSCS Score for site	54.7
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008)
Score Summary S-10529 Lower Dumbell Lake

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics	Known	Potential
1. Residency Media	4	1
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	2	---
4. Contaminant Quantity	2	---
5. Modifying Factors	2	---
Raw Total Score	18	1
Raw Total Score (Known + Potential)	19	
Adjusted Total Score (Raw Total / 40 *33)	15.7	(max 33)

II. Migration Potential	Known	Potential
1. Groundwater Movement	0	---
2. Surface Water Movement	12	---
3. Soil	0	---
4. Vapour	0	---
5. Sediment Movement	12	---
6. Modifying Factors	0	0
Raw Total Score	24	0
Raw Total Score (Known + Potential)	24	
Adjusted Total Score (Raw Total / 64 * 33)	12.4	(max 33)

III. Exposure	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		0.5
b. Accessibility		2
c. Exposure Route		
i. Direct Contact		3
ii. Inhalation		3
iii. Ingestion		3.5
2. Human Receptors Modifying Factors	6	---
Raw Total Human Score	6	12
Raw Total Human Score (Known + Potential)	18	
Adjusted Total Human Score	18.0	(maximum 22)
3. Ecological Receptors		
A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	2	---
Raw Total Ecological Score	14	0
Raw Total Ecological Score (Known + Potential)	14	
Adjusted Total Ecological Score	14.0	(maximum 18)
5. Other Receptors	2	0
Total Other Receptors Score (Known + Potential)	2	
Total Exposure Score (Human + Ecological + Other)	34.0	
Adjusted Total Exposure Score (Total Exposure / 46 * 34)	25.1	(max 34)

Site Score

Test Site

Site Letter Grade	C
Certainty Percentage	94%
% Responses that are "Do Not Know"	-45%
Total NCSCS Score for site	53.2
Site Classification Category	2

Site Classification Categories*:
Class 1 - High Priority for Action (Total NCS Score >70)
Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
Class N - Not a Priority for Action (Total NCS Score <37)
Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

APPENDIX B

Certificates of Analysis for 2008 Field Work