Remedial Action Plan
Eureka High Arctic Weather Station

FY12/13

FINAL

FCSI 2747 – Eureka High Arctic Weather Station
DFRP: #07573
ARMS: #00546

Prepared for:

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List of Abbreviations

AANDC	Aboriginal Affairs and Northern Development Canada
AEC	Area of Environmental Concern
ASTRO	Arctic Stratospheric Observatory
BTEX	Benzene, Toluene, Ethylbenzene, Total Xylenes
BTL	Background Threshold Level
CCME	Canadian Council of Ministers on the Environment
COC	Contaminant of Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DND	Department of National Defence
DQRA	Detailed Quantitative Risk Assessment
EC	Environment Canada
FCSAP	Federal Contaminated Sites Action Plan
FRANZ	Franz Environmental Inc.
GSC	Geological Survey of Canada
ha	Hectares
HAWS	High Arctic Weather Station
HHRA	Human Health Risk Assessment
LTM	Long Term Monitoring
MSC	Meteorological Services of Canada
NIRB	Nunavut Impact Review Board
NRCan	Natural Resources Canada
NRI	Nunavut Research Institute
PAH	Polycyclic Aromatic Hydrocarbon
PCSP	Polar Continental Shelf Project
PEARL	Polar Environment Atmospheric Research Laboratory
PHC	Petroleum Hydrocarbon
PWGSC	Public Works and Government Services Canada
QA/QC	Quality Assurance and Quality Control
RAP	Remedial Action Plan
RPD	Relative Percent Difference
ROA	Remedial Options Analysis
SARA	Species at Risk Act
SENES	SENES Consultants Ltd.
SSTL	Site Specific Target Level
US EPA	Unites States Environmental Protection Agency

1.0 INTRODUCTION

SENES Consultants Ltd. (SENES), in association with Franz Environmental Inc. (FRANZ), was retained by Public Works and Government Services Canada (PWGSC) on behalf of Environment Canada (EC) to prepare a Remedial Action Plan (RAP) at the Eureka High Arctic Weather Station (HAWS).

This project was completed under PWGSC Northern Supply Arrangement Agreement Number EW699-100053/002/NCS, Call-up number EW699-123266/001/NCS, and Amendments # 1 and # 2. This report describes the RAP completed for the Eureka HAWS and was prepared in accordance with the *Terms of Reference Remedial Planning and Remedial Action Plan Eureka High Arctic Weather Station FY11/12 and 12/13* dated March 2012, and the SENES/FRANZ work plan dated June 14, 2012.

Throughout this report the Eureka High Arctic Weather Station (HAWS), will be referred to as the site.

The project has been conducted in four stages, the first of which included a supplemental investigation at the Eureka HAWS to address the identified data gaps. The results of the supplemental investigation were reported separately.

The second stage included the evaluation of feasibility of different remedial options in support of the development of a RAP. The feasibility study incorporated considerations such as practicality, safety, cost, and site-specific logistics for each of the different options for the remediation at Eureka HAWS.

The third stage consisted of the development of a substantive cost estimate, work breakdown structure, and Gantt chart for the preferred remedial strategy chosen by PWGSC and EC. The cost estimate included all assumptions made, items of work, quantities, unit prices, complete list of all exclusions and reasoning for the exclusions.

The final stage was the preparation of the RAP based on the remediation strategy chosen by EC. This report covers the third and fourth stage of the project. Based on conversations with PWGSC and EC, the area near the landing strip (AEC A) will not be included in this RAP. A separate report titled *Long-Term Monitoring Plan AEC A, Eureka High Arctic Weather Station* by SENES/Franz (2013) outlines the risk management strategy for AEC A.

1.1 Study Area

Eureka HAWS is located on the north side of Slidre Fiord, at the northwestern tip of Fosheim Peninsula, Ellesmere Island, Nunavut (see Figure 1; Appendix A). The Eureka HAWS coordinates are 79°59'41"N and 85°48'48"W (according to a sign located at the corner of the living quarters). The site is accessed primarily by air, with an all-season airstrip located

approximately 1.5 km northeast of the main operations facility and living quarters. Eureka HAWS is situated on a hillside sloping down from the airstrip, levelling out where most facilities are located, before sloping into the ocean. Down the slope south of the Eureka HAWS Main Complex is a flat section of land known as the Delta area. This area is used as an access point by the Canadian Coast Guard for the delivery of supplies via sea-lift. The Fiord is ice covered for most of the year (i.e., from September through June).

1.2 Project Objectives

The objectives of the project include the preparation of a RAP for the main area of the Eureka HAWS. EC has identified that risk management though long-term monitoring (LTM) is the preferred remedial option until such a time comes when the fresh water lagoon recapitalization project will result in changes to on-site infrastructure. The proposed project may impact the assumptions and evaluation of the various remedial options outlined in the SENES/FRANZ 2013 Remediation Planning and Remedial Action Plan – Feasibility Study. It was recommended once the final plans for the fresh water lagoon recapitalization have been approved; the remedial options analysis will be updated. Other projects that may have impacted the assumptions and evaluations of the remedial options include updates to the sewage lagoon and the demolition of old station buildings.

1.3 Scope

The scope of the project included the development of:

1. A plan for risk management through LTM;
2. A substantive cost estimate for the proposed LTM plan;
3. A work break down structure; and
4. A Gantt chart.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Identification

Table 2-1 provides a summary of the site identification information.

Table 2-1: Site Identification

FCSI No. of Contaminated Site	2747
DFRP Number	07573
Exact Site Name as listed in IDEA	Eureka High Arctic Weather Station
Site Address	Eureka High Arctic Weather Station, Ellesmere Island Nunavut
Reporting Organization	Environment Canada
Legal Description	Land Reserve 1021
Approximate Site Area	4,744 ha
Centre of Site Coordinates	79°59'41"N and 85°48'48"W

2.2 Previous Report

Table 2-2 identified the previous reports reviewed by SENES/FRANZ prior to the preparation of the RAP report.

Table 2-2: Previous Reports

Date	Author	Title
1995	PWGSC	Detailed Site Characterization and Monitoring at the Abandoned Landfill, Eureka NWT
1998	PWGSC	Detailed Site Characterization and Remediation of the Eureka High Arctic Weather Station, NWT
2000	PWGSC	Follow-up Monitoring Report, Contaminated Site Assessment & Remediation of the Eureka High Arctic Weather Station, Eureka, Nunavut
2000	EBA Engineering Consultants Limited	In Situ Remediation of Eureka High Arctic Weather Station, Eureka, Nunavut
2003	PWGSC	Eureka Surveillance Network Program
2003	PWGSC	In-situ Bioremediation Treatment at the Eureka High Arctic Weather Station
2005	Jacques Whitford Limited	Environmental Status Report: Eureka High Arctic Weather Station, Nunavut
2005	National Research Council Biotechnology Research Institute	Eureka Project – Bioremediation Treatment of Hydrocarbon Contaminated Soils From Eureka Nunavut (Phase 4)
2006	EC Environmental Affairs Division	Inventory and Evaluation High Arctic Weather Station

Date	Author	Title
2006	National Research Council Biotechnology Research Institute	Eureka Project – Bioremediation Treatment of Hydrocarbon Contaminated Soils From Eureka Nunavut (Phase 5)
2007	National Research Council Biotechnology Research Institute	Characterization of Contaminated Sites at CFS-Alert and CFS-Eureka, Nunavut
2007	Nunami Jacques Whitford Limited	Eureka High Arctic Weather Station Biotreatment Cell Phase II Environmental Site Assessment Eureka, Nunavut
2007	PWGSC	Phase I Environmental Site Assessment Eureka High Arctic Weather Station Eureka Nunavut
2008	EBA Engineering Consultants Limited	Eureka High Arctic Weather Station Geophysical Investigation Eureka, NU
2009	Franz Environmental Inc.	Phase III Environmental Site Assessment, Eureka High Arctic Weather Station, Nunavut Canada
2010	Columbia Environmental Consulting Ltd and Franz Environmental Inc.	Phase III Environmental Site Assessment Eureka High Arctic Weather Station Nunavut Canada Final Report
2011	SENES Consultants Ltd. and Franz Environmental Inc.	Detailed Quantitative Risk Assessment (DQRA), 2010 Monitoring Activities and Remedial Options Analysis
2011	WorleyParsons Canada Ltd	Eureka Civil Consulting Services Project No.: R.015446.01. 2011
2013	SENES Consultants Ltd. and Franz Environmental Inc.	2012 Supplemental Investigation, Eureka High Arctic Weather Station, Nunavut
2013	SENES Consultants Ltd. and Franz Environmental Inc.	Remediation Planning and Remedial Action Plan – Feasibility Study, Eureka High Arctic Weather Station FY12/13

2.3 Background

The Eureka HAWS occupies a Federal Department of Aboriginal Affairs and Northern Development Canada's land reserve #1021, of an original area 2.23 ha (PWGSC, 2007). The permit was initially established in 1955 and was expanded to its current size of approximately 4,744 ha in 1972. It is assumed that Station Creek forms most of the western boundary and extends to the water line at the present beach loading location. The reserve extends northeast to encompass the existing airstrip several kilometres north. The facility is owned and operated by EC and the Meteorological Services of Canada (MSC) and has been in operation since April 7th, 1947. The facility consists of one runway, the experimental Arctic Stratospheric Observatory (ASTRO) laboratory, the main compound, and a Department of National Defence (DND) summer camp.

The new operation facility and living quarters was constructed by PWGSC and Ledcor Industries, and was first occupied in 2005. The facility is an 18,000 sq. ft., two-storey modified pre-engineered building, built on wood pile foundations into the permafrost and has an exterior envelope of a pre-finished Aluma Shield insulated panel system. The building consists of a main floor, which contains a cafeteria, laundry room, recreational amenities, and all the weather

station offices. The second floor houses the living quarters for Eureka staff and visitors. There are no basements or crawl spaces.

The original Powerhouse is still in use to supply heat and electricity to the compound. A heat exchange and recovery system provides heat throughout the station. An equipment maintenance warehouse and water storage areas are attached to the Powerhouse.

The Eureka HAWS is fuelled by a new tank farm constructed in 1992, located immediately north of the main facilities. The capacity of the storage system is approximately 1.31 million L. Three fuel tanks are in service, each with a 90,000 L capacity. This replaced a 14 tank in-line system segregated into two farms, one farm placed north of the area comprising of 8 tanks and one farm placed south comprising of 6 tanks. The original tank farm was located immediately northwest of the main facilities. The three fuel bladders were also in service at the time of the original tank farm.

Historically, fuel had been stored by the Geological Survey of Canada (GSC) at the west end of Station Creek and west of the main operation facilities. This is no longer in service and the fuel system has been removed. Remnants left at the study area include sections of the berm used for secondary containment. Barrels of product used to support both the EC and DND facilities and operations are stored immediately east of the main operation facilities.

2.4 Study Area Ownership and Occupiers

It is SENES/FRANZ's understanding that with the exception of the DND warehouse, located north of the living quarters and Fort Eureka, all buildings are owned and operated by EC. The DND warehouse and Fort Eureka are owned and operated by DND. A 20 km road to the north connects the area with an experimental facility, the former ASTRO Laboratory, now known as the PEARL Facility (Polar Environment Atmospheric Research Laboratory). The PEARL facility is not part of the same land reserve as Eureka HAWS, it is located on reserve number 49G/15-2. The area on the western side of Station Creek is not part of the EC lease.

2.5 Existing Buildings and Infrastructure

There are presently 15 primary buildings and other facilities at the Eureka HAWS. Buildings and infrastructure include:

- main complex and warehouse;
- former main complex;
- new garage;
- powerhouse and water storage;
- hydrogen shed;
- DND warehouse;
- old transient barracks;

- Building #17 (Plumbing Shack) (storage) with former water tanks;
- former bunkhouse;
- carpentry shop;
- greenhouse;
- storage shed;
- original Quonset /storage shed;
- sea canisters;
- red Quonset;
- an active landfill and a closed landfill;
- two contaminated soil treatment facilities;
- roads;
- water reservoir;
- sewage lagoon; and
- tank farm and fuel pipeline.

DND and First Air Services also have facilities south of the airstrip.

2.6 Climate Conditions

The climate around Eureka is dry and cold and influenced by hemispherical air circulation patterns. The area around Eureka is classified as a desert and most of the precipitation is in the form of snow, which generally covers the ground for ten months a year, between September and June. The mean annual precipitation ranges from 50-150 millimetres. The mean temperature ranges from -30.5°C in the winter to 0.5°C in the summer. The highest temperatures occur in the months of July and August, and the lowest temperatures occur in the months of December and January.

Summers at Eureka are characterized by 24 hours of daylight, from mid-April through mid-August, while 24 hour darkness occurs from mid-October to mid-February. The Arctic receives its energy from solar radiation during the daylight months. Due to the high latitude, the sun does not rise very high. The sun's rays are dispersed, reducing the intensity of energy that reaches the surface. In winter, the land loses energy. As a result, the atmosphere is heated very little in the summer and is significantly cooled in the winter.

3.0 SUMMARY OF ENVIRONMENTAL ACTIVITIES

3.1 Risk Drivers

3.1.1 Current and Adjacent Land Use

Presently, Eureka HAWS is used for government sponsored scientific research, including research by EC atmospheric scientists. The world class ozone research facility, PEARL, operated by EC, became fully operational in 1993. PEARL plays an important role in the global monitoring and understanding of stratospheric ozone. The PEARL facility is located 14 kilometres west of Eureka, at 600 m elevation. It is also a centre for research scientists from around the world conducting studies on ozone depletion, UV radiation, stratospheric aerosols, and trace gases associated with ozone depletion. The other major scientific initiative at Eureka HAWS is the Natural Resources Canada (NRCan) Polar Continental Shelf Project (PCSP), a project dedicated to providing graduate students the opportunity to research the Arctic. In addition, the Canadian Military operates out of barracks located by the airstrip, known as Fort Eureka.

Eureka's proximity to Axel Heiberg Island and Ellesmere National Park Reserve make it a base point for many scientific and tourist expeditions. Eureka is also used for many expeditions to the North Pole as it is the most northern permanent civilian site. Supply planes for the expeditions must refuel at Eureka.

3.1.2 Future Land Use

The site will continue to be used for MSC operations. Based on information provided in the 2011 WorleyParsons geotechnical report, the following land use changes may occur:

- Relocation of the drinking water reservoir;
- Demolition of the old station building and buildings located on the delta; and
- Modifications to the sewage lagoon.

3.1.3 Areas of Environmental Concern

The areas of environmental concern (AECs) identified in previous environmental investigations included in the RAP are:

- AEC B-2: *In situ* Landfarm
- AEC D: Powerhouse and Delta Area
- AEC H: Old Maintenance Garage

3.1.4 Sources of Contamination

Two major spill events are reported to have occurred on site at the old tank farm (AEC B-2). Approximately 40,000 L of diesel was spilled in 1973/74, and between 37,000 L to 40,000 L of diesel was spilled in 1990. A spill was reported in 1996/1997 at the day tank north of the Powerhouse. Additional sources of contamination may be associated with localized vehicle and

equipment spills, and fuel handling. In 2008 and 2009 oil was observed dripping from a valve at the Powerhouse into an open drum.

3.1.5 Off-Site Contamination Sources

No potential off-site sources of contamination have been identified.

3.1.6 Physical Risks

Physical risks at the site include the slope west of the Powerhouse. Significant stability issues with the slope were identified in the 2013 Feasibility Study. Any work at the top and the bottom of the slope should be conducted with caution. Work should also limit the exposure of the permafrost, as the foundation of the Powerhouse relies on the permafrost for structural support. Excavation with heavy equipment should be limited in the area.

3.1.7 Affected Media and Contaminants of Concern

Based on the results from the 2012 Supplemental Investigation, the site-specific target levels (SSTLs) established in the SENES/FRANZ 2010 Detailed Quantitative Risk Assessment (DQRA) were updated for the site (see the SENES/FRANZ Remediation Planning and Remedial Action Plan – Feasibility Study (2013), for additional details).

No potentially unacceptable risk to humans at the Eureka HAWS was identified in the Human Health Risk Assessment (HHRA). The soil related pathways for terrestrial mammals and birds do not sum to any potentially unacceptable risk. There is potentially unacceptable risk to terrestrial plants and invertebrates from the PHC F2 concentration in soil, and benthic invertebrates and macrophytes from petroleum hydrocarbon (PHC) F1 and F2 and 1-methylnaphthalene in sediment. Lithium presents a potentially unacceptable risk for fish, algae, and invertebrates in surface water. Table 3-1 provides a summary of the ecological receptors and the contaminants of concern (COCs) in the different medium at the site (see Figure 2; Appendix A). The updated SSTLs are provided in Table 3-2.

Table 3-1: Summary of Contaminants Exceeding Ecological Target Risk or Hazard Quotients

Parameter	Medium	Soil	Sediment	Surface Water
	Receptor	Terrestrial Plants & Invertebrates	Benthic Invertebrates & Macrophytes	Fish, Algae & Invertebrates
PHCs	F1		x	
	F2	x	x	
BTEX	Xylenes		x	
PAHs	1-methylnaphthalene		x	
Metals	Lithium			x

Table 3-2: Summary of SSTLs in Soil, Surface Water, and Sediment

Chemical Name	SSTL
SOIL	
PHC F2	1374 mg/kg
SURFACE WATER	
Lithium	0.0128 mg/L
SEDIMENT	
Xylenes	1.46 mg/kg
1-methylnaphthalene	3.6 mg/kg
PHC F1	10 mg/kg
PHC F2	12 mg/kg

Based on the results of the background sampling conducted at Eureka HAWS, background threshold levels (BTL) were developed for metals using the 95% upper prediction limit (see SENES/FRANZ 2013 Remediation Planning and Remedial Action Plan – Feasibility). Table 3-3 provides a summary of the BTLs for metals in soil, sediment, and surface water.

Table 3-3: Summary of the Background Threshold Levels

Parameter	Soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)
Aluminum (Al)	16208	13322	4.544[1]
Antimony (Sb)	<1.0	0.707[1,2]	<0.0060
Arsenic (As)	14.69	24.92[3]	0.0122[3]
Barium (Ba)	106.6[3]	66.32	0.0628
Beryllium (Be)	10.919[2]	1.204	<0.0010
Bismuth (Bi)	<1.0	<1.0	---
Boron (B)	20.72	20.67[1]	0.0635
Cadmium (Cd)	<1.0	0.255[1,2]	0.000152[2]
Calcium (Ca)	14753[1]	10997	219.3[1]
Chromium (Cr)	25.04	27.12	0.0072[1, 2]
Cobalt (Co)	17.59[1]	14.73[1]	0.0172[1,2]
Copper (Cu)	28.21	40.85	0.021[1]
Iron (Fe)	67130[3]	34487	32.15[3]
Lead (Pb)	13.66	17.28	0.00795[2]
Lithium (Li)	---	---	0.0128[2]
Magnesium (Mg)	9704[1]	5643	102.2[1]
Manganese (Mn)	897.7[3]	344.1	0.497[1]
Mercury (Hg)	0.0588[1,2]	0.129[2]	---
Molybdenum (Mo)	1.496(2)	3.58[3]	0.000891[2]
Nickel (Ni)	28.67	36.53	0.0389[1]

Parameter	Soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)
Phosphorus (P)	1422[3]	651.4	0.462[2]
Potassium (K)	4551[3]	2122	6.265[1]
Selenium (Se)	0.803[2]	1.031[2]	0.00286[1]
Silicon (Si)	---	---	8.057[3]
Silver (Ag)	<1.0	<1.0	<0.00010
Sodium (Na)	8059[3]	293.9[2]	191.7[1]
Strontium (Sr)	81.38	88.69	1[1]
Sulphur (S)	---	---	302.6[1,2]
Titanium (Ti)	---	---	0.0765
Thallium (Tl)	<1	<1	<0.00020
Tin (Sn)	<5	<1	<0.0010
Uranium (U)	<2	1.162[1,2]	0.00154
Vanadium (V)	77.69[3]	84.26[3]	0.0209[2]
Zinc (Zn)	71.19	75.89	5.891[3]

Notes: 1: No discernable distribution (5% significance level) – normal distribution assumed
2: Not enough non-detect data points, reduced reliability
3: Lognormal distribution

Indoor air samples were collected from the operation and maintenance buildings at the site and the results exhibited concentrations above the generic guidelines. The maximum concentration for each parameter was input into the HHRA model. The results indicated that there was no potentially unacceptable risk to humans through vapour inhalation. As the maximum concentrations did not have a potentially unacceptable risk, the maximum observed concentration or the Health Canada guideline, which ever is higher, was used to establish the threshold concentrations for indoor air. Table 3-4 provides a summary of the indoor air threshold concentrations.

Table 3-4: Indoor Air Threshold Concentrations

Parameter		Threshold	Source
BTEX µg/m^3	Benzene	9.2	New Garage
	Toluene	760	Health Canada
	Ethylbenzene	200	Health Canada
	Total Xylenes	148	New Garage
PHCs µg/m^3	F1-BTEX - C6-C10 (as Toluene)	774	New Garage
	F2 - C10-C16 (as Decane)	1090	New Garage

3.2 Volumes of Impacted Material

The estimated volume of impact material from the 2013 SENES/FRANZ Feasibility Study is summarized in Table 3-5.

Table 3-5: Estimated Volume of Impacted Soil

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F2	AEC B-2	470	1.2	3,830
	AEC D, H, and Delta	190	0.9	170
		760	1.3	980
		5,800	1.3	7,600
	TOTAL			12,600

A summary of the estimated volumes of impacted sediment, west of the Powerhouse is provided in Table 3-6.

Table 3-6: Estimated Volume of Impacted Sediment

COC	AEC	Area (m^2)	Depth (m)	Total Volume (m^3)
PHC F1 & F2, Xylenes, and 1-methylnaphthalene	AEC B-2 and AEC D	2,400	1.0	2,400
			TOTAL	**2,400**

3.3 Risk Management Targets

The objective of the risk management strategy is to verify that the assumptions used in the risk assessment remain valid. Assumptions that are included in risk assessment modelling are:

- Pathways: monitor that new pathways are not created by changes in land-use;
- Contaminant concentrations: that concentrations of contaminants are not increasing;
- Contaminant migrating: that contaminants are not migrating to non-impacted areas; and
- Receptors: that no new receptors are on site (i.e., new species, young children).

Table 3-7 provides a summary of the risk management requirement for each impacted medium. Additional details regarding the risk management plan are provided in Section 6.

Table 3-7: Risk Management Requirements

Medium	COC	Location	Receptor	Operable Pathway	Potential Unacceptable Risk Currently Identified	Risk Management Measure Recommended
Soil	PHC F2	Landfarm	Plants and Invertebrates	Dermal contact	Yes	Ensure concentrations are not changing through a LTM program – Collection of soil samples
		Powerhouse and Maintenance Area	Human	Vapour Inhalation	No	Ensure concentrations of indoor air do not exceed maximum allowable concentrations through a LTM program – Collection of indoor air samples
			Plants and Invertebrates	Dermal contact	Yes	Ensure concentrations are not changing through a LTM program – Collection of soil samples
Soil	PHC F2	Delta	Human	Vapour Inhalation	No	Ensure concentrations of indoor air do not exceed maximum allowable concentrations through a LTM program – Collection of indoor air samples
			Plants and Invertebrates	Dermal contact	Yes	Ensure concentrations are not changing through a LTM program – Collection of soil samples
Soil	Metals	Landfarm	Plants and Invertebrates	Dermal contact	No	Ensure concentrations are not changing through a LTM program – Collection of soil samples
		Powerhouse and Maintenance Area	Plants and Invertebrates	Dermal contact	No	Ensure concentrations are not changing through a LTM program – Collection of soil samples
		Delta	Plants and Invertebrates	Dermal contact	No	Ensure concentrations are not changing through a LTM program – Collection of soil samples
Sediment	BTEX/ PHC F1	Drainage Pond	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
		Stream	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
	PHC F2	Drainage Pond	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
		Stream	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples

Medium	COC	Location	Receptor	Operable Pathway	Potential Unacceptable Risk Currently Identified	Risk Management Measure Recommended
Sediment	PAH	Drainage Pond	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
		Stream	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
	Metals	Drainage Pond	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	No	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
		Stream	Invertebrates and Macrophytes	Dermal Contact/ Ingestion	No	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
Surface Water	BTEX/ PHC F1	Drainage Pond	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program –Collection of sediment samples
		Stream	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program – Collection of surface water samples
	PHC F2	Drainage Pond	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program – Collection of surface water samples
		Stream	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program – Collection of surface water samples
	Metals	Drainage Pond	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program – Collection of surface water samples
		Stream	Fish, Algae, Macrophytes	Dermal Contact/ Ingestion	Yes	Ensure concentrations are not changing through a LTM program – Collection of surface water samples
Seep Water	BTEX/PHC F1	Delta	Plants and Invertebrates	Dermal contact	No	LTM – collection of sample to monitor potential migration through active layer
	PHC F2	Delta	Plants and Invertebrates	Dermal contact	No	LTM – collection of sample to monitor potential migration through active layer

Medium	COC	Location	Receptor	Operable Pathway	Potential Unacceptable Risk Currently Identified	Risk Management Measure Recommended
Seep Water	Metal	Delta	Plants and Invertebrates	Dermal contact	No	LTM – collection of sample to monitor potential migration through active layer

4.0 AUTHORITY AND ACCOUNTABILITY

EC is the responsible authority for Eureka HAWS. They are responsible for the management of the Eureka HAWS; therefore, they are responsible for the authorization of the risk management of the site. The Eureka Station Manager will be consulted to verify the schedule of activities that will occur at the site and any restrictions on these activities at the site. It is assumed that PWGSC is responsible for contracting out the LTM program and will be given the authority for the project by the EC Project Manager. The PWGSC Project Manager will be responsible for the management of the project and authorizing the contract to the consultant. The consultant is responsible for the execution of the LTM program including logistics, permitting, and contracting the analytical analysis to a laboratory. The consultant is also responsible for the execution of the field program, data interpretation, and preparation of the monitoring report. The consultant will report directly to the PWGSC Project Manager. The PWGSC Project Manager is responsible for communication with the EC Project Manager. Figure 4-1 provides an organizational chart for reference.

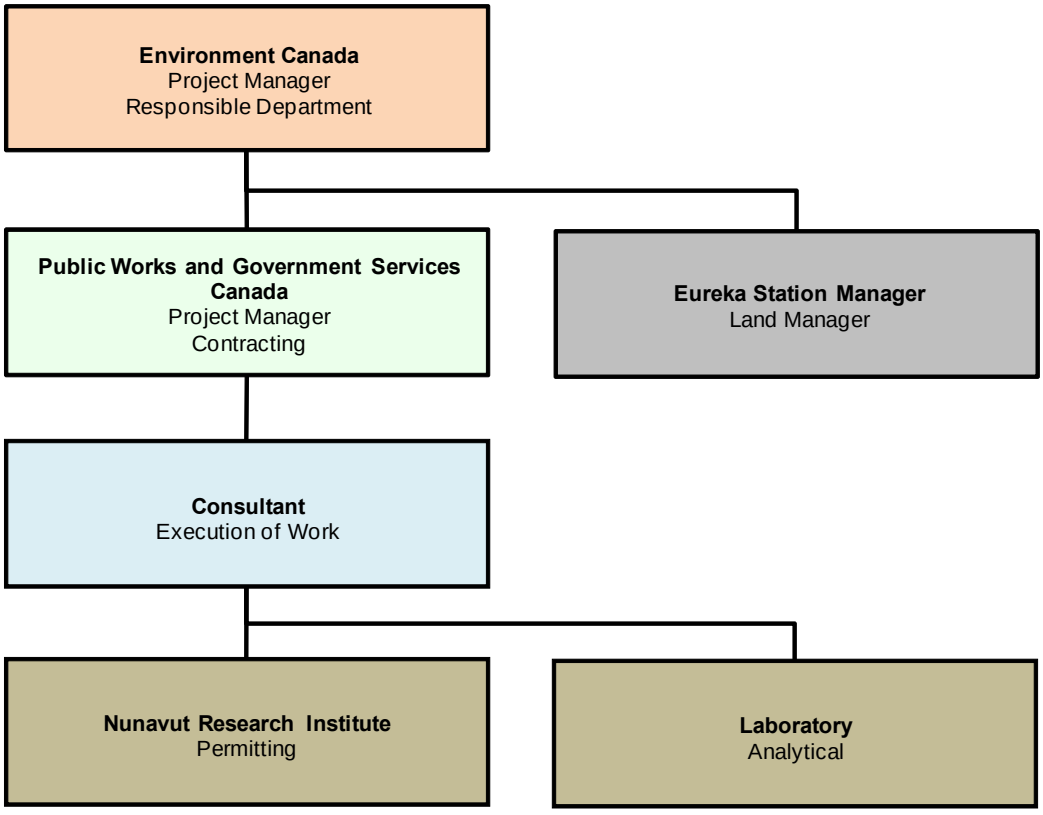

Figure 4-1: Long-term Monitoring Organizational Chart

5.0 REGULATORY REQUIREMENTS

Currently, there are no legal requirements that specifically apply to LTM of federal contaminated sites. The federal government has jurisdiction over contaminated sites located on federally-owned land. Statutes that apply to the management of contaminated sites include *Fisheries Act*, *Canadian Environmental Protection Act*, *Migratory Birds Conservation Act*, *Arctic Waters Pollution Prevention Act*, and *Species at Risk Act*. The *Treasury Board Policy on the Management of Real Property* (2006) provides the framework for the management of contaminated sites. The policy includes instructions to federal departments to ensure that:

- real property is managed in an environmental responsible manner (section 6.1.11);
- known and suspected contaminated sites are assessed and classified and risk management principles are applied to determine the most appropriate and cost-effective action for each site (section 6.1.12); and
- contamination of real property or negative impacts on the environment through the use or permitted third-party use of real property is avoided. In the event of contamination, immediate and responsible action must be taken to protect the health and safety of persons and the environment prior to assessing a future course of action (section 6.1.13).

A *Guidance Document on the Management of Contaminated Sites in Canada* by the Canadian Council of Ministers of the Environment (CCME, 1997) recommends that LTM may be required to ensure that contamination problems to not recur after remediation and that LTM is always required for activities using containment, isolation, and *in situ* stabilization techniques.

The Federal Contaminated Sites Action Plan (FCSAP) program has a ten step process to assess and prioritize contaminated sites. Step ten is the implementation of an optional LTM to confirm that the nature and extent of the remediation activities have been carried out as per the site management goals. To be eligible under FCSAP, the LTM plan must be a component of a RAP or a Risk Management Plan. The 2012 FCSAP Long Term Monitoring Planning Guidance (FRANZ, 2012) provides a framework for the development and implementation of LTM plans.

EC's current policy is to revisit all its contaminated sites after five years of inactivity; therefore, the maximum time between LTM visits will be five years.

The *Environmental Guideline for Contaminated Site Remediation*, Department of the Environment, Government of Nunavut (2009) document outlines Nunavut's approach to contaminated sites. The Government of Nunavut has the authority to ensure the preservation, protection, and enhancement of the environment on Commissioner's land (lands that have been transferred by Order-in-Council to the Government of Nunavut, including roadways and land subject to block land transfer); however, Aboriginal and Northern Development Canada (AANDC) retains management of inland waters including surface water and groundwater.

Under the Nunavut guideline the preparation of a remedial action plan can include a LTM program.

Under Nunavut's *Science Act,* any research conducted in the territory requires a licence or permit. The research licensing process provides an opportunity for communities to comment and receive updates on the projects near their communities. The Nunavut Research Institute (NRI) is responsible for issuing such research permits. Based on a review of the website and discussions with the Research Liaison Manager, a Land and Water Research application would be required as part of the long-term monitoring process. The NRI screens the applications and forwards them to other territorial regulatory bodies including, the Nunavut Impact Review Board (NIRB), Nunavut Planning Commission, and the Nunavut Water Board, if applicable. The timeframe for approval varies between 45 to 100 days, dependant on the complexity of the project.

6.0 DESCRIPTION OF PREFERRED REMEDIAL OPTION

6.1 Preferred Remedial Option Identified by Environment Canada

Environment Canada has identified the preferred remedial option as risk management through long-term monitoring (LTM) for the soil, surface water, and sediment impacts identified at the Eureka HAWS. As concentrations of PHCs were detected above the SSTLs near the operations and maintenance buildings, indoor air and sub-slab vapour samples will continue to be collected as part of the LTM to assess vapour intrusion.

It was noted that there are capital projects currently in the planning phase that may result in changes to on-site infrastructure at Eureka, including the current placement of the freshwater reservoir. Planning is underway for the reservoir relocation project, and the on-site work could begin in 2014-2015 or 2015-2016, depending on preparatory work and regulatory approvals. Relocation of the reservoir will include work being completed in the area of the impacted soil, sediment, and surface water; therefore, EC has indicated that yearly monitoring is to occur until such time as:

1. The location for the new water reservoir has been established; and
2. A plan can be put in place to address the impacted media which will be disturbed during the reservoir relocation project.

A work breakdown structure of the LTM plan is provided in Appendix B.

6.2 Risk Management Objectives

The risk management objective is to ensure that risks to human health and the environment associated with the presence of impacted media at a site are below the established acceptable levels or follow a decreasing trend. This will be achieved through the development and execution of a LTM plan. The LTM will ensure that pathways, contaminants of concern, and receptors at the site have not changed.

6.3 LTM Monitoring Plan

6.3.1 Data Requirements

Contaminants above the established SSTLs have been identified in soil, surface water, sediment, indoor air, and sub-slab vapour. Samples will be collected in each medium during the monitoring events to determine if the concentrations remain below the acceptable levels. Photographic evidence of the site will be collected to document any changes to pathways and receptors. Any wildlife or evidence of wildlife encountered at the site will also be recorded.

For soil, PHC F2 has been identified as the contaminant above the SSTL; therefore, all samples will be analysed for PHC F2. Since metals, specifically arsenic, have been identified at levels above the established BTLs, metals will be also analysed in select soil samples.

In sediment, the contaminants of concern are benzene, toluene, ethylbenzene and xylenes (BTEX), PHCs F1 and F2, and polycyclic aromatic hydrocarbons (PAHs), specifically, 1-methylnaphthalene, which must be specifically requested as it is not always included in the standard PAH analysis. Metals will also be analyzed to confirm that concentrations remain below values used in the risk assessment.

Surface water contained lithium above the SSTL; therefore, metals will be analysed in the surface water samples. Since the drainage pond acts as a receptor of PHC impacts, surface water samples will be analysed for PHCs.

An active layer seep was detected in the roadway with elevated concentrations of metals and PHCs. If the seep is present, a sample will be collected and analyzed for those parameters.

Indoor air and sub-slab vapour will be collected from inside select operation and maintenance buildings and will be analysed for BTEX and PHC F1 and F2.

The site has been divided into the following areas:

- Landfarm Area;
- Powerhouse and Maintenance Area;
- Delta Area;
- Drainage Pond Area; and
- Stream Area.

A sufficient number of samples are required in order to conduct statistical analysis to assess trends in the impacted areas (i.e., stable, increasing or decreasing concentrations). It is recommended that a minimum of ten samples be collected from the large soil impacted areas of the *in situ* landfarm and the delta areas. In smaller areas, a minimum of three samples is recommended. Table 6-1 presents the proposed sampling plan for each of the areas at the site.

Table 6-1: Proposed Sampling Plan

Location	Medium	Parameter	Number of Samples
Landfarm Area	Soil	PHC F2	14 + 2 duplicates
		Metals	4 + 1 duplicate
Powerhouse Area	Soil	PHC F2	6 + 1 duplicates
		Metals	2+ 1 duplicate
	Indoor Air	BTEX, PHC F1 and F2	4 + 1 duplicate
	Sub-slab vapour	BTEX, PHC F1 and F2	1

Location	Medium	Parameter	Number of Samples
Delta Area	Soil	PHC F2	14 + 2 duplicates
		Metals	4 + 1 duplicate
	Seep	BTEX, PHC F1 and F2	1
		Metals	1
	Indoor Air	BTEX, PHC F1 and F2	2
Drainage Pond	Sediment	BTEX, PHC F1 and F2	6 + 1 duplicate
		PAH	6 + 1 duplicate
		Metals	4 + 1 duplicate
	Surface Water	BTEX, PHC F1 and F2	3 + 1 duplicate
		Metals	3 + 1 duplicate
Stream Area	Sediment	BTEX, PHC F1 and F2	4 + 1 duplicate
		PAH	4 + 1 duplicate
		Metals	4 + 1 duplicate
	Surface Water	BTEX, PHC F1 and F2	3 +1 duplicate
		Metals	3 + 1 duplicate

6.3.2 Monitoring Locations

Monitoring locations and boundaries of the impacted areas are presented in Figure 2; Appendix A. The locations have been chosen to assess the potential changes in contaminant concentrations in the known contaminated area or to provide confirmation that contaminants have not migrated. Duplicate samples will be collected within the boundaries of the impacted areas.

Soil, sediment, surface water, indoor air, and sub-slab vapour will be monitored as part of the LTM. As samples should not be collected in the exact sample locations each monitoring round, SENES/FRANZ proposes marking the locations with a magnetic stake that can be detected with a magnetic locator. As capital projects, such as building demolition, have been proposed for the site, it is not recommended to use measured distances from a fixed point, such as a building, to establish sampling locations in areas where the infrastructure may change.

The stakes would be either flush with the ground surface or a stick-up with reflectors, depending on approval from EC and discussion with station staff. Samples would be collected from within a one metre radius of the marked sampling location. Each stake would have an identification tag with the sample location. In areas where placing stakes is not appropriate, such as in the area of the *in situ* landfarm, two stakes will be placed outside the area to allow for triangulation of the monitoring location. Distances from each stake will be provided in order to properly triangulate the location. The stakes would be installed during the first year of monitoring. Photographs will be taken to provide visual reference of the monitoring locations.

6.3.3 Sampling Methodology

6.3.3.1 Soil

Soil sampling will be conducted by manual test pitting with a stainless steel shovel or auger. Subsurface conditions encountered in the test pits will be logged at the time of excavation. Soil descriptions, including approximate grain size, colour, moisture content, stratigraphy, and nature and extent of apparent contamination, will be recorded for each unit. Where possible, test pits should be advanced to a maximum of 1 metre below ground surface. In areas with water infiltration, shallower test pit may be required.

These procedures will be followed for soil sampling:

- Subsurface materials will be inspected, described and photographed; and
- Representative composite samples will be collected from each soil horizon.

Once the samples have been collected, the soil will be placed in laboratory supplied containers. The containers will be transferred to a cooler with ice to preserve the samples. Samples will subsequently be kept at the appropriate temperature prior to submission to the laboratory. All sampling equipment will be decontaminated with Alconox prior to the collection of subsequent samples.

6.3.3.2 Surface Water

Surface water will be collected directly into laboratory supplied bottles by submerging the bottle under the surface of the water, removing the cap and allowing the bottle to fill, then recapping the bottle. Field parameters including pH, temperature, and conductivity will be measured using hand-held water quality meter, and recorded in field logs for inclusion in the LTM report. The containers will be transferred to a cooler with ice to preserve the samples. Samples will subsequently be kept at the appropriate temperature prior to submission to the laboratory. All sampling equipment will be decontaminated with Alconox prior to the collection of subsequent samples.

6.3.3.3 Sediment

Sediment samples will be collected using a sediment core sampler or shovel. For each sample collected, a depth measurement, GPS coordinates, and description of the sediment (including colour, odour, sheen, staining, and grain size), the presence of debris, and any unusual characteristics will be recorded. Immediately after collection, the sediment will be transferred into laboratory supplied containers. The bottled sediment samples will be placed into a cooler with ice to minimize biological activity and associated chemical changes. Samples will subsequently be kept at the appropriate temperature prior to submission to the laboratory. All sampling equipment will be decontaminated with Alconox prior to the collection of subsequent samples.

6.3.3.4 Indoor Air Crawl and Space Sampling

Samples will be collected from the breathing zone (i.e., above 1 m from the floor level) using a laboratory supplied 6 L SUMMA® Canisters with a 24-hour mass control value. Crawlspace samples will be collected in the void space beneath the building foundation. The following buildings will be included in the LTM program for indoor air sampling:

- New Garage;
- Powerhouse;
- Crawlspace beneath the Powerhouse;
- Old Garage;
- Old Transient Barracks; and
- Building # 17 (Plumbing Shack).

One duplicate indoor air sample will also be collected.

6.3.3.5 Sub-slab Vapour Sampling

A sub-slab sample will be collected to assess the vapour intrusion through the floor slab in the Old Garage. The sub-slab vapour sample will be collected from the pre-existing sub-slab vapour probes installed in the Old Garage in the summer of 2012. Prior to mobilization to the site, a request to the Eureka Station Manager should be made to request verification that the probe has not been damaged since the previous monitoring round. The verification process would involve determining if the screw cap can be removed from the vapour probe. If the vapour probe appears damaged, the installation of a new vapour probe will be required.

As the probe is made from copper piping and concreted into the floor, little to no maintenance is expected to be required. Prior to collection of the sample, the probe should be checked to ensure there are no blockages by inserting a metal rod into the probe. During the first year of monitoring a sign will be placed on the wall near the probe indicating its location.

Before sampling, the vapour probes will be purged with Gilair pumps with low-flow attachments. The Gilair pumps will be attached to the sampling train with low-density polyethylene t-joints. A ball valve will connect the pumps and the t-joint so that the pumps can be turned off without allowing any ambient air into the sampling train. Samples will be collected in 6 L stainless steel SUMMA® canisters. A sample of air from each vapour probe will be drawn directly from the sample tubing using a laboratory-calibrated valve/flow regulator calibrated for 20 minute sampling. The pre-evacuated SUMMA® canisters will be opened, enabling collection of time-weighted air samples.

6.3.3.6 Seep Water

Seep water will be collected where the permafrost active layer is seeping out of the ground surface. As monitoring wells are not located on the site, the seep water will be collected by creating a small trench in the seep area. Water will pool in the trench and will be collected from the into a laboratory supplied bottle.

6.3.3.7 Quality Assurance/Quality Control

To assess the reliability of the laboratory data, 10% QA/QC samples will be collected for soil, surface water, and sediment. One duplicate sample will be collected for indoor air.

6.3.3.8 Photograph Collection

Photographs will be taken from the same location in each monitoring round. The locations will be established during the first year of LTM. Photographs will be taken to provide visual evidence of the areas where samples were collected and the overall site conditions. Additional photographs of any specific condition, such as new infrastructure or change in land use, will also be required.

6.3.4 Data Analysis

Data collected during each monitoring round will be compared to the SSTLs, or the established threshold levels as outlined in Section 3.1.7. For the impacted areas, statistical analysis will be conducted to determine if there is a decreasing trend. For large impacted areas, such as the delta, the data will be input into the US EPA ProUCL or a similar statistical software program to model the trend of the large impacted area. ProUCL is a free software program (http://www.epa.gov/osp/hstl/tsc/software.htm) and is a comprehensive statistical software package used to address many environmental sampling and statistical issues (US EPA, 2012). ProUCL can address full sets of environmental data including non-detects. A two sample set t-test with non-detects will be used to determine if there is a significant difference between the sets of data. It is recommended that three years of data be analyzed prior to making recommendations or conclusions regarding trends in contaminant concentration.

For smaller impacted areas, where the collection of ten or more sample is not realistic (such as the bottom of the slope west of the Powerhouse) the data will be compared using a linear regression model or Mann-Kendall analysis, which also can be run using the ProUCL software.

The samples collected outside the boundary of the impacted areas will be compared to the previous monitoring round data.

To ensure the reliability of the analytical data, the relative percent difference (RPD) will be used to compare the primary sample to the duplicate. The RPD is calculated using the following formula:

$$RPD = \frac{|X_1 - X_2|}{X_{average}} \times 100$$

where, X_1 and X_2 are the duplicate concentrations and $X_{average}$ is the mean of these two values. The duplicate results were evaluated using criteria developed by Zeiner[1], which draws from several data validation guidelines developed by the United States Environmental Protection Agency. According to these criteria, the RPD for duplicate samples should be less than 20% for aqueous samples and less than 40% for solid samples. For air samples, the Massachusetts Department of Environmental Protection recommends that RPDs be calculated for duplicate pairs and deemed acceptable if the value is below 25%, in accordance with the US EPA's air sampling and analysis methods (Commonwealth of Massachusetts, 2004). RPDs can be calculated only when the compound is detected in both the original and the duplicate sample at a concentration above the method detection limit. Alternative criteria are used to evaluate duplicate pairs where one or both of the results is less than five times the detection or quantitation limit, or where one or both of the results is less than the detection or quantitation limit (i.e. nd or 'not-detected'). A full description of the criteria is provided in Table 6-2.

Table 6-2: Criteria for the Evaluation of Duplicate Sample Results

Result A	Result B	Criteria for Acceptable Precision	
		Aqueous (water)	Solid (soil)
Organic			
nd	nd	acceptable precision, no evaluation required	
nd	positive	result B - 0.5 x QL < QL	result B - 0.5 x QL < 2 x QL
positive and > 5 x QL	positive and > 5 x QL	RPD < 20%	RPD < 40%
positive and < or = 5 x QL	positive	|result B - result A| < QL	|result B - result A| < 2 x QL
Inorganic			
nd	nd	acceptable precision, no evaluation required	
nd	positive	result B - IDL < LRL	result B - IDL < 2 x LRL
positive and > 5 x LRL	positive and > 5 x LRL	RPD < 20%	RPD < 40%
positive and < or = 5 x LRL	positive	|result B - result A| < QL	|result B - result A| < 2 x QL

Source: Zeiner, S.T., 1994
Notes:
nd – not detected
QL – quantitation limit
IDL – instrument detection limit
LRL – laboratory reporting limit

6.3.5 Schedule

The proposed schedule for the LTM monitoring is to do so annually monitoring until the proposed relocation of the drinking water reservoir on-site work has been approved. Once the on-site work of the reservoir relocation as been approved, the remedial options evaluation will be updated. If risk management through long-term monitoring is confirmed as the preferred

[1] Zeiner, S.T., *Realistic Criteria for the Evaluation of Field Duplicate Sample Results*, Proceedings of Superfund XV, November 29-December 1, 1994, Sheraton Washington Hotel, Washington, D.C.

remedial option, a new schedule will be developed. If the proposed on-site work for recapitalization of the fresh water lagoon is not approved, there will be no changes to the assumptions and evaluation of the remedial options; therefore, LTM would remain the preferred option. The schedule is as follows:

- Year 1 to 5 – Annual Sampling
- Year 7
- Year 10
- Year 15
- Year 20
- Year 25

Twenty-five years is a common timeframe for a LTM plan and has been implemented at the Aboriginal Affairs and Northern Development Canada and DND Distant Early Warning (DEW) Line sites. After year 3, sufficient data will have been collected to analyze contaminant concentration trends based on statistical testing. Prior to collection of the third round of data, determining if there is a continued statistically significant trend is not possible. Previous data collected in the area can be used to augment the dataset; however, not all monitoring locations will have historical data. If after Year 3, no annual increase in concentration or migration of the contaminants of concern is observed, it is recommended that monitoring in Year 4 is not required unless significant land use changes are proposed. It is recommended that after each monitoring round after year 3, that the consultant make recommendations based on the statistical results if any changes to the scope and schedule are required. The above schedule is based on the assumption that during the first three to five years of monitoring, trends on the contaminant concentration can be established. Once contaminant concentration trends are determined and provide an indication that no increase in concentration is occurring, the time between monitoring rounds can be extended. If contaminant trends cannot be established, annual monitoring is recommended.

A Gantt chart for a typical monitoring year is provided in Appendix C.

6.3.6 Reporting

A report will be provided by the consultants to PWGSC and EC upon the completion of each monitoring round. The report will follow the outline provided in Appendix D. Any deviation from the LTM plan will be noted in the report. Additionally, if any changes to land use are observed, it will be included in the report.

The first year monitoring report will summarize in a spreadsheet any existing data from historical reports based on samples collected within a one metre radius of the LTM sampling locations. The set-up of the input spreadsheet for the ProULC analysis will also be completed after first year of monitoring. Additionally, a map will be created to indicate the location the photographs

were taken, along with a view point reference number. This will allow future monitoring photographs to be collected from the same location, in the same direction and labelled consistently.

All electronic working files should be provided to Environment Canada with the final report.

6.3.7 Contingency Plans/Emergency Response

PWGSC and EC should be notified immediately if any conditions on site have changed the conditions of the assumptions made in the development of the SSTLs. These include, but are not limited to:

- Change in receptors: a new ecological receptor identified at the site, workers under the age of 20, workers on site for greater than 16 weeks at a time.
- Changes in pathway: new active layer seep identified, identification of free product, changes in building usage (i.e., switch from occasional to full time use).
- Changes in land use: construction of a new building, or relocation of critical infrastructure.

Any of the above noted changes would require an update to the risk assessment.

If free product is observed, attempts should be made to determine the source by stepping out with additional test pits. Samples will be collected to attempt to delineate the extent of the free product plume. Additional sampling containers provided by the laboratory will be brought to the site in order to collect additional samples, as required. Analytical results will be reviewed against the risk assessment to determine if any potential unacceptable risk may be present at the site.

If emergency situations, such as natural disasters or slumping, arise while the consultant is on site, an assessment of the change in conditions will take place, if it is safe to do so. This would include: a visual inspection of the fuel pipe line and tanks to determine if there are any visible signs of leaks; assessment if there are any changes in the condition of the slope west of the Powerhouse; or if any chemical or fuel leaks have occurred. Photographs will be collected to document any changes to the site conditions. If new contaminated area are identified during the monitoring visit, the consultant will inform the PWGSC and EC project managers immediately.

If the emergency situation or changes in risk assumptions occur, the risk assessment and remedial option evaluation will require an update. Based on the results of the updated risk assessment, new remedial options will be considered.

If spills, releases, or leaks from the fuel system were to occur, it would first be dealt with by the Eureka HAWS emergency response protocol. Any major spill, release or leak would change the

concentrations and pathway assumptions in the risk assessment; therefore, an update to the risk assessment and remedial options would be required.

If the review of the analytical data indicates that contaminant plumes appear to be migrating, the concentration within the impacted areas continues to increase, or there is a potential risk to human health, a change in the remedial option would be required. The consultant will review the assumptions made in the initial remedial options analysis to determine if any of the site conditions has changed, (i.e., the location of the drinking water reservoir or fuel pipe line). Options such as excavation with shoring along the slope or construction of a drainage system with water treatment may be required to reduce the potential for an unacceptable risk.

6.4 Information and Records Management

The following table should be kept up to date by the EC Project Manager. Any additional risk management measures implemented at the site (i.e., restrictions on property use, maintaining equipment) will be included in the table.

Table 6-3: Long-term Monitoring Documentation Management

Measure	Objective	Brief Description	Frequency and Duration	Responsibility
Monitoring Contamination - soil	To ensure that concentrations of contaminants are not increasing or migrating	Collection of soil samples from the impacted areas and adjacent to the impacted areas in the: • Landfarm Area • Powerhouse and Maintenance Area • Delta Area As vapour intrusion as been identified as an operable pathway, indoor air and sub-slab vapour samples will be collected from the New Garage, Powerhouse, crawlspace beneath the Powerhouse, Old Garage, sub-slab vapour probe in Old Garage, Old Transient Barrack, and Building #17 (Plumbing Shack). A report with data interpretation is to be provided after each monitoring round.	Once a year for 5 years, then year 7, 10, 15, 20, 25 for approximately 7 days a year	EC – Authorization PWGSC – Contracting Consultant - Execution
Monitoring Contamination - sediment	To ensure that concentrations of contaminants are not increasing or migrating	Collection of sediment samples to measure on site concentrations from the impacted areas in the drainage pond and stream. A report with data interpretation after each monitoring round.	Once a year for 5 years, then year 7, 10, 15, 20, 25 for approximately 7 days a year	EC – Authorization PWGSC – Contracting Consultant - Execution
Monitoring Contamination	To ensure that concentrations of contaminants are	Collection of surface water samples to measure on site concentrations from the impacted areas in the drainage	Once a year for 5 years, then year 7, 10, 15,	EC – Authorization

Measure	Objective	Brief Description	Frequency and Duration	Responsibility
- surface	not increasing or migrating	pond and stream. A report with data interpretation after each monitoring round.	20, 25 for approximately 7 days a year	PWGSC – Contracting Consultant - Execution
Monitoring Contamination – seep water	To ensure that concentrations of contaminants are not increasing or migrating	Collection of seep water sample to measure on site concentrations from the impacted areas in the delta area. A report with data interpretation after each monitoring round.	Once a year for 5 years, then year 7, 10, 15, 20, 25 for approximately 7 days a year	EC – Authorization PWGSC – Contracting Consultant - Execution

Documentation of LTM (list all LTM plans and progress reports prepared for the site)
1.
2.
3.
4.
5.
6.
7.

Long-term Monitoring Log (Document the frequency, duration, and most recent assessment of each LTM event

Activity	Date of Last LTM Event	Document Number	Risk Management Measure Operating as Intended (Yes/No)

6.5 Closure Criteria

The Treasury Board definition of a ‘closed’ site is that no future action is required and no future liability exists with the site. The current liability at the site is based on the potentially unacceptable risk to terrestrial plants and invertebrates and benthic invertebrates and macrophytes. If the conditions outlined in the DQRA, such as receptors and pathways, remain unchanged, the liability is removed once the SSTLs are met. To ensure that the concentrations remain below the SSTLs, no further action will be required once three consecutive monitoring rounds exhibited concentrations below the SSTLs.

7.0 PUBLIC PARTICIPATION

Community involvement can be required for specific activities, including monitoring, within a LTM plan. The closest community to Eureka HAWS is Grise Fiord, over 400 km south of the site. Based on a conversation with the Eureka Station Manager during the summer 2012 field season, hunting is discouraged in the area surrounding the HAWS. Public use of the site is limited to visitors from northern expedition, research programs, crews from the sealift, and potential community members from Grise Fiord during hunting excursion; therefore, public participation in the LTM process will most likely be based on the permit requirements. Public input from nearby communities is part of the Research Permit Application. The NRI provides the applicant with a list of community groups that may provide input into a proposed project. As part of the research permit, a non-technical summary must be provided to the NRI for distribution to local communities.

8.0 CULTURAL, NATURAL, AND HISTORICAL PRESERVATION

No cultural areas have been identified in the area surrounding Eureka HAWS. A search for sensitive habitat, which includes the network of protected areas administered by EC was conducted. The network, which includes Migratory Bird Sanctuaries, National Wildlife Areas, and Marine Wildlife Areas, represent diverse habitats of national and international significance protected under federal legislation. Territorial websites were also reviewed for information regarding critical wildlife habitat. SENES/FRANZ reviewed the Government of Nunavut and the EC website and did not identify any protected or sensitive areas within 100 km of the Eureka HAWS.

The federal *Species at Risk Act* (*SARA*, 2003) provides for the legal protection of wildlife species and the conservation of their biological diversity. Within *SARA*, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established as an independent body of experts responsible for identifying and assessing wildlife species considered to be at risk. Once identified by COSEWIC, these results are considered for legal protection and recovery under SARA. The SARA Public Registry (http://www.sararegistry.gc.ca/sar/index/default_e.cfm) includes a listing of all species at risk, including the provinces they are known to inhabit, and their status under SARA and/or COSEWIC. In order to identify any species at risk that could potentially inhabit or use the Eureka HAWS site and/or surrounding environs, the SARA Public Registry was consulted. The range filter for Nunavut was used, and habitat/range maps for each species at risk listed for Nunavut were consulted to determine whether the species could be present at Eureka HAWS. Those species that could be present are listed in Table 8-1 below.

Table 8-1: Species at Risk

Common Name	Latin Name	COSEWIC Status	SARA Status
Ivory Gull	*Pagophila eburnean*	Endangered	Endangered
Peary Caribou (High Arctic population)	*Rangifer tarandus pearyi*	Endangered	Endangered
Polar Bear	*Ursus maritimus*	Special Concern	No status
Red Knot – rufa subspecies	*Calidris canutus rufa*	Endangered	No status
Red Knot - islandica species	*Calidris canutus islandica*	Special Concern	No status
Wolverine (Western population)	*Gulo gulo*	Special Concern	No status

Observations made during the monitoring visit pertaining to any visual evidence of wildlife at the site (tracks, scat, or actual sightings) will be included in the monitoring report. Any evidence of species at risk in the area should also be noted. Polar Bears, Red Knots, and Peary Caribou

have been spotted near the main station in pervious years. An increase in the population of the species at risk could change the receptor assumptions made in the ecological risk assessment.

9.0 COST ESTIMATE FOR SELECTED OPTION

The cost for a 25 year LTM program is summarized in Table 9-1. A breakdown of the costs is provided in Appendix E.

Table 9-1: Cost for Proposed LTM Program

Category	Year 1	Year 2 to 25 (per year)
Professional Fees	$43,000	$37,000
Travel Expenses and Accommodations	$50,000	$50,000
Office Expenses	$4,000	$4,000
Field Supplies	$1,200	$200
Field Instruments and Equipment	$1,200	$1,200
Chemical Analyses	$11,000	$11,000
Communication Mark-up	$900	$700
Disbursement Mark-up	$1,300	$1,200
SUB TOTAL	$112,000	$104,000
Total for 10 rounds of LTM		$1,050,000

The following assumptions were made during the preparation of the cost estimate:

1. Mobilization will be from Ottawa, ON to Resolute Bay, NU;
2. Charter flight to and from Eureka, NU from Resolute Bay, NU;
3. Field equipment and laboratory supplies will be shipped to Resolute Bay, NU;
4. Laboratory samples will be shipped priority from Resolute Bay, NU to Ottawa, ON upon completion of the field program;
5. Two field personnel will be on site;
6. Monitoring locations will be staked during the first year of monitoring; therefore, an extra day is required;
7. The recommended monitoring plan in Table 6-1 is implemented;
8. The recommended monitoring schedule outlined in Section 6.3.5 is implemented;
9. Work is not being done in conjunction with any other projects;
10. A backhoe is not available for test pits;
11. A 12 hour work day is assumed and 1 hour per soil and sediment location is required; and
12. Compiling and summarizing of historical data will be completed during the preparation of the Year 1 monitoring report.

The costing is based on cost incurred during the previous investigations at the Eureka HAWS. As travel costs vary substantially, the uncertainty in the cost estimate for the monitoring

between year 1 to year 5 is approximately 20%. After 5 years, the uncertainty in the cost estimate increases substantially, to approximately 50%.

10.0 REFERENCES

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11.0 LIMITATIONS

This report has been prepared for Public Works and Government Services Canada and Environment Canada. The report may not be relied upon by any other person or entity without the express written consent of SENES Consultants Ltd. and Franz Environmental Inc.

Any use, which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. SENES Consultants Ltd. and Franz Environmental Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The conclusions presented represent the best judgment of the assessor based on current environmental standards and on the site conditions. Due to the nature of the investigation and the limited data available, the assessors cannot warrant against undiscovered environmental liabilities.

Should additional information become available, SENES Consultants Ltd. and Franz Environmental Inc. requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

There is no warranty, expressed or implied that the work reported herein has uncovered all potential environmental liabilities, nor does the report preclude the possibility of contamination outside of the areas of investigation. The findings of this report were developed in a manner consistent with a level of care and skill normally exercised by members of the environmental science and engineering profession currently practicing under similar conditions in the area.

A potential remains for the presence of unknown, unidentified, or unforeseen surface and sub-surface contamination. Any evidence of such potential site contamination would require further surface and sub-surface exploration and testing.

If new information is developed in future work (which may include excavations, borings, or other studies), SENES Consultants Ltd. and Franz Environmental Inc. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

12.0 CLOSURE

We trust that this information is satisfactory for your present requirements. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours truly,

SENES Consultants Ltd./ Franz Environmental Inc.

Catherine LeBlanc, B.Eng.
Project Manager and Report Author

Christian Ludwig, M.Eng., P.Eng., PMP
Project Principal and Senior Reviewer

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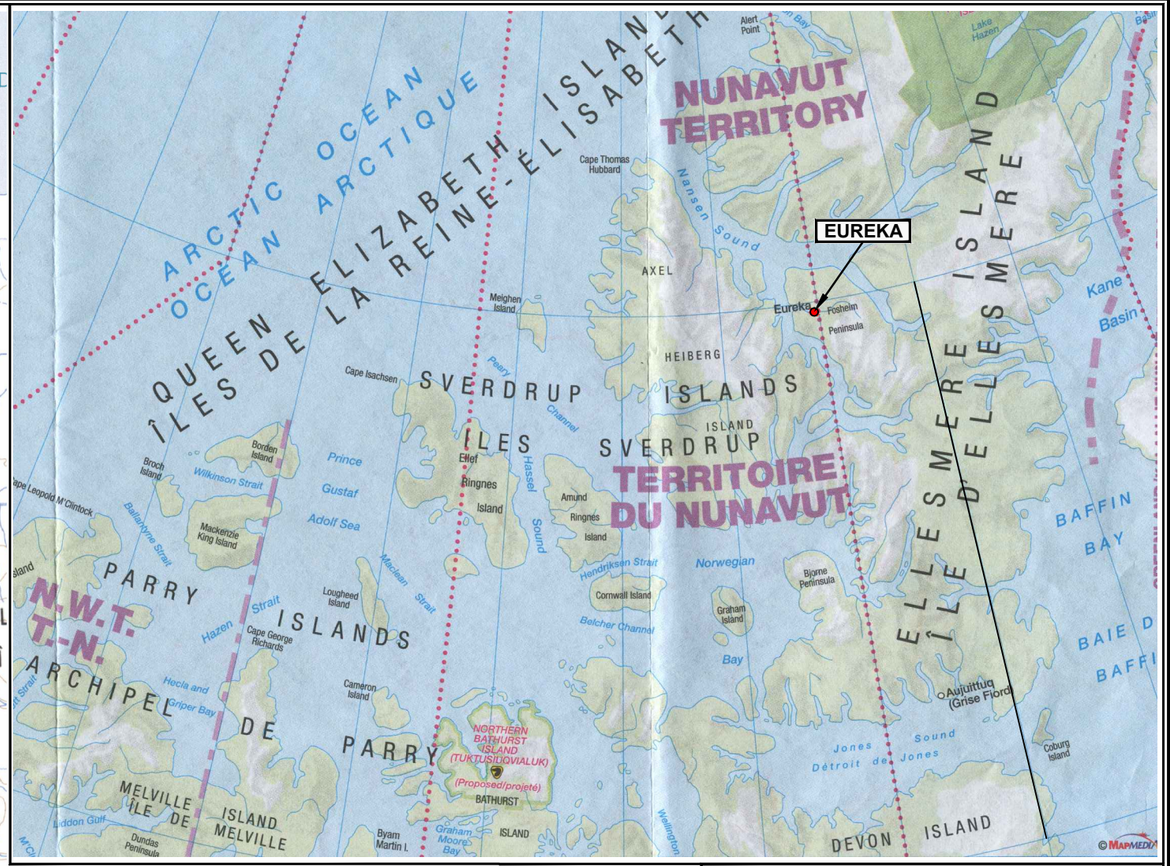
Appendix A
Figures



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100 50 0 100 200 300

Kilometres

1:225,000

5 4 3 2 1 0 2.5 5 7.5 10

Kilometers

References:

(above) "*Canada Road Map*", MapArt Publishing, 2003.

(left) Energy, Mines and Resources Canada NTS Sheet 340-B Elmerson Peninsula, Nunavut (formerly District of Franklin, Northwest Territories), NAD27, Edition 2, 1986 and NTS Sheet 49-G Slidre Fiord, Nunavut (formerly District of Franklin, Northwest Territories), NAD27, Edition 3, 1984 (interrim corrections made 1993).

(Note: ground elevations shown in feet above mean sea level).

Title: **SITE LOCATION - EUREKA HIGH ARCTIC WEATHER STATION**

Project: **LONG TERM MONITORING PROGRAM EUREKA HIGH ARCTIC WEATHER STATION EUREKA, NU**

Client: **PWGSC / EC**

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Date: **October 2008**

Updated: **MARCH, 2013**

FIGURE 1

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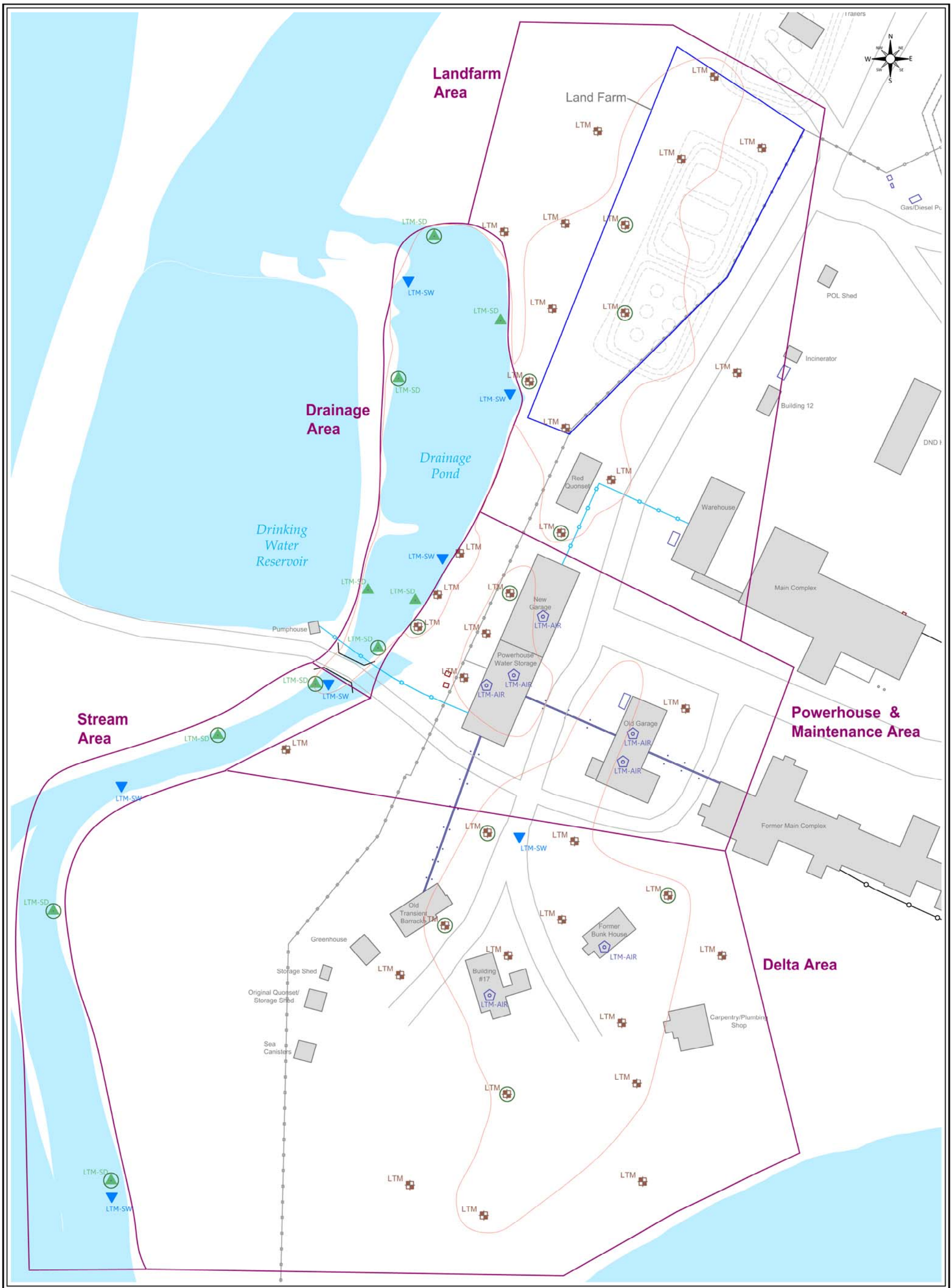

Legend

- Building
- Pipeline
- Hydro Overhead
- Water Line
- Road
- Sewer
- Tank
- Powerbox

LTM = Long Term Monitoring

- Long Term Monitoring Work Areas
- Land Farm
- Proposed LTM Test Pit Location
- Proposed LTM Sediment Sample Location
- Proposed LTM Surface Water Sample Location
- Proposed LTM Indoor/Sub-slab Air Sample Location
- Proposed Sample Location Analyzed for Metals (soil and sediment only)
- Outline of Identified PHC Impacts to Soils and Sediment

Title:

Sampling Locations - Long Term Monitoring

FRANZ ENVIRONMENTAL INC.
CONSULTING ENGINEERING TECHNOLOGIES

Project: LONG TERM MONITORING
EUREKA HIGH ARCTIC
WEATHER STATION
EUREKA, NU

Client: PWGSC/EC

Date: MARCH 2013

SCALE 1:1000

25 20 15 10 5 0 metres 25 50

FIGURE 2

updated on 27-Mar-13 by rfletcher

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Appendix B
Work Breakdown Structure

Figure B-1: Work Breakdown Structure - LTM

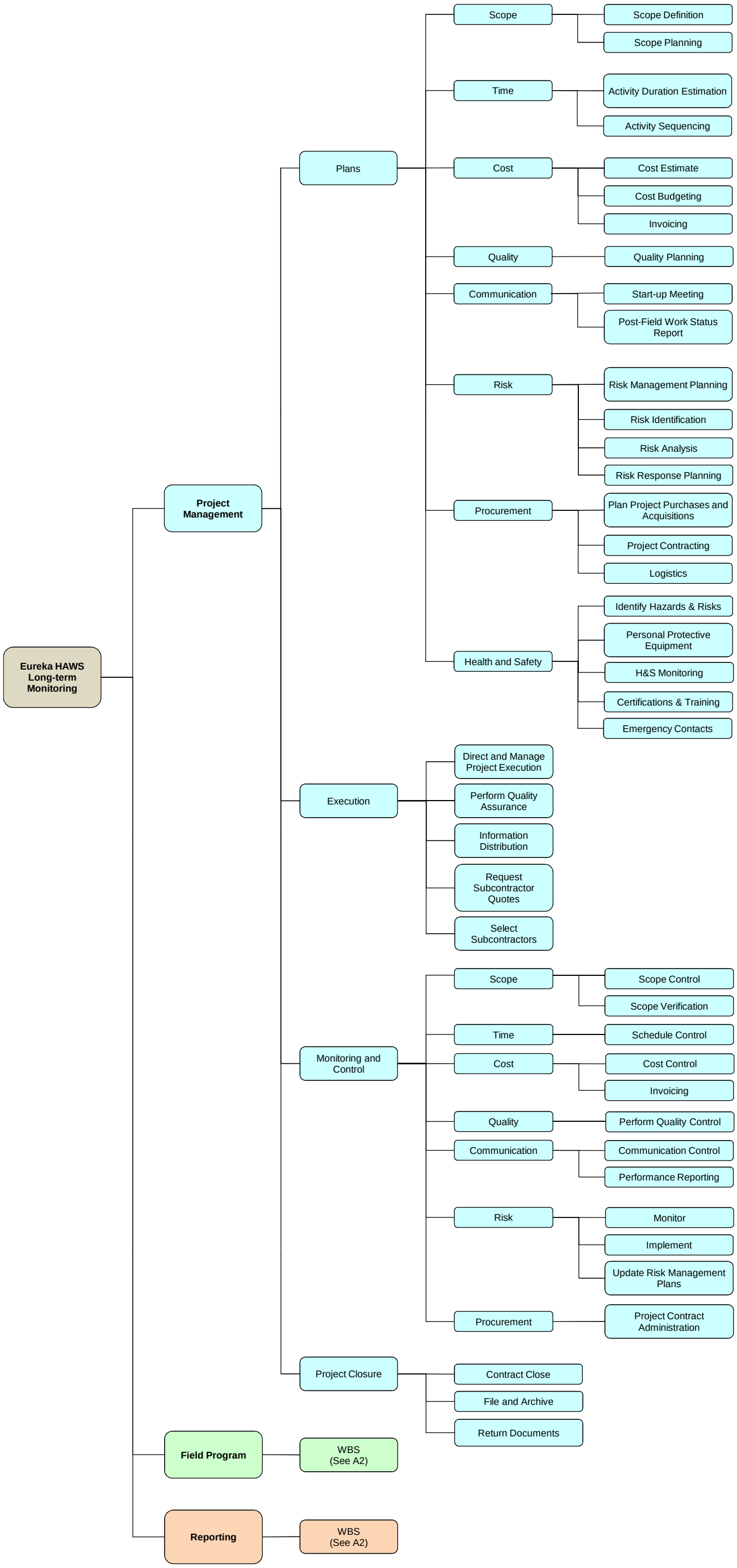
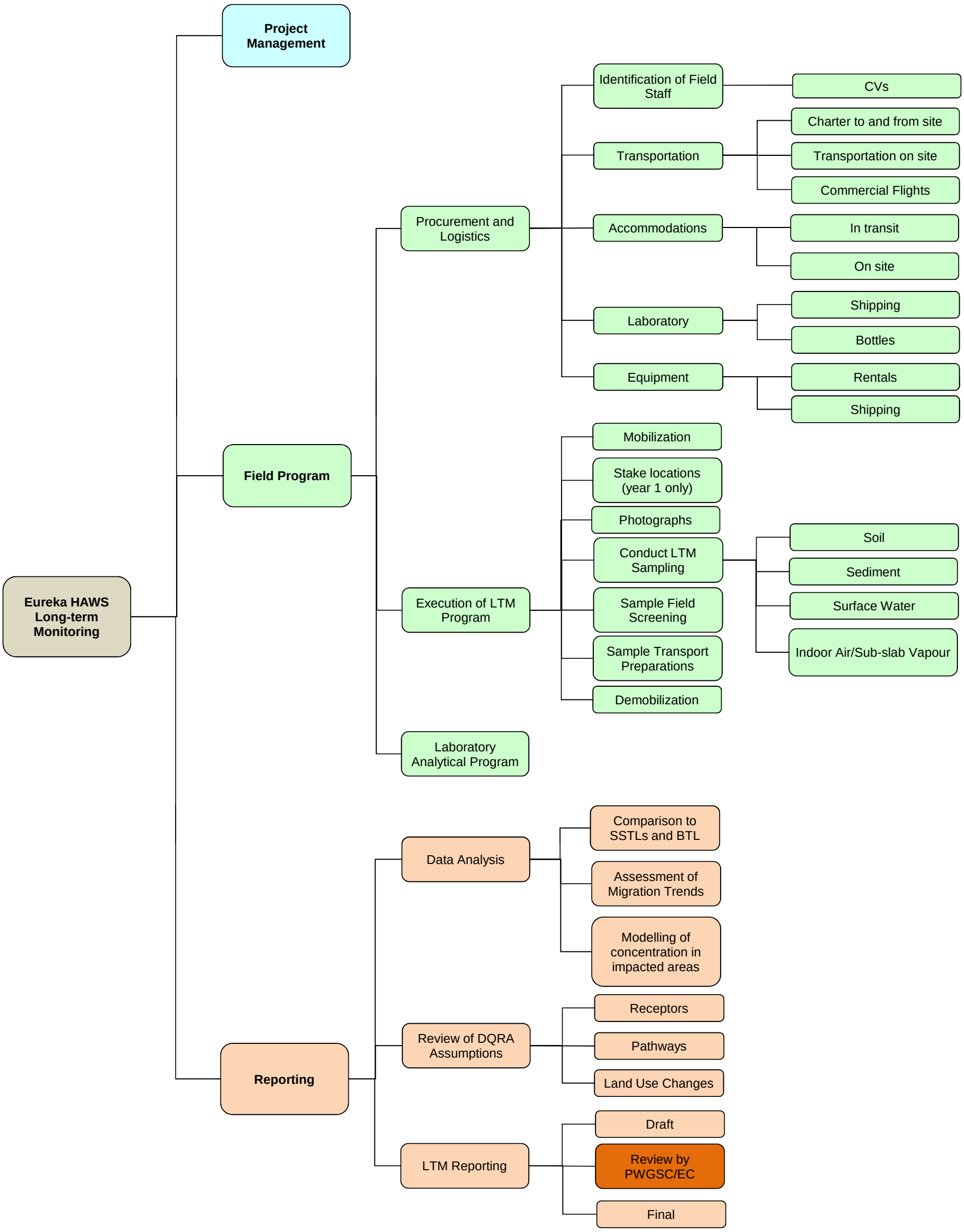


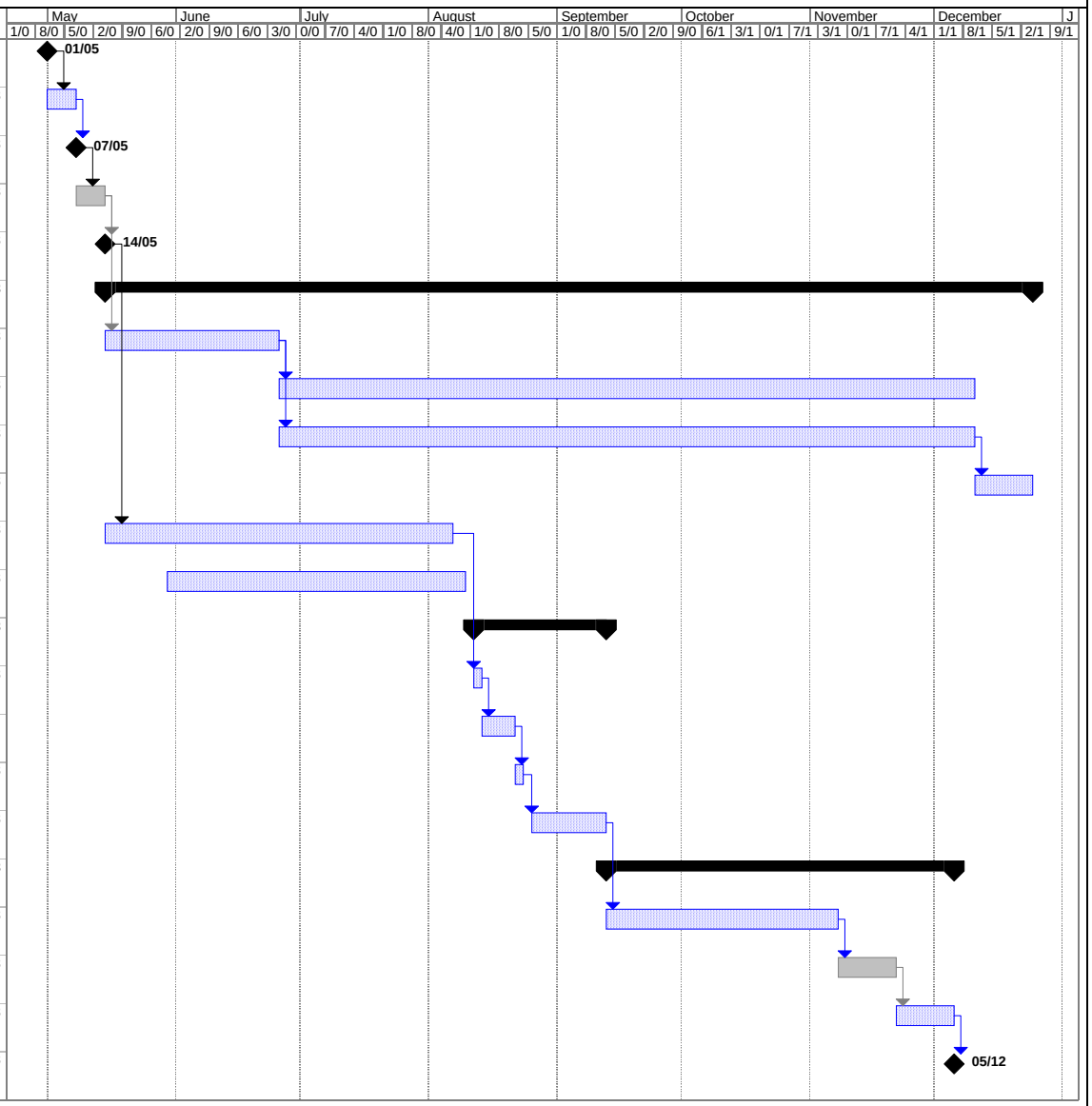
Figure B-2: Work Breakdown Structure - LTM



Appendix C
Gantt Chart

Figure C-1: Long-term Monitoring Schedule

ID	Task Name	Duration	Start	Finish
1	Issue RFP	0 days	Wed 01/05/13	Wed 01/05/13
2	Proposal Preparation	5 days	Wed 01/05/13	Tue 07/05/13
3	Proposal Submission	0 days	Tue 07/05/13	Tue 07/05/13
4	Review by PWGSC	5 days	Wed 08/05/13	Tue 14/05/13
5	Contract Award	0 days	Tue 14/05/13	Tue 14/05/13
6	**Project Management**	**160 days**	**Wed 15/05/13**	**Tue 24/12/13**
7	Plan	30 days	Wed 15/05/13	Tue 25/06/13
8	Execution	120 days	Wed 26/06/13	Tue 10/12/13
9	Monitoring and Control	120 days	Wed 26/06/13	Tue 10/12/13
10	Project Closure	10 days	Wed 11/12/13	Tue 24/12/13
11	Permitting	60 days	Wed 15/05/13	Tue 06/08/13
12	Field Logistics and Procurement	52 days	Thu 30/05/13	Fri 09/08/13
13	**Field Program**	**24 days**	**Mon 12/08/13**	**Thu 12/09/13**
14	Mobilization to Site	2 days	Mon 12/08/13	Tue 13/08/13
15	Collect Samples	6 days	Wed 14/08/13	Wed 21/08/13
16	Demobilize from Site	2 days	Thu 22/08/13	Fri 23/08/13
17	Laboratory Analytical Program	14 days	Mon 26/08/13	Thu 12/09/13
18	**Reporting**	**60 days**	**Fri 13/09/13**	**Thu 05/12/13**
19	Preparation of LTM Report	40 days	Fri 13/09/13	Thu 07/11/13
20	Review of LTM Program Report by PWGSC and EC	10 days	Fri 08/11/13	Thu 21/11/13
21	Finalize LTM Program Report	10 days	Fri 22/11/13	Thu 05/12/13
22	Submit Final LTM Program Report	0 days	Thu 05/12/13	Thu 05/12/13



Task | Milestone | Summary | External Tasks

Appendix D
Long-term Monitoring Report Template

LIST OF APPENDICES

Appendix E
Cost Estimate

Category	*Rate*	*Units*	Year 1								Year 2 to 25 (per year)								Totals	
			#	$	#	$	#	$	#	$	#	$	#	$	#	$	#	$	hours	$
			Project Management		Travel		Onsite Work		Reporting		Project Management		Travel		Onsite Work		Reporting			
Professional Fees																				
Corporate Principal	210	hr	12	$2,520.00		$0.00		$0.00	4	$840.00	12	$2,520.00		$0.00		$0.00	4	$840.00	32	$6,720.00
Principal Engineer	210	hr	16	$3,360.00		$0.00		$0.00	8	$1,680.00	16	$3,360.00		$0.00		$0.00	8	$1,680.00	48	$10,080.00
Senior Engineer	180	hr		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
Junior Scientist #1	88	hr	40	$3,520.00	36	$3,168.00	70	$6,160.00	60	$5,280.00	40	$3,520.00	36	$3,168.00	56	$4,928.00	32	$2,816.00	334	$29,392.00
Junior Scientist #2	88	hr		$0.00	36	$3,168.00	70	$6,160.00	60	$5,280.00		$0.00	36	$3,168.00	56	$4,928.00	52	$4,576.00	274	$24,112.00
Drafting	77.5	hr		$0.00		$0.00		$0.00	12	$930.00		$0.00		$0.00		$0.00	8	$620.00	20	$1,550.00
Admin	62	hr		$0.00		$0.00		$0.00	8	$496.00		$0.00		$0.00		$0.00	8	$496.00	16	$992.00
	Totals			$9,400.00		$6,336.00		$12,320.00		$14,506.00		$9,400.00		$6,336.00		$9,856.00		$11,028.00		**$72,846.00**
Communication (2%)				$188.00		$126.72		$246.40		$290.12		$188.00		$126.72		$197.12		$220.56		**$1,456.92**
Personnel Expenses																				
Meals (Iqaluit/Resolute)	132	day/person		$0.00	5	$660.00		$0.00		$0.00		$0.00		$0.00	5	$660.00		$0.00	10	$1,320.00
Hotel (Iqaluit)	220	day/person		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
Hotel (Resolute)	300	day/person		$0.00	4	$1,200.00		$0.00		$0.00		$0.00		$0.00	4	$1,200.00		$0.00	8	$2,400.00
Meals & Accommodation Eureka	360	day/person		$0.00	14	$5,040.00		$0.00		$0.00		$0.00		$0.00	14	$5,040.00		$0.00	28	$10,080.00
Vehicle use at Eureka	105	hour		$0.00	4	$420.00		$0.00		$0.00		$0.00		$0.00	4	$420.00		$0.00	8	$840.00
Fuel at Eureka	5	L		$0.00	20	$100.00		$0.00		$0.00		$0.00		$0.00	20	$100.00		$0.00	40	$200.00
Charter Flight - Resolute to Eureka	37000	return		$0.00	1	$37,000.00		$0.00		$0.00		$0.00		$0.00	1	$37,000.00		$0.00	2	$74,000.00
Scheduled Flight (Ottawa-Resolute)	2500	per person one way		$0.00	2	$5,000.00		$0.00		$0.00		$0.00		$0.00	2	$5,000.00		$0.00	4	$10,000.00
Taxi/Gas	40	each		$0.00	4	$160.00		$0.00		$0.00		$0.00		$0.00	4	$160.00		$0.00	8	$320.00
	Totals			$0.00		$49,580.00		$0.00		$0.00		$0.00		$0.00		$49,580.00		$0.00		**$99,160.00**
Office Expenses																				
Shipping	1000	ea.		$0.00		$0.00	4	$4,000.00		$0.00		$0.00		$0.00	4	$4,000.00		$0.00	8	$8,000.00
Copying & Production Fees	125	ea.		$0.00		$0.00		$0.00	2	$250.00		$0.00		$0.00		$0.00	2	$250.00	4	$500.00
	Totals			$0.00		$0.00		$4,000.00		$250.00		$0.00		$0.00		$4,000.00		$250.00		**$8,500.00**
Field Supplies																				
Alcanox (sample decontamination detergent)	5	ea.		$0.00		$0.00	1	$5.00		$0.00		$0.00		$0.00	1	$5.00		$0.00	2	$10.00
Distilled Water (4L)	5	ea		$0.00		$0.00	1	$5.00		$0.00		$0.00		$0.00	1	$5.00		$0.00	2	$10.00
Gloves (nitrile)	35	box		$0.00		$0.00	4	$140.00		$0.00		$0.00		$0.00	4	$140.00		$0.00	8	$280.00
Soil Sample Bags	10	box		$0.00		$0.00	4	$40.00		$0.00		$0.00		$0.00	4	$40.00		$0.00	8	$80.00
Stakes	25	each		$0.00		$0.00	40	$1,000.00		$0.00		$0.00		$0.00		$0.00		$0.00	40	$1,000.00
Vapour Tubing	8	foot		$0.00		$0.00	2	$16.00		$0.00		$0.00		$0.00	2	$16.00		$0.00	4	$32.00
	Totals			$0.00		$0.00		$1,206.00		$0.00		$0.00		$0.00		$206.00		$0.00		**$1,412.00**
Field Instruments and Equipment																				
GPS	100	week		$0.00		$0.00	1.5	$150.00		$0.00		$0.00		$0.00	1.5	$150.00		$0.00	3	$300.00
RKI Eagle	300	week		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
Water Chemistry Probe	215	week		$0.00		$0.00	1.5	$322.50		$0.00		$0.00		$0.00	1.5	$322.50		$0.00	3	$645.00
GilAir Pump	65	week		$0.00		$0.00	1.5	$97.50		$0.00		$0.00		$0.00	1.5	$97.50		$0.00	3	$195.00
Health and Safety Equipment	150	person		$0.00		$0.00	2	$300.00		$0.00		$0.00		$0.00	2	$300.00		$0.00	4	$600.00
Sediment Auger	150	week		$0.00		$0.00	1.5	$225.00		$0.00		$0.00		$0.00	1.5	$225.00		$0.00	3	$450.00
Hand Trowel (Surface Sampling)	10	week		$0.00		$0.00	1.5	$15.00		$0.00		$0.00		$0.00	1.5	$15.00		$0.00	3	$30.00
Hand Shovel (Sub-surface Sampling)	10	week		$0.00		$0.00	3	$30.00		$0.00		$0.00		$0.00	3	$30.00		$0.00	6	$60.00
Digital camera	50	week		$0.00		$0.00	1.5	$75.00		$0.00		$0.00		$0.00	1.5	$75.00		$0.00	3	$150.00
	Totals			$0.00		$0.00		$1,215.00		$0.00		$0.00		$0.00		$1,215.00		$0.00		**$2,430.00**
Chemical Analyses																				
Soil/Sediment																				
CWS for PHC F1 (C6-C10), Includes BTEX	45	each		$0.00		$0.00	12	$540.00		$0.00		$0.00		$0.00	12	$540.00		$0.00	24	$1,080.00
CWS for PHC F2-4 (C10-16,C16-34, C34-50)	50	each		$0.00		$0.00	50	$2,500.00		$0.00		$0.00		$0.00	50	$2,500.00		$0.00	100	$5,000.00
VOCs	5	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
PCBs	65	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
PAHs	90	each		$0.00		$0.00	12	$1,080.00		$0.00		$0.00		$0.00	12	$1,080.00		$0.00	24	$2,160.00
Metals	80	each		$0.00		$0.00	23	$1,840.00		$0.00		$0.00		$0.00	23	$1,840.00		$0.00	46	$3,680.00
	Totals			$0.00		$0.00		$5,960.00		$0.00		$0.00		$0.00		$5,960.00		$0.00		**$11,920.00**
Water																				
CWS for PHC F1 (C6-C10), Includes BTEX	45	each		$0.00		$0.00	9	$405.00		$0.00		$0.00		$0.00	9	$405.00		$0.00	18	$810.00
CWS for PHC F2-4 (C10-16,C16-34, C34-50)	50	each		$0.00		$0.00	9	$450.00		$0.00		$0.00		$0.00	9	$450.00		$0.00	18	$900.00
VOCs	85	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
PCBs	65	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
PAHs	90	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
Metals ICP-MS	60	each		$0.00		$0.00	9	$540.00		$0.00		$0.00		$0.00	9	$540.00		$0.00	18	$1,080.00
Hardness	10	each		$0.00		$0.00	9	$90.00		$0.00		$0.00		$0.00	9	$90.00		$0.00	18	$180.00
Sample Disposal	1.75	each		$0.00		$0.00	61	$106.75		$0.00		$0.00		$0.00	61	$106.75		$0.00	122	$213.50
Grain Size	20	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
Organic carbon content	25	each		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00	0	$0.00
	Totals			$0.00		$0.00		$1,591.75		$0.00		$0.00		$0.00		$1,591.75		$0.00		**$3,183.50**
Air Sampling																				
Ambient Air	150	each		$0.00		$0.00	7	$1,050.00		$0.00		$0.00		$0.00	7	$1,050.00		$0.00	14	$2,100.00
Sub-slab vapour sampling	135	each		$0.00		$0.00	1	$135.00		$0.00		$0.00		$0.00	1	$135.00		$0.00	2	$270.00
Analysis - F1/F2 PHCs	225	each		$0.00		$0.00	8	$1,800.00		$0.00		$0.00		$0.00	8	$1,800.00		$0.00	16	$3,600.00
	Totals			$0.00		$0.00		$2,985.00		$0.00		$0.00		$0.00		$2,985.00		$0.00		**$5,970.00**
Disbursement (10%)				$0.00		$0.00		$1,295.78		$0.00		$0.00		$0.00		$1,195.78		$0.00		**$2,491.55**
	Grand Totals			**$9,588.00**		**$56,042.72**		**$30,819.93**		**$15,046.12**		**$9,588.00**		**$6,462.72**		**$76,786.65**		**$11,498.56**		**$1,050,520.09**