Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

CAM-F SARCPA LAKE LONG-TERM MONITORING PLAN

January 23, 2007

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Appendices

1.0 Introduction

CAM-F Sarcpa Lake was an Intermediate Distant Early Warning (DEW) Line site, a remediation project was conducted at the site between 2005 and 2008. The remediation involved the demolition and disposal of buildings, structures and other debris, as well as the clean up of hazardous materials. . The remediation included the excavation and disposal of contaminated soil, which was either shipped off site or placed in a secure soil disposal facility on site.

1.1 Location

CAM-F Sarcpa Lake is located on the Melville Peninsula within the Baffin Region of Nunavut. The two nearest communities are Hall Beach, located approximately 85 kilometres to the East, and Igloolik, which is located approximately 100 kilometres to the Northeast. The GPS Coordinates of the site are 68°33'0"N - 83°19'0"E (see Figure 1).

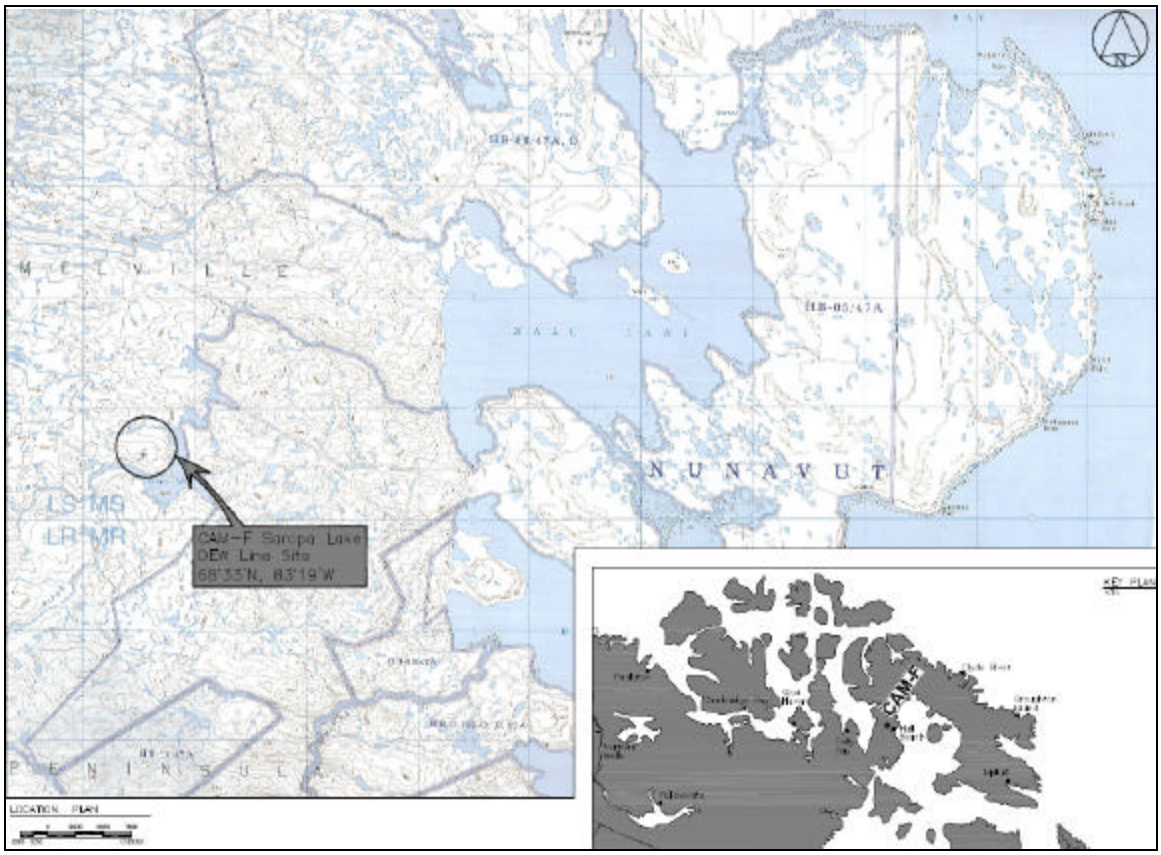


Figure 1: CAM-F Sarcpa Lake Location

1.2 Site Characteristics

The CAM-F Intermediate DEW Line Site was constructed in 1957 and subsequently abandoned in 1963. It was converted to a scientific research station in 1977 under the Science Institute of the Northwest Territories and Canada, Department of Indian and Northern Affairs and operated seasonally until 1988.

The site and buildings were within a favoured hunting area and the buildings had been used as temporary hunting shelters.

The CAM-F site consists of two main parts - the station area and the former construction camp area at Sarcpa Lake (See Appendix A).

The station is accessed via 3 km of road from the shores of Sarcpa Lake. Site facilities consisted of an airstrip, small module train, warehouse, garage, Quonset, Inuit house, two former landfill areas, and oil and lubricants (POL) storage facilities. The site contained approximately 10,000 barrels, a radar tower that had been knocked down, other site debris and contaminated soil. There were also some miscellaneous wastes and chemicals from the years as a research site.

The beach area at Sarcpa Lake included a former construction camp that consisted primarily of scattered barrels (in and around the lake), abandoned construction equipment, and a small machine shop and generator pad.

1.3 Climate

Climatic data information was obtained from the closest weather stations at Hall Beach (elevation 8 m, 85 km east of Sarcpa Lake) and Mackar Inlet (elevation 395 m, 100 km west of Sarcpa Lake) as no weather station was available at Sarcpa Lake. In total, approximately 215 mm and 189 mm of precipitation occur per year at Hall Beach and Mackar Inlet respectively, of which 60% is rainfall and 40% is snowfall. Generally, the wettest months are July through September.

The mean annual air temperature at Hall Beach is -14.7 °C, and at Mackar Inlet -14.4 °C. Daily temperature ranges from 6.0°C in July to -32.7°C in February. Winds are primarily from the northwest, with an average wind speed of 21 km/hr.

1.4 Geology

Regionally, the terrain is undulating to hilly with numerous bedrock outcrops. The landscape is characterized by a surficial veneer or blanket of glacial drift. Occasional small water ponds or thaw lakes occur throughout the area. The ponds are generally small and irregular in shape and follow valleys in the bedrock terrain. Drainage channels and patterns are generally well developed

throughout the area, with drainage directed toward the Kingaroo River and Sarcpa Lake.

Sarcpa Lake is within the zone of continuous permafrost. No ground temperature measurements were made at the site; however, ground temperatures have been measured at Hall beach. The mean annual ground temperatures at Hall Beach varied from -9°C to -10° C.

The CAM-F site sits on a ridge approximately 1,000 m north of Sarcpa Lake. Surface drainage around the station flows off the ridge outward to the southwest and north. Surface water drains either overland or in short drainages which follow the bedrock valleys towards Sarcpa Lake.

Elevation at the main site is 260 m above sea level and the shoreline of Sarcpa Lake is approximately 165 m above sea level.

2.0 Monitoring Areas

During the remediation of CAM-F two structures were constructed and remain on the site, the Non-Hazardous Waste Landfill (NHWL) and the Secure Soil Disposal Facility (SSDF).

2.1 Non-Hazardous Waste Landfill

Construction of the NHWL at CAM-F started in July 2006 and was completed in September 2007. A site map detailing the location of the NHWL can be found in Appendix B.

2.1.1 Design

The NHWL was designed to contain non-hazardous materials only. It was constructed on native ground with the organic matter stripped and consists of four perimeter berms constructed of granular material. The non-hazardous waste was placed in the landfill in layers consisting of 0.5 metre lifts of waste covered by 0.15 metres of granular fill. Once all the layers were completed a final cover consisting of a minimum of 1.0 metres of granular fill was used to cap the landfill. See Appendix C for a detailed schematic of the design.

2.1.2 Contents

The NHWL at CAM-F contains the following:

- Tier I contaminated soil (see Table 1)
- F3 and F4 fraction hydrocarbon contaminated soil
- Non-hazardous demolition debris, such as timbers, plywood, and sheet metal
- Non-hazardous site debris, such as scrap metal and wood
- Non-hazardous debris/soil excavated from landfills
- Creosote timbers
- Double-bagged asbestos

Table #1: DEW Line Cleanup Criteria Tier I Contaminant Criteria

Parameter	Criteria
Lead	200 to 500 ppm
PCBs	1 to <5 ppm

2.1.3 Monitoring Requirements

The NHWL will be monitored by:

- Visual Monitoring
    - This will check the physical integrity of the NHWL and look for evidence of erosion, ponding, frost action, settlement and lateral movement (Appendix D contains a Visual Monitoring Checklist).

- Photographs will be taken to document the condition of the NHWL and substantiate the recorded observations.

2.2 Secure Soil Disposal Facility (SSDF)

Construction of the SSDF at CAM-F started in July 2006 and was completed in September 2007. A site map detailing the location of the SSDF can be found in Appendix E.

2.2.1 Design

The SSDF was designed to contain non-hazardous, contaminated soils. The design was based on the characteristics of the contaminants in the soil and the local geothermal and permafrost properties. The design uses permafrost as the primary containment barrier with both the contents and perimeter berms remaining in a frozen state (the SSDF should reach a frozen state within 3-4 years of construction). The thickness of the cover material was calculated to prevent the thaw of the contaminated soil even after 10 consecutive 1 in 100 warm years. The initial design was modified in 2007 and an additional metre of cover was added increasing the total cover material from 2.3 to 3.3 metres. The additional cover material was added after data from an international project called the Arctic Climate Impact Assessment was assessed and it was determined that the long term recommendations for climate change had increased.

Secondary containment is achieved by using High-Density Polyethylene (HDPE) liners welded together to cover the base, sides, and top of the facility. The HDPE liners are chemically compatible with the contaminated soil and prevent precipitation percolation as well as the movement of contaminants during permafrost aggradation.

The SSDF was constructed by first preparing the subgrade and installing the key trench and four exterior berms using saturated silty gravel. The HDPE liner on the base and sides was then installed and contaminated soils were placed inside the facility. Following this an intermediate granular cover was placed on top followed by the top HDPE liner and the final granular cover. The final construction steps are to grading to promote drainage and the installation of thermistors and monitoring wells. See Appendix F for a detailed schematic of the design.

2.2.2 Contents

The SSDF at CAM-F contains the following:

- Tier II contaminated soil (see Table 2)
- PHC (petroleum hydrocarbon) contaminated soils (BTEX, F1 and F2)

Table #2: DEW Line Cleanup Criteria Tier I Contaminant Criteria

Parameter	Criteria
Arsenic	30 ppm
Cadmium	5 ppm
Chromium	250 ppm
Cobalt	50 ppm
Copper	100 ppm
Lead	500 ppm
Mercury	2 ppm
Nickel	100 ppm
Zinc	500 ppm
PCBs	>5 to <50 ppm

2.2.3 Monitoring Parameters

The SSDF will be monitored by:

- Visual Monitoring
  - This will check the physical integrity of the SSDF and look for evidence of erosion, ponding, frost action, settlement and lateral movement (Appendix D contains a Visual Monitoring Checklist).
  - Photographs will be taken to document the condition of the SSDF and substantiate the recorded observations.
- Active Layer Water Monitoring
  - Samples will be taken from the 2 monitoring wells installed down-gradient from the SSDF. These samples will be analysed and the results will be compared to those from background samples. The parameters that will be analysed include:
    - Colour
    - Odour
    - pH
    - Conductivity
    - Temperature
    - Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc
    - Polychlorinated biphenyls (PCBs)
    - Total Petroleum Hydrocarbons (TPH)
- Soil Monitoring
  - Soil samples will be taken at the toe of the SSDF in the vicinity of the monitoring wells. These samples will be analysed and the results will be compared to baseline/background samples. The parameters that will be analysed include:
    - Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc
    - Polychlorinated biphenyls (PCBs)
    - Total Petroleum Hydrocarbons (TPH)

- Thermal Monitoring
  - The thermal monitoring system consists of 4 thermistor strings with beads at selected intervals to provide ground temperature profiles at various locations within the SSDF (See Appendix G for the Thermistor Installation Reports). Automatic data loggers attached to the thermistors allow remote data collection. The data from this system will be collected and analysed to determine the permafrost aggradation in the facility.

2.3 Monitoring Schedule

Monitoring at the CAM-F Sarcpa Lake site will begin in 2008 and continue for 25 years until 2032. Monitoring will occur every year for the first 5 years, then in year 7, 10, 15, 20 and 25. At the completion of the 25 year monitoring program a review will take place and the need for continued monitoring will be assessed. The table below outlines the schedule:

Table #3: Monitoring Schedule

Year	Site Monitoring Scheduled (X)
2008	X
2009	X
2010	X
2011	X
2012	X
2013	
2014	X
2015	
2016	
2017	X
2018	
2019	
2020	
2021	
2022	X
2023	
2024	
2025	
2026	
2027	X
2028	
2029	
2030	
2031	
2032	X

2.4 Monitoring Plan Summary

The monitoring plan at CAM-F Sarcpa Lake will begin in 2008 and continue for 25 years. The areas to be monitored are the NHWL and the SSDF; the parameters that will be monitored include visual characteristics, water, soil, and temperature. The monitoring requirements for the NHWL and the SSDF are summarized in the tables below:

Table #4: General Monitoring Requirements

Area	Monitoring Parameter			
	Visual	Water	Soil	Temperature
NHWL	X			
SSDF	X	X	X	X

Table #5: Specific Monitoring Requirements

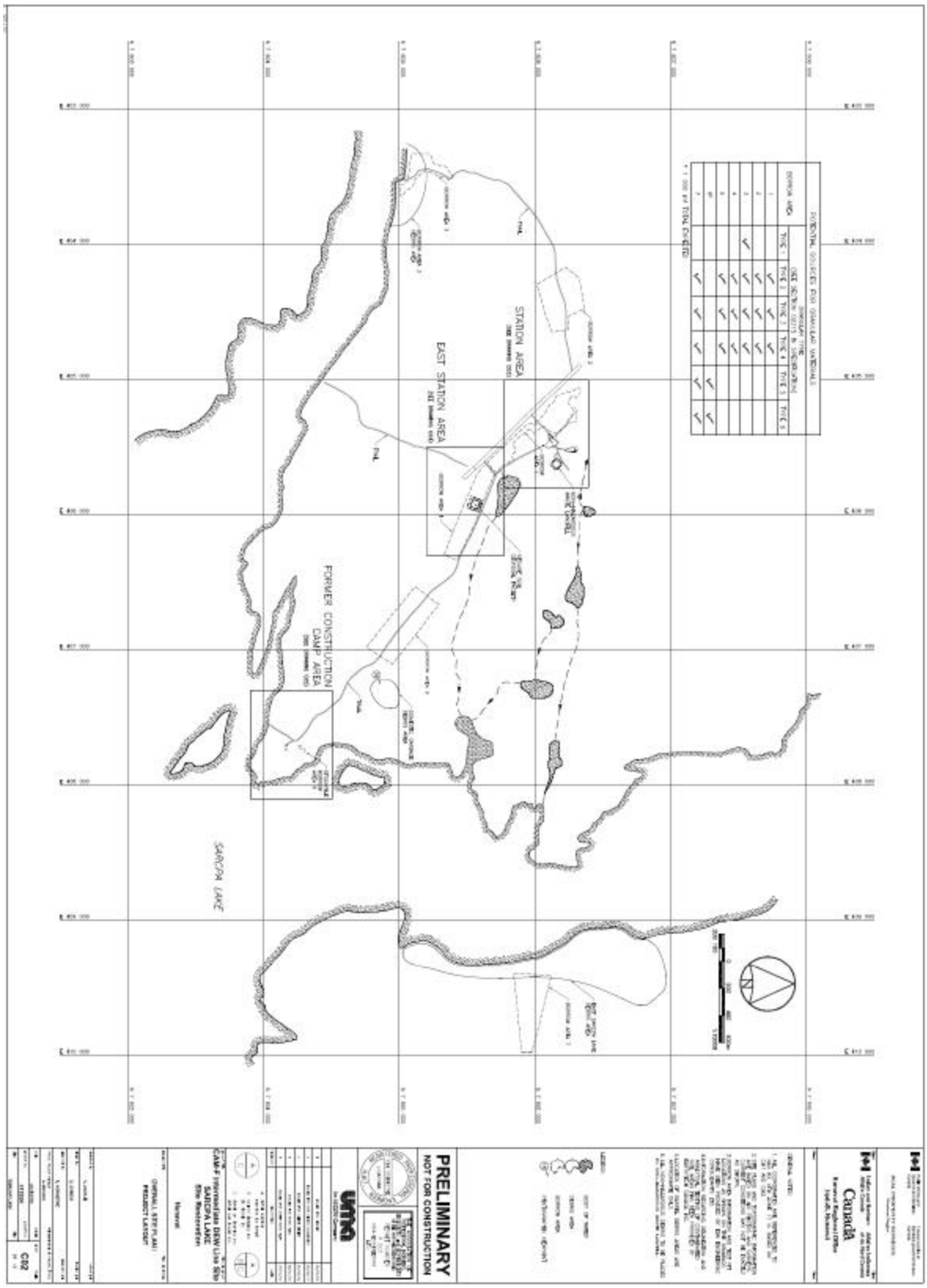
Area	Water & Soil				Temperature		
	ID	Notes	Distance	Install Date	ID	Depth	Install Date
SSDF	BM-1	Up-gradient	~ 60 m	2006	VT-1	4.8 m	2007
	BM-2	Up-gradient	~ 57 m	2006	VT-2	4.8 m	2007
	MW-5	Down-gradient	~ 18 m	2006	VT-3	6.9 m	2007
	MW-6	Down-gradient	~ 19 m	2006	VT-4	6.9 m	2007

3.0 Quality Assurance/Quality Control

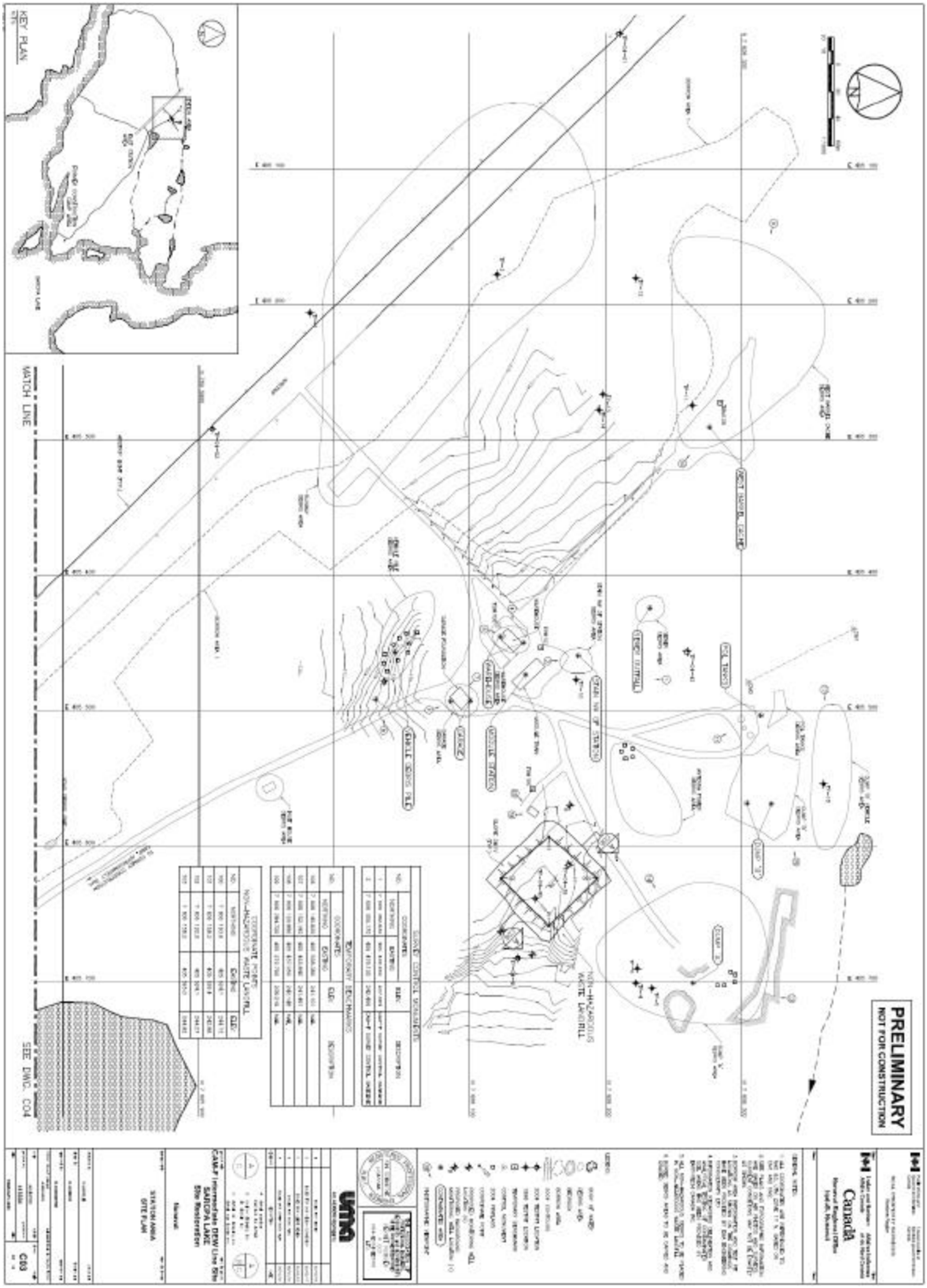
All sampling, sample preservation and analyses will be conducted in accordance with methods prescribed in the current edition of “Standard Methods for the Examination of Water and Wastewater”. All analysis will be performed in a Canadian Association of Environmental Analytical Laboratories (CAEAL) Accredited Laboratory.

Quality Assurance/Quality Control (QA/QC) will be consistent with CAEAL regulations and guidelines. At least 20% of samples will be taken and analyzed in duplicate and all appropriate QA/QC data will be generated and reported.

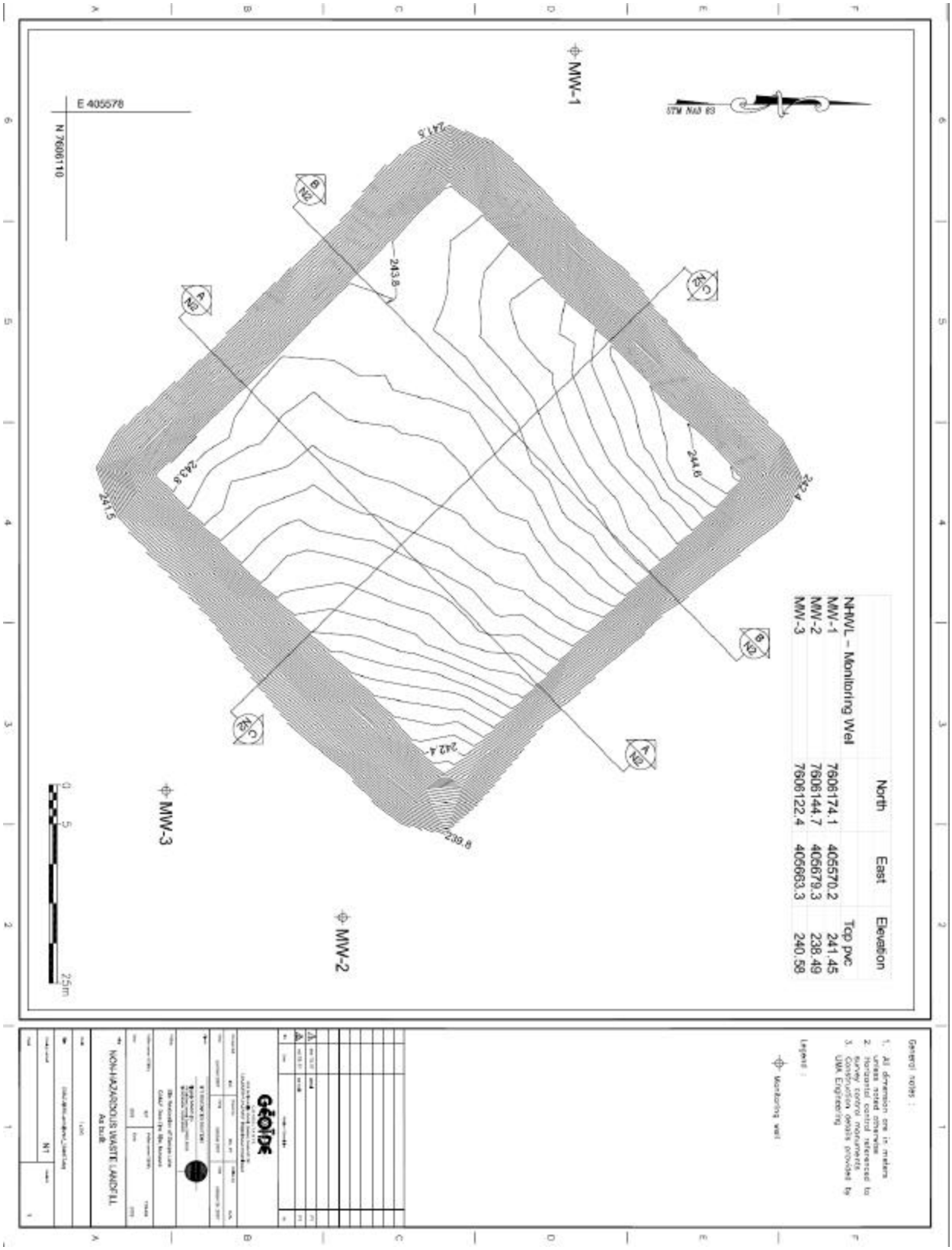
Appendix A: CAM-F Sarcpa Lake Site Map

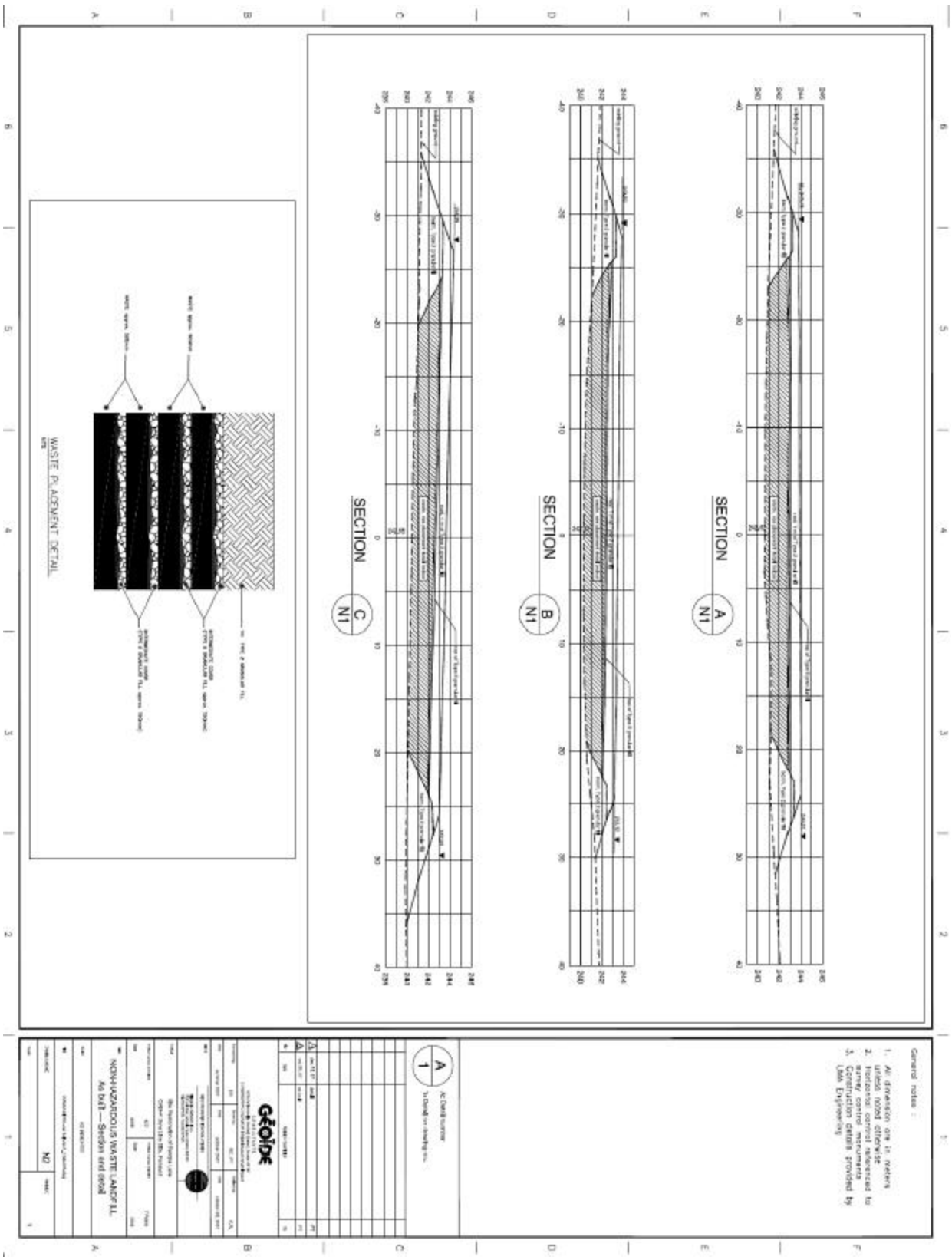

STATION AREA
EAST STATION AREA
FORMER CONSTRUCTION CAMP AREA
SARCPA LAKE
PRELIMINARY
NOT FOR CONSTRUCTION

Appendix B: Non-Hazardous Waste Landfill Location Map


KEY PLAN
WATCH LINE
SEE DWG. C04
PRELIMINARY
NOT FOR CONSTRUCTION
Canada

Appendix C: Non-Hazardous Waste Landfill As-Built Drawings


MW-1
MW-2
MW-3
E 405578
N 7606110
241.5
243.8
244.6
242.4
239.8
242.4
0
5
25m
NHWL – Monitoring Wel
North
East
Elevation
MW-1
7606174.1
405570.2
Top pvc 241.45
MW-2
7606144.7
405679.3
238.49
MW-3
7606122.4
405663.3
240.58
Monitoring well
NON-HAZARDOUS WASTE LANDFILL
As built


SECTION
A
N1
SECTION
B
N1
SECTION
C
N1
WASTE PLACEMENT DETAIL
NONHAZARDOUS WASTE LANDFILL
As built — Section and details
GÉOLINE

Appendix D: Visual Monitoring Checklist

CAM-F SARCPA LAKE
VISUAL MONITORING CHECKLIST

Date:	
Landfill:	

Visually assess the landfill for the following items & provide a photograph record

1. Erosion	Answer
a) Is erosion occurring on the surface or berms of the landfill?	
i) Are there preferred drainage channels?	
ii) Is there sloughing of material?	
b) What is the extent of the erosion? *(percentage of surface area)*	
i) Is it localized or continuous?	
c) Where is the erosion occurring? *(i.e. along the toe, on the surface, through the berms)*	
d) Explanation: *(i.e. evidence of significant surface water run-off, poor material)*	

2. Settlement	Answer
a) Is there differential settlement occurring on the surface?	
i) Are there low areas or depressions?	
ii) Are voids forming?	
b) What is the extent of the settlement? *(percentage of surface area)*	
i) Is it localized or continuous?	
ii) How deep is it?	
c) Where is the settlement occurring? *(i.e. near berms, near the centre of the facility)*	
d) Explanation: *(i.e. evidence of significant surface infiltration, water ponding, snow drifting)*	

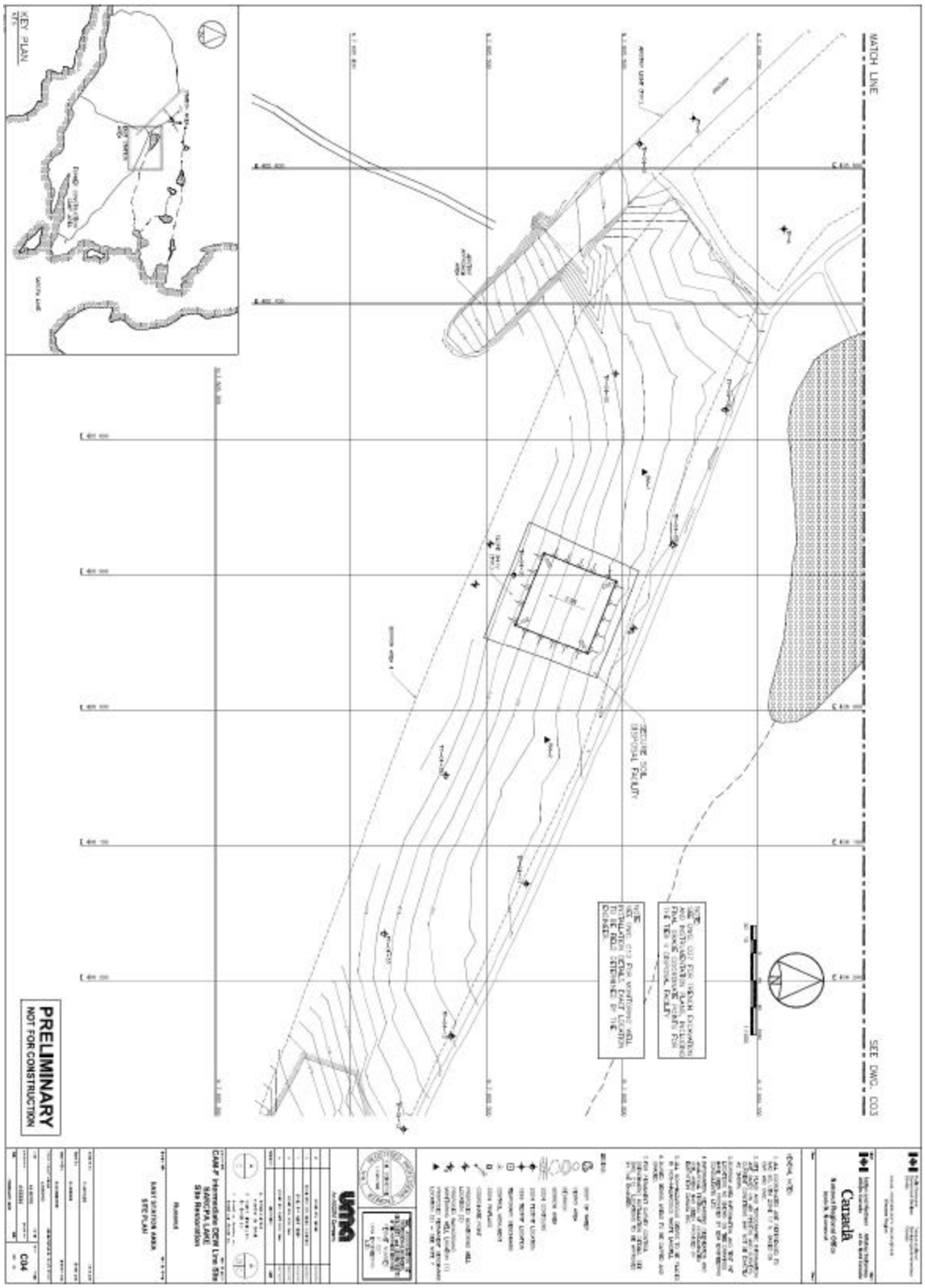
3. Frost Action	Answer
a) Is there frost action/damage to the landfill?	
i) Is there exposed debris due to uplift?	
ii) Is there tension cracking along the berms?	
iii) Is there sorting of granular fill?	
b) What is the extent of the frost action? *(percentage of surface area)*	
i) Is it localized or continuous?	
c) Where is the heaving/cracking occurring? *(i.e. along the toe, on the surface, through the berms)*	
d) Explanation: *(i.e. poor material, poor compaction, high water/silt content in cover material)*	

4. Monitoring Instruments
a) What is the condition of the monitoring wells and thermistor strings *(if applicable)*?

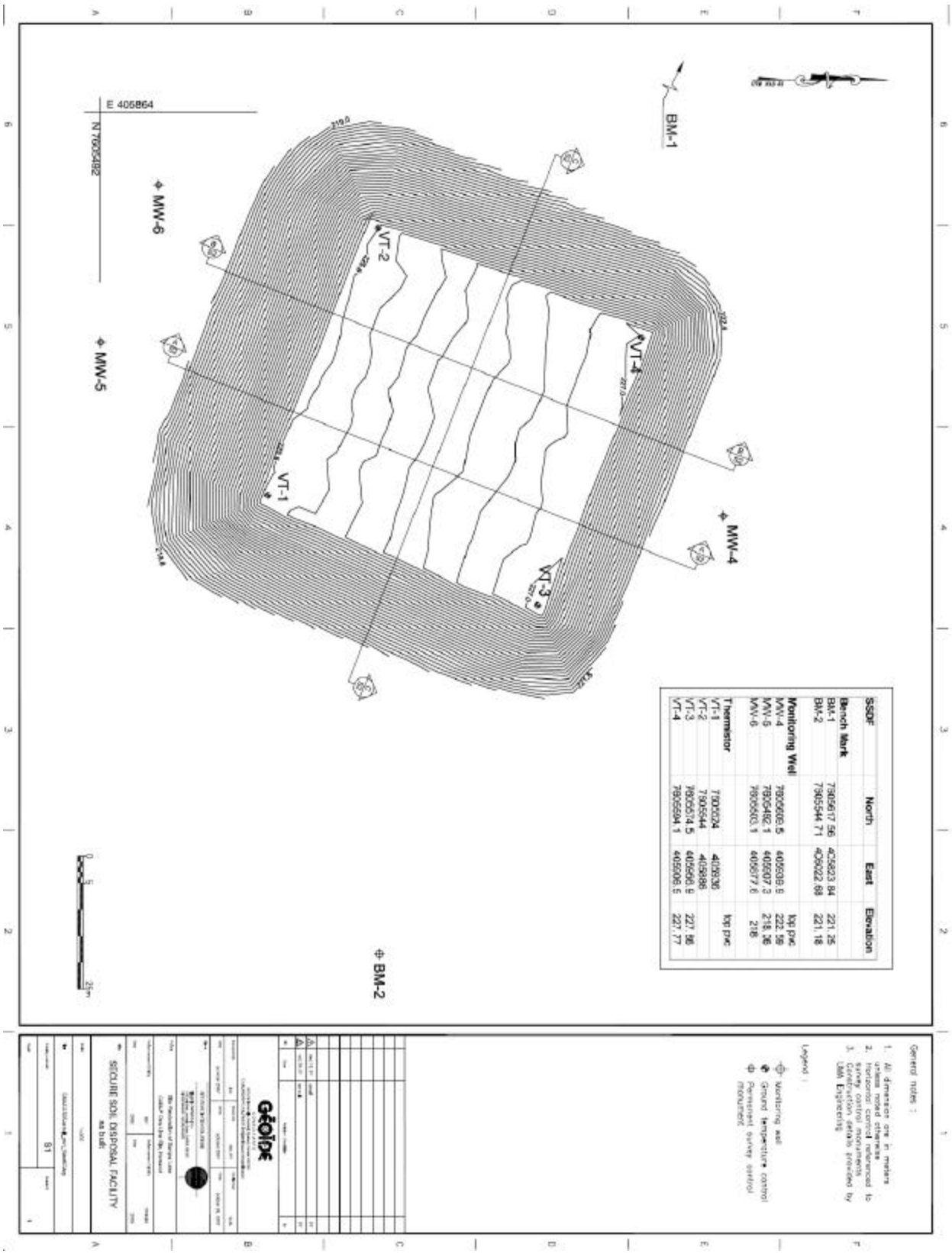
5. Sketch

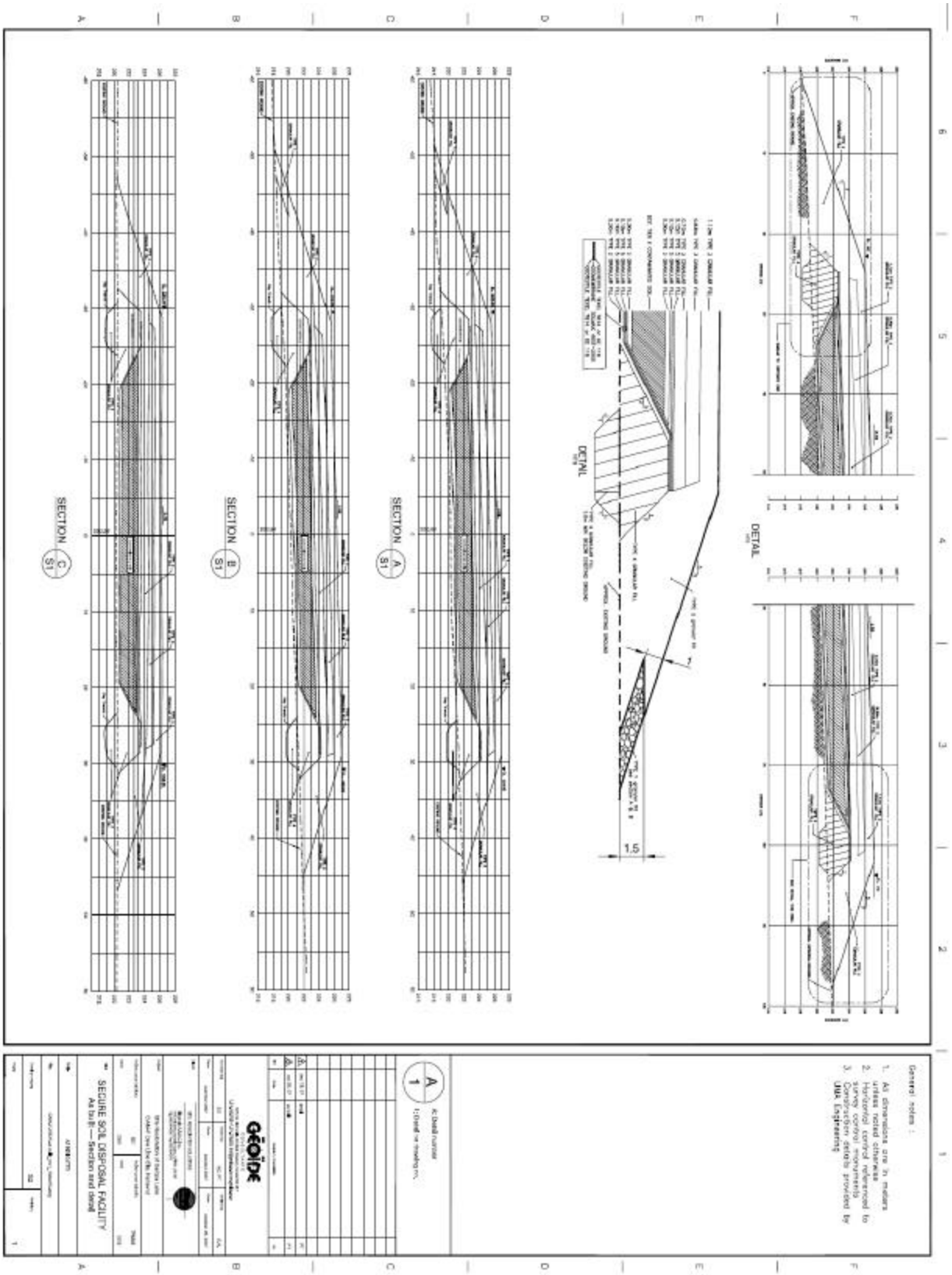
6. General Comments

Appendix E: Secure Soil Disposal Facility Location Map


KEY PLAN
WATCH LINE
SEE DWG. C03
PRELIMINARY
NOT FOR CONSTRUCTION

Appendix F: Secure Soil Disposal Facility As-Built Drawing


BM-1
BM-2
MW-4
MW-5
MW-6
VT-1
VT-2
VT-3
VT-4
E 405864
N 7905492
SSDF
Bench Mark
BM-1 7905617.56 405823.84 221.25
BM-2 7905544.71 405922.68 221.18
Monitoring Well
MW-4 7905609.5 405609.9 top pvc 222.58
MW-5 7905492.1 405607.3 218.26
MW-6 7905503.1 405577.6 218
Thermistor
VT-1 7905524 405936 top pvc
VT-2 7905544 405686 227.86
VT-3 7905514.5 405568.9 227.77
VT-4 7905594.1 405506.5 227.77
General notes :
1. All dimension are in meters
2. Horizontal control referenced to survey control monuments
3. Construction details provided by LMA Engineering
Legend :
Monitoring well
Ground temperature control
Permanent survey control monument
SECURE SOIL DISPOSAL FACILITY
as built
Géofor
81


SECTION C S1
SECTION B S1
SECTION A S1
DETAIL
DETAIL
1.5
SEGURE SOIL DISPOSAL FACILITY
As built — Sections and detail
GÉOLIDE

Appendix G: Thermistor (Ground Temperature Cable) Installation Reports

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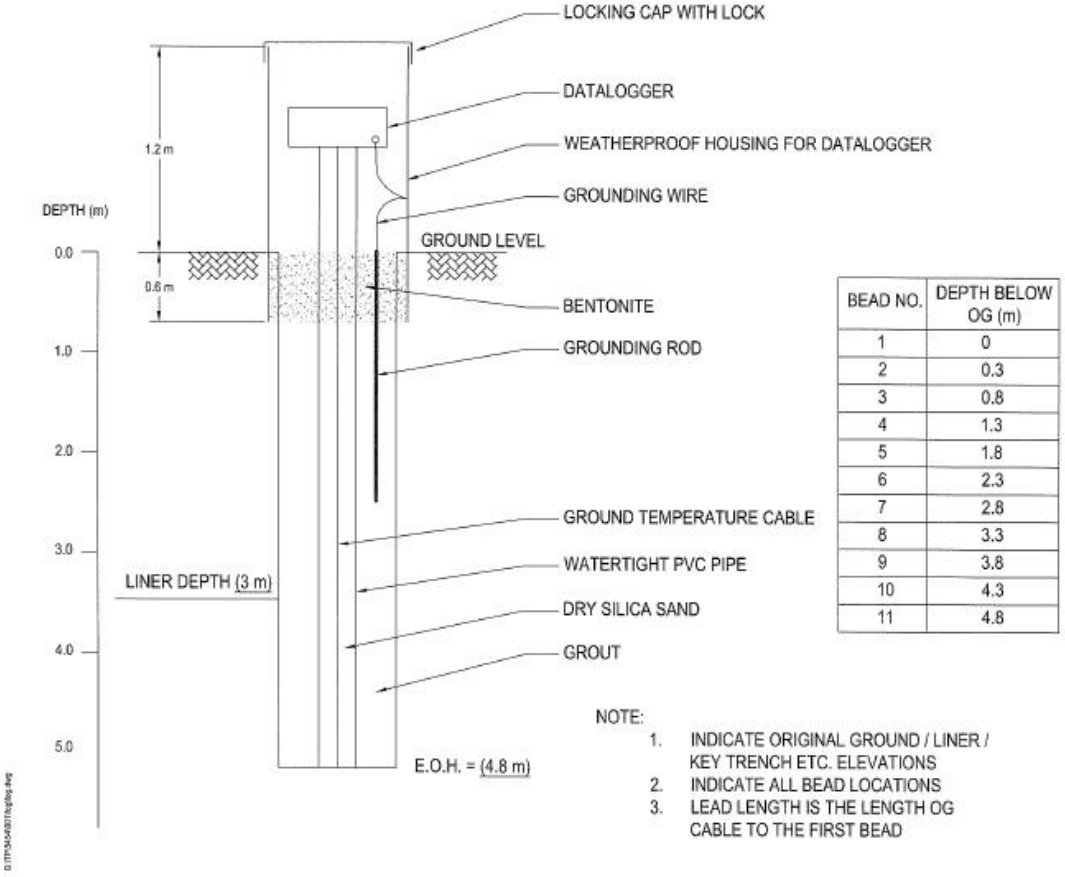
CAM-F DEW LINE CLEAN UP PROJECT
GROUND TEMPERATURE CABLE INSTALLATION REPORT

SITE: SSDF SE & SW CORNERS
LOCATION NORTHING: -
GROUND ELEVATION: -
CABLE LENGTH: 7.8 m
CABLE LENGTH ABOVE GROUND: 3.0 m
NUMBER OF BEADS: 11

CABLE INSTALLATION NO.: 3
CABLE SERIAL NO.: CAMF VTO1
EASTING: -
DATE: SEPT. 2007
LEAD LENGTH: 3.0 m
FIRST BEAD ELEVATION: 0 m BOG
HOLE DEPTH: 4.8 m
VT01 STICKUP: 76 cm



BEAD NO.	DEPTH BELOW OG (m)
1	0
2	0.3
3	0.8
4	1.3
5	1.8
6	2.3
7	2.8
8	3.3
9	3.8
10	4.3
11	4.8

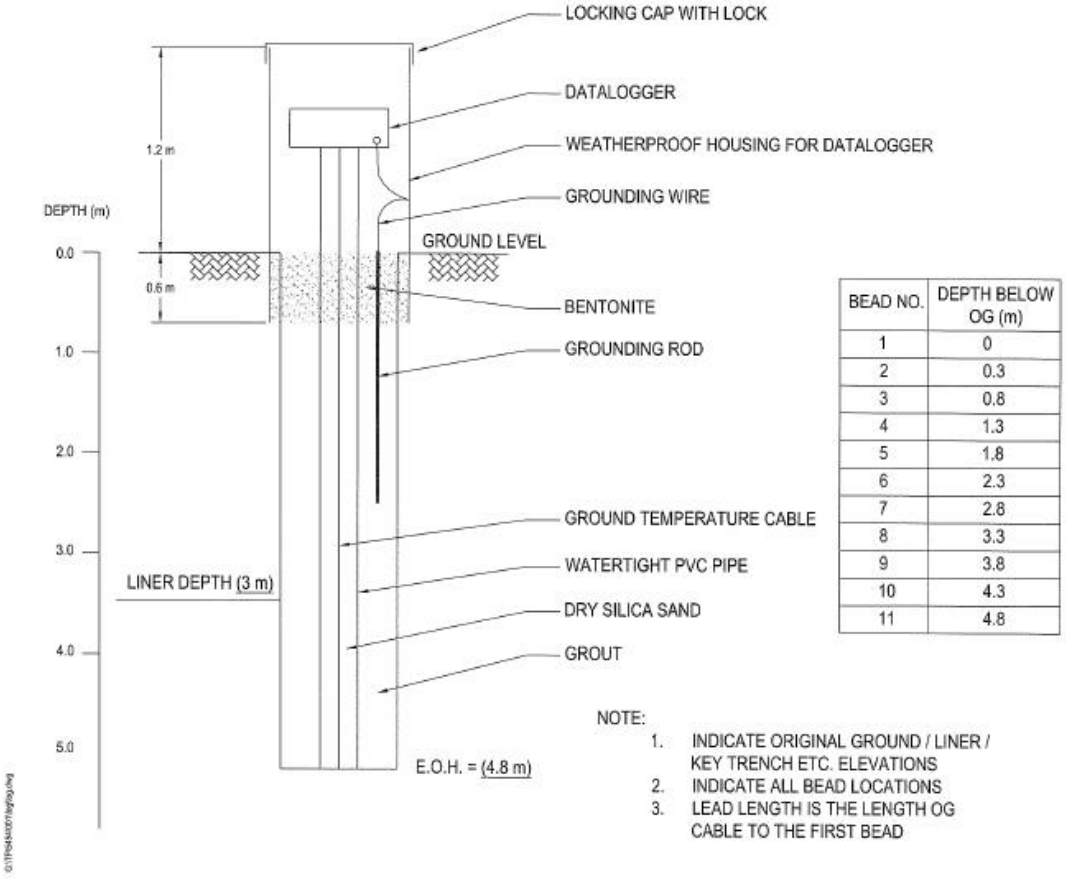
NOTE:
1. INDICATE ORIGINAL GROUND / LINER / KEY TRENCH ETC. ELEVATIONS
2. INDICATE ALL BEAD LOCATIONS
3. LEAD LENGTH IS THE LENGTH OG CABLE TO THE FIRST BEAD

Biogénie

CAM-F DEW LINE CLEAN UP PROJECT
GROUND TEMPERATURE CABLE INSTALLATION REPORT

SITE: SSDF SE & SW CORNERS
LOCATION NORTHING: -
GROUND ELEVATION: -
CABLE LENGTH: 7.8 m
CABLE LENGTH ABOVE GROUND: 3.0 m
NUMBER OF BEADS: 11

CABLE INSTALLATION NO.: 4
CABLE SERIAL NO.: CAMF VT02
EASTING: -
DATE: SEPT. 2007
LEAD LENGTH: 3.0 m
FIRST BEAD ELEVATION: 0 m BOG
HOLE DEPTH: 4.8 m
VT02 STICKUP: 90 cm



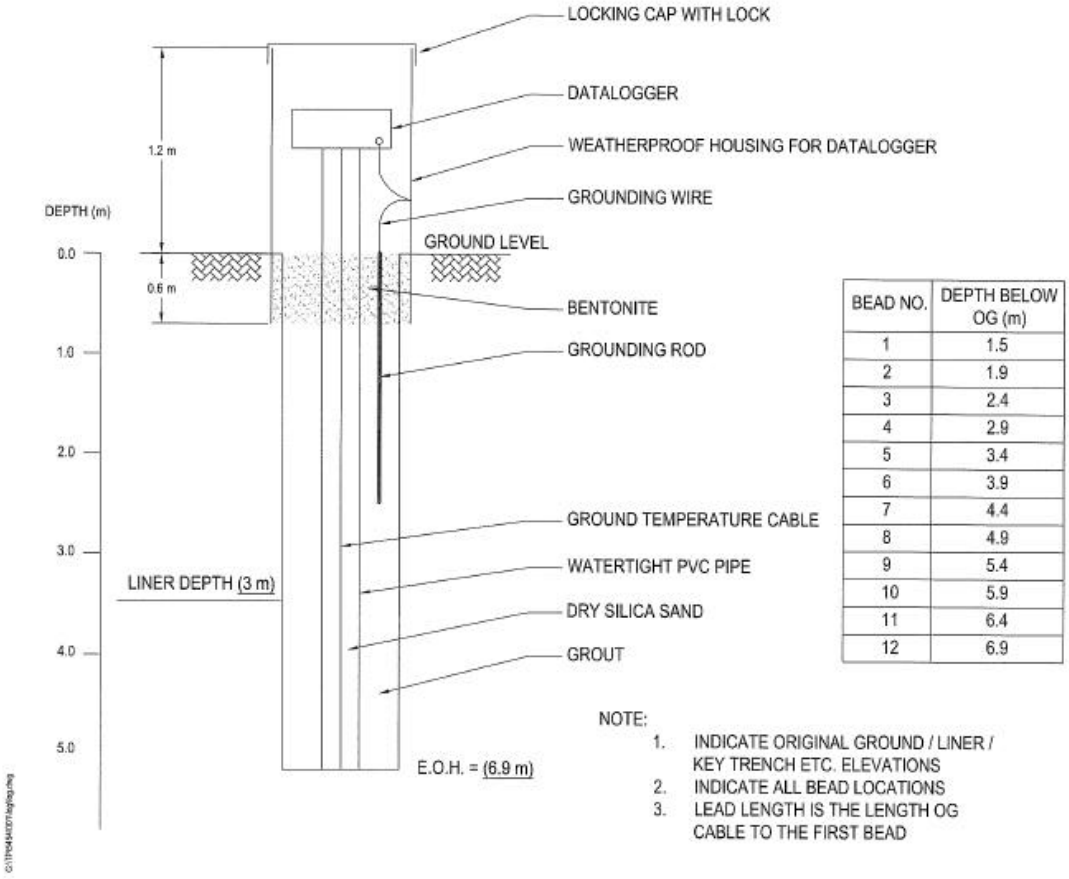
BEAD NO.	DEPTH BELOW OG (m)
1	0
2	0.3
3	0.8
4	1.3
5	1.8
6	2.3
7	2.8
8	3.3
9	3.8
10	4.3
11	4.8

NOTE:
1. INDICATE ORIGINAL GROUND / LINER / KEY TRENCH ETC. ELEVATIONS
2. INDICATE ALL BEAD LOCATIONS
3. LEAD LENGTH IS THE LENGTH OG CABLE TO THE FIRST BEAD

Biogénie

CAM-F DEW LINE CLEAN UP PROJECT
GROUND TEMPERATURE CABLE INSTALLATION REPORT

SITE: SSDF NE & NW CORNERS	CABLE INSTALLATION NO.: 1
LOCATION NORTHING: -	CABLE SERIAL NO.: CAMF VTO3
GROUND ELEVATION: -	EASTING: -
CABLE LENGTH: 8.4 m	DATE: SEPT. 2007
CABLE LENGTH ABOVE GROUND: 1.5 m	LEAD LENGTH: 3.0 m
NUMBER OF BEADS: 12	FIRST BEAD ELEVATION: 1.5 m
	HOLE DEPTH: 6.9 m
	VT03 STICKUP: 76 cm



BEAD NO.	DEPTH BELOW OG (m)
1	1.5
2	1.9
3	2.4
4	2.9
5	3.4
6	3.9
7	4.4
8	4.9
9	5.4
10	5.9
11	6.4
12	6.9

NOTE:
1. INDICATE ORIGINAL GROUND / LINER / KEY TRENCH ETC. ELEVATIONS
2. INDICATE ALL BEAD LOCATIONS
3. LEAD LENGTH IS THE LENGTH OG CABLE TO THE FIRST BEAD

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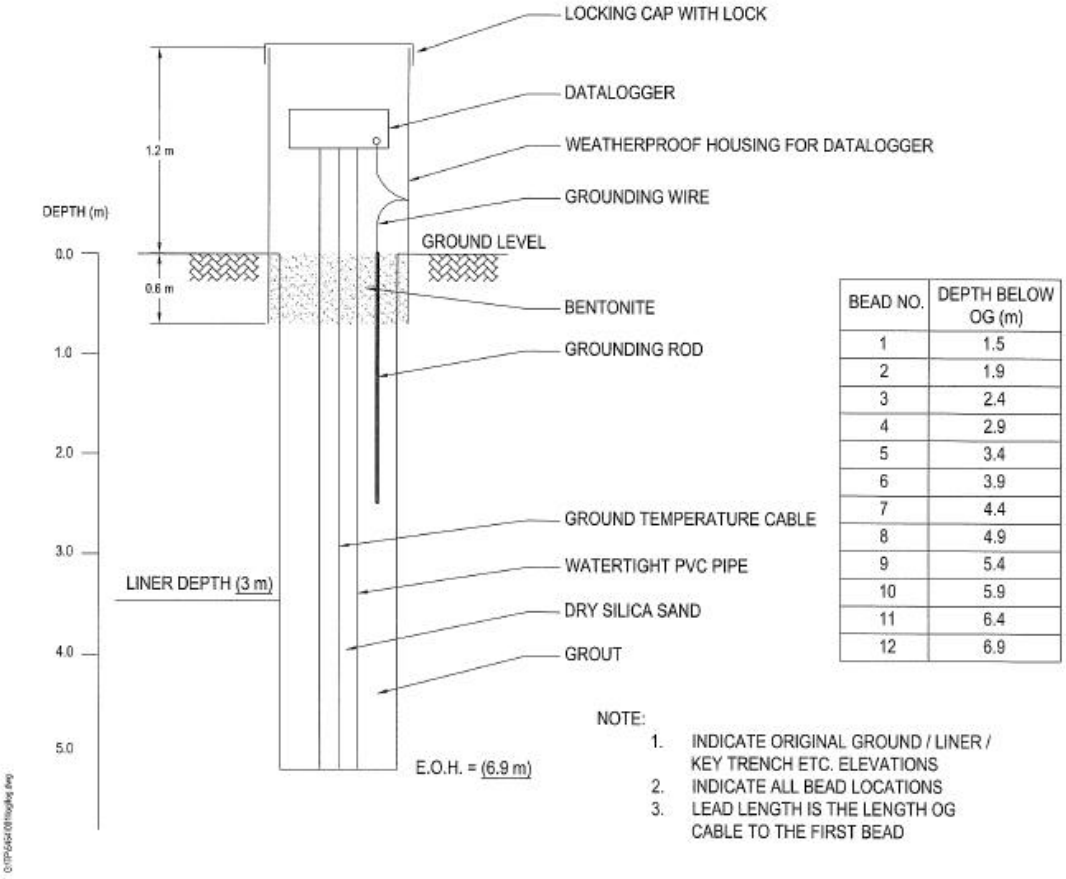
CAM-F DEW LINE CLEAN UP PROJECT
GROUND TEMPERATURE CABLE INSTALLATION REPORT

SITE: SSDF NE & NW CORNERS	CABLE INSTALLATION NO.: 2
LOCATION NORTHING: -	CABLE SERIAL NO.: CAMF VTO4
GROUND ELEVATION: -	EASTING: -
CABLE LENGTH: 8.4 m	DATE: SEPT. 2007
CABLE LENGTH ABOVE GROUND: 1.5 m	LEAD LENGTH: 3.0 m
NUMBER OF BEADS: 12	FIRST BEAD ELEVATION: 1.5 m BOG
	HOLE DEPTH: 6.9 m
	VT04 STICKUP: 73 cm



BEAD NO.	DEPTH BELOW OG (m)
1	1.5
2	1.9
3	2.4
4	2.9
5	3.4
6	3.9
7	4.4
8	4.9
9	5.4
10	5.9
11	6.4
12	6.9

NOTE:
1. INDICATE ORIGINAL GROUND / LINER / KEY TRENCH ETC. ELEVATIONS
2. INDICATE ALL BEAD LOCATIONS
3. LEAD LENGTH IS THE LENGTH OG CABLE TO THE FIRST BEAD