CAM - D DEW Line Site
Simpson Lake, Nunavut
Remedial Action Plan

REMEDIAL ACTION PLAN

CAM-D DEW Line Site
Simpson Lake, Nunavut

Prepared for:
Public Works Government Services Canada
Acquisitions & Contracting Services
Northern Contaminated Sites Program
5th Floor Telus Plaza North
10025 Jasper Avenue
Edmonton, Alberta, T5J 1S6

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December 2007

Over 100 years of Engineering in Canada

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December 1, 2007

Refer to File: 88122-03

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Public Works and Government Services Canada
Environmental Services
1000-9700 Jasper Avenue
Edmonton, AB
T5J 4E2

Attention: Mr. Matthew McElwaine, P.Eng.

Dear Sir:

Re: CAM-D DEW Line Site, Remedial Action Plan – Final Report

Please find enclosed the Earth Tech Canada Remedial Action Plan for the CAM-D DEW Line Site.

It has been Earth Tech's pleasure to complete this project. If you have any questions, please do not hesitate to contact the undersigned at (780) 732-9462.

Very truly yours,

EARTH TECH (CANADA) INC.
Per:

Written By:

Greg Wright, M.Sc.
Project Manager, Environmental Group

REGISTERED PROFESSIONAL ENGINEER
G.L. WOOLLETT
LICENSEE
NWT/NU

Gordon Woollett, P.Eng.
Senior Manager, Environmental Group
12/3/07

NAPEGG Permit to Practice No. P005

GTW:vad
Encls.

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December 2007
Project No.: 88122-03

Executive Summary

As the caretaker of federal lands in Canada's north, Indian and Northern Affairs Canada (INAC) is responsible for the care and management of sites that are no longer maintained by the original owner/operator. These sites are often contaminated as a result of mining, oil and gas activities, as well as from government military activities, which took place before environmental impacts were understood. Through the Contaminated Sites Program (CSP), INAC has made it a priority to assess, prioritize and mitigate/remediate the environmental impacts of contaminated sites in Canada's North. As a result, INAC is required to develop a Remedial Action Plan (RAP) for the former CAM-D Intermediate Distant Early Warning (DEW) Line Site, located at Simpson Lake, Nunavut.

In support of the Remedial Action Plan, Earth Tech Canada, on behalf of Public Works and Government Services Canada (PWGSC) and INAC, has prepared this report which identifies remediation options, critiques potential remediation methods, and provides recommendations for site restoration, as well as a cost estimate to undertake the remedial work.

This RAP for the former CAM-D DEW Line Site was designed in accordance with the INAC Abandoned Military Site Remediation Protocol (March 2005). This Protocol is designed to address legal requirements, health and safety issues, INAC's Contaminated Sites Management Policy requirements and standard environmental issues. The Protocol identifies financially prudent methodologies that address all the requirements listed above while maintaining a cost effective remediation project.

The table below provides a summary of the environmental issues identified at CAM-D and the proposed remedial action for each.

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
Metals Contaminated Soils	45 m^3 of soils with concentrations of As, Cd, and Zn, which exceed the DCC Tier II criteria were identified onsite. This volume includes 3 m^3 of material that is co-contaminated with PCBs. In addition, 240 m^3 of Tier I soils and 319 m^3 of Tier II soils may be located in the buried waste sites.	Excavate, containerize and label soils that exceed DCC Tier II criteria and dispose offsite. Dispose of soils that exceed DCC Tier I soils in an onsite landfill.
Petroleum Hydrocarbon Contaminated Soils	Approximately 326 m^3 of hydrocarbon contaminated soil in exceedance of the INAC Abandoned Military Site Remediation Protocol for PHC Soils.	Excavate contaminated soils and place into containers, and ship off site to a licensed disposal facility.
Petroleum Hydrocarbon Impacted Soils	Approximately 3,074 m^3 of impacted soils with elevated concentrations of F2, F3, BTEX and/or PAHs	Excavation of impacted soils, use as intermediate fill in non-hazardous landfill.
Buried Debris	Buried debris on the site contains various amounts of hazardous and non-hazardous materials as well as contaminated soils. Based on previous experience by UMA Engineering, there may be 428 m^3 of non-hazardous material and 56 m^3 of hazardous	All buried and partially debris should be excavated, sorted and separated into different waste types. All non-hazardous wastes to be disposed in a non-hazardous

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
	material buried onsite (asbestos and painted materials).	landfill.
Surface Debris and Dumps	Approximately 745 m^3 of non-hazardous debris consisting of heavy equipment, barrels, scrap metal, scrap wood, concrete, electrical equipment and plumbing parts.	Consolidate and dispose in a non hazardous landfill constructed onsite.
POL Fluids	There are approximately 16.4 m^3 (16,400 L) of Petroleum, Oil and Lubricant fluids.	Incinerate POL fluids that meet incineration criteria (< 2 ppm PCBs and Cd and < 10 ppm Cr and <100 ppm lead and <1000 ppm Chlorine), otherwise treat as Hazardous Waste.
Water in barrels	Analysis of collected water in the abandoned barrels indicates that the dissolved metals meet DLCU barrel protocol.	Disposal on ground is permitted once water has been polished with an absorbent materials, additional sampling of more barrels during remediation program is required.
PCB/Lead Amended Paint Products	Approximately 40 m^3 of PCB/lead amended paint materials were discovered on site, an additional 53 m^3 is estimated to be deposited in the buried debris areas.	Dismantle contaminated paint items and ship off site to an appropriate disposal facility. Remove painted items from buried debris locations and dispose offsite.
Hazardous Materials	Approximately 18 m^3 of hazardous materials were identified at the site. These materials consisted of lead acid batteries (1 m^3) and asbestos containing materials (17 m^3). There is also potentially 3 m^3 of additional asbestos materials deposited in the buried debris locations.	Asbestos waste to be collected bagged and disposed of in an on-site landfill. All hazardous materials (such as batteries) will be containerized and labeled and shipped to be disposed at a licensed southern facility.
Compressed Gas Cylinders	Approximately 20 compressed gas cylinders were identified onsite.	Vent and dispose of cylinders according to the INAC AMSRP in the non-hazardous landfill.
Structures	POL pump shed Garage Concrete foundations	All buildings shall be demolished to their foundations and all site debris placed and compacted in an on site landfill.

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

CAM-D is a former DEW Line site situated on the Boothia Peninsula between Sheppard Bay and Pelly Bay. More specifically, the site is located approximately 120 km southeast of Taloyoak (Spence Bay), 100 km east of Gjoa Haven, and 80 km west of Kugaaruk, Nunavut (**Figure 1.0**). The DEW Line site was in operation from 1957 to 1963, after which the site was vacated and left abandoned.

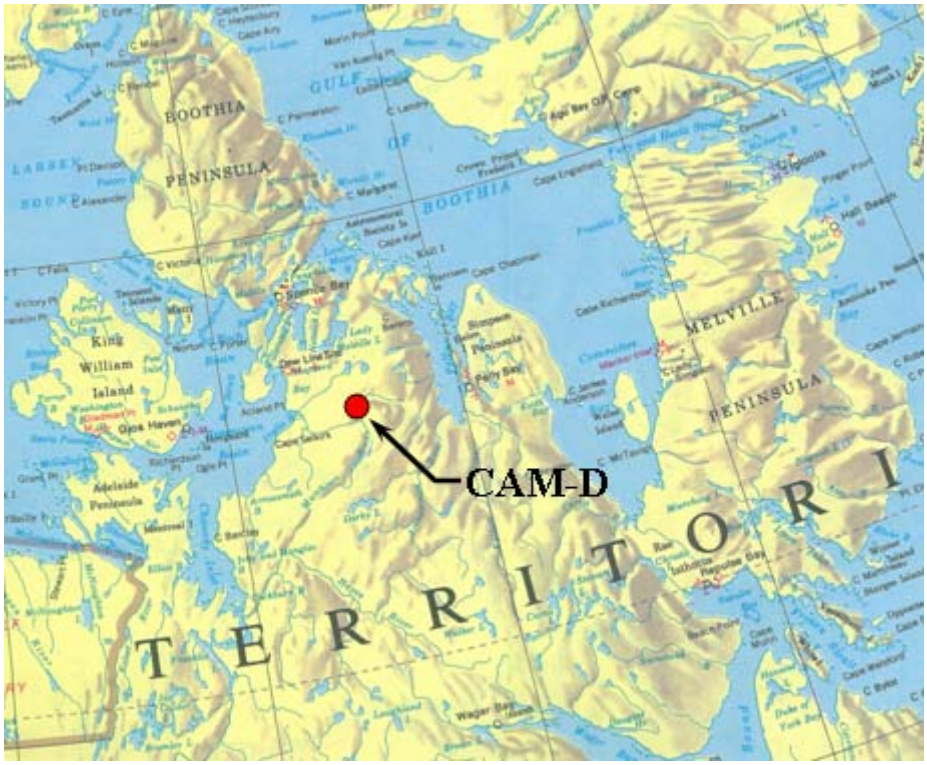


Figure 1.0 CAM-D Site Location

As the caretaker of federal lands in Canada's north, Indian and Northern Affairs Canada (INAC) is responsible for the care and management of contaminated sites that are no longer maintained by the original owner/operator. Consequently, in 1965 the site, including all structures, equipment, debris and environmental disturbances, became the responsibility of INAC.

In conjunction with activities being completed at other DEW Line sites, a partial clean up of the CAM-D site was conducted in 1985 by INAC, the Department of National Defence (DND) and Environment Canada. Remedial work completed at that time included removal of equipment considered to be either hazardous or containing hazardous materials, burning of excess fuels, and excavation of a minor amount of stained soils. This being said, the site remained scattered with debris and barrels, decrepit buildings, and sources for environmental contamination.

Between 1992 and 1995, a Short Range Radar (SRR) facility was constructed by DND approximately 1 km east of the former CAM-D site. The SSR is an unmanned station equipped with facilities that include a technical services building with an emergency shelter, diesel tanks, helipad, communication domes, an old shack and the construction camp accommodation module. The gravel pad for the SRR was constructed using material stripped from the former CAM-D DEW Line site.

In 1994, the Environmental Sciences Group (ESG) of the Royal Roads Military College (RRMC) was requested by INAC to conduct a scientific investigation and develop a cleanup plan following the DND DEW Line Cleanup Protocol. The investigation was concentrated on soil, water and plant media to investigate the presence, migration and dispersion of contamination resulting from previous site activities. It was concluded that there was contamination at CAM-D that could migrate offsite, as well as areas with signs of contamination that required further investigation. Areas of concern were identified and qualified, however estimates for volume of impacted material was not obtained. In addition, the scope of work of the ESG investigation did not include the assessment of hydrocarbon contamination.

Based on information gained from the 1994 investigation and through the Contaminated Sites Program (CSP), INAC has made it a priority to assess, prioritize and mitigate/remediate the environmental impacts of contaminated Sites in Canada's North. CAM-D was classified as a high priority site, which required an additional assessment to accurately quantify the volumes of contaminated soil, as well as identification and assessment of hazardous and non-hazardous materials remaining on site. Earth Tech completed the site investigation activities in August 2005, which provided the necessary information to complete this Remedial Action Plan (RAP). This RAP was prepared to provide a conceptual remediation design and preliminary specifications for cleanup of the CAM-D site.

2.0 OBJECTIVES

The main purpose of this Remedial Action Plan was to identify remediation options, critique potential remediation methods, and provide recommendations for site restoration. Based on assessment activities completed by Earth Tech in August 2005, a comprehensive site remediation work plan was developed. Remediation options were developed for each waste stream identified at the site, and were critically evaluated to discuss potential risks, advantages, and disadvantages of each remediation option. Based on a number of factors, outlined below, recommendations were made as to the preferred remediation approach. Also, community meetings with PWGSC and INAC in Taloyoak, Gjoa Haven and Kugaaruk were conducted to incorporate community contribution in selecting the remedial option for each waste stream.

The RAP was designed to meet the following cleanup objectives in accordance with the Indian and Northern Affairs Canada Abandoned Military Site remediation Protocol:

1. Restore the site to an environmentally safe condition;
2. Prevent the migration of contaminants into the Arctic ecosystem;
3. Remove physical hazards for the protection of human health and safety; and
4. Implement a cost effective remediation solution.

The end product is a cost effective RAP for CAM-D, complete with cost estimate to undertake remedial work (attached as a separate document).

3.0 SITE DESCRIPTION

As previously shown in **Figure 1.0**, the former CAM-D DEW Line site is located on the Boothia Peninsula between Sheppard Bay and Pelly Bay, Nunavut, at 68°35' N, 91°57' W. The communities nearest to CAM-D include Taloyoak, Gjoa Haven and Kugaaruk, which are 120 km to the northwest, 100 km to the west and 80 km to the east, respectively.

The DEW Line station was constructed in 1957 and operated until 1963 at which point it was abandoned. In 1965, responsibility for the site was assumed by INAC. The site consists of a Main Station Area, Airstrip Area, Freshwater Lake, Simpson Lake and a Short Range Radar station. Elevation at the main site is approximately 370 m above sea level and the shoreline of Simpson Lake is approximately 50 m above sea level. All existing infrastructure is located at the Main Station Area.

Facilities located at the Main Station Area, as well as at the Airstrip area, are illustrated in **Figures 2.0 and 3.0**. The photos in these figures are aerial photographs of the site taken in July 1964, which is much different that the site appears today. Past facilities in the main station area include; a module building train, warehouse, garage, Inuit house, Quonset huts, POL (Petroleum, Oils, and Lubricants) tanks and pumphouse, sewage outfall, radar antenna tower, as well as several dumpsites, debris piles and barrel caches. The majority of the original facilities at CAM-D have been demolished and partially buried. In fact, the garage, one POL tank and fuel pump shed, and the warehouse foundation are the only remaining structures left in place. Also, the majority of the gravel fill used to construct the main station area was removed and used for the construction of the adjacent Short Range Radar (SRR) which is part of the North Warning System (NWS). So much gravel was removed that the remaining buildings and foundations are left standing on steep mounds of gravel.

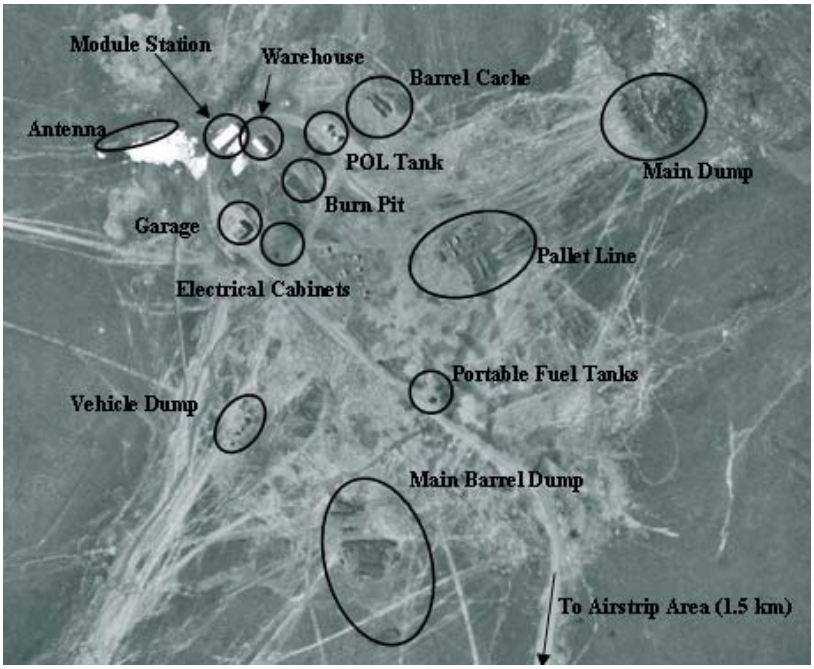


Figure 2.0 CAM-D Main Station Area (1964)

There are two debris areas located on the north side of the Airstrip, on either side of the road to the Main Station Area (**Figure 3.0**). The area to the west, referred to as the Vehicle and Debris Area, contains various heavy equipment piled off the side of the apron on a bedrock outcropping, and the area to the east, referred to as the Crane Area, contains a large crane atop the gravel apron.

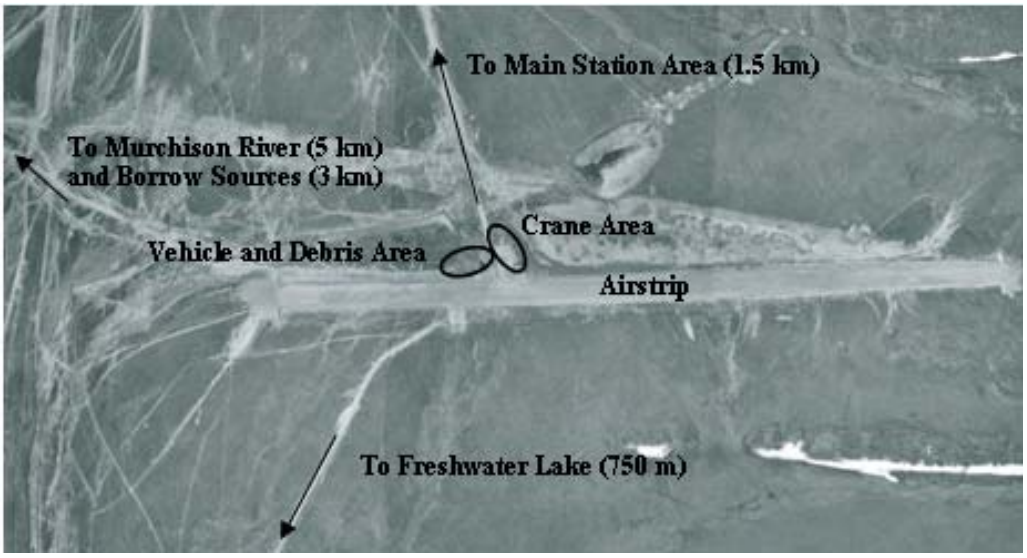


Figure 3.0 CAM-D Airstrip Area (1964)

Approximately 4.7 kms northeast of the Airstrip, on the southern shore of Simpson lake, is a site that was used in the winter months as a staging area for the winter airstrip. The trail or path used to get between Simpson Lake and the Airstrip is completely degraded and marked only by sporadic marker barrels. Debris in this area consisted of approximately 300 barrels that were randomly stacked in small piles and scattered about the shoreline approximately 1 km to the east of the winter staging area. A small amount of domestic debris was also observed in this area.

The Freshwater Lake area, which was thought to be the drinking water source while CAM-D was in operation, is approximately 750 m south of the airstrip area. The Freshwater Lake has scattered debris all along its eastern shoreline.

Along the north shore of a small lake, and to the southwest of the Freshwater Lake, is an area referred to as The Plumbers Dump (**Figure 6.0**). The Plumbers Dump area is situated approximately 1,500 m southwest of the Airstrip area. The site appears to have been a drop point for supplies that were never transported to the main station area. The debris is approximately 10 m from the shoreline of the lake on a gentle upward slope.

Potential borrow source areas are located 3 km south of the main station area and contain various potential borrow sources. Debris in this area was limited to caches of empty barrels (approximately 200 barrels).

Figure 4.0 (**Appendix A**) provides a detailed site drawing of CAM-D, including the locating of all sub sites listed above.

4.0 BIOPHYSICAL ENVIRONMENT

4.1 PHYSIOGRAPHIC DESCRIPTION

The CAM-D site is located in the Ross Hills, with surrounding terrain characterized by rolling grassy hills cut by faulted and fractured granite outcrops. Several lakes and rivers are also located in the area, and the site is located adjacent to the Rasmussen Lowlands. Native soils on site consist of wet/soft silty-clays with varying amounts of sand. In September 2005, permafrost was present at approximately 1 to 1.5 m below ground surface. Although the upper 1.5 m (approximate) of soil thaws seasonally, the site lies within the zone of continuous permafrost. Surface soils located within the seasonal thaw stratigraphy are typically under saturated conditions.

4.2 CLIMATE

The daily mean temperatures for the Simpson lake area varies from approximately -39.3ºC in January to approximately 11.5ºC in July, and the average annual temperature is approximately -11ºC. The average annual precipitation is approximately 6.5 cm of rainfall and 103 cm of snow.

4.3 FLORA AND FAUNA

Sedges, willows, grasses, mosses, and flowering herbs, characterize the vegetation at the site.

4.4 FAUNA

Fauna in the area includes caribou, arctic hare, arctic fox, arctic ground squirrels and several species of birds.

5.0 INAC SITE REMEDIATION PROTOCOL

5.1 GENERAL

Numerous factors affect the suitability of site remediation plans, and must be considered when determining a site specific remediation plan. For this reason, INAC has created the Abandoned Military Site Remediation Protocol (March 2005) to provide a consistent approach for designing RAPs for abandoned military sites. This protocol is designed to address all legal requirements, health and safety issues, INAC's Contaminated Sites Management Policy requirements and standard environmental issues. The protocol identifies financially prudent methodologies that address all the requirements listed above while maintaining a cost effective remediation project. This Remedial Action Plan for the former CAM-D DEW Line Site was designed in accordance to the INAC Protocol.

The following sections provide an outline of typical environmental issues and their remedial action procedures addressed by the Protocol. These technical aspects are described in greater detail in the INAC Abandoned Military Site Remediation Protocol (**Appendix B**). The following considerations (as outlined in the INAC Protocol) need to be considered in the development and implementation of the remedial action plan for the CAM-D site:

- Respect all historical agreements and obligations in a fair and reasonable manner;
- Ensure consistency with federal guidelines for the management of contaminated sites;
- Apply the Canadian Council of Ministers of the Environment (CCME) environmental protection and management approaches (CCME 1996, 1997, 1999, 2001);
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they are identified;
- Establish cost effective solutions through the use of best practices to ensure appropriate levels of environmental protection for all sites;
- Recognize the concerns of global warming in an Arctic setting; and
- Ensure the long-term effectiveness of the environmental remedial measures.

5.2 LANDFILLS

5.2.1 Landfill Closure

Landfills on INAC abandoned military sites are classified as Class A, Class B or Class C. A Class A landfill is a landfill located in an unstable, high erosion location. These landfills require relocation. If during the relocation process, hazardous materials are noted, the hazardous materials are segregated and disposed of off site. A Class B landfill is a landfill located in a suitable, stable location but there is contaminated leachate being released from the landfill. These landfills require the contaminated leachate to be contained within an engineered containment system. If this is not feasible, the landfill must be relocated to an engineered landfill or the waste must be disposed of off site. Lastly, a Class C landfill is a landfill located in a suitable and stable location with no contaminated leachate being released. These landfills can be left in place and additional granular material can be placed to prevent erosion and promote proper drainage if required.

5.2.2 Landfill Development

The design of landfills at abandoned military sites must give consideration to the type of waste that is to be stored in the landfill, proximity to drainage courses and distance to borrow sources required for landfill construction. Only non hazardous materials and/or non regulated contaminated soils are to be stored in newly constructed on site landfills. All hazardous waste is to be disposed of off site.

Capping of the landfills must include a minimum 0.6 m granular cover, promote run-off, prevent infiltration and minimize erosion. Visual inspection monitoring must be conducted to confirm the integrity of the landfill.

5.3 PHYSICAL DEBRIS

Debris throughout the site must be collected and segregated into hazardous and non hazardous waste streams. To reduce volumes, non hazardous material shall be crushed, shredded and/or incinerated prior to placement in the on site landfill. Hazardous materials shall be disposed of off site in accordance applicable guidelines and regulations.

5.4 CONTAMINATED SOILS

Soil conditions at CAM-D were assessed using the INAC Abandoned Military Site Remediation Protocol (March 2005) as the governing criteria. Heavy metal and PCB concentrations in soils were compared to the DEW Line Cleanup Criteria, which was developed for the Department of National Defence. Petroleum hydrocarbons, which includes F1-F4 fraction hydrocarbons and BTEX parameters, were compared the CCME Canada Wide Standards for Petroleum Hydrocarbons in Soil – Tier 1 Soil Ingestion criteria (coarse grained, surface soils).

Contaminated soils identified will be categorized as regulated, hazardous, or contaminated but not hazardous. Soils that are identified as being regulated will be remediated and/or disposed of following applicable regulations. Hazardous soils will be disposed of off-site. Contaminated but not hazardous soils must be remediated to meet DCC DEW Line Clean Up (DLCU) Criteria. Soils classified as contaminated, but not hazardous, are to be remediated based on one of three primary contaminated soil types. Firstly, metal contaminated soils must be disposed off site or encapsulated on site. Secondly, remediation options for hydrocarbon contaminated soil include remediated in situ, exsitu, or offsite; capped in place; natural attenuation; or chemical amendment. Lastly, PCB contaminated soil must be either disposed off site or encapsulated on site. In cases where co-contamination of soils are present, the most conservative remedial option that addresses both contaminants must be applied.

5.5 CONTAMINATED WATER

Surface water with heavy metal contamination (in exceedance of the CCME Freshwater Aquatic Life Criteria) was observed at CAM-D; however, it should be noted that the concentrations are diluted relatively quickly and all elevated levels were observed in seasonal water bodies only. Also, the areas where exceedances were noted are a significant distance away from any possible fish habitats. It also must be noted that the volumes of surface water where the exceedances were noted are minimal. It is not anticipated that contamination noted on site is adversely affecting water sources downgradient and off site. It is expected that removal of the source contamination (contaminated soils) would address the problem and therefore no remedial options for contaminated water are discussed in this remedial action plan.

5.6 HAZARDOUS MATERIALS

In general, all hazardous materials will be shipped off site to a licensed hazardous waste disposal facility. Exceptions include asbestos, which is to be double bagged and disposed in an engineered landfill onsite, in accordance to local regulations. Petroleum products, free of chlorine, PCBs, heavy metals, etc, are to be incinerated. Heavier petroleum products are to be mixed and burned on site, or shipped off site. Compressed gas cylinders, with known contents, are to be vented and subsequently placed in engineered landfills on site. Creosote treated timbers are to be wrapped in polyethylene and disposed of in an on site landfill. PCB Paint and PCB painted components regulated under the CEPA (>50 ppm) are to be disposed of off site at an appropriate facility. Lead-based paint (>5 mg/L) considered to be hazardous will be collected and transported offsite, whereas painted components not considered hazardous will be disposed in on site landfills.

5.7 BARRELS

Barrels located at the site will be addressed in accordance with the DEW Line Cleanup Barrel Protocol (**Appendix C**). In general, empty barrels will be crushed and disposed in on site landfills. The contents of filled barrels will inspected and tested, and either be incinerated on site or shipped off site for disposal. The now empty barrels will then be rinsed, crushed and disposed in on site landfills. Buried barrels will be addressed by geophysical testing. If the buried barrels are empty, the area will either stabilized by compaction and covered in place. If fluids are noted in the barrels, the barrels will be excavated and the contents will be inspected and tested. Depending on the results, the contents will either be incinerated on site or shipped off site for disposal. A water sample was collected by UMA Engineering Ltd. from a barrel at the pallet line and submitted for laboratory analysis (UMA, 2007). Results indicated that neither glycol nor non-aqueous phase liquids were observed in the barrels, and dissolved metals concentrations were below the DLCU Barrel Protocol. Consequently, specific barrels at the pallet line were identified to be within the allowable range for disposal to ground following polishing with absorbent material. Assessment of individual batches of water in barrels at the pallet line will be required prior to disposal.

5.8 BUILDINGS AND INFRASTRUCTURE

All existing buildings and infrastructure shall be demolished to their foundations. All hazardous material is to be removed prior to or during demolition activities. All removed hazardous material is to be disposed of in accordance with protocol outlined in Section 5.4. Under special circumstances, some buildings may be left place once clear ownership of the building has been outlined.

5.9 BORROW SOURCES

Borrow sources for granular material will be required for the construction of new landfills and for general site grading purposes. Existing borrow sources, including abandoned gravel pads and road infrastructure, will be fully exhausted prior to exploiting new sources. Upon completing remedial activities, all borrow areas will be recontoured to restore natural drainage and to match surrounding topography.

5.10 SITE GRADING

Disturbed areas on the site will be graded and shaped to blend in with the natural contours and to eliminate potential hazards for wildlife and humans accessing the site in the future. The disturbed areas include contaminated soils excavations, existing and new landfills, debris areas, disturbed areas resulting from demolition activities; borrow areas, and any areas disturbed as a result of remediation activities.

5.11 CONTRACTOR SUPPORT ACTIVITIES

For the completion of remedial activities, a camp will be established on site and will be situated in a previously disturbed location to minimize the extent of new disturbances. Waste generated by the camp will be incinerated and disposed of in on site landfills. Sewage will be treated using an appropriately sized treatment system, and effluent quality will adhere to applicable licenses. Potable water located on site will be tested and used in accordance with the applicable water license. Contingencies for water supply will include filters, and a supply of bottled water. Fuel required to operate the camp and to complete remedial activities will be stored on site in accordance with applicable legislation and licenses.

6.0 COMMUNITY MEETINGS

A draft copy of the RAP was offered to Nunavut Tunngavik Incorporated as well as the communities of Gjoa Haven, Kugaruuk and Taloyoak for their review and comment. In addition, community meetings open to the public, hosted by INAC, were also conducted in April 2006 in the three communities listed above. A copy of the meeting minutes from each of these communities is located in **Appendix D**. To date, no concerns were raised by any of the communities with the proposed Remedial Action Plan.

7.0 EVALUATION OF REMEDIAL OPTIONS

7.1 CLEANUP OBJECTIVES

The following remedial objectives are based on guidance provided from Northern Contaminated Sites, Public Works and Government Services Canada and the Indian and Northern Affairs Canada Abandoned Military Site Remediation Protocol, March 2005.

- Restore the site to an environmentally safe condition;
- Prevent the migration of contaminants into the Arctic ecosystem;
- Remove physical hazards for the protection of human health and safety; and
- Implement a cost effective remediation solution.

7.2 SITE ISSUES

The following sections present a summary of the contaminant and waste disposal issues, as well as the potential remedial methods, for site issues identified from past site assessments. In the cases where more than one remedial method is identified, the options will be evaluated based on the remedial objectives and a recommendation for the favourable remedial method will be provided. Specific issues that need to be addressed at the CAM-D site include;

- Disposal of contaminated soils (PHC, metals, PCBs),
- Treatment/disposal of impacted soils (PHCs, and PAHs),
- Collection and disposal of hazardous materials (POL liquids, asbestos containing materials),
- Collection and disposal of lead and PCB amended paint,
- Proper disposal for the buried and partially buried debris located near the former Warehouse, Module Train, POL tanks and in the East Station areas, and
- Collection and disposal of non-hazardous surface debris piles and dumps (located at Main, Simpson Lake, and Plumbers dumps, barrel, electrical cabinet, airstrip, pallet line debris piles, borrow areas and scattered in other areas of the site).

7.3 CONTAMINATED SOILS

The following table presents a summary of the contaminated soils and remedial methods recommended to address the contaminated soils at the identified at the CAM-D site.

Table 1: Summary of Contaminated Soils at CAM-D

Location	Contaminant Exceeding CCME and/or INAC Criteria	DCC I	DCC II	INAC AMSRP for PHC Contaminated Soil	PHC Impacted Soils*	Comments
		m^3	m^3	m^3	m^3	
Garage	**PHC**s *				**700**	Elevated F2 and F3 fractions for intermediate fill in landfill
Electrical Cabinet Area	**Metals**		**16**			Exceeds DCC Level II criteria
Burn Pit Area	**PHCs ***				**39**	Elevated F2, F3 and F4 fractions for intermediate fill in landfill
POL Tank	**PHC**s			**72**		Offsite disposal
	PAHs & PHCs *				**1600**	Elevated F2 and PAHs for intermediate fill in landfill
Outfall	**Metals & PCB**s		**3**			Impacted area is co-contaminated
Pallet Line	**PHCs**			**254**		Offsite disposal
	PHCs *				**147**	Elevated F3 and F4 fractions for intermediate fill in landfill
Portable Fuel Tanks	**PAHs & PHCs**				**588**	Elevated F2, F3, BTEX and PAH for intermediate fill in landfill
Airstrip Vehicle and Debris Area	**Metals & PHCs**		**10**			Impacted area is co-contaminated
Plumbers Dump	**Metals**		**13**			Impacted area not delineated
Simpson Lake	**Metals**		**3**			Soils in the vicinity of the battery in the noted debris area
Buried debris – Warehouse Area	**Metals**	**43**	**57**			

		DCC I	DCC II	INAC AMSRP for PHC Contaminated Soil	PHC Impacted Soils*	
Buried debris – Module Train Area	**Metals**	**60**	**79**			Based on previous experience, DCC Tier I and II soils can be expected in buried debris areas
Buried debris – POL Site	**Metals**	**132**	**176**			
Buried debris – East Station Areas	**Metals**	**5**	**7**			
	Total Estimated Volumes	**240**	**364**	**326**	**3,074**	

Note: * Denotes parameters below INAC protocol, but at elevated concentrations suitable to be used as intermediate fill (see Section 7.3.4).

A Human Health and Ecological Risk Assessment was conducted by Jacques Whitford. The report indicated that the risks to humans and the environment from the contamination are negligible. However, in accordance with the Indian and Northern Affairs Canada Abandoned Military Site Remediation Protocol, March 2005, the following remedial options are presented for consideration. CAM-D is an abandoned and remote site; therefore the remedial plan must be designed accordingly. Solutions that achieve remedial objectives and minimize site remediation costs will be deemed favourable.

Despite the fact that in-situ technologies reduce contaminant exposure to humans and the environment, in-situ remediation technologies were not researched in detail. In situ remedial technologies are care and maintenance intensive and have not generally proven to be pragmatic technologies for remote, northern site remediation. For this reason in situ technologies were not explored in great detail.

7.3.1 PCB Contaminated Soils

7.3.1.1 Contaminant Issue

The 3 m^3 of PCB contaminated soil that exists on site is located at the outfall area of the previous module train building location as shown in **Figure 5.7** of **Appendix A**. The soil exceeds the INAC Abandoned Military Sites Remediation protocol (Greater than DCC Tier I but less than DCC Tier II) for PCBs; however, the ESG investigation at the sewage outfall identified heavy metals (copper, zinc and arsenic) in exceedance of the DCC Tier II criteria. Therefore due to the metal concentrations the PCB contaminated soils are classified as exceeding Tier II.

7.3.1.2 Remedial Method

Due to the limited quantities delineated, the soil shall be excavated, containerized, labelled in accordance with the Transportation of Dangerous Goods Act and shipped off site to a disposal facility that is licensed to accept metal contaminated soils co-contaminated with PCBs. These soils should be addressed as per the Tier II soils identified in Section 7.3.2 below.

7.3.2 Metal Contaminated Soils

7.3.2.1 Contaminant Issue

The assessment identified 42 m^3 of metal contaminated soil at the electrical cabinet area (**Figure 5.2**), the Airstrip (**Figure 6.1**), the Plumbers Dump (**Figures 8.1 and 8.2**) and Simpson Lake (**Figure 7.0**). As previously indicated in **Table 1**, these soils exceed DCC Tier II criteria. Following discussions with UMA Engineering, a further 240 m^3 of Tier I soils and 319 m^3 of Tier II soils could be expected to be located within the four buried debris areas (Warehouse, Module Train, POL site, and East Station).

7.3.2.2 Remedial Method

Due to the small amounts of metal contaminated soils on site and the large operational and maintenance costs of metal contaminated soil remedial technologies as well as the high costs to construct a hazardous waste landfill, on site remediation or disposal of the soils on site was not explored. All metal contaminated soils that exceed the DCC Tier I criteria, but less than DCC Tier II criteria (240 m^3) should be buried in the non-hazardous landfill and it is recommended that all metal contaminated soils that exceed the DCC Level II criteria (364 m^3) be excavated, containerized, labelled in accordance with the Transportation of Dangerous Goods Act and shipped off site to a disposal facility that is licensed to accept metals contaminated soils.

7.3.3 Hydrocarbon Contaminated Soils

7.3.3.1 Contaminant Issue

The Phase III site investigation identified approximately 326 m^3 of PHC contaminated soil that exceed the INAC Abandoned Military Sites Remediation protocol. It should be noted that soil volumes are likely to increase as a result of bulking during excavation; therefore a 25% contingency should be applied to the total volume of PHC contaminated soil. The hydrocarbon contaminated soils are located at the POL tank area (**Figure 5.6**) and the Pallet Line area (**Figure 5.8**). Hydrocarbon fractions in the contaminated soils at the POL tank are mostly F1's and F2's typical of diesel fuel contamination. The hydrocarbons associated with the Pallet Line area are heavier, F2's, F3's and even F4's. The heavier end hydrocarbons are associated with waste oils and contamination remaining from the burning of oils and heavier fuels.

7.3.3.2 Remedial Options

Excavation and Off-Site Disposal

The first potential remedial option for the hydrocarbon soils at CAM-D is to excavate the PHC contaminated soils ship them south to a facility licensed to accept hydrocarbon contaminated soils. Since the contamination is completely removed from the site, it meets all of the remedial objectives; however the major disadvantage of this method is the cost for shipping the material off site.

CAM-D is landlocked; however, due to the relatively small volume of PHC contaminated soil (326 m^3), this option is favourable because it removes the material from the site, thus prohibiting future site visits for landfarming or monitoring purposes. It is anticipated that the cost of removing the material via cat train is more cost effective than building, operating and monitoring a landfarm cell or landfill. Also, this remedial option would meet all INAC clean up objectives.

On Site Land Farming

Option 2 for handling the petroleum contaminated soils is the use of a land farm. Land farming is a remediation technique used to reduce the hydrocarbon levels in soil via volatilization, biodegradation and photo degradation. The hydrocarbon soils are spread out on a self contained, lined land farm cell in a lift approximately 0.3 m thick. Chemical amendments (fertilizer) and water are added to the soil to promote biodegradation of the hydrocarbons. The soil is scarified or "turned" using heavy equipment to break up the soil, add oxygen and promote volatilization. Microbes in the soil, (bacteria and fungi) breakdown the hydrocarbon chains converting them into biomass.

Advantages of land farming are that the contamination is eventually eliminated. This eliminates the need for long term inspections and monitoring, and removes any long term liability of the site. Notable disadvantages include the time and effort required for the construction of the land farm cell and the remediation process, as well as monitoring the activity and ensuring the material is remediated to the applicable criteria.

In a northern climate, a minimum of two to three years is required for remediation depending on temperatures, moisture, soil contaminants and fertilizer application/soil turning. Land farming also requires a work crew to visit the CAM-D site to scarify the contaminated soil, add the chemical fertilizer and monitor the soil contamination levels. Once the soil has been remediated below the applicable criteria, the land farm cell will be decommissioned in place and contoured into natural topography. Due to the time requirement for this method, additional site trips are required after the initial remedial program has been completed.

Land farming of the contaminated soils would meet the INAC Cleanup Objectives one, two and three. Due to the small volume of impacted soils and the cost associated with building, operating and monitoring a landfarm cell, it is not cost effective to landfarm the hydrocarbon contaminated soil.

Landfill On Site

A secure landfill was evaluated as a third option. A landfill can be constructed at the CAM-D site using the available borrow sources. A landfill containing contaminated soils shall have an engineered clay/synthetic liner to ensure the contaminants within the soil are not allowed to become mobile. Proper design of the landfill will also ensure that permafrost is developed within the landfill to further decrease the mobility potential of the contaminants.

Advantages of the landfill are that the remedial work can be completed in one season. Disadvantages for this option are similar to the capping option (described below). The main disadvantages of land filling the contaminated soils are that the contamination will remain on site. This requires long term inspections and monitoring of the landfill at a significant extra capital and labour cost to ensure the contamination is contained within the landfill.

The landfill option meets INAC Cleanup Objectives one, two and three, however long term monitoring and inspections of the landfill are required as the contamination will remain on site. Consequently, the cost for building and monitoring a landfill is likely offset by the cost to excavate the material and dispose of it off site.

Engineered Cap in Place

Option 4 for dealing with the hydrocarbon contamination at the CAM-D site is to grade and cover the contaminated areas with an engineered cap. The cap would consist of a 1.0 m thick layer of compacted engineered fill, graded to promote drainage.

A cap would reduce the amount of rain and surface water coming into contact with the contamination and prevent further dispersion of the hydrocarbon contamination. The cap would also eliminate the possibility of humans and/or fauna from coming into contact with the contamination. This remedial option has a relatively low cost and a minimal level of effort. The capping of the hydrocarbon contaminated soils could easily take place during other site remedial activities.

In addition to the engineered cap a chemical amendment can be added to the contaminated soil. The chemical amendment (fertilizers, nutrients, nitrogen etc.) promote biodegradation of the hydrocarbons by providing the necessary chemicals and nutrients required by the microbes for the degradation to occur. The hydrocarbon impacted soils are excavated and the chemical amendment would be mixed into the soils and the soils would be replaced and capped as noted above. The additional costs for the chemical amendment include the costs for the excavation of the impacted areas; the addition of the amendment, the amendment itself and the cost to replace and compact the soils after the amendment is added.

Disadvantages associated with this remedial option are that it would require further monitoring events to ensure the capping system remains in good condition (no erosion, frost heaving) and that the hydrocarbons do not become mobile. The capping would also greatly reduce the natural occurring bioremediation of the soils by limiting the amount of oxygen reaching the contaminated soil. Less oxygen reduces the rate of aerobic degradation of the hydrocarbons. There would be little to no control over the bioremediation process and ongoing monitoring of the contaminated area would be required.

In Situ Soil Vapour Extraction

Vapour extraction is a remedial method used to remediate hydrocarbon contaminated soils. Air is pushed or drawn through the contaminated soils and the lighter end hydrocarbons volatilize into the air. The air is then released into the atmosphere or run through carbon filters to remove the hydrocarbons. Contamination favouring this option is light end hydrocarbons (F1 Fractions). Heavier fractions of hydrocarbons are less likely to volatilize and require different remediation methods. The soils must also be porous, freely allowing the air to move through the soil and volatilize the hydrocarbons. Poorly graded dry sands and gravels are ideal for vapor extraction. Saturated well graded soils are not favourable for Soil Vapour Extraction.

Vapour Extraction systems rely on powered blowers and require frequent adjustments and maintenance during the extraction process. Since CAM-D is a remote unmanned site the cost of instituting this remedial measure is not cost effective. The soils and type of hydrocarbon contamination at CAM-D are not compatible with vapor extraction remediation methods. The contamination at the CAM-D site is the larger fractions of hydrocarbons (F2, F3 and F4 at some locations). Also, during the investigation, much of the investigation areas were noted to be saturated with water. Vapour extraction will not be explored further as a remedial option.

Biopile

A biopile is a remediation technology used to remediate hydrocarbon contaminated soils. The PHC contaminated soils are collected into piles and wrapped in synthetic liners to promote anaerobic degradation of the hydrocarbons and retain heat to promote the bioactivity. Temperatures measured within an active biopile are often much higher than ambient temperatures. Biopiling has had limited success as an effective remediation technique at remote and unmanned northern sites due to low ambient temperatures and the care and maintenance involved with operating the biopile system. Biopiles will not be explored further as a remedial option.

7.3.3.3 Recommendation

Based on the evaluation of the remedial options in the context of the remedial objectives, it is recommended that the hydrocarbon soils be excavated and shipped off site for disposal. It is should be noted that additional samples will be collected at the Pallet Lines in an attempt to further delineate the contaminated soils in this area. Consequently, the total PHC contaminated soil volume will likely shrink, making off site disposal the far superior remediation option.

7.3.4 Hydrocarbon Impacted Soils

7.3.4.1 Contaminant Issue

In addition to the estimated 326 m^3 of hydrocarbon contaminated soil, there is approximately 3,074 m^3 of soil that has elevated PHC and PAH concentrations. Although this soil is not classified as contaminated under the INAC protocol and does not require remediation, INAC will, as a demonstration of responsible environmental stewardship, address these impacted soils during the site remediation program. Elevated PHCs and PAHs exist at the Garage area (**Figure 5.1**), the Burn Pit area (**Figure 5.3**), the POL Tanks area (**Figure 5.6**), the Pallet Line area (**Figure 5.8**), and the Portable Fuel Tank area (**Figure 5.9**). Hydrocarbon impacted soils in these areas include F2/F3/F4 fraction hydrocarbons, BTEX compounds, and/or PAHs. The approximate extent of elevated PHCs or PAHs is illustrated in the site figures.

7.3.4.2 Recommendation

It is recommended that the soils with elevated concentrations of F2, F3 fractions, BTEX or PAHs and below the INAC Protocol, be excavated and used as intermediate fill for the non-hazardous waste landfill. By using this soil as intermediate fill, INAC will be able to remove oil stained areas from the site which has the additional benefit of removing the contaminant from the arctic ecosystem and improving the aesthetics of the site.

7.4 SITE MATERIALS

7.4.1 Non Hazardous Materials

Approximately 1,173 m^3 of non hazardous materials are estimated to be deposited at the CAM-F DEW Line site. This volume includes 640 m^3 of surface debris, 98 m^3 of debris that will be generated when the buildings are demolished and approximately 7 m^3 of culverts that will be removed and land filled once remedial program is completed. The waste inventory also includes approximately 428 m^3 of material that was partially buried at the Main Station area during the construction of the Short Range Radar Station. The following table presents a summary of the non hazardous locations of the non-hazardous materials.

Table 2 – Summary of Non-Hazardous Materials

Location	Volume (m^3)	Comments
Modular Train Buried materials	176	Partially covered, potentially buried with hazardous materials and contaminated soils
Warehouse Buried materials	60	Partially covered, potentially buried with hazardous materials and contaminated soils
POL Site Buried materials	185	Partially covered, potentially buried with hazardous materials and contaminated soils
East Station Area Buried materials	7	Partially covered, potentially buried with hazardous materials and contaminated soils
Main Dump	215	Deposited on ground surface, potentially contains hazardous materials (i.e. paint products)
Plumbers, Simpson Lake, Vehicle and Main Barrel dumps	288	Deposited on ground surface
Scattered in other others	242	Deposited on ground surface
Total	**1,173**	

Based on the soil sample results and inspections of the buried debris, the buried debris areas are classified as Class C landfills in accordance with the INAC Abandoned Military Site Remediation Protocol, March 2005. It is speculated that when the DEW line site was demolished to allow for the construction of the Short Range Radar, the debris from the Warehouse, Module Train and second POL tank were deposited in the buried debris areas without the removal of the hazardous building materials (asbestos lead and PCB amended paint). Therefore it is expected that the hazardous materials have been buried along with the non-hazardous materials in these locations.

Remedial options for the buried debris include the following: Firstly, the buried or partially buried debris areas can be crushed and stabilized/capped in place, as to create a landfill. The second option involves unearthing the debris, followed by assessing and sorting the debris, and disposing of the debris according to the remedial option selected.

The 2006 Phase III ESA included the collection and analysis of concrete samples collected from three areas of the site. As reported, the analysis indicated PCBs concentrations less than 50 ppm in all the samples; however due to an elevated PCB concentration of 43 ppm from a sample collected from the Modular Station buried debris, it is recommended that additional testing be completed to confirm that all of the buried concrete rubble at this location be less than CEPA requirements.

All buildings/infrastructure shall be demolished to their foundations in accordance with the INAC, Abandoned Military Site Remediation Protocol, March 2005. All barrels shall be addressed using the Department of National Defence (DND) DEW Line Clean up Barrel Protocol (**Appendix C**). A detailed summary of the non-hazardous materials located at the CAM-D site is provided in **Table E1** (**Appendix E**). Remedial options for non hazardous materials are described below, and options for hazardous materials are discussed in Section 7.4.2.

7.4.1.1 Remedial Options

Buried in Place

Once all the structures have been demolished to their foundations, the site materials can be buried in place. The debris would be flattened and covered with compacted engineered fill or placed in a nearby excavation or low spot in the surrounding terrain and then covered with compacted fill. The cover of compacted fill must be engineered to promote positive drainage and the cap must also be graded to match surrounding terrain. Advantage of this method is that it is less expensive as the contractor does not have to remove, transport and place material in a landfill some distance away. The disadvantages of this method is that the material is not placed in a secure engineered landfill and that a large contractor effort would be required to move fill to cover the debris piles that are scattered around the site. In the event that additional debris is discovered on site, the debris shall be addressed using the INAC Abandoned Military Site Remediation Protocol, March 2005. In the event that the materials are buried onsite, future monitoring would be required.

Consolidate Wastes and Place in On Site Non Hazardous Waste Landfill

Once all the structures have been demolished to their foundations, the demolished materials as well as the non-hazardous materials from the surface debris piles that are scattered around the site, as well as from the buried debris area would be transported to an engineered landfill. This option is more cost intensive, but it gathers all the site material into one secure area reducing future monitoring inspection efforts. Placing the non hazardous demolition waste in an on-site engineered landfill is in accordance with the INAC Abandoned Military Site Protocol, March 2005.

Off Site Disposal

Once all the structures have been demolished to their foundations, the demolished material can be collected and transported off site. As CAM-D is landlocked, a cat train would be required to deliver the material to a sea port for barge pick up or disposal at another location. Due to the large costs associated with hauling demolition material via cat train and barging, off site disposal is deemed too expensive and not cost effective.

7.4.1.2 Recommendation

It is recommended that an engineered non-hazardous waste landfill be constructed on site using the available borrow sources. It is recommended that all non-hazardous waste materials be collected, consolidated and deposited in one central landfill. This landfill should be large enough to place all of the non-hazardous debris plus the disposable Tier I soils, the hydrocarbon impacted soils as well as the bagged asbestos waste and vented compressed gas cylinders.

Since the debris piles that are scattered around the site (Main dump, Simpson Lake and Plumbers dump, etc.) are located on the ground surface and are not buried (other than the three partially buried debris piles in the Main Station) the collection of these materials and disposal in a common landfill is recommended over burial in-place as the remedial option. It is also recommended that all non-hazardous wastes be recovered from the four buried debris areas. This material should also be placed into the common landfill. All non hazardous material on site is to be placed in the landfill and compacted and capped in accordance with the landfill design. The proposed location of the landfill is shown on **Figure 10.0** of **Appendix A**.

7.4.2 Hazardous Materials

Hazardous materials are known to be present at the CAM-D Site based on assessment work completed in 2005. A detailed inventory of hazardous waste is provided in **Table E2** (**Appendix E**). All hazardous materials (with the exception of Asbestos Containing Materials, POL Fluids, and empty compressed gas cylinders) will be containerized and labelled in accordance with the Transportation of Dangerous Goods act in Accordance with the INAC Abandoned Military Sites Remediation protocol and disposed of offsite.

Approximately 93 m^3 of PCB/Lead painted materials and 23 m^3 of hazardous materials (asbestos materials and lead-acid batteries, gas cylinders) were identified during the 2005 Earth Tech site assessment and 2007 UMA supplementary site assessment. A detailed description of the painted materials that are considered hazardous/ non-hazardous is provided in **Table E3** (**Appendix E**). It should be noted that additional paint samples from the materials where the paint was applied to a metal substrate (i.e. POL tank, crane and grader at the airstrip, POL pump shed, etc) should be collected at the commencement of remediation activities to avoid any uncertainties with the proper method to handle these paint products. The paint samples must include the substrate as well as the paint, and are to be submitted for leachable lead analysis. The presented volumes of hazardous materials, includes potential materials that may have been deposited in the four buried debris areas. The volumes for hazardous materials in these buried debris areas were estimated by UMA Engineering based on there experience on other DEW Line site.

7.4.2.1 Petroleum Oil and Lubrication (POL) Fluids and Collected Water

Incinerate on Site

During the initial bidder's meeting, the POL fluids on site will be sampled and analyzed for PCB, Cadmium, Chromium and Lead content. The fluids can be burned if the levels of the previously listed parameters are below the criteria for incineration as listed in the Department of Defence DEW Line Clean up Barrel Protocol (the POL fluid contains <2 ppm PCBs and Cd and <10 ppm Cr and <100 ppm lead

and <1000 ppm Chlorine). If the POL fluid analysis indicates any of these contaminant levels have been exceeded, the fluid will be classified as a hazardous material and must be treated in accordance with Section 7.4.2 (Hazardous Material) of this document. There is approximately 16.4 m^3 of POL liquids stored onsite.

Disposal on Ground

The additional investigation work completed by UMA in 2007 confirmed that the dissolved metal concentrations in the water that has collected in the barrels at the pallet line meets DLCU barrel protocol and is suitable for ground disposal following polishing with adsorbent material.

7.4.2.2 Asbestos

Asbestos Containing Materials (ACM) at the CAM-D site is limited to the main station area. Asbestos is located throughout the remaining structures and within the buried debris piles. Asbestos Containing Materials include floor tiles, pipe insulation, fire door insulation, transite board and vermiculite insulation. All asbestos is to be properly abated, in accordance with applicable Federal and Territorial Asbestos regulations, prior to any demolition activities.

Asbestos Abatement, Place in On Site Landfill

All asbestos is to be abated in accordance with applicable Federal and Territorial Asbestos regulations and guidelines. All asbestos debris shall be abated and placed in a sealed, airtight container, clearly labelled "ASBESTOS". The asbestos is then placed in the engineered landfill constructed onsite. The location of the asbestos material located within the landfill should be noted for future reference. This method is in accordance with the INAC Abandoned Military Site Remediation Protocol. Due to the transport costs associated with transport of materials from the CAM-D site, off site disposal is not recommended for the asbestos waste.

7.4.2.3 PCB & Lead Contaminated Paint

Paint Removal, Off Site Disposal

Paint abatement consists of physically removing the PCB and/or lead contaminated paint from the substrate. This is accomplished by physical scrapping, chemical stripping, sand blasting and various other abrasive physical removal techniques. As the paint being removed contains lead and or PCBs, abatement methods must be conducted in a manner that protects the worker and the environment from PCB and lead contamination. Abatement methods generating dust must be conducted in a sealed, negative pressure environment with the area exhaust filtered with a certified High Efficiency Particulate Air (HEPA) Filter. Misted water is also used to control the paint dust, requiring the waste water to be filtered to remove the contaminated paint or collected and treated as hazardous waste. These required mitigation measures increase costs dramatically. This option would meet the INAC cleanup objectives for restoring the site to an environmentally safe condition and preventing the migration of the contaminants as all of the PCB containing paint would be removed from site. The abatement process; however, is involved and costly. The abatement costs combined with the disposal costs make this option less cost effective.

Remove Painted Materials, Off Site Disposal

As an alternative to paint abatement, building materials painted with contaminated paint can be dismantled and disposed of as hazardous materials, bypassing the requirement for the paint to be abated. The transport and disposal costs are higher due to the fact that the painted building materials are disposed of along with the paint; however these additional costs are smaller than the additional costs of paint abatement. As there is minimal scrapping and abrasion during the dismantling activities, negative air enclosures and filtration systems are not required. Dismantled material volumes can be minimized by cutting and compacting.

This option meets the INAC Abandoned Military Site Clean up Protocol Cleanup Objectives one, two and three. This option is also less expensive than the abatement options making it more cost effective than the other options proposed.

7.4.2.4 Buried Debris

Due to the high potential that hazardous building materials have been deposited in the buried debris areas, and that these materials may contain products with PCB levels greater that 50 ppm (regulated by CEPA), it is recommended that the buried waste sites be unearthed, sorted and disposed of accordingly. Based on field observations it appears that the Warehouse and Module train buildings were knock down and partially buried onsite without removing the hazardous materials. Based on the volumes of materials that were identified in the three buried debris locations, there is the potential that 56 m^3 of hazardous materials (PCB/lead painted materials and asbestos) may be buried at these locations.

7.4.2.5 Recommendations

It is recommended that the lead and PCB amended paint materials be dismantled and disposed off site. This remedial method is in accordance with the INAC Abandoned Military Site Remediation Protocol, March 2005. Care is to be taken during the dismantling to prevent dust and paint chips from being released into the environment and to protect the workers that are conducting the dismantling from PCB and lead contamination. All dismantled PCB and/or lead contaminated paint material shall be packaged, transported and disposed of in accordance with the current regulations governing the handling and disposal of hazardous materials.

It is recommended that all compressed gas cylinders as well as asbestos waste be disposed in the constructed landfill.

It is recommended that the remedial/excavation work in the buried debris areas be completed following a specific work procedure and onsite workers will need to wear the appropriate level of PPE and be properly trained. During the sorting operation, specific items that should be removed from the non-hazardous debris include asbestos containing material tiles and insulation, painted products, and the second silver painted POL tank.

7.5 RECOMMENDED REMEDIATION METHODS

The following table presents a summary of the recommended remedial methods.

Table 3: Summary of Recommended Remediation Methods

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
Metals Contaminated Soils	45 m^3 of soils with concentrations of As, Cd, and Zn, which exceed the DCC Tier II criteria were identified onsite. This volume includes 3 m^3 of material that is co-contaminated with PCBs. In addition, 240 m^3 of Tier I soils and 319 m^3 of Tier II soils may be located in the buried waste sites.	Excavate, containerize and label soils that exceed DCC Tier II criteria and dispose offsite. Dispose of soils that exceed DCC Tier I soils in an onsite landfill.
Petroleum Hydrocarbon Contaminated Soils	Approximately 326 m^3 of hydrocarbon contaminated soil in exceedance of the INAC Abandoned Military Site Remediation Protocol for PHC Soils.	Excavate contaminated soils and place into containers, and ship off site to a licensed disposal facility.
Petroleum Hydrocarbon Impacted Soils	Approximately 3,074 m^3 of impacted soils with elevated concentrations of F2, F3, BTEX and/or PAHs	Excavation of impacted soils, use as intermediate fill in non-hazardous landfill.
Buried Debris	Buried debris on the site contains various amounts of hazardous and non-hazardous materials as well as contaminated soils. Based on previous experience by UMA Engineering, there may be 428 m^3 of non-hazardous material and 56 m^3 of hazardous material buried onsite (asbestos and painted materials).	All buried and partially debris should be excavated, sorted and separated into different waste types. All non-hazardous wastes to be disposed in a non-hazardous landfill.
Surface Debris and Dumps	Approximately 745 m^3 of non-hazardous debris consisting of heavy equipment, barrels, scrap metal, scrap wood, concrete, electrical equipment and plumbing parts.	Consolidate and dispose in a non hazardous landfill constructed onsite.
POL Fluids	There are approximately 16.4 m^3 (16,400 L) of Petroleum, Oil and Lubricant fluids.	Incinerate POL fluids that meet incineration criteria (< 2 ppm PCBs and Cd and < 10 ppm Cr and <100 ppm lead and <1000 ppm Chlorine), otherwise treat as Hazardous Waste.
Water in barrels	Analysis of collected water in the abandoned barrels indicate that the dissolved metals meet DLCU barrel protocol.	Disposal on ground is permitted once water has been polished with an absorbent materials, additional sampling of more barrels during remediation program is required.

Environmental Concern	Site Assessment Findings	Recommended Remediation Method
PCB/Lead Amended Paint Products	Approximately 40 m^3 of PCB/lead amended paint materials were discovered on site, an additional 53 m^3 is estimated to be deposited in the buried debris areas.	Dismantle contaminated paint items and ship off site to an appropriate disposal facility. Remove painted items from buried debris locations and dispose offsite.
Hazardous Materials	Approximately 18 m^3 of hazardous materials were identified at the site. These materials consisted of lead acid batteries (1 m^3) and asbestos containing materials (17 m^3). There is also potentially 3 m^3 of additional asbestos materials deposited in the buried debris locations.	Asbestos waste to be collected, bagged and disposed of in an on-site landfill. All hazardous materials (such as batteries) will be containerized and labeled and shipped to be disposed at a licensed southern facility.
Compressed Gas Cylinders	Approximately 20 compressed gas cylinders were identified onsite.	Vent and dispose of cylinders according to the INAC AMSRP in the non-hazardous landfill.
Structures	POL pump shed Garage Concrete foundations	All buildings shall be demolished to their foundations and all site debris placed and compacted in an on site landfill. Due to the previous removal of the granular material around the garage, removal of the garage foundation is recommended in order to reduce safety concerns and access underlying PHC contaminated soils.

8.0 REMEDIAL DESIGN AND IMPLEMENTATION

8.1 REMEDIAL OBJECTIVES

The remedial design for the CAM-D DEW Line site has been developed in accordance with the Indian Affairs and Northern Development, Abandoned Military Site Protocol, March 2005. The following section outlines the general design and implementation of the preliminary draft CAM-D Remedial Action Plan (RAP).

Remedial Design and Implementation Objectives:

1. Ensure safety of workers on site;
2. Prevent further contamination at the CAM-D DEW Line site;
3. Minimize impact to environment, fauna, flora and
4. Achieve remedial objectives.

The contractor shall have a site specific, Health and Safety Plan (HASP) in place and understood by all involved workers prior to work starting on the site. Contractor shall also have a spill contingency plan in place to deal with any unforeseen and accidental releases of contaminants.

8.2 CAMP

A camp will be required during the remedial activities. The camp must be large enough to support approximately 30 site workers and approximately 3-5 camp staff. The camp shall include a potable water source, sewage collection and treatment in accordance with all applicable guidelines and regulations, bear safety measures, emergency rations and an emergency rescue contingency plan. A water sample was collected by UMA Engineering Ltd. from the freshwater lake south of the Airstip area (**Figure 4.0**) and submitted for routine potable and total metals analysis (UMA, 2007). Results for major ion and total metals in the water sample were found to be below the CCME Guidelines for Canadian Drinking Water Quality. It should be noted however that additional testing would be required on an on-going basis for potable use during remediation.

8.3 INFRASTRUCTURE/ROADS

8.3.1 Airstrip

As was presented in the Earth Tech Phase III report, there are some signs of erosion at the airstrip and exposed gravel and vegetation at both ends of the airstrip. If contractors are preparing to use the airstrip at CAM-D, it is recommended that the contractor evaluate the runway condition prior to use. The contractor shall utilize the airstrip at its own risk. The airstrip must be continually evaluated by the operational pilots and staff at the CAM-D site. If and when excessive erosion and/or rutting are noted, the airstrip shall be repaired immediately as required and to the satisfaction of the operational pilots. Further assessments and the use of a Boeing Penetrometer shall be employed before larger aircraft are taken under consideration for landing on the airstrip at CAM-D.

Given the lack of actual in-situ data, Earth Tech cannot recommend any aircraft larger than the Shorts Skyvan with tundra tires to land at the airstrip at CAM-D. Other permissible choices of similar weighted aircraft include DHC6 Twin Otter Series 300, Beech King Air 100, 200 Series, and Beech King Air 300, 300C 350, 350C all equipped with larger tires suitable for gravel runway landings.

8.3.2 Existing Roads

Due to lack of upkeep and erosion, some of the existing roads to be utilized during remedial activities will require repair and upgrading. The main road to be utilized on site will be the road leading from the airstrip to the main station area. The settlements and washout areas (highlighted in **Figure 9.0**) shall be patched and compacted using existing fill from the main station area and borrow material from the Murchison River borrow source area (as shown in **Figures 4.0 and 11.0**). Fill material is not to be taken from either the road leading to the Short Range Radar Station or the short Range Radar Station itself.

8.3.3 New Road Construction

To bring material from the main dump area to the new landfill location at the main station area, a temporary road shall be constructed, as shown in **Figure 10.0** of this document, complete with a turn around area near the main dump. Material used to build the road will be taken from the fill at the main station area and borrow material from the Murchison River borrow source area (as shown in **Figures 4.0 and 11.0**).

The main site and associated support facility sites for CAM D are situated on top of soft, water-saturated silty-clay. Pools of standing water around the main site are frequent. The surface material can hold an ATV, and in some places where sufficient gravel thickness remains, (after site stripping of gravel for construction of the SRR site) the site could be accessible with a four wheel drive passenger ton pick up truck. This access however, would be short-lived as rutting commences and underling wet soils and water gets worked to the surface. Travel to work areas around the CAM D site via heavy wheeled vehicles would not be possible under current conditions. It would be considered prudent for the successful contractor to prepare for wheeled access to the sites (requiring repeated vehicle traffic) with preplanning and utilizing track equipment until sufficient road bases are established to access the work. This could be completed by the construction of temporary work pads and roads utilizing gravel and/or the combination of layers of reinforcing geotextile.

8.4 BORROW SOURCE DEVELOPMENT

Borrow sources shall be developed in accordance with the Indian and Northern Affairs Canada Abandoned Military Site Remediation Protocol. Required borrow material shall be drawn preferentially from the main station area gravel. Borrow source requirements required beyond those available amounts shall be taken from the Murchison River borrow source areas as shown in **Figure 4.0**.

Once the borrow source requirements for the CAM-D remediation have been satisfied all borrow sources will be recontoured to restore natural drainage and to match surrounding topography and minimize changes to the existing permafrost.

The 2006 Environmental Assessment report compared material gradations to a slightly different set of granular classifications than is currently being used for the design of landfills on northern DEW Line sites. The following table presents the current DND soil classification to the classifications presented in the 2006 assessment report.

Granular Material Classification presented in 2006 Assessment Report	DND Classification
Type 1	Type 1
Type 2	Type 2
Type 5	Type 3
Type 4	Type 4
Type 4	Type 5
Type 5	Type 6

In order to access the borrow source near the Murchison River, the successful contractor will be required to construct a channel/creek crossing across the drainage pattern at the base of the shallow valley. This will be required to prevent construction traffic accessing the borrow source from silting the flow through the drainage pattern leading to the nearby Murchison River and preventing damage to the sensitive fish habitat. It is anticipated that in the early thaw portion of the season (May, June and July, early August) that flows could be substantial and carry significant hydraulic forces and volume. It is suggested a series of culverts be placed at the base of the drainage pattern and covered with gravel to allow equipment to cross the drainage pattern to gain access to the sand and gravel deposits. Proper design using larger size cobble and boulders to secure the culverts is strongly encouraged. The suggested location of the crossing is shown in **Figure 11.0** of **Appendix A**.

The clay borrow source located at Murchison River is estimated to contain approximately 14,000 m^3 of clay. Based on the clay requirements of the landfill (5,000 m^3), it is anticipated that the Murchison clay stockpile is adequate for the remedial activities.

8.5 NON-HAZARDOUS WASTE LANDFILL ENGINEERING AND CONSTRUCTION

The landfill location was selected based on the required landfill size, distance to material to be landfilled and distance to borrow sources. The landfill location (shown in **Figure 10.0**) at the main station area requires the least amount of transportation for the majority of the waste and it is on the crest of a hill, minimizing the probability of erosion and infiltration.

Landfill shall be constructed in a controlled manner with minimal lifts to control compaction and settlement.

Surface water run-on and run-off will be controlled through proper grading to positively shed water and to prevent ponding and seepage into the landfill. Consideration to the landfill cap angles must be designed as to not to encourage erosion of capping material.

Leachate control should be accomplished by control measures (rather than containment and collection such as synthetic liner cover). Control measures include placing only dry and stable material in the landfill and preventing water infiltration into the landfill to prevent leachate generation. Fill material shall be "frost stable" and placement outside of high groundwater or constant surface water area recharge area. Settling of the landfill surface shall be avoided by placing thin lifts (0.15 m) and compacting/vibrating to fill voids.

Outside berms shall be constructed at 3H:1V and inside berms at 1.5H:1V. The top of the berm should have a minimum width of 2 m. Since the berm material will be erodible, the berms should have a minimum 0.5 m thick cover of gravel and cobbles.

The reduction of surface settlement over the landfill should be completed by ensuring all debris voids are filled in and the total debris thickness in the landfill does not exceed 3 m. The landfill cap shall be compacted to 95% of the maximum density.

8.6 WASTE HANDLING FACILITY CONSTRUCTION

A Waste Handling Facility (WHF) will be required at the CAM-D site to receive and sort various waste items. The fluids handling area within the WHF shall be lined with an engineered clay/synthetic liner to prevent the migration of contaminants resulting from any accidental spills. The fluids handling area is to be bermed and the engineered liner should have some fill cover to protect the liner integrity. The waste handling facility shall have applicable safety items and PPE which include but are not limited to:

extinguisher, first aid kit, eye wash station, emergency spill kit etc. Materials to be received and sorted at the WHF include but are not limited to:

- Barrels (Barrel Protocol)
  - Empty
  - Unknown fluids
  - POLs
  - Cleaning, rinsate, crushing
- Batteries
- Compressed Gas Cylinders
- Items painted with PCB and Lead Paint
- Soils for off Site Removal
- Creosote Treated timbers (wrap in poly, on site landfill),

The WHF area shall be located southeast of the landfill area as shown on **Figure 10.0**. The WHF is surrounded by temporary road to provide access to vehicles and equipment required in the delivery sorting and transport of the site waste. Upon decommissioning of the WHF the area beneath the facility shall be sampled for confirmatory purposes.

8.7 SCHEDULE

8.7.1 Schedule

Assuming the project is tendered in the fall 2007, the following is a proposed schedule for the remediation of this site:

- Community meetings (Spring 2006)
- Permitting (Winter 2007)
- Bidders site meeting (Summer 2007)
- Contract tender (Winter 2007)
- Contract award (Spring 2008)
- Mobilization Summer-Winter 20008)
- Year 1 Remedial Activities (Summer 2009)
- Year 2 Remedial Activities (Summer 2010)
- Demobilization (Spring 2011)
- Sea-lift Demobilization of Equipment (Summer 2011).

9.0 PROJECT AND LONG TERM MONITORING

The purpose of project and long term monitoring is to confirm compliance of the remedial activities with the specified clean up objectives and clean up criteria. During the remedial program, quantities of all site materials should be estimated, tracked and measured. Contaminated areas that have been excavated shall be confirmed clean by field screening methods and then samples shall be taken for laboratory confirmation.

As all dumps are recommended to be excavated, long term monitoring of these areas will not be required. However, any newly constructed non-hazardous landfill will be inspected visually. This visual inspection will look for any settling, ponding, erosion or frost action that may have occurred. If there are signs of instability at these landfills such that buried material becomes exposed, then remedial action will be implemented. Visual monitoring will be conducted at all constructed landfills in approximately mid-August. The frequency of the program will be on an annual basis for the first five years, then if no problems area encountered year 7, 10, 15 and 25. A full review of data will be completed in the fifth year.

10.0 REFERENCES

Indian and Northern Affairs Canada, 2005. Abandoned Military Site Protocol.

Environmental Study of Abandoned DEW Line Sites, One Auxiliary and Eight Intermediate Sites in the Canadian Arctic, Royal Roads Military College, Victoria British Columbia, 1994.

CAM-D DEW Line Site, Phase III Investigation and Waste Audit, Earth Tech Canada, February 2006.

A Federal Approach to Contaminated Sites, Contaminated Sites Management Working Group, November 1999.

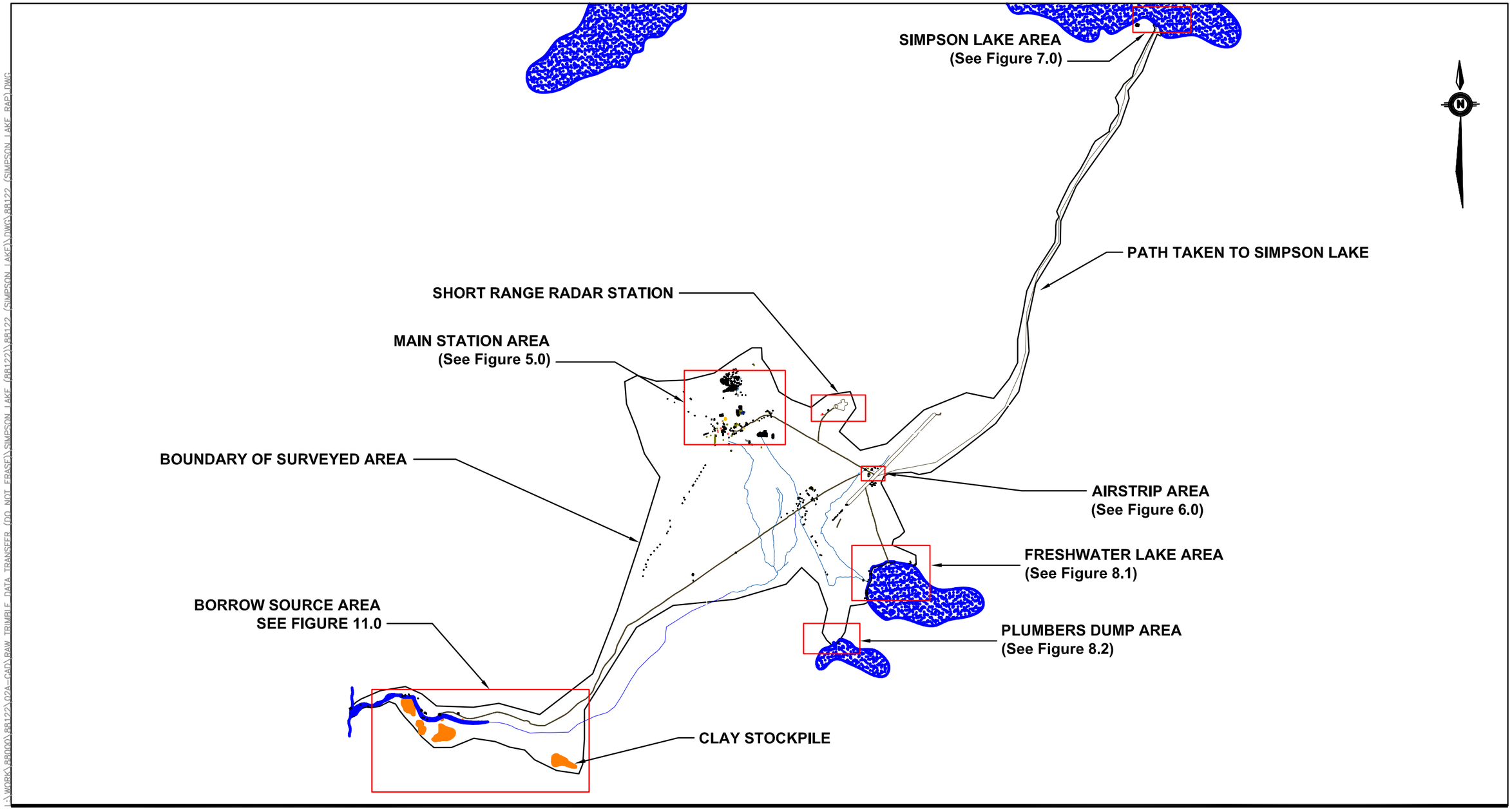
Site Remediation Technologies: A Reference Manual, Contaminated Sites Management Working Group, March 1997.

www.climate.weatheroffice.ec.gc.ca, National Climate Data and Information Archive, Environment Canada, March 2006.

Additional Assessment of CAM-D DEW Line Site, UMA Engineering Ltd., November 2007.

APPENDIX A

FIGURES



Date: NOVEMBER, 2007

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EarthTech
A Tyco International Ltd. Company

PWGSC

CAM–D DEW LINE REMEDIATION ACTION PLAN

SITE PLAN

Figure 4.0

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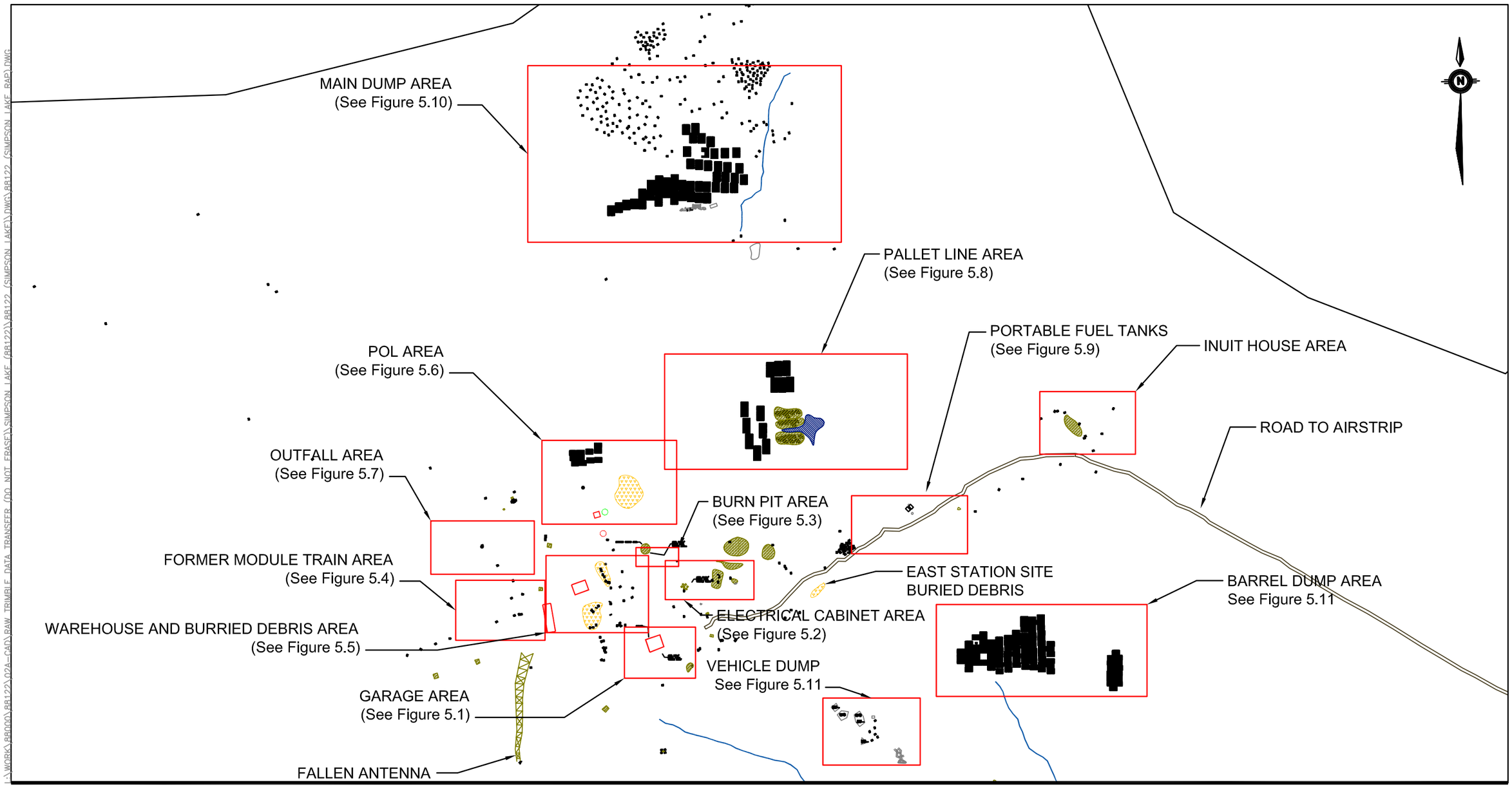

Date: NOVEMBER, 2007

SCALE:

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EarthTech
A Tyco International Ltd. Company

PWGSC

CAM–D DEW LINE REMEDIATION ACTION PLAN

MAIN STATION AREA

Figure 5.0

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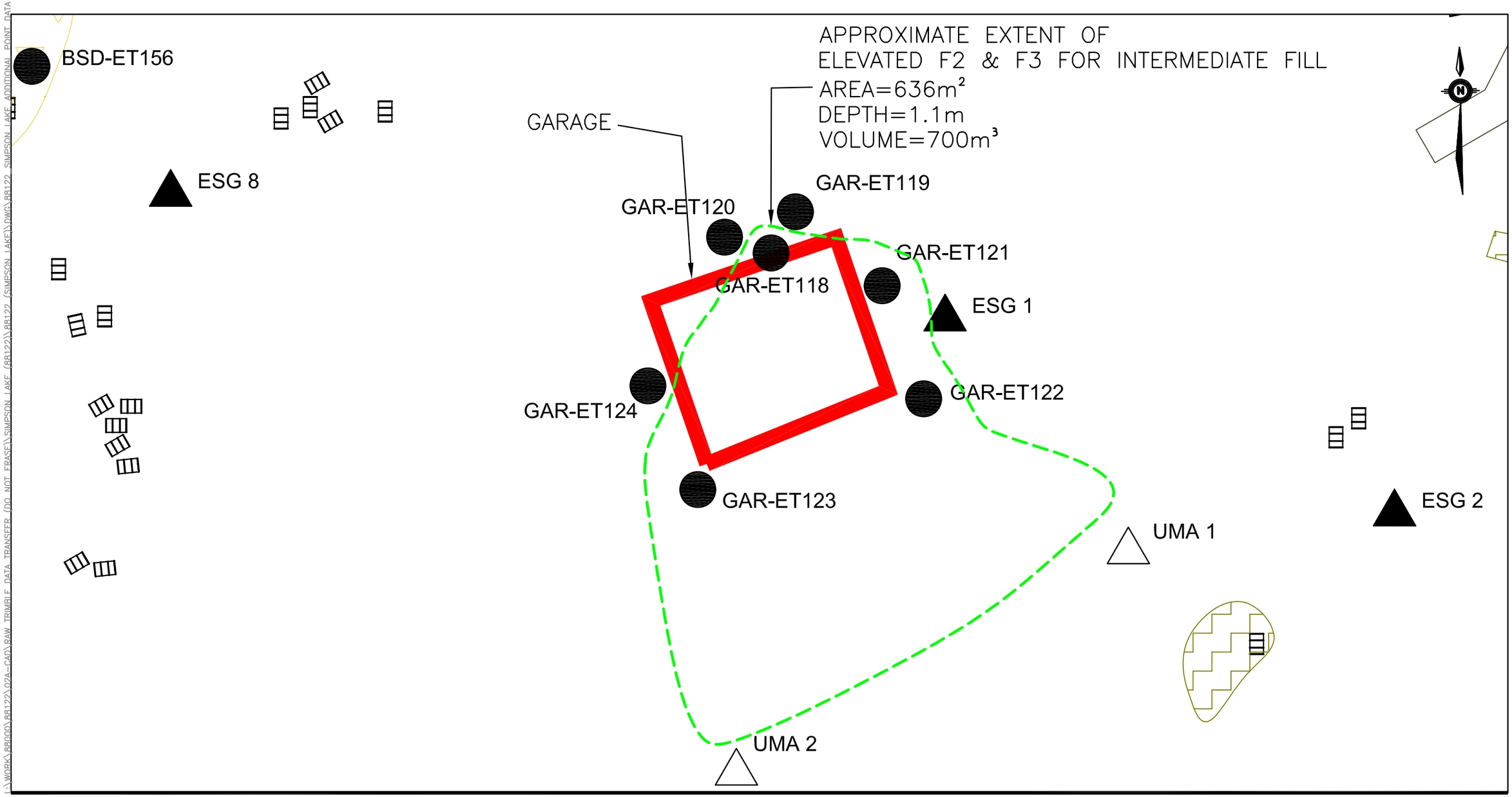

Date: NOVEMBER, 2007
SCALE:

0 5 10
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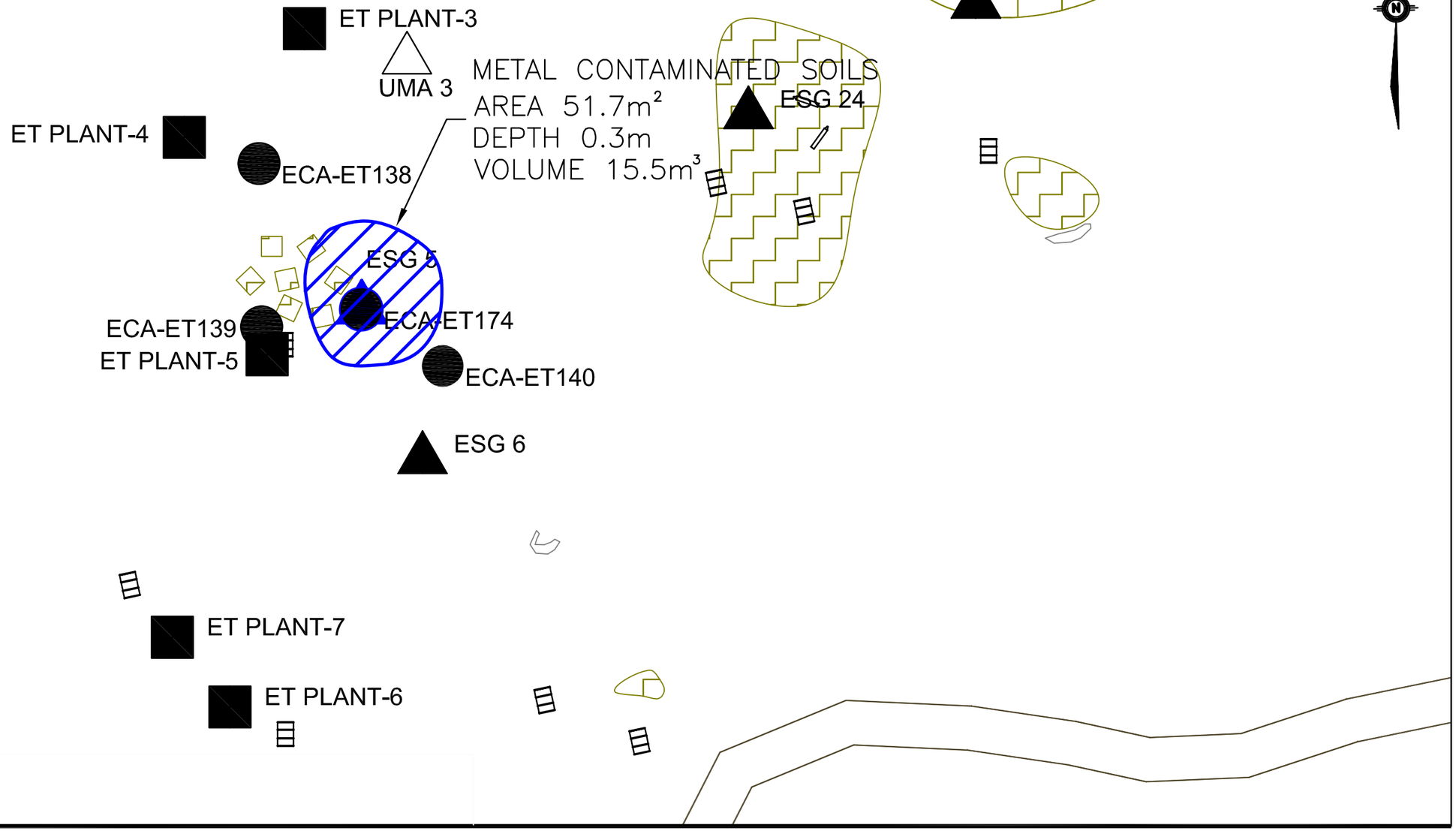
EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

- ET SOIL SAMPLE
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
GARAGE AREA (0–110 cm)
Figure 5.1

L:\WORK\88000\88122\02A-CAD\RAW_TRIMBLE_DATA_TRANSFER_(DO_NOT_ERASE)\SIMPSON_LAKE_(88122)\88122_(SIMPSON_LAKE)\DWG\88122_SIMPSON_LAKE_ADDITIONAL_POINT_DATA_ADDED.DWG



Date: NOVEMBER, 2007
SCALE:
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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

- ET SOIL SAMPLE
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
ELECTRICAL CABINET AREA (0–30 cm)
Figure 5.2

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POL-ET127

L-ET126

UMA 5

7

UMA 6

ESG 16

BURRIED DEBRIS AREA

BRN1-ET135

BRN1-ET134

BRN1-ET136

BRN1-ET137

UMA 9

APPROXIMATE EXTENT OF ELEVATED F2, F3, AND F4 FOR INTERMEDIATE FILL
AREA 55.8m²
DEPTH 0.7m
VOLUME 39.1m³

WBD-ET161

ET159

WBD-ET160

ET PLANT-3

UMA 3

META

AREA

Date: NOVEMBER, 2007
SCALE:

0 5 10
1:250

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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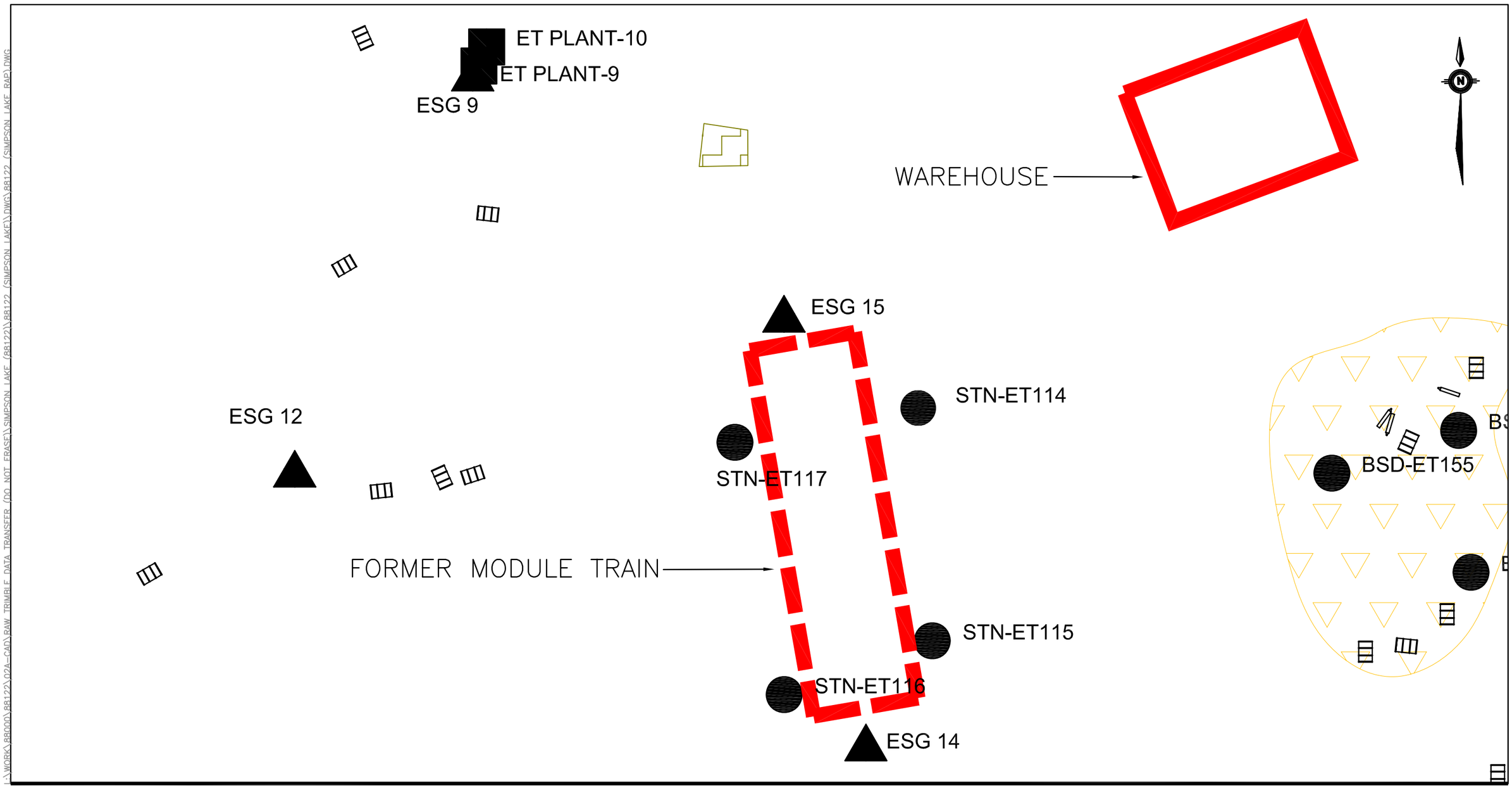
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
BURN PIT AREA (0–70 cm)
Figure 5.3



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Date: NOVEMBER, 2007
SCALE:

0 5 10
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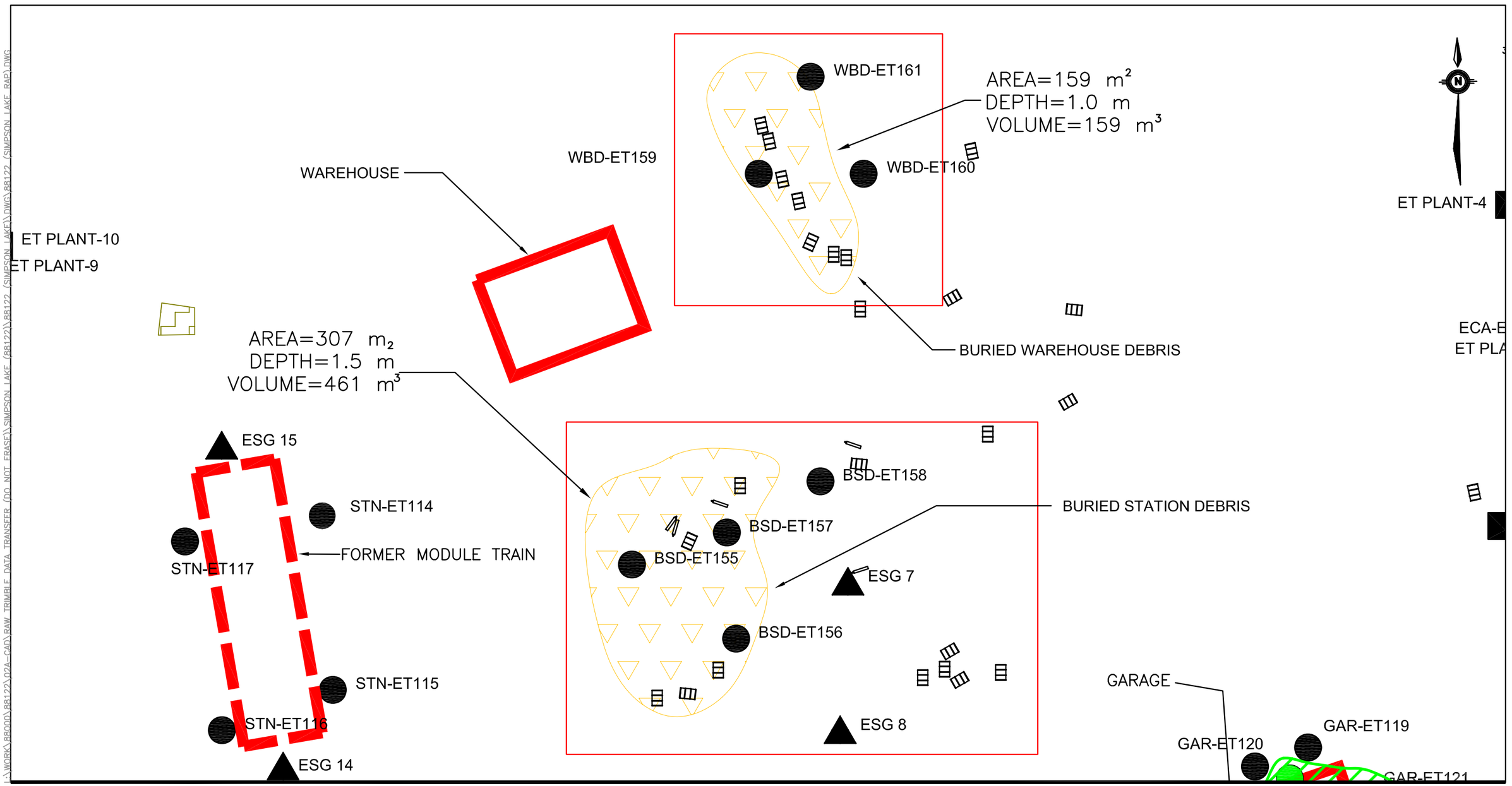
EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

- ET SOIL SAMPLE
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
FORMER MODULE TRAIN AREA
Figure 5.4



Date: NOVEMBER, 2007
SCALE:

0 5 10
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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
WAREHOUSE AND BURIED DEBRIS AREAS
Figure 5.5

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ESG 19

ESG 22

POLBD-ET164

ESG 23

HYDROCARBON CONTAMINATED SOILS
AREA 179m²
DEPTH 0.4m
VOLUME 72m³

POL SW

POL-ET132

ET PLANT-8

POL-ET131

POL-ET133

POLBD-ET163

ESG 18

POL-ET128

UMA 4

POL-ET129

POL-ET130

POL TANK

ESG 17

APPROXIMATE EXTENT OF ELEVATED F2 and PAH'S FOR INTERMEDIATE FILL
AREA 1067m²
DEPTH 1.5m
VOLUME 1600m³

UMA 8

POL-ET125

POL-ET127

PUMP HOUSE

POL-ET126

UMA 5

Note: ESG 17 & 18 were not analyzed for PAH or PHC

UMA 7

UMA 6

BURRIED DEBRIS AREA

ESG 16

BRN1-ET135

Date: NOVEMBER, 2007
SCALE:

0 5 10
1:125

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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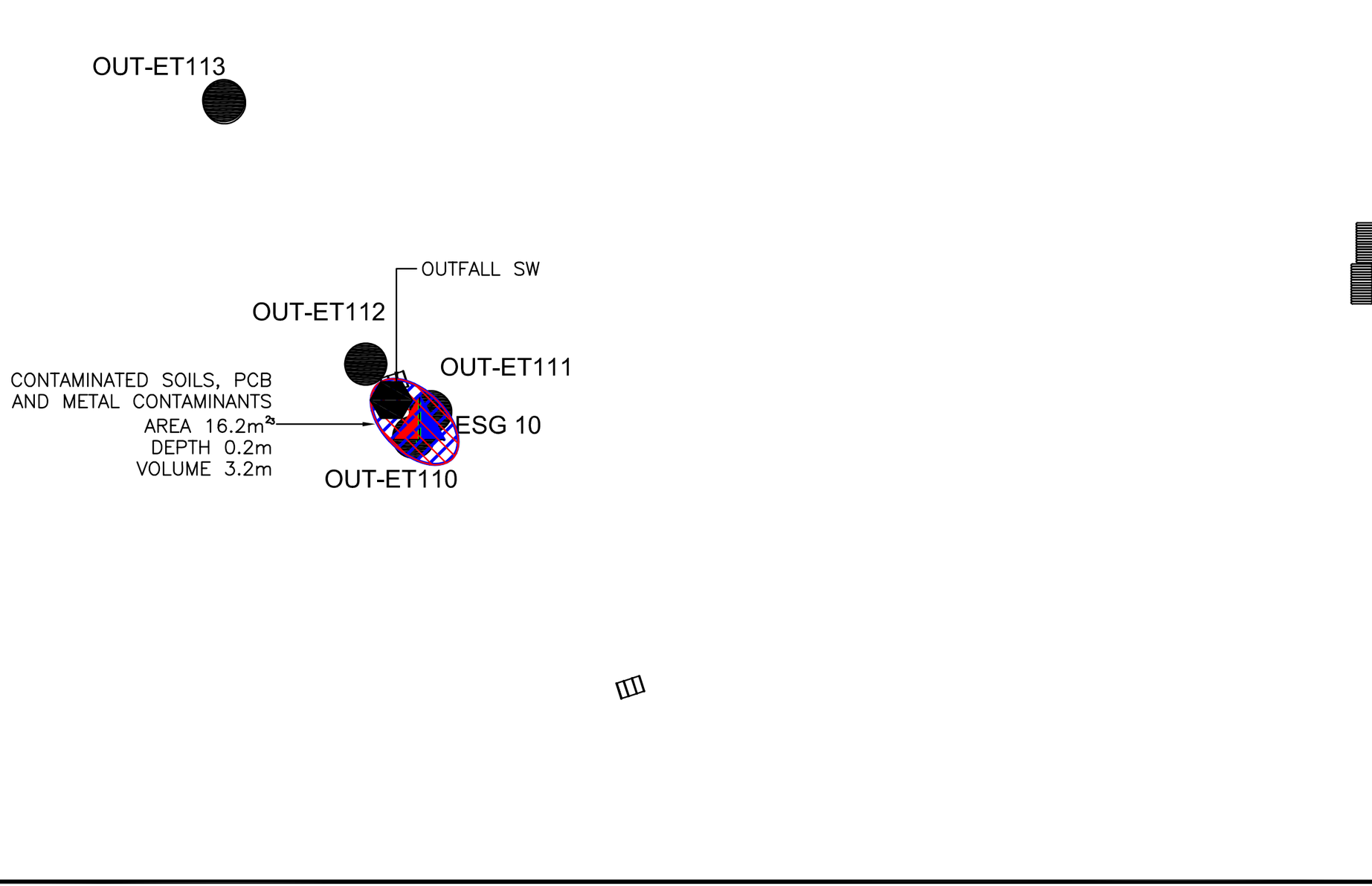
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
POL AREA
Figure 5.6



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SCALE:

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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- ESG SOIL SAMPLE
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- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
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- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
OUTFALL AREA (0–20 cm)
Figure 5.7

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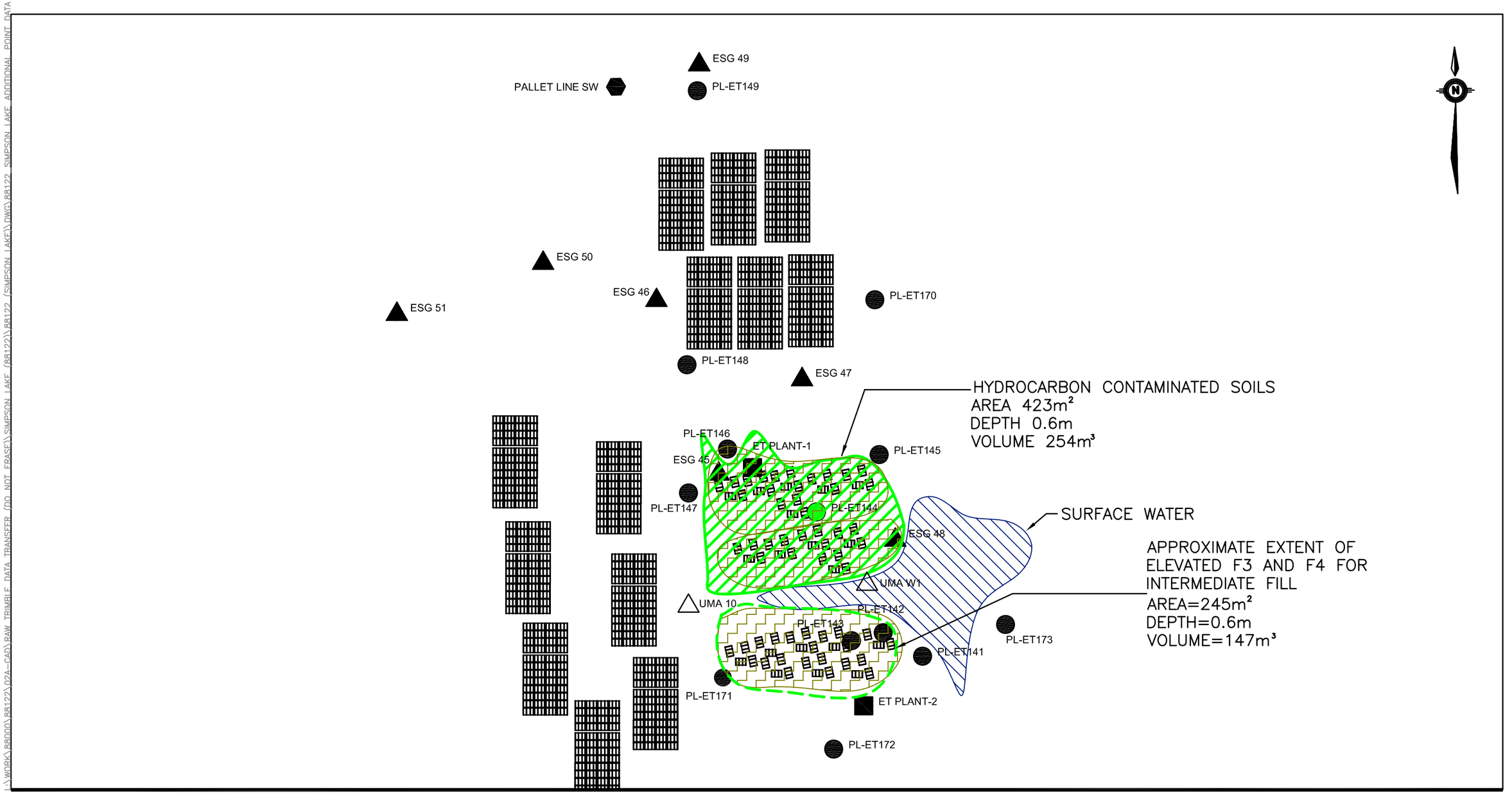

Date: NOVEMBER, 2007
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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
PALLET LINE BOREHOLE LOCATIONS (0–60 cm)
Figure 5.8

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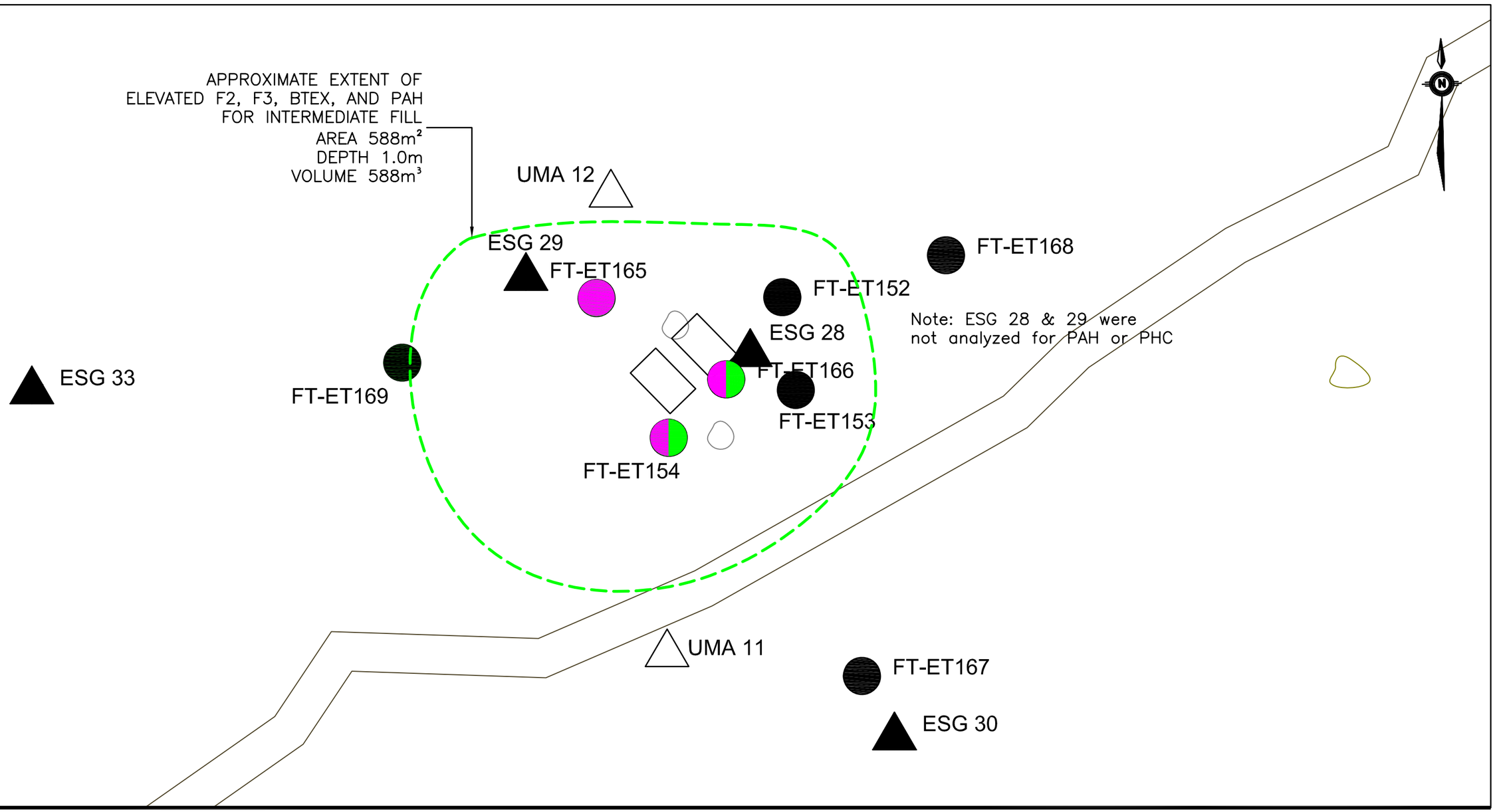

Date: NOVEMBER, 2007
SCALE:

0 5 10
1:250

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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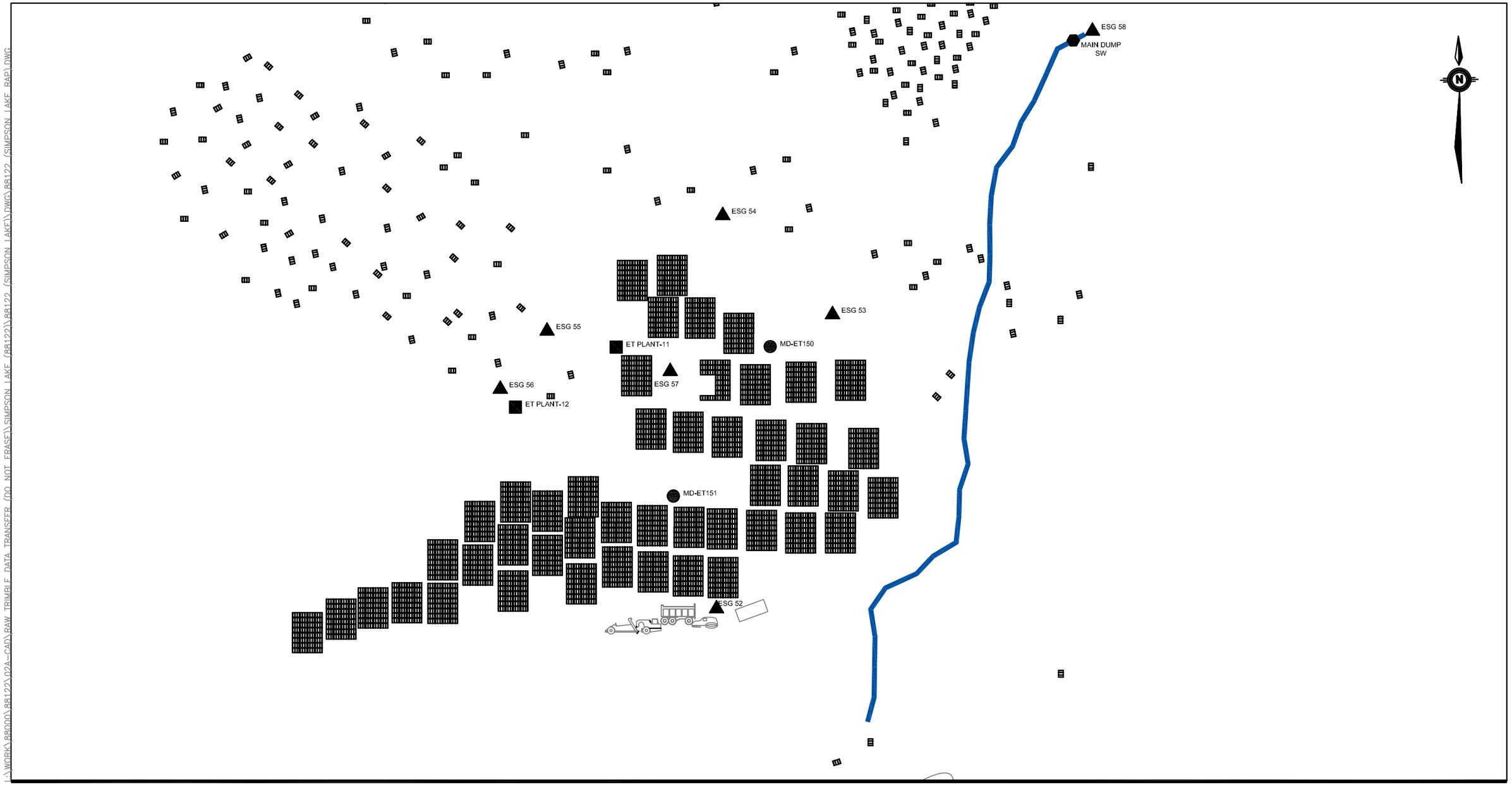
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
PORTABLE FUEL TANKS
Figure 5.9



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Date: NOVEMBER, 2007
SCALE:

0 25 50

1:750

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
MAIN DUMP AREA
Figure 5.10

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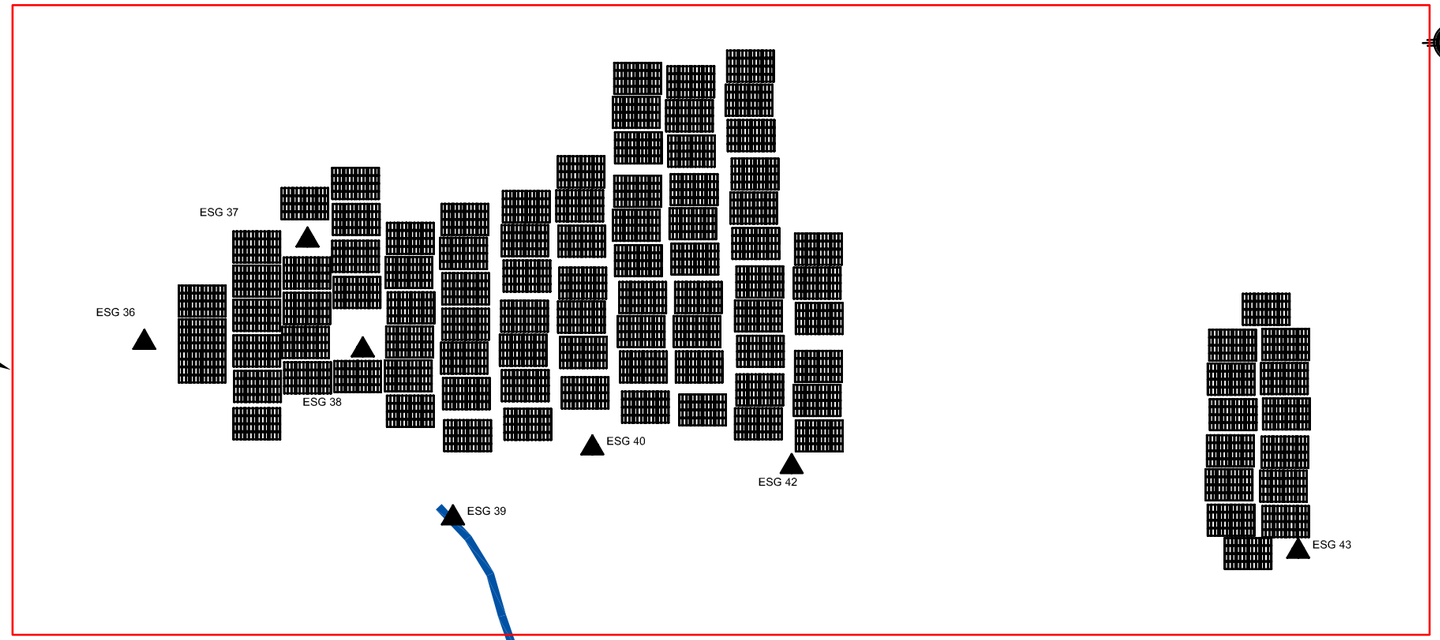
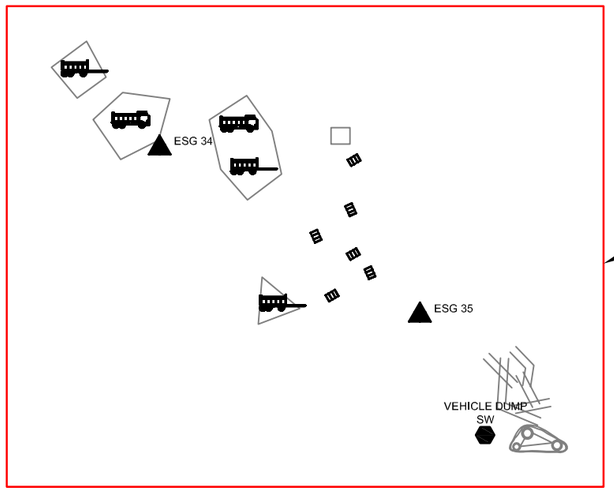
MAIN BARREL DUMP



VEHICLE DUMP AREA



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SCALE:

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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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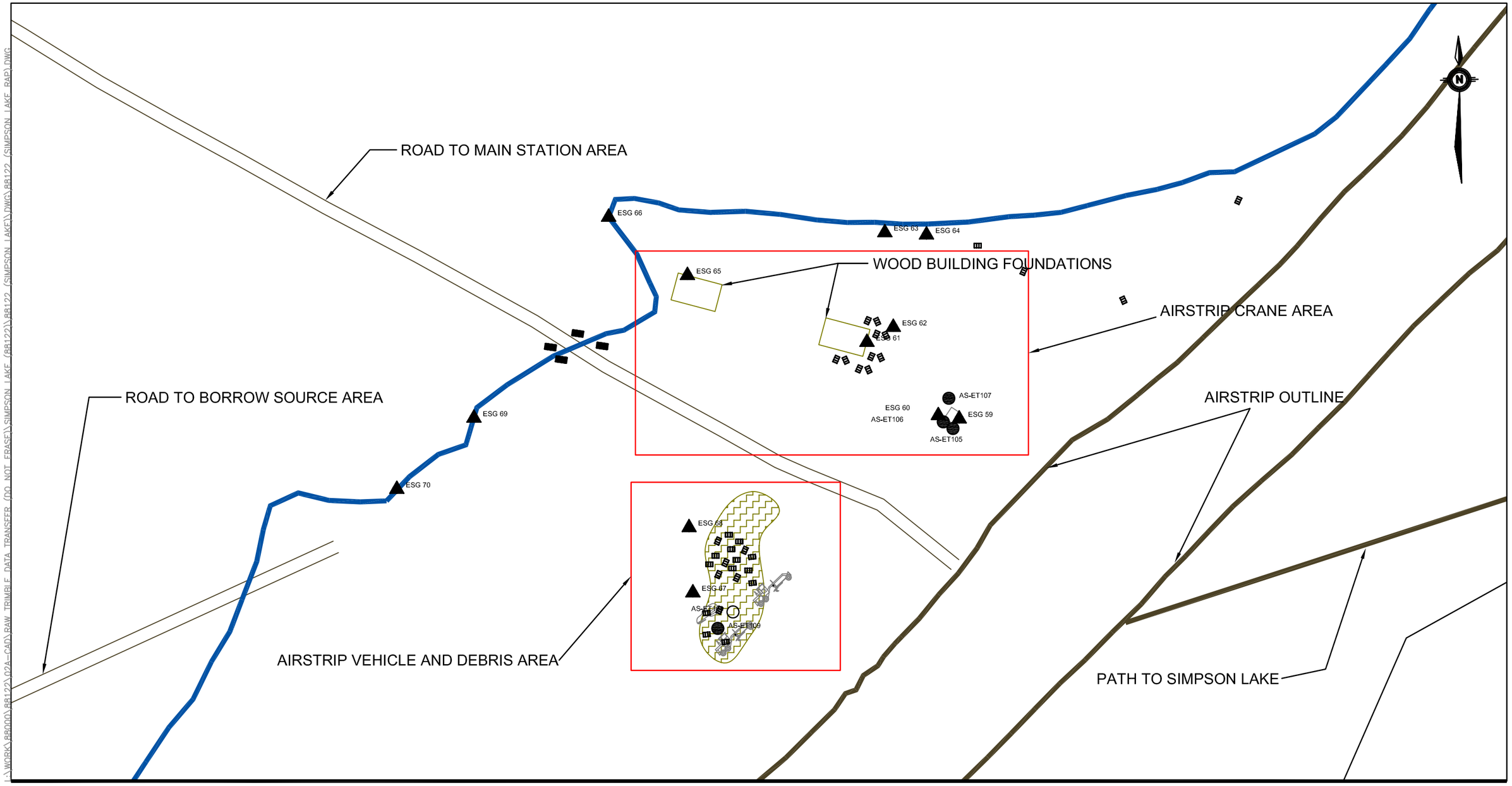
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC

CAM–D DEW LINE REMEDIATION ACTION PLAN

VEHICLE AND MAIN BARREL DUMP AREA

Figure 5.11



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Date: NOVEMBER, 2007
SCALE:

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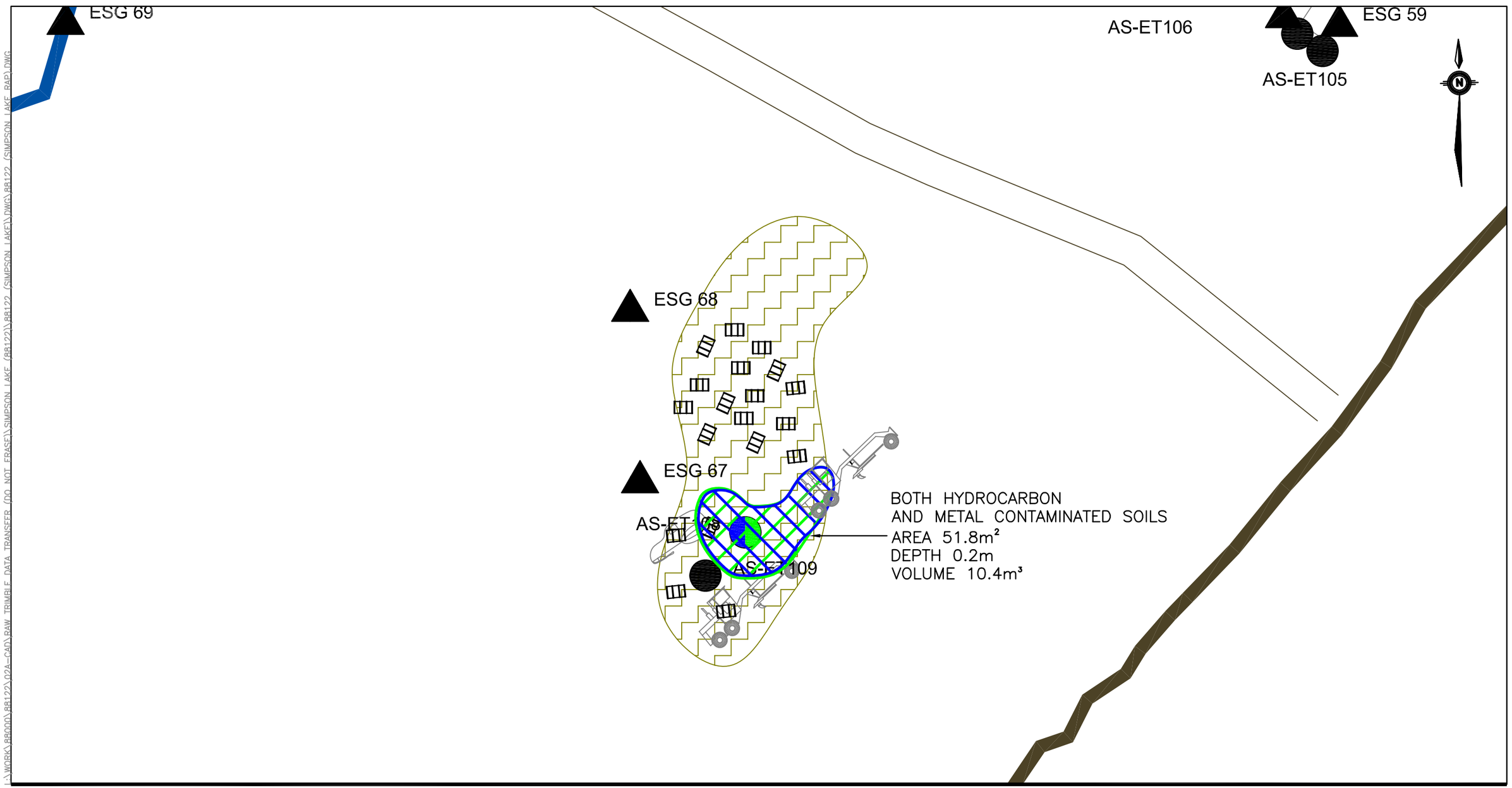
EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

- ET SOIL SAMPLE
- ESG SOIL SAMPLE
- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
- PCBs EXCEEDANCE
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
AIRSTRIP AREA
Figure 6.0



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Date: NOVEMBER, 2007
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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- UMA SOIL SAMPLE
- PLANT SAMPLE
- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
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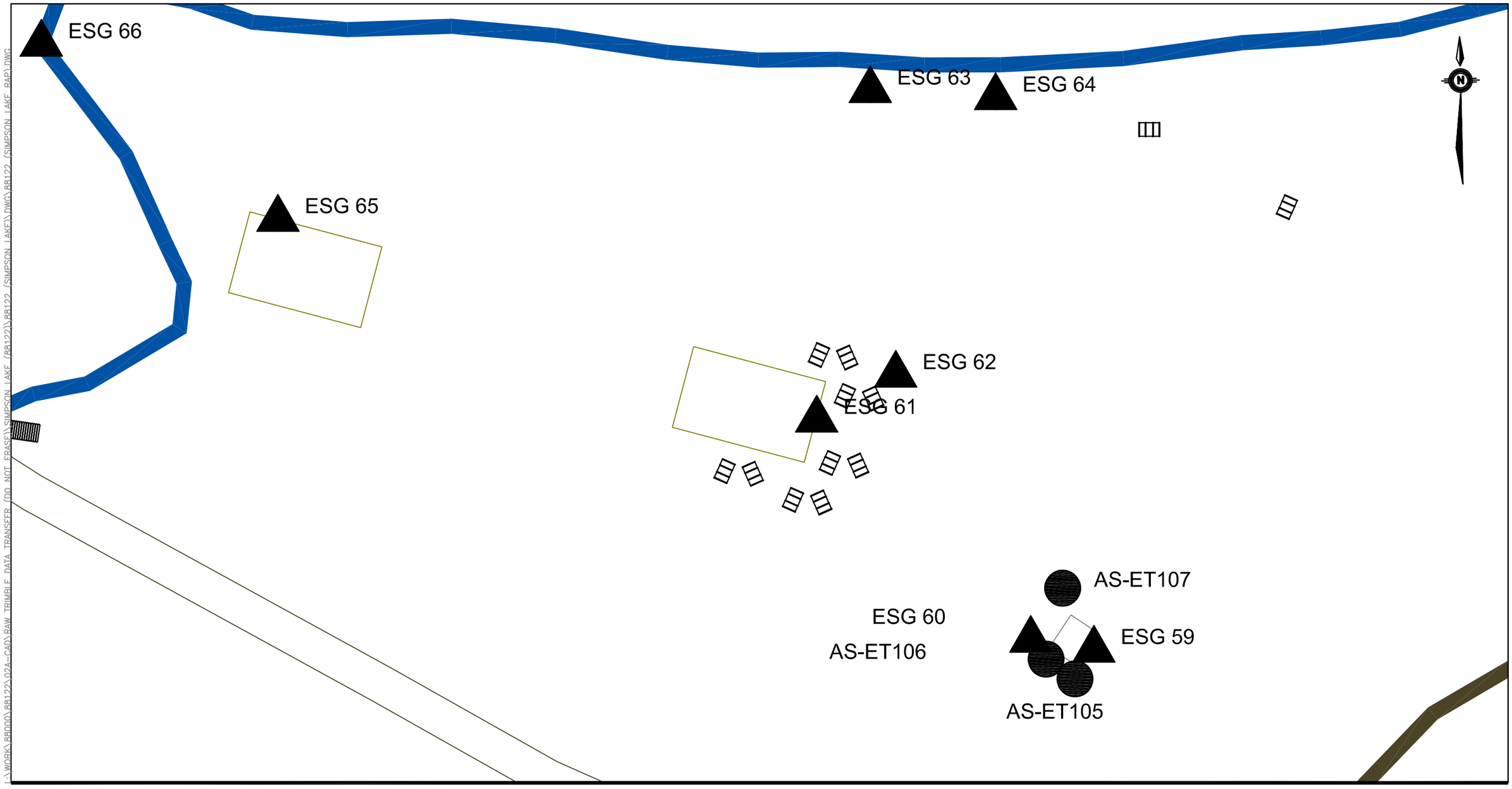
- METALs EXCEEDANCE
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
AIRSTRIP VEHICLE AND DEBRIS AREA (0–20 cm)
Figure 6.1



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EarthTech
A Tyco International Ltd. Company

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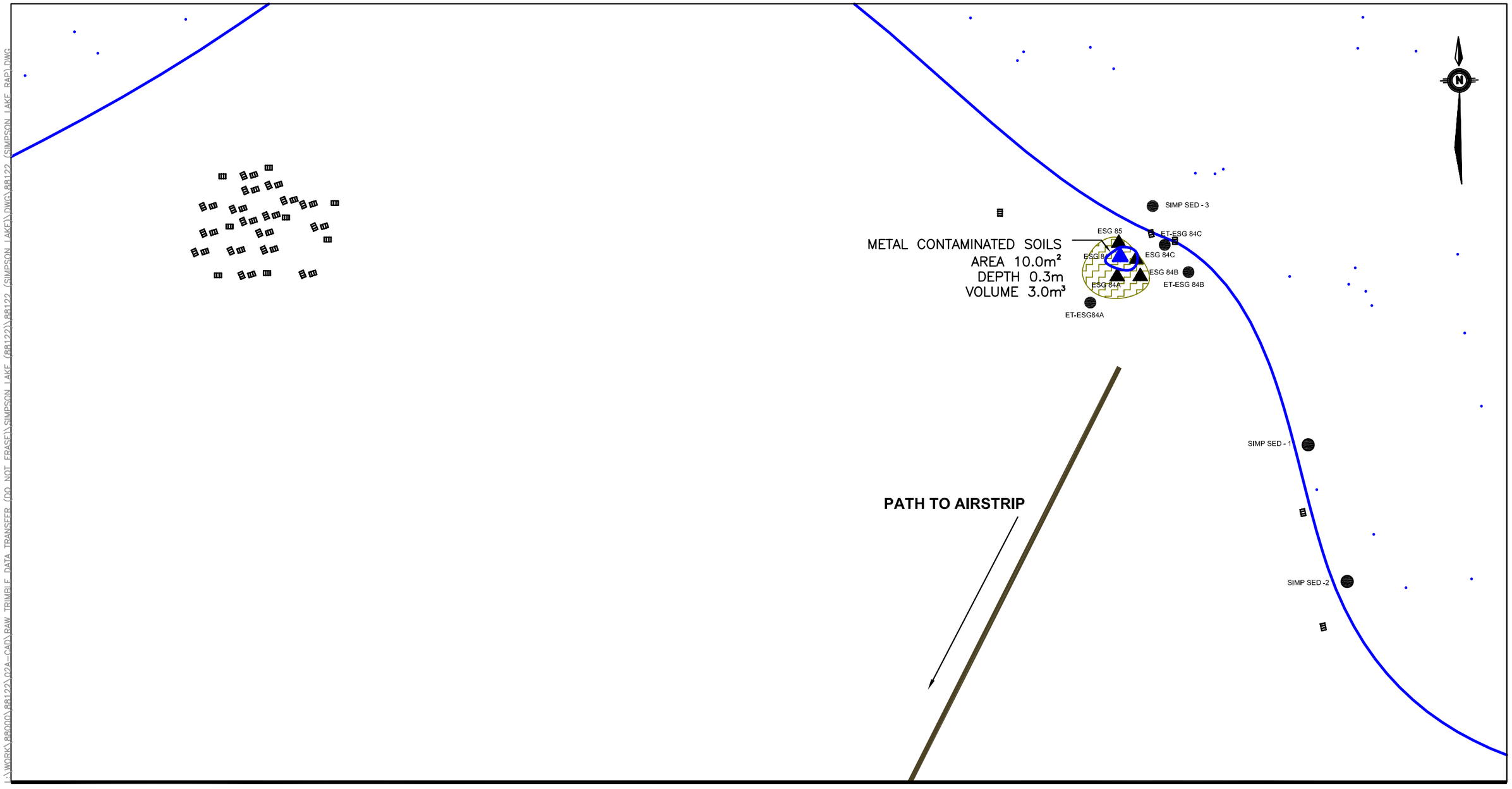
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
CRANE AREA
Figure 6.2



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Date: NOVEMBER, 2007
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EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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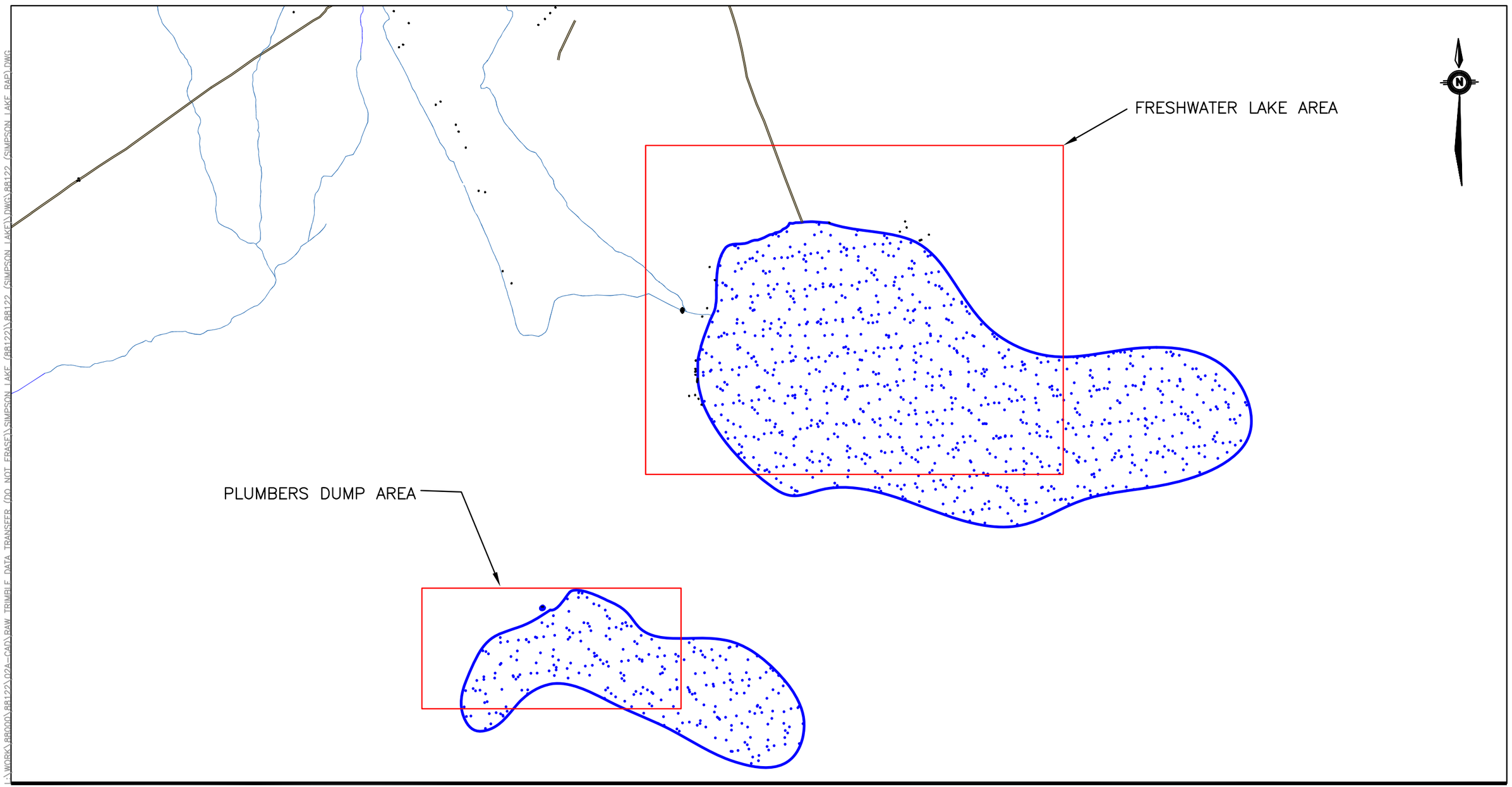
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
SIMPSON LAKE AREA
Figure 7.0



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Date: NOVEMBER, 2007
SCALE:

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Scale 1:7500

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- BARREL
- CULVERT
- COMPRESSED GAS CYLINDER
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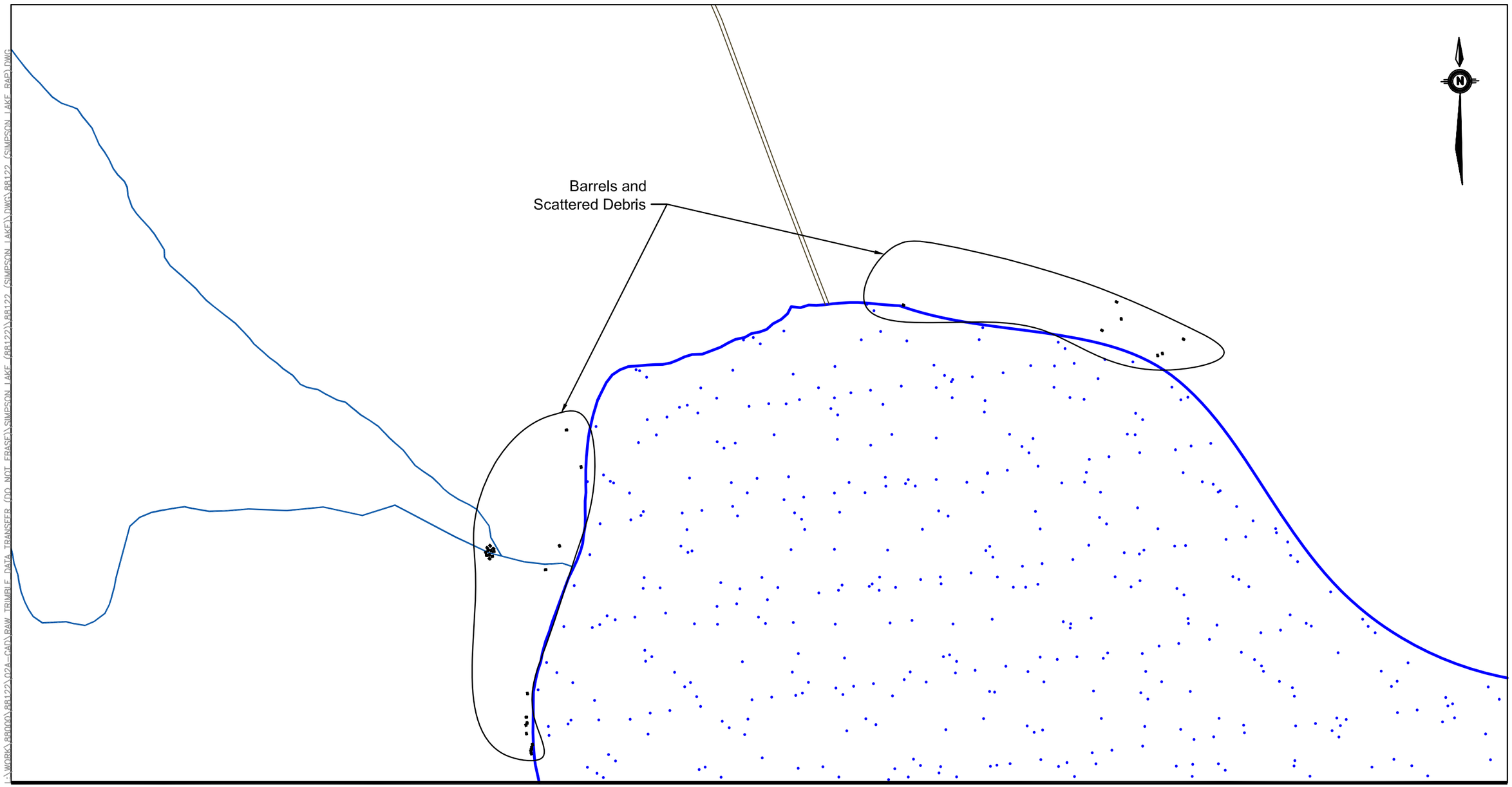
- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
FRESHWATER LAKE AND PLUMBERS DUMP AREA
Figure 8.0



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EarthTech
A Tyco International Ltd. Company

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- PAHs EXCEEDANCE
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- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
FRESHWATER LAKE AREA
Figure 8.1

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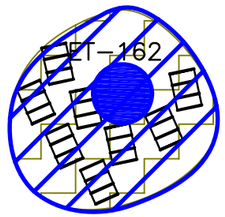

METAL CONTAMINATED SOILS
AREA 41.9m²
DEPTH 0.3m
VOLUME 12.6m³

Date: NOVEMBER, 2007
SCALE:

0 5 10
1:250

EarthTech
A Tyco International Ltd. Company

Legend (Note: ESG Samples were not analyzed for PHC or PAH)

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- UMA SOIL SAMPLE
- PLANT SAMPLE
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- PHCs EXCEEDANCE
- PAHs EXCEEDANCE
- MISCELLANEOUS DEBRIS
- BURIED DEBRIS
- PCBs CONTAMINATION PLUME
- METALs CONTAMINATION PLUME
- PHCs CONTAMINATION PLUME
- PAHs CONTAMINATION PLUME
- WATERCOURSE

PWGSC
CAM-D DEW LINE REMEDIATION ACTION PLAN
PLUMBERS DUMP AREA
Figure 8.2

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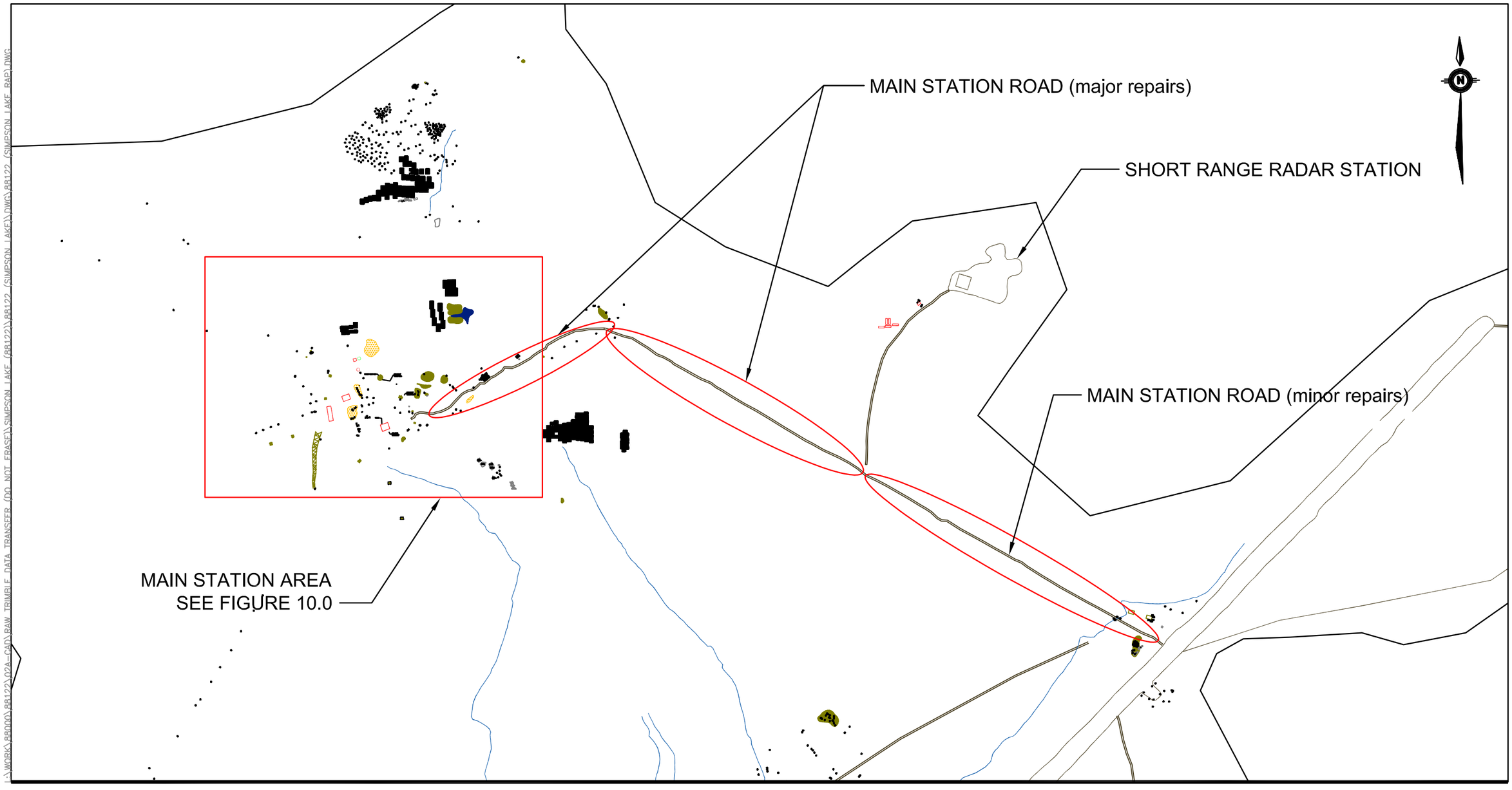

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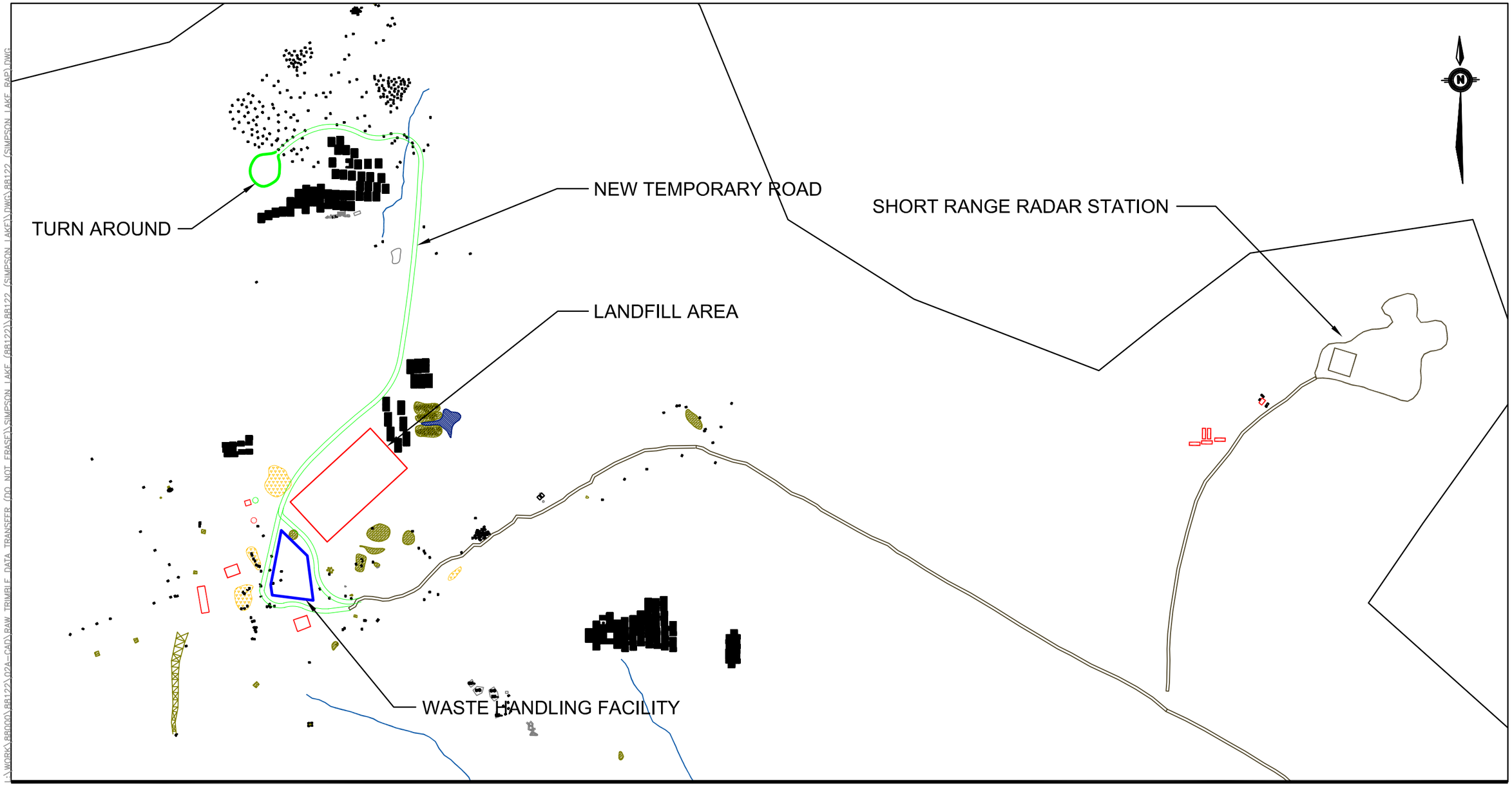
Date: NOVEMBER, 2007
SCALE:

EarthTech
A Tyco International Ltd. Company

PWGSC
CAM–D DEW LINE REMEDIATION ACTION PLAN
REMEDIATION ACTION PLAN MAIN STATION AREA ROAD UPGRADES
Figure 9.0



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Date: NOVEMBER, 2007
SCALE:

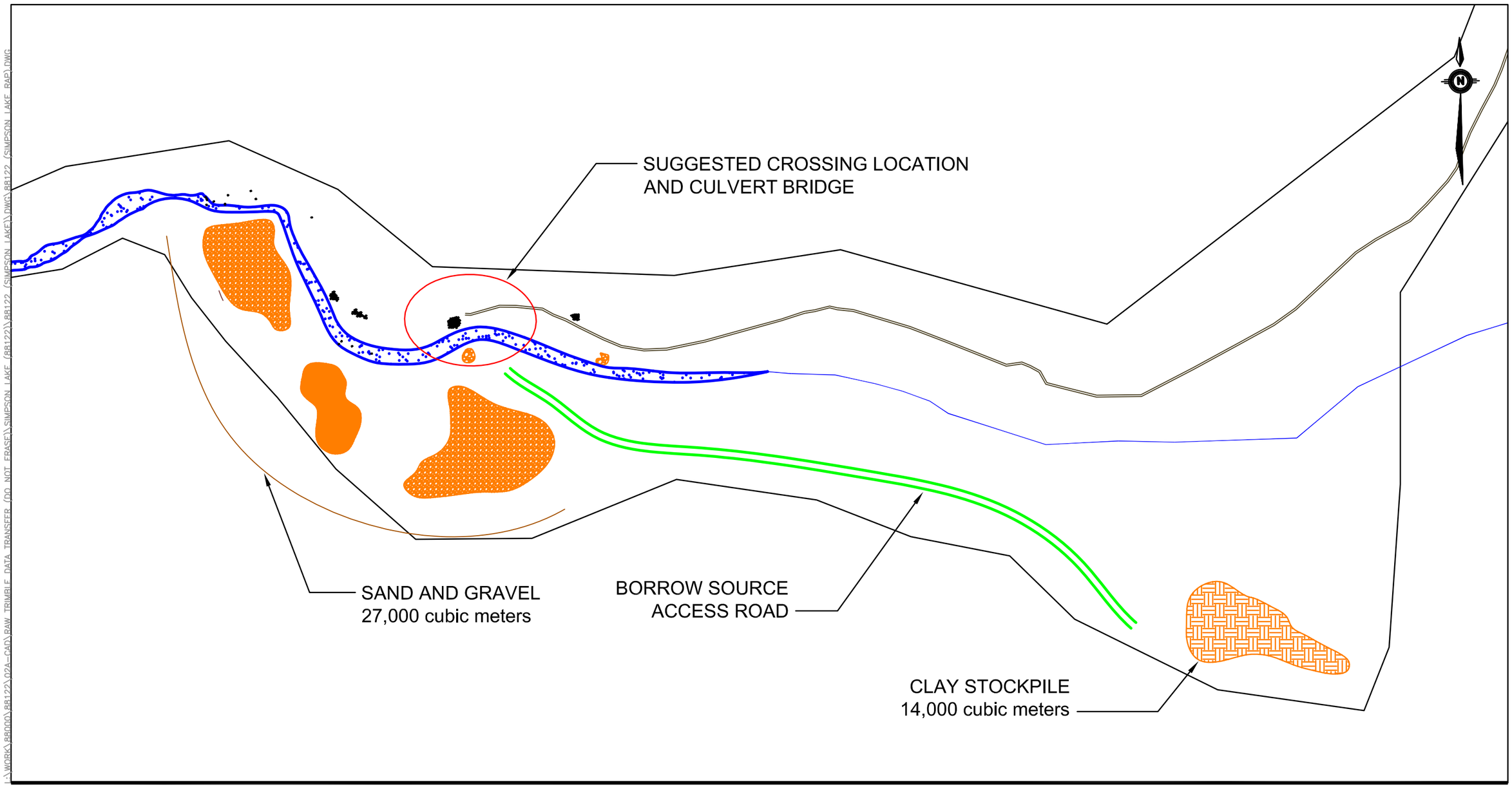
EarthTech
A Tyco International Ltd. Company

PWGSC

CAM–D DEW LINE REMEDIATION ACTION PLAN

REMEDIATION ACTION PLAN MAIN STATION AREA

Figure 10.0



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Date: NOVEMBER, 2007
SCALE:

EarthTech
A Tyco International Ltd. Company

PWGSC

CAM–D DEW LINE REMEDIATION ACTION PLAN

REMEDIATION ACTION PLAN BORROW SOURCE AREA

Figure 11.0

APPENDIX B

INAC ABANDONED MILITARY SITE REMEDIATION PROTOCOL

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Abandoned Military Site Remediation Protocol

March 2005

Indian And Northern Affairs Canada

Abandoned Military Site Remediation Protocol

March 2005

TABLE OF CONTENTS

LIST OF APPENDICES

(at end of text)

CHAPTER 1

1.0 INTRODUCTION

The Department of Indian and Northern Affairs Canada (INAC) is responsible for contaminated military sites, including intermediate and auxiliary Distant Early Warning (DEW) Line sites, in the Canadian Arctic (Fletcher 1989; INAC 2002). Environmental issues of concern at these sites have been identified that need to be addressed. This site remediation Protocol provides the guiding principles for the remediation of the contaminated sites under the control of INAC. The main DEW Line sites are the responsibility of the Department of National Defence (DND). Most of the INAC sites differ from the related DND sites in that they were in operation for a very limited period of time and were significantly smaller than the DND sites. Six of the INAC sites, Hat Island (CAM-B), Simpson Lake (CAM-D), Rowley Island (FOX-1), Bray Island (FOX-A), Nadluarjuk Lake (FOX-B) and Resolution Island (BAF-5), have currently operational North Warning System (NWS) sites co-located with the original DEW Line Site reserve.

INAC has undertaken the remediation of a number of sites across the Canadian Arctic namely Iqaluit Upper Base, Resolution Island, Horton River (BAR-E), and Pearce Point (PIN-A). The approach adopted for the remediation of these sites has generally been consistent with the DLCU Protocol (ESG 1991, 1993) with some site-specific modifications. Although no formal protocol was established or followed, remediation levels achieved at these sites were established for the protection of the environment. Due to the federal governments commitment to future funding of contaminated site clean up, INAC recognizes the need for a consistent protocol for abandoned military site cleanup (INAC 2002).

There are a number of factors that must be considered when determining the most suitable approach to site remediation. This protocol is based on an approach which addresses all legal requirements, INAC's Draft Contaminated Sites Policy (including risk management requirements) and standard environmental management practices (INAC 2002). This Protocol also takes into consideration financially prudent methodologies that address all the site environmental issues while striking a balance with remedial cost.

CHAPTER 2

2.0 CLEANUP OBJECTIVES

The following cleanup objectives, which are consistent with the CSMWG objectives to "integrate sustainable development and pollution prevention principles while meeting environmental regulations and protecting public health" (CSM, 2000, TB 1998, 2000, 2002), have been identified:

- To restore sites to an environmentally safe condition;
- To prevent migration of contaminants into the Arctic ecosystem;
- To remove physical hazards for the protection of human health and safety; and
- To implement a cost effective remediation solution.

These objectives are consistent with those applied by DND in the remediation of DEW Line sites under DND control (ESG 1991, 1993). The following considerations need to be taken into account when developing and implementing a remediation plan for the INAC sites:

- Respect all historical agreements and obligations in a fair and reasonable manner;
- Ensure consistency with federal guidelines for the management of contaminated sites;
- Apply the Canadian Council of Ministers of the Environment (CCME) environmental protection and management approaches (CCME 1996, 1997, 1999, 2001);
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they are identified;
- Establish cost effective solutions through the use of best practices to ensure appropriate levels of environmental protection for all sites;
- Recognize the concerns of global warming in an Arctic setting; and
- Ensure the long-term effectiveness of the environmental remedial measures.

CHAPTER 3

3.0 BACKGROUND

It is Canadian government policy that all federal departments and agencies ensure sound environmental stewardship with respect to property in their care by avoiding contamination and managing contaminated sites in a consistent and systematic manner that recognizes the principle of risk management and results in the best value for the Canadian taxpayer (TBRP 1998, 2000, 2002). The following sections discuss the various factors that have been taken into consideration in developing a remediation approach.

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT APPROACH

Where remediation of federal real property is undertaken, departments and agencies are to set remediation objectives in accordance with the most applicable of the three methods developed by the Canadian Council of Ministers of the Environment (CCME) (CCME 1997):

- *Method 1*: Follow CCME Environmental Quality Guidelines (CCME 1997, 1999), as amended from time to time, and, where applicable, the *Canada-wide Standard for Petroleum Hydrocarbons in Soil* (CCME 2001). To the extent that such guidelines do not exist for a particular type of contamination, or are technically or economically inappropriate for a particular situation, departments and agencies may follow equivalent guidelines or standards (e.g. provincial);
- *Method 2*: Follow modified CCME Environmental Quality Guidelines where site conditions, land use, receptors, or exposure pathways differ only slightly from the protocols used in the development of the Guidelines; and
- *Method 3*: Develop site-specific remediation objectives based on a site-specific risk assessment, as outlined by the CCME, or equivalent, where site conditions are unique or particularly sensitive.

DEPARTMENT OF NATIONAL DEFENCE (DND) DEW LINE CLEAN UP PROTOCOL

The DLCU Protocol was developed by DND, with other government agency and stakeholder involvement, as a functional strategy for the effective remediation of the DND DEW Line sites (ESG 1991, 1993, 2003). The Protocol was developed at a time when no remediation standards and criteria specific to the Canadian Arctic existed. The

DEW Line Cleanup Criteria (DLCU Criteria) was validated through the collection of soil and vegetation samples from all of the DEW Line sites to monitor contaminant uptake using a contaminant source and pathway targeted approach. A broad suite of chemicals was investigated and the contaminants of concern at DEW Line sites were identified as those contaminants that were consistently elevated relative to the site background levels and the available Canadian federal or provincial guidelines (CCME 1991). The importance of the sites acting as point sources for contaminants in the Canadian Arctic was demonstrated through radial studies conducted at a number of DEW Line sites (ESG 1995). Contaminant concentrations were demonstrated to decrease with the increase in distance from the site but with constant contaminant patterns.

In 1996 DND initiated remediation of the first DEW Line sites using the DLCU Protocol and since then has applied this Protocol to all DND sites. A number of developments and modifications have been made to the approach to address issues that have arisen during the DND site remediations, such as the addition of petroleum hydrocarbons (PHC), elevated metal background concentrations in excess of the DLCU Criteria etc. These have been necessary due to the changing regulatory framework and to address site-specific conditions (e.g. CCME 2001, ESG 2005).

The development of the DLCU Protocol, the DND application of the Protocol and the Protocol itself has been reviewed by INAC to determine the applicability of the DLCU Protocol to the INAC abandoned military sites (WESA 2004). The Protocol has been determined to be generally applicable and indicates that this approach can be adopted to address specific remediation technical issues, is applicable at the smaller sites, and is appropriate for the INAC military sites. The DLCU Protocol has therefore been retained with minor modifications for application to the INAC sites. The supporting technical protocols have been developed to ensure the INAC Protocol remains relevant to the unique characteristics of INAC's sites.

The DEW Line Protocol has been retained with modifications appropriate to the scale of the site remediation requirements. These criteria remain relevant in accordance with the federal real property approach. The Criteria are adopted under the *CCME Method 1* where equivalent guidelines or standards are permissible for technical or economical reasons (CCME 1997). Where contaminants (not including hydrocarbons) are not addressed by the adopted DEW Line Cleanup Criteria, the CCME risk assessment approach (Method 3) will be applied. Hydrocarbon related contaminants will be addressed according to the CCME Canada Wide Standards (CWS) (CCME 2001).

CLEANUP CRITERIA FOR ADDITIONAL CONTAMINANTS OF CONCERN

The DEW Line Cleanup (DLCU) Protocol that includes criteria for a specific limited set of contaminants will be adopted for the INAC sites. An alternative mechanism is required to establish the cleanup criteria for contaminants of concern, identified below, that are not included in the DLCU Criteria.

PETROLEUM HYDROCARBON CONTAMINANTS

Consistent with the *CCME Method 1,* hydrocarbon contamination will be addressed through the application of the CCME CWS for Petroleum Hydrocarbons (PHC) Tier 2 (CCME 2001). Where it can clearly be demonstrated that Tier 2 levels are inappropriate due to the absence of specific pathways or receptors, a Tier 3 risk assessment approach may be adopted (CCME 1996).

Where free product is encountered the free phase liquid will be addressed prior to the application of the CCME CWS PHC or risk assessment methods for establishing remediation requirements.

ADDITIONAL NON-HYDROCARBON CONTAMINANTS

The level of environmental protection afforded the Arctic through the remediation of these contaminated sites needs to be consistent with the increased sensitivity of the receptors that are present, or frequent the sites. Environmental cleanup criteria developed for application at other more southerly latitudes are not necessarily sufficient to protect the sensitive Arctic ecosystem (INAC 2000). In order to demonstrate that the cleanup criteria adopted for the INAC military sites are sufficiently protective, an Ecological and Human Health Risk Assessment was conducted at two sites, Sarcpa Lake (CAM-F) and Ekalugad Fiord (FOX-C) (JW 2005). The impacts of the contaminants with a wide range of parameters on selected representative receptors were assessed and the related risk to the ecological or human health determined. The results of the risk assessment applying the DLCU Protocol showed that the level of risk posed by residual contaminants following remediation to these standards is well below the acceptable risk levels for both ecological and human receptors. The ecological risks at the DLCU levels are negligible. The human health risks are also negligible except in the case of PCBs where the risk is small; however below the Health Canada human health effects levels (HC 2002).

The Ecological and Human Health Risk Assessment will be used to establish appropriate remediation criteria for parameters that are not included in the DLCU Protocol.

In a limited number of cases the INAC military sites served as centres for other non-military activities. In these cases it is possible that contaminants have been introduced and are present that have not been identified as common to all sites and therefore are not included in the DLCU Protocol. At sites where this is known or suspected to be the case, the ecological and human health data will be collected and the corresponding risk assessment completed to determine the appropriate remedial standard for any additional elements detected during the investigation phase. The contaminants, not addressed by the DLCU Criteria or the CCME PHC CWS, will be addressed through *CCME Method 3 site-specific risk assessment* (CCME 1996). A site-specific risk assessment is required due to the unique and sensitive nature of the Arctic environment.

SENSITIVE RECEPTORS

Where contaminants are present in close proximity to sensitive receptors special attention, that may require a risk assessment, should be given to the remediation approach and residual contaminant levels post-cleanup to ensure effective protection of the sensitive receptors.

ECONOMIC CONSIDERATIONS - COST BENEFIT ANALYSIS

Prior to implementing any remedial plan the costs of implementing all potentially suitable remedial solutions for each component of the site need to be evaluated and the total costs of the alternative solutions established to determine the most cost effective solution. The total costs should include consideration of the logistical and resource requirements. In addition to these costs, the long-term monitoring and maintenance of the sites should be considered and the future liability of residual site contamination and facilities be addressed.

The costs associated with implementing approved remedial solutions during site remediation arise from a number of assorted expenses. These include, but are not limited to, resources (i.e. materials, suitable equipment, human resources with the necessary technical skill sets, on-site maintenance and support services) and logistics (transportation and communication).

Typically the complexities of the post-cleanup monitoring and maintenance efforts conducted under remote Arctic conditions are associated with the logistical aspects of the operation and the remoteness of the sites from technical resources and support services. The cost of implementing an acceptable technical remedial solution is often overshadowed by the costs of mobilizing the necessary resources including material, equipment and human resources with the required skill sets for demanding work under difficult conditions.

Following implementation of a technically feasible remedial solution, increased costs may be incurred to ensure effective monitoring of the sites. Problems identified during the monitoring program may result in a requirement to perform additional remedial action with additional costs.

RISK MANAGEMENT CONSIDERATIONS - RISK ASSESSMENT

The risks to the Department during the monitoring and maintenance of the site need to be identified (eg. National Classification System (NCS) and Northern Environmental Risk Assessment Strategy (NERAS)). The costs incurred during the implementation of the cleanup need to be commensurate with the environmental benefit and the residual risk to the Department (TB 2000). The risks associated with the site may be more readily reduced during the remediation phase than during the post-cleanup monitoring phase.

The risks to the project should be evaluated through standard risk assessment tools applied to Departmental projects.

CHAPTER 4

4.0 INAC MILITARY SITE PROTOCOL - TECHNICAL ASPECTS

The elements of this remediation protocol have been developed through the review of previous work at related sites (eg. PWGSC 2001, 2001b, 2001c, 2002, 2002b, 2002c, 2002d, 2002e, 2002f, 2003, IEG 2001, EWG 1998 & 1999, UMA 1994) and taking into consideration information of particular relevance to the unique character of the INAC sites. Typical environmental issues and their associated remedial action procedures addressed by the Protocol are outlined below.

LANDFILLS

LANDFILL CLOSURE

Landfills on INAC abandoned military sites can be classified into one of three broad categories. Actions associated with each category of landfill have been identified. Where a landfill exists on INAC abandoned military sites, the condition of the landfill will be evaluated to determine the most appropriate action;

- If the landfill is located in an unstable, high erosion location, it will be relocated to a properly engineered landfill. During the relocation process, any identified hazardous materials will be segregated for off-site disposal (Class A landfill);
- If the landfill is located in a suitable, stable location, but there is evidence of contaminated leachate, a suitably engineered containment system will be constructed. If this course of action is cost prohibitive, the landfill may be relocated to an engineered landfill or the waste may be disposed of off-site (Class B Landfill); and
- If the landfill is located in a suitable, stable location, with no evidence of contaminated leachate, it will be left in place. If required, additional granular fill will be placed to ensure erosion protection and proper drainage (Class C Landfill).

LANDFILL DEVELOPMENT

New engineered landfills may be required to address specific contaminants. These landfills will be used for the disposal of non-hazardous materials and non-regulated contaminated soils only. The landfills will be capped with a minimum of 0.6m of granular fill material or other thickness as determined by site conditions, which will be graded to

promote surface run-off and minimize erosion. The cover thickness will promote redevelopment of the permafrost layer to stabilize the non-regulated contaminated soil landfill contents.

Consideration for the location of any new landfill will include the proximity to drainage courses, material to be placed within the landfill, borrow source locations and the overall topography of the site.

Monitoring of the new landfills will be required to ensure that they are operating as intended. Monitoring activities may include visual inspection to ensure that water is not ponding on the landfill cover, that the cover is not eroding and that the permafrost is developing within the landfill consistent with the design.

PHYSICAL DEBRIS

Visible site debris will be collected and segregated into hazardous and non-hazardous waste streams for disposal;

- Non hazardous waste: The volume of the non-hazardous materials will be minimized through crushing, shredding, or incineration, prior to their placement in an on-site engineered landfill. If there is no existing landfill on-site, and no suitable location for a new engineered landfill, the non-hazardous materials will be disposed of off-site; and
- Hazardous waste: These materials will be disposed of off-site, in accordance with the current regulations governing the handling and disposal of hazardous materials.

CONTAMINATED SOILS

Contaminated soils will be considered in three primary categories; soils that are regulated, soils that are classified as hazardous and soils that are classified as contaminated but not hazardous waste. Contaminated soils that are regulated will be remediated and/or disposed of in compliance with the applicable regulations. Contaminated soils that are not regulated or hazardous will be remediated to meet the DLCU Criteria (see Appendix B). Where the historical land use has been for another industry in addition to the military operations, additional parameters will be assessed and remediated to levels established through Site Specific Risk Assessments. Hydrocarbon contaminated soil remediation levels will be established through the

application of the CCME Canada Wide Standards - Petroleum Hydrocarbons in Soil (CCME 2001).

Three primary contaminated soil types have been identified; metal contaminated soil, hydrocarbon contaminated soil and PCB contaminated soil. Where multiple contaminants are present in the soils, the most conservative remedial option that addresses both contaminant types will be applied.

METALS CONTAMINATED SOILS

All soils with metal concentrations exceeding the DLCU Criteria or criteria derived through Risk Assessment processes will be either disposed of off-site or encapsulated on-site.

PETROLEUM HYDROCARBON CONTAMINATED SOILS

Hydrocarbon contaminated soil remediation levels will be established through the application of the CCME Canada Wide Standards - Petroleum Hydrocarbons in Soil. Tier 2 levels will be routinely applied with Tier 3 levels applied to sites where conditions are significantly different than the norm. Where hydrocarbon contamination is determined to exceed these protective levels, in-situ or ex-situ remediation options will be considered. Where on-site remediation is not cost effective, hydrocarbon contaminated soils may be transported off site for disposal. If they do not pose a significant environmental risk, they may be capped in place or left in place to remediate through natural attenuation.

Where free product is encountered the free phase liquid will be addressed prior to the application of the CCME CWS PHC or risk assessment methods for establishing remediation requirements.

PCB CONTAMINATED SOILS

All soils with PCB concentrations exceeding the DLCU Criteria will be either disposed of off-site or encapsulated on-site. If the PCB contaminated soils are considered to be a PCB Waste under the Canadian Environmental Protection Act (CEPA 1999), soil handling and disposal will be governed by the PCB regulations.

HAZARDOUS MATERIALS

Hazardous materials referred to in this section are defined as any materials, which are, designated "hazardous" or "dangerous goods" under Nunavut Territorial or federal legislation. Generally, all hazardous materials identified at the site will be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act (TC 2002), to a licensed hazardous waste disposal facility. There are a few exceptions, which are described below:

- Asbestos: Asbestos waste will be collected, double bagged and disposed of in an on-site engineered landfill, in accordance with the appropriate legislation;
- Petroleum Products: Petroleum products, such as gasoline or diesel, which do not contain other hazardous products (chlorine, PCB, heavy metals, etc.) will be incinerated on-site under appropriate emissions controls. Heavier petroleum products such as lubricating oil will be disposed of off-site or mixed with lighter petroleum products and incinerated on-site under appropriate emissions controls;
- Compressed Gas Cylinders: Compressed gas cylinders with known contents will be vented. Once empty, the metal cylinder will be disposed on-site in an engineered landfill;
- Creosote Treated Timbers: Timbers will be wrapped in polyethylene sheets and disposed on-site in an engineered landfill;
- PCB Paint on Building Components: PCB paint and PCB painted components which are regulated under the CEPA, will be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed hazardous waste disposal facility; and
- Lead-Based Paint on Building Components: Lead-based painted components which are classified as hazardous material will be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed hazardous waste disposal facility. Painted components that exceed the relevant federal or Territorial criteria but are not considered hazardous will be collected and disposed in an on-site engineered landfill.

BARRELS

Barrels identified at the site will be handled according to the DLCU Barrel Protocol (see Appendix D) as outlined below:

- Empty Barrels: Empty barrels will be crushed and disposed in an on-site engineered landfill;
- Filled or Partially Filled Barrels: Barrel contents will be inspected and tested if necessary and disposed of appropriately (off-site or incinerated). The empty barrel will be rinsed, crushed and disposed on-site in an engineered landfill. The spent rinse liquid will be treated with absorbent material and disposed as hazardous material, as required; and
- Buried Empty Barrels: Areas containing buried empty barrels will be inspected to determine if any of the barrels contain material and characterized through a geophysical survey. If the barrels are found to be empty the area will be stabilized through compaction to crush any corroded barrels. A cover of borrow material will be placed over the area and compacted.

BUILDINGS AND INFRASTRUCTURE

The existing buildings and infrastructure at a site will be demolished to their foundations. All hazardous materials will be segregated prior to or during demolition. Non-hazardous demolition materials and asbestos will be collected and disposed in an on-site engineered landfill. Hazardous demolition materials will be disposed off-site.

Only in exceptional circumstances will existing buildings remain intact on site following the remediation program. These structures may remain as emergency shelters once clear transfer of ownership has been established.

BORROW SOURCES

Granular borrow material will be required for the development of new landfills and general site grading purposes. Available existing sources of borrow material will be exhausted before exploiting new areas. Abandoned gravel pads and road infrastructure will be used as granular source material wherever possible. At the completion of the remedial activities, all borrow areas will be recontoured to restore natural drainage and to match the surrounding topography, in accordance with all applicable licenses.

SITE GRADING

Grading operations will consist of the shaping and regrading of disturbed areas to blend in with the natural contours, in accordance with all applicable licenses. The disturbed areas may include:

- contaminated soil excavation areas,
- existing and new landfill areas,
- debris areas,
- areas disturbed during demolition activities,
- granular borrow areas, and
- any area disturbed during the establishment and operation of the remediation camp, equipment storage and maintenance activities.

CONTRACTOR SUPPORT ACTIVITIES

For the implementation of the remedial activities, a Contractor will establish a camp and storage areas on-site, where required. Where possible, these will be located in previously disturbed areas such as borrow or storage areas, to minimize any new disturbances, in accordance with all applicable licenses.

Domestic refuse generated by the camp will be incinerated and disposed of on-site in an engineered landfill. Sewage will be handled by an appropriately sized sewage treatment system, in accordance with applicable legislation, in accordance with all applicable licenses.

Potable water supplies at the site will be tested and used, only if they meet the Canadian Drinking Water Quality Standards (CCME 2002), in accordance with all applicable licenses.

Fuel required for the operation of the camp will be stored on-site in accordance with applicable legislation and licenses.

CHAPTER 5

5.0 POST CONSTRUCTION LANDFILL MONITORING

Monitoring of the historical landfills and new landfills will be required to ensure that they are operating as intended. Monitoring activities may include visual inspection to ensure that water is not ponding on the landfill cover, that the cover is not eroding and that the permafrost is developing within the landfill consistent with the design.

The landfill monitoring will follow a pre-established monitoring program and will occur at regular intervals following closure of the site. Once it has been demonstrated that the landfill is stable physically and chemically then the frequency of monitoring will be reduced. Physical stability of the landfill will be established as a minimum through visual inspection and may include instrumentation for thermal monitoring. Chemical stability of the landfill will be established through the collection of suitable samples from around the landfill site consistent with the monitoring program and site specific monitoring plan.

CHAPTER 6

6.0 CLOSURE

The approach presented here and to be adopted during the INAC abandoned military site remediation program is consistent with federal and departmental policies. It takes advantage of the historical research and development previously completed and respects the approach adopted and experience gained in the past to remediate similar contaminated sites. It accounts for site-specific conditions and allows flexibility to address unforeseen issues at individual sites through risk assessment and risk management methods consistent with federal guidelines.

The supporting technical guidance documents will provide sufficient information and detail to ensure the consistent application of this approach which will provide a consistent level of environmental protection and quality assurance for all of the sites remediated during the program.

The financial analyses and control coupled with the risk evaluation and management approach will ensure that the funds expended on the remediation effort are most beneficial to the local and greater Canadian community stakeholders over the lifetime of the project and the ensuing years.

APPENDIX A:

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APPENDIX B:

DEW Line Cleanup Soil Criteria

GENERAL PROTOCOL FOR DEW LINE CLEANUP

A. STAINED SOIL

1. Remediation will be applied to all areas where inorganic elements and/or PCBs are at concentrations in excess of the Quebec B[1] or CCME R/P[2] criteria, whichever is lower.
2. This combination of the Quebec B and CCME R/P criteria form the DEW Line Cleanup Criteria (DCC). The DCC (Table 1) were determined, on the basis of site specific investigations, to be protective of the Arctic ecosystem.
3. Remediation responses differ depending on the tier of DCC, I or II that is applied. Thus:
   - All soils containing substances in excess of the DCC Tier II (numerically equal to CCME R/P) criteria will be containerized[3]; and
   - Excavated soils containing PCBs at concentrations between 1 and 5 ppm, and/or lead at concentrations between 200 and 500 ppm may be landfilled. The lower of the concentrations for these elements form the DCC Tier I criteria.
4. Some site specific exceptions may be applied; for example, the bird sanctuary at Cape Parry may be treated more rigorously.
5. Follow up (confirmation) testing will be to the DCC II (CCME R/P) criteria.

B. SEWAGE OUTFALLS

1. Use of active outfalls to be discontinued and secure sewage lagoons to be established where practical.
2. Abandoned outfalls to be considered as stained areas.

1. This refers to the Quebec Soil Contamination Guidelines (as of 1991).
2. Refers to the Interim Canadian Environmental Quality Criteria for Contaminated Sites (as of 1991) produced for the Canadian Council of Ministers of the Environment (CCME).
3. Containerized" refers to removal of the soil in a manner which precludes contact with the Arctic ecosystem.

C. SEWAGE LAGOONS

1. Existing lagoons which are not highly contaminated can continue in use provided measures are applied for leachate control.

2. Existing lagoons which are highly contaminated are to have their use discontinued, evaporation allowed to take place, and the dried residue removed and disposed in accordance with the protocol for stained soils.

D. LANDFILLS

Fall into one of three categories:

1. Located in an unstable, high erosion area; must be removed;
   Contents to be treated as per the procedures adopted for stained soils and physical debris.
2. Suitable location and no evidence of contaminated leachate;
   Can remain as is.
3. Suitable location, but source of contaminated leachate;
   Action must be taken to contain leachate. Options for the containment/stabilization of landfills can include the addition of clean fill; other suitable measures can be employed.

E. PHYSICAL DEBRIS

Visible physical debris is to be sorted into hazardous and non-hazardous components.

1. Hazardous material is to be containerized and stored in a secured location.
2. Non-hazardous material is to be buried in a suitable landfill location.

Debris from the demolition of facilities no longer required should be dealt with in the same manner as visible physical debris. Incineration of this material is not recommended; if burning is employed, the ash should be treated as hazardous waste.

It should be noted that this last requirement does not preclude the incineration of some non-hazardous materials, although it is advisable to ensure that the ash from all burning be buried in a suitable landfill. Structures that contain paints, metal etc

which could form a hazardous ash after combustion, should be broken down and buried; if this is not practical due to lack of a suitable landfill location and/or fill, then incineration may be considered as long as the ash is treated as hazardous waste.

TABLE 1: DEW LINE CLEANUP CRITERIA (DCC)[a]

SUBSTANCE	CRITERIA[b]	
Inorganic Elements	*DCC-I*[c]	DCC-II[d]
Arsenic (As)		30
Cadmium		5.0
Chromium		250
Cobalt		50
Copper	--	100
Lead	200	500
Mercury	--	2.0
Nickel		100
Zinc		500
Polychlorinated biphenyls		
PCBs	*1.0*	*5.0*

a. These criteria were adopted specifically for the cleanup of Arctic DEW Line Sites from the 1991 versions of the Quebec Soil Contamination Indicators and the Canadian Council of Ministers of the Environment Interim Canadian Environmental Criteria for Contaminated Sites.

b. Soil criteria are given in parts per million, ppm.

c. Soils containing lead and/or PCBs at concentrations in excess of DCC I, but less than DCC II, may be landfilled,

d. Soils containing one or more substrates in excess of DCC II must be containerized - i.e. removed in a manner which precludes contact with the Arctic ecosystem.

Table B-1: DEW Line Cleanup Summary

Cleanup requirement	DLCU Protocol
Building demolition and physical debris removal	– After demolitions sort debris into hazardous/nonhazardous waste. – Bury nonhazardous waste in unlined-engineered landfill and cover with clean fill. – Ship hazardous material South.
Barrels	– Crush or shred, analyze contents, then incinerate or ship to southern facility
Landfills - three types: 1. In unstable locations or leaching high levels of contaminants. 2. Contaminants leaching at low levels, and situated in a stable location which is not subject to erosion. 3. No contaminants leaching from the toe of dump.	After removal of any visible debris from the surface of the dump: 1. Excavate and sort into hazardous/nonhazardous debris. 2. Design engineering solution to stabilize in place by the use of liners and fill. 3. Cover with clean fill and recontour to direct surface waters away from the landfill.
Contaminated soil: 1. PCB level > 50 ppm (CEPA) 2. > DCC Tier II but < CEPA 3. > DCC Tier I but < DCC Tier II	1. Shipment to Southern licensed facility. 2. Isolate from the Arctic ecosystem (Northern Disposal Facility or ship South). 3. Burial in nonhazardous landfill.

APPENDIX C:

CCME CWS PHC Tier 1 and Tier 2 Criteria

HYDROCARBON CONTAMINATED SOIL
CANADA –WIDE STANDARDS FOR PETROLEUM HYDROCARBONS

A. INTRODUCTION

The Canadian Council of Ministers of the Environment (CCME) have developed the Canada Wide Standards (CWS) for petroleum hydrocarbons (PHC) in soil (CCME, 2001) in an attempt to provide a consistent evaluation and analytical approach to dealing with hydrocarbon contamination throughout Canada.

The PHC CWS is a three-tiered risk-based remedial standard for contaminated soil and subsoil occurring in four land use categories. Tier 1 sets generic numerical levels; Tier 2 allows for adjustments to Tier 1 levels based on site-specific information; whereas Tier 3 involves a site-specific risk assessment consistent with the CCME approach to the development of remedial objectives.

The PHC CWS four generic land uses are agriculture, residential/parkland, commercial and industrial. The exposure scenario associated with each of these land use categories forms the basis of the PHC CWS. Jurisdictions may also elect to define generic land uses involving the presence or absence of any relevant receptors and pathways, if appropriate in the context of geographic location, local land use and development trends.

B. CCME CWS PHC APPLICATION TO INAC SITES

LAND USE

Residential/Parkland has been applied to the INAC sites and is defined as the land use where the primary activity is residential or recreational activity. The parkland land use is defined as a buffer between the areas of residency and occupation, but this does not include wild lands such as national or provincial parks or undeveloped areas, other than campgrounds.

PATHWAYS AND RECEPTORS

The key receptors and exposure pathways considered for residential/parkland land use are as follows:

EXPOSURE PATHWAY	RECEPTOR
soil contact	invertebrates, plants, human (child)
soil ingestion	wildlife*, human (child)
groundwater / surface water	aquatic life, human (child)
vapour inhalation	child indoor

*wildlife dermal contact and ingestion is applicable when free product is present at surface, but there are insufficient data to develop guidelines that address this exposure pathway. Also, there are insufficient data to evaluate PHC exposure through the food chain. The few data available indicate that plant uptake of PHCs and subsequent exposure at higher trophic levels is not a concern.

HUMAN HEALTH EXPOSURE SCENARIOS

The critical receptor assumed at the residential/parkland land use category is a toddler. Exposed to PHC impacted soil and groundwater by ingestion, inhalation and dermal contact is assumed to be for 24 hours/day, 7 days/week, and 52 weeks/year. In addition, other receptor characteristics include soil ingestion rates (0.08 g/day), water ingestion rate (0.6 L/day), and inhalation rate (9.3 m^3/day). Route specific absorption rates are assumed to be 100% for ingestion and inhalation, and 20% for dermal contact. Additionally, to account for non-point source pollution, a soil allocation factor (SAF) of 0.5 is assumed for F1 and F2. SAFs of 0.6 and 0.8 are assumed for F3 and F4 respectively.

ECOLOGICAL EXPOSURE SCENARIOS

The ability for soil to support plant and soil invertebrate communities is deemed to be important for both short-term and long-term ecological sustainability. CWS does not consider mammalian and avian wild life as critical receptors as most PHCs are readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues. In addition, PHCs are not readily absorbed into and accumulated into plant tissues. The net result of consumption of either plants and/or other animals (as opposed to direct soil ingestion) does not tend to constitute a major component of exposure for PHCs in wild life and livestock populations. Therefore, direct

soil contact with soil invertebrates and plants is the only direct ecological exposure pathway considered applicable by CWS. The indirect contact of aquatic life with the PHCs is also considered by CWS.

TOXICOLOGICAL BASIS

The PHC CWS adopted the US Total Petroleum Hydrocarbons Working Group (TPHCWG) system and uses the oral reference doses (RfDs) and inhalation reference concentrations (RfCs) for each of the 14 aliphatic or aromatic sub-fractions identified in this system. Toxicological information for each TPHCWG sub-fraction is combined with the information on the expected mass of each sub-fraction to produce a toxicological benchmark for each of the four PHC CWS sub-fractions. The toxicological basis for ecological receptors is based on the toxicological data for vascular plants and soil invertebrates. Endpoints examined included chronic and sub-chronic responses (*e.g.,* root elongation, shoot growth, reproduction) as well as acute and lethal responses (*e.g.,* invertebrate survival and seed germination) in both field and artificial soils. The studies were based on the use of either whole products or vacuum distillates of fresh as opposed to weathered Whole Federated Crude Oil, using coarse textured soils.

ANALYTICAL METHOD

A significant development introduced through the CWS is the adoption of a benchmark method for the determination of PHC in soil. The adoption of a standard analytical method addresses major sources of variability and uncertainty related to the extraction, purification, quantification, and reporting of hydrocarbon contaminant levels in soils. Different analytical methods are prescribed for the four Fractions recognized by the PHC CWS. F1 PHC is isolated through purge and trap procedures followed by gas chromatography with a flame ionization detector (GC-FID). F2 - F4 PHC up to C50 are extracted by a Soxhlet procedure, “cleaned up” on silica gel and determined by GC-FID. C50+ PHC, if present, is determined either gravimetrically or through extended chromatography. Specific chromatograph calibration standards are required.

PHC CWS is implemented in three tiers: (1) the application of generic Tier 1 levels that are protective of the human health and the environment, (2) site-specific adjustments to Tier 1 levels to calculate Tier 2 levels that accommodate unique site characteristics, and (3) Tier 3 levels that are developed from site-specific ecological or human health risk assessment, when assumptions in the Tier 1 values are not appropriate for a site. The level of protection is the same for all three tiers.

Residential/parkland land use category was adopted as a conservative basis for the development of DEW Line Cleanup (DLCU) Criteria for inorganic elements and PCBs listed as the primary contaminants of concern. Residential/Parkland Tier 1 levels (mg/kg soil) for PHCs for coarse-grained surface soils are presented in Table 1 given below. Typical soil conditions at INAC military sites are located within 1.5 m from the ground surface and with grain size greater than 0.75 µm. These are defined as coarse-grained surface soils within the CWS system.

TABLE 1: CCME RESIDENTIAL/PARKLAND TIER 1 LEVELS (mg/kg SOIL) FOR PHCS FOR COARSE-GRAINED SURFACE SOILS

EXPOSURE PATHWAYS	F1 (C_6-C_{10})	F2 (>C_{10}-C_{16})	F3 (>C_{16}-C_{34})	F4 (>C_{34})
Soil ingestion	15,000	8,000	18,000	25,000
Vapour inhalation (slab-on-grade)	30	150	NA[3]	NA[3]
Protection of GW for aquatic life[1]	230	150	NA[3]	NA[3]
Eco soil contact[2]	130	450	400	2800

[1] Assumes surface water body at 10 m from HC source area.
[2] Tier 1 values based mainly on laboratory bioassay response to fractions derived from fresh Federated Crude Oil.
[3] NA – not applicable.

If Tier 1 levels, as outlined above, are implemented, the governing pathways are protection of aquatic life at the beach POLs, and ecological soil contact at other PHC impacted areas such as module train, garage, and hangars. Most of these source areas (*i.e.,* pads) contain sparse vegetation. Furthermore, invertebrates are not present at least at the sites in the central and eastern Arctic (Nunavut). The presence of PHCs in the soil may have some adverse impact on the microbial processes. Because of the sparse vegetation, the microbial processes in soil are relatively less important than aquatic ecosystem in the Arctic. Therefore, the ecological soil contact pathway can be qualitatively eliminated for soils well removed from the aquatic ecosystem. Exposure to indoor inhalation is not applicable as the garages and hangars are demolished during the cleanup. The remaining applicable pathways are soil ingestion and protection of aquatic life. Therefore, the most likely cleanup levels applicable are as follows (see Table 2).

The resulting soil remediation criteria for fuel oils in areas removed from life supporting water bodies is 8,000 ppm and the soil remediation criterion in areas in close proximity to life supporting water bodies within 10 m of the hydrocarbon contaminant source is 150 ppm.

TABLE 2: CCME RESIDENTIAL/PARKLAND TIER 1 LEVELS (MG/KG SOIL) APPLICABLE PATHWAYS

EXPOSURE PATHWAYS	F1 (C_6-C_{10})	F2 (>C_{10}-C_{16})	F3 (>C_{16}-C_{34})	F4 (>C_{34})
Soil ingestion (garages, hangars, etc.)	15,000	8,000	18,000	25,000
Protection of GW for aquatic life[1] (beach POLs)	230	150	NA[2]	NA[2]

[1] Assumes surface water body at 10 m from HC source area.
[2] NA – not applicable.

In cases where pertinent site conditions are similar relative to each other, it may be possible and cost effective to develop site-specific objectives based on one site. Provided the site similarities can be demonstrated to be sufficiently similar that the risk assessment assumptions and inputs for each site are equivalent the results may be generally applicable to all of the similar sites. Reviewing site assumptions and dependencies will require verification of the similarity of the sites. Where significant differences are identified the impacts of the differences on the risk assessment output will need to be assessed.

C. CONCLUSIONS AND RECOMMENDATIONS

The CCME guidelines for contaminated sites provide generic standards or the mechanism for modifying the standards and developing site-specific risk based standards.

The development of site-specific criteria through the application of a CCME Method 2 (modified generic guidelines) or Method 3 (risk assessment derived site-specific objectives) approach is provided for application. The approach used to modify the soil quality guidelines should adhere to the soil protocols and minimum data requirements established in the soil protocol (CCME 1996a). Risk assessment derived soil objectives applicable for a particular site may be transferable to the other similar sites.

The application of the CWS PHC at the Tier 2 level is considered to be more appropriate for the derivation of contaminant criteria. The standards achieved through the application of the CWS are of the order of 150 ppm for ecologically sensitive areas and 8000 ppm for areas removed from ecologically sensitive areas. However, the application of the CWS has some practical application limitations. The analytical requirements are rigorous and demanding especially for implementation in remote locations where on-site analytical capabilities are limited and significant time is required to transport samples to an analytical laboratory.

The soils at the sites are typically contaminated with petroleum hydrocarbons, PCBs, and inorganic elements specifically lead, copper and zinc. Soils impacted by petroleum hydrocarbons should be delineated to two different criteria as follows:

1. Petroleum hydrocarbon impacted soils close to fisheries sensitive environment should be delineated to 150 ppm; and
2. Petroleum impacted soils in other areas of the site should be delineated to 5,000 ppm.

Typical areas include POL facilities at the beach and the station areas. Stains of heavy end hydrocarbons (lube oil) are common around module trains and garages. The type of hydrocarbons present include diesel, gasoline, waste lube oils. The diesel and gasoline contamination typically extends to the permafrost boundary. Permafrost is typically encountered at 0.3 – 2.5 m below surface.

It is necessary to collect source, pathway and receptor information for all the petroleum hydrocarbon areas to ensure sufficient information is available to perform the appropriate level of risk assessment. Risk assessment derived soil objectives applicable for a particular site may be transferable to the other similar sites.

In many instances the volume of contaminated soil present at a site may be sufficiently small that removal of the contaminant through excavation and disposal or remediation is the most cost effective approach. It is therefore appropriate to address contaminated areas site-specifically and area specifically.

The completion of the Risk Assessment for a typical model site as well as the CCME Tier 2 comparison will provide a clear understanding of the primary influencing factors in the level of risk posed by contaminated soil at INAC contaminated sites. With this level of understanding flexibility in the implementation of the requirements and therefore the approach is available. The interaction of source, pathway and receptor in determining the risk posed by the contamination allows for various points of intervention to mitigate the risk. Where options are available field decisions may be required to ensure the most appropriate site-specific solution is applied.

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APPENDIX D:

DEW Line Cleanup Barrel Contents Criteria

DEW LINE CLEANUP BARREL PROTOCOL

A. INTRODUCTION

In order to determine the correct disposal method for barrels and their contents, the contents must first be identified. All barrel contents should be sampled and analyzed according to DEW Line Cleanup standard procedures, as described in this section.

Analytical data obtained for the samples collected from barrels located at the site should be compared to the criteria included in Table 1, below. Barrel contents are identified as organic or aqueous and the concentrations of glycols, alcohols, PCBs, chlorine, cadmium, chromium and lead are determined. Uncontaminated aqueous phases can be disposed of on the land; uncontaminated organic phases can be incinerated; contaminated aqueous material should be scrubbed free of organic material; and contaminated organic material should be disposed of as hazardous material.

During the delineation phase of the site investigation, an inventory of the number and locations of barrels at the site is to be compiled. This inventory should include buried or partially buried barrels that will be taken out of the landfills during excavation. Barrels are only sampled during the cleanup phase and as such, the handling, transportation and opening of barrels is the responsibility of the site contractor.

Other waste fuels and oils are also sampled according to this protocol. These may come from a variety of sources including, but not necessarily limited to, old generators, fuel tanks and pipelines, and transformers.

TABLE 1: DLCU BARREL PROTOCOL CRITERIA AND DISPOSAL SUMMARY

PHASE	% glycols or alcohols	PCB	Cl	Cd ppm	Cr	Pb	Disposal
Organic	-	<2	<1000	<2	<10	<100	Incineration
Organic	-	>2	>1000	>2	>10	>100	Ship south
Aqueous	>2 %	>2	>1000	>2	>10	>100	Ship south
Aqueous	>2 %	<2	<1000	<2	<10	<100	Incineration
Aqueous	<2 %						Scrub and discard

B. INSPECTION

1. All barrels are to be inspected to address the following items which shall be recorded and used as a guide prior to opening barrels.
2. Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.
3. Symbols, words, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.
4. Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves, or signs that the barrel is under pressure such as bulging and swelling.
5. Spillage or discoloration on the top and sides of the barrel.

C. SAMPLING

1. Barrels shall not be transported until it has been determined that they are not under pressure, do not leak, and are sufficiently sound for transport.
2. Barrels to be sampled should be set in an upright position, provided that this does not cause them to leak and that it is physically possible.
3. Barrels should only be opened according to accepted procedures and under qualified supervision, preferably using remotely operated, non-sparking equipment.
4. Once open, barrels will be sampled by personnel wearing proper personal protective equipment as described below (G.1). Samples of the contents of all barrels shall be extracted using a drum thief and placed into a pre-labelled glass vial. The depth of liquid and the size of each barrel are to be recorded.
5. In instances where there are a large number of barrels with obviously similar contents, these can be grouped together and 30 to 40% of the barrels in the group sampled. Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents, which consist of black oil, shall not be consolidated.
6. All barrels shall be clearly numbered using spray paint or other suitable marker. The number on this label should be the only sample coding provided to the laboratory.

7. The barrel locations and barrel sample descriptions should be recorded.
8. Samples should be kept at ambient temperatures and shipped by guaranteed freight to laboratories where they should be kept cold pending analysis.

D. TESTING

1. Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analyzed to confirm that they are indeed water, and contain less than 2% glycols or alcohols.
2. The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for PCBs, total chlorine, cadmium, chromium and lead, in addition to identification of the major components e.g. fuel oil, lubricating oil.
3. Contents of barrels which contain two or more phases shall have all phases analyzed; the organic phases as described above and the aqueous phase to ascertain whether it contains less than 2% organic substances. In addition, the aqueous phase shall be tested for any components found in the organic phases above the criteria described below.

E. DISPOSAL OF BARREL CONTENTS

1. Barrels containing only rust and sediment shall be treated as empty barrels.
2. Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water may then be discarded on to the ground that is a minimum of 30 meters distance from natural drainage courses. Used oil absorbent material shall be treated as described in below (E.5.).
3. Barrel contents which are composed of water with glycols and/or alcohols or organic phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium, and 100 ppm lead, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to not be leachable shall be disposed of as DCC Tier II

contaminated soil. Leachable material shall be treated as hazardous waste and disposed of off-site at a licensed disposal facility.

4. Barrel contents, which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 100 ppm lead shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes. Flash points may be required to be determined if they cannot be inferred from the product identification.
5. Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility. If it is shown to be uncontaminated with PCBs (< 2 ppm), chlorine (< 1000 ppm), cadmium (< 2 ppm), chromium (< 10 ppm) and lead (< 100 ppm), it may be incinerated on-site.

F. DISPOSAL OF BARRELS

1. Empty barrels may be crushed or shredded and landfilled on-site as non-hazardous waste after they have been cleaned in an appropriate manner. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.

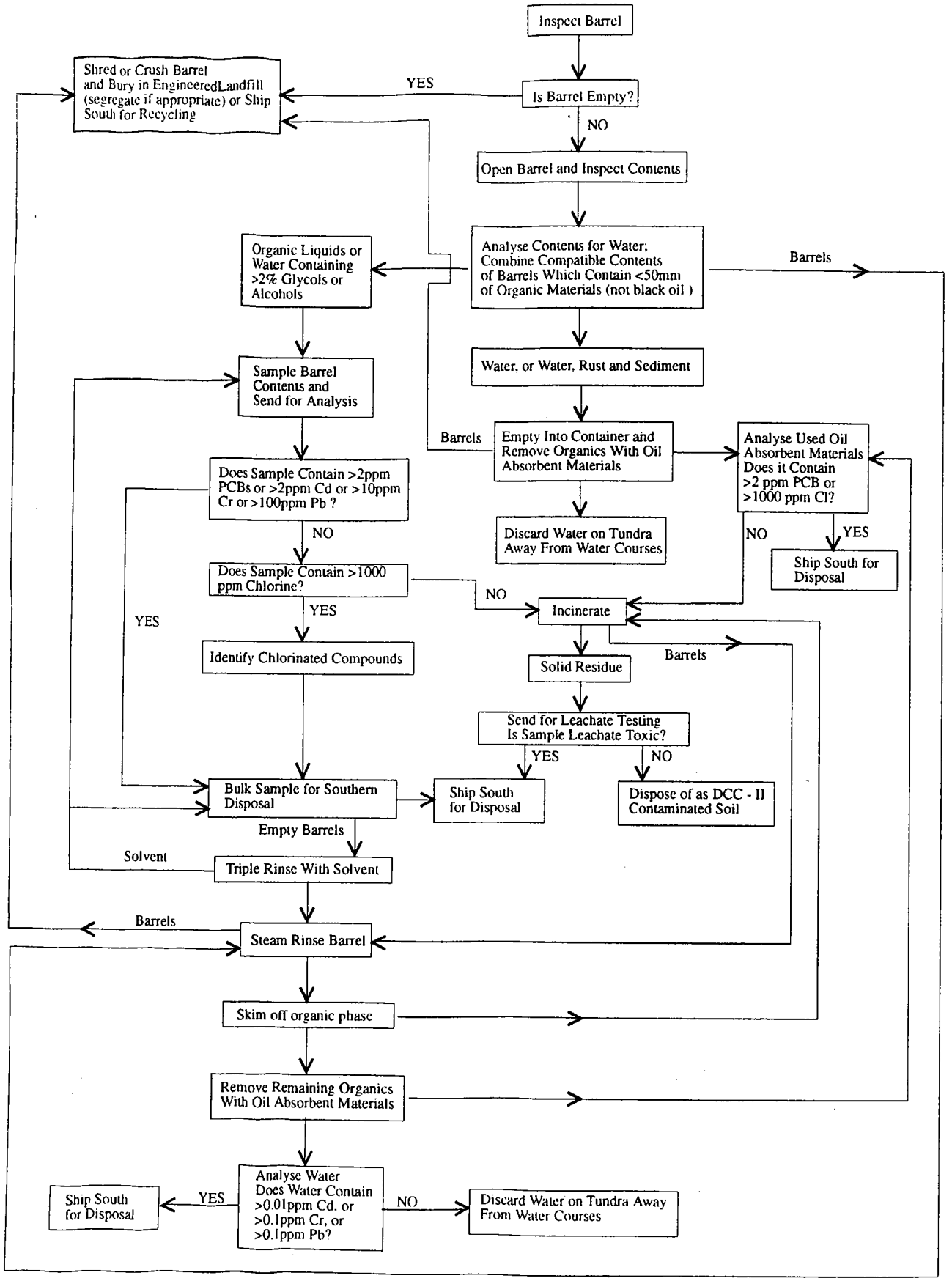
G. PERSONNEL PROTECTIVE EQUIPMENT

1. Safety equipment required includes a respirator with organic vapour cartridges, safety glasses, a hard hat, rubber safety boots, double gloves (chemically resistant on the outside, and latex on the inside) and disposable Syranex-coated coveralls.
2. A decontamination procedure should be established at the barrel sampling area(s) to prevent tracking potentially contaminated liquids outside of the sampling area(s).
3. It is advisable to have one person outside of the sampling area to observe the sampler(s) in case of unexpected hazards, and also to record the samplers' observations.

APPENDIX C

DND DEW LINE CLEANUP BARREL PROTOCOL

FLOW CHART FOR THE DEW LINE CLEAN UP BARREL PROTOCOL



APPENDIX D

MEETING MINUTES – COMMUNITY MEETINGS

CAM-D (SIMPSON LAKE)
2006 Community Consultation - Questions & Answers

Lou Spagnuolo (INAC) Brad Thompson (PWGSC) Greg Wright (Earth Tech)

Presentation:
Lou – Remedial Action Plan

Taloyoak
April 26, 2006
7:00-8:00pm (presentation) 8:00-10:00pm (questions)

Attendees: 15 - Joseph (interpreter)

C (English) – Lots of exploration activity in the area. A mining company is doing a presentation next week.

C (Inuktitut) – I've been through the area on the way to Kugaaruk and I know about the DEW line

Q (Inuktitut) – If there is a landfill would it leak into water and rivers?
A (English) – No, we will continue to monitor any landfill we construct to ensure it is not leaking [Lou].

Q (Inuktitut) – Where are the contaminants going?
A (English) – All of the contaminated soil will be shipped south for disposal. Only the debris will remain onsite in a newly constructed landfill [Lou].

Q (Inuktitut) – Who do we contact for hiring labourers?
A (English) – We aren't sure who the Contractor will be yet, but we expect approximately 30-40 workers will be required to complete this work. We will be back to let you know about hiring once a Contract is awarded [Lou].
C: (Inuktitut) – Due to high cost of unemployment I'm happy to have jobs and happy to know contaminants are being removed.

Q (Inuktitut) – Do you need PCB contractors? Have you found a Contractor for PCB cleanup?
A (English) – Not yet, but we'll be evaluating Contractor's based on their experience with similar work [Lou].
C (Inuktitut) – I helped on the site (DND) last year and PCB's were a priority. Since they (USA) ruined our land they should give us money.

Q (Inuktitut) – How are the contaminants being removed?
A (English) – We are evaluating the best route and are looking for your input. The material will be shipped offsite by CAT Train using specialized containers [Lou].

Discussion ensued regarding some possible routes via CAM-3 or the nearby rivers.

Q (Inuktitut) – I remember the site with a lot of barrels around. What's happening to the buildings that are still onsite?
A (English) – Because of the level of contamination they will be demolished and disposed of either onsite or shipped offsite [Lou].

Q (Inuktitut) – How long will the clean up take?
A (English) – We expect the clean up to take one full summer plus there will be some long term monitoring [Lou].
C (Inuktitut) – Due to the high unemployment we're happy to see job opportunities. I would like to see those that haven't had opportunity to get jobs.

Q (Inuktitut) – Thank you for coming to share information and to talk about job opportunities. Has a study been done to check the risk of the site for humans and animals?
A (English) – Yes, we've found that there is little to no risk to humans or wildlife, but, we're still going to clean up the site [Lou].

Q (Inuktitut) – Our community needs employment and we have very little training.
A (English) – The Contract that is selected will be providing training as part of the clean up work for this project [Lou].
C (Inuktitut) – Due to the high unemployment in Taloyoak I want to see jobs kept to local communities.

Q (Inuktitut) – Is there a risk for cancer or illness from this site?
A (English) – PCB's can be carcinogenic, but there is very little contamination on the site and someone would have to spend a lot of time there for there to be any risk.

C (Inuktitut) – I worked at CAM-3 and got married there and I seem to remember all the heavy equipment was brought to CAM-D using a Hercules.

Gjoa Haven
April 28, 2006
9:00-10:00am (presentation)

Attendees: 2 - Simon (interpreter)

C (English) – Simpson Lake is also known as Kook (sp?)

Kugaaruk
April 28, 2006
7:00-8:00pm (presentation)

Attendees: 3 - Chris (interpreter)

C (English) – February, March and early April are better times of year for community meetings.

APPENDIX E

SUMMARY TABLES

CAM-D DEW Line Site
Remedial Action Plan
Table E1: Detailed Summary of Non-Hazardous Materials

Location	Items	Material	Quantity	Comments	In Situ Volume	Crushed or Cut Volume	Landfilled Volume m^3
Main Dump	Tracked Bombardier	Steel/Iron	1		4	2.00	2.20
	Wobbly Tired Grader Box	Steel/Iron	1		4	4.00	4.40
	Buggy Earthmover Frame	Steel/Iron	1		4	4.00	4.40
	Truck	Steel/Iron	1		4	3.00	3.30
	Barrels	Steel/Iron	2500		400	132.00	132.00
	Scrap Metal	Steel/Iron	Lump sum		40	20.00	22.00
	Scrap Wood	Wood	Lump sum		40	20.00	22.00
	Waste Concrete	Concrete	Lump sum		5	5.00	5.50
	Random Heavy Equipment	Steel/Iron	Lump sum		20	18.00	19.80
Pallet Line Area	Barrels	Steel/Iron	688		110.08	33.02	36.33
	Scrap Metal	Steel/Iron	Lump sum		1	0.50	0.55
POL Area	Barrels	Steel/Iron	245		39.2	11.76	12.94
	Scrap Metal	Steel/Iron	Lump sum		1.0	0.50	0.55
	Scrap Wood	Wood	Lump sum		1.0	0.50	0.55
	POL pads	Concrete	3		6.0	6.00	6.00
	POL Shed	Metal/Wood	1		10.0	5.00	5.00
	Buried Debris	Steel/Iron	Lump sum		185.0	185.00	185.00
Warehouse, Burn Pit and Buried Debris Area	Warehouse buried debris	Steel/Iron	Lump sum		60.0	60.00	60.00
	Modular Train buried debris	Steel/Iron	Lump sum		176.0	176.00	176.00
	Warehouse foundation	Concrete	Lump sum		30.0	30.00	30.00
	East Station Site buried debris	Steel/Iron	Lump sum		7.0	7.00	7.00
	Barrels	Steel/Iron	28		4.48	1.34	1.48
Electrical Cabinets and Miscellaneous Debris Piles Area	Barrels	Steel/Iron	15		2.4	0.72	0.79
	Scrap Metal	Steel/Iron	Lump sum		2.5	1.25	1.38
	Scrap Wood	Wood	Lump Sum		9	4.50	4.95
	Waste Concrete	Concrete	Lump sum		1	1.00	1.10
	Electrical Cabinets	Metal	8		8	4.00	4.40
Portable Fuel Tank Area	Barrels	Steel/Iron	38		6.08	1.82	2.01
	Portable Fuel Tanks	Steel/Iron	2		20.00	10.00	11.00
	Random Heavy Equipment	Steel/Iron	Lump sum		1.50	1.35	1.49
Inuit House Area	Barrels and Culverts	Steel/Iron	20		5.00	5.00	2.50
	Scrap Metal	Steel/Iron	Lump sum		2	1.75	2.00
	Scrap Wood	Wood	Lump sum		1	0.50	0.55
Barrel Dump	Barrels	Steel/Iron	5100		816	244.80	269.28
Vehicle Dump	Barrels	Steel/Iron	8		1.28	0.38	0.42
	Trucks	Steel/Iron	2		8	7.20	7.92
	Random Heavy Equipment	Steel/Iron	Lump sum		8	7.20	7.92
Garage, Upper Station Area (Includes Antenna)	Barrels and Culverts	Steel/Iron	35		8	1.20	4.50
	Heat Exchanger	Steel	1		2	1.00	1.10
	Garage Foundation	Concrete	Lump sum		24	24.00	24.00
	Antenna	Steel	1				35.00
	Fuel Tanks	Steel	2		1	0.50	0.55

CAM-D DEW Line Site
Remedial Action Plan
Table E1: Detailed Summary of Non-Hazardous Materials

Location	Items	Material	Quantity	Comments	In Situ Volume	Crushed or Cut Volume	Landfilled Volume m^3
Airstrip Area	Barrels	Steel/Iron	50		8	2.40	2.64
	Scrap Metal	Steel/Iron	Lump sum		1	0.50	0.55
	Scrap Wood	Wood	Lump sum		3	1.50	1.65
	Tracked Bombardier	Steel/Iron	1		4	3.60	3.96
	Grader	Steel/Iron	1		4	3.60	3.96
	Truck	Steel/Iron	1		4	3.60	3.96
Freshwater Lake	Barrels	Steel/Iron	38		7.50	4.90	4.90
	Scrap Wood	Wood	Lump sum		2	1.00	1.10
	Scrap Metal	Steel/Iron	Lump sum		2	1.00	1.10
	Truck Box	Steel/Iron	Lump sum		3	2.70	2.97
	Random Heavy Equipment	Steel/Iron	Lump sum		0.5	0.45	0.50
	Large Steel Cabinet	Steel/Iron	Lump sum		2.5	1.25	1.38
Plumbers Dump Area	Barrels	Steel/Iron	8		1.28	0.38	0.42
	Plumbing material and Fittings	Steel/Iron	Lump sum		1.5	1.35	1.49
	Scrap Metal	Steel/Iron	Lump sum		0.5	0.25	0.28
	Scrap Wood	Wood	Lump sum		0.5	0.25	0.28
Borrow Source Area	Barrels	Steel/Iron	260		41.6	12.48	13.73
	Scrap Wood	Wood	Lump sum		1	0.50	0.55
	Scrap Metal	Steel/Iron	Lump sum		1	0.50	0.55
	Clay borrow Material	Clay	Lump sum		110,090	N/A	N/A
	Sand/Gravel Borrow Source 1	Sand/Gravel	Lump sum		181,713	N/A	N/A
	Sand/Gravel Borrow Source 2	Sand/Gravel	Lump sum		9,378	N/A	N/A
	Sand/Gravel Borrow Source 3	Sand/Gravel	Lump sum		11,748	N/A	N/A
	Cobble Volume	Cobble	Lump sum		846	N/A	N/A
Simpson Lake Area	Barrels	Steel/Iron	50		8	2.40	2.64
	Bombadier	Steel/Iron	Lump sum		4	3.60	3.60
	Scrap Wood	Wood	Lump sum		1	0.50	0.55
	Scrap Metal	Steel/Iron	Lump sum		1	0.50	0.55
Total Volume by Category							
	Main Dump	Main Station Area	Airstrip Area	Freshwater Lakes	Borrow Source Area	Simpson Lake	Totals
Heavy Equipment	34	17	12	3	0	4	**70**
Barrels	132	330	3	5	14	3	**487**
Scrap Metal	22	62	1	4	1	1	**89**
Scrap Wood	22	6	2	1	1	1	**32**
Concrete	6	61	0	0	0	0	**67**
Buried Debris	0	428	0	0	0	0	**428**

TOTAL NON-HAZARDOUS VOLUME (m^3) **1,173**

CAM-D DEW Line Site
Remedial Action Plan
Table E2: Detailed Summary of Hazardous Materials

Location	Items	Material of Concern	Quantity	Comments	Surface Area m^2	Material Volume m^3
Upper Station Area	Vermiculite (in soil near Warehouse)	Asbestos				5
	Floor Tile	Asbestos		Grey Floor Tile (5% Chrysotile) broken and scattered throughout debris piles.		2
	Transite Board (Warehouse)	Asbestos		20% Chrysotile, Broken and edges exposed	30	4
	Pipe Insulation (Garage mechanical room)	Asbestos		60-80% Chrysotile, 2% Amosite, poor condition, friable		5
	Door Insulation (Garage interior)	Asbestos		60% Chrysotile, 1 door is broken, friable asbestos		1
	Grey painted wood stockpiled under warehouse concrete slab	PCB Paint		78.2 ppm PCBs, poor condition, flaking	10	3
	Grey Garage Interior Paint (over exterior metal cladding)	PCB Paint		166.5 ppm PCBs, poor condition, flaking	426	5
	Orange/Grey Garage Interior Paint over garage Structural Steel	Lead Paint		128,000 ug/g total lead	20	10
	POL Tank Paint	PCB/Lead Paint		139 ppm PCB, 50.7 mg/L leachable lead, location of second tank unknown		16
	Warehouse Buried Debris	Mixture of PCB and lead amended paint products		Hazardous material potentially buried with non-hazardous wastes, sorting required, assumed 0.15 m^3 asbestos products		3
	Modular Train Buried Debris	Mixture of PCB and lead amended paint products		Hazardous material potentially buried with non-hazardous wastes, sorting required, assumed 2.2 m^3 asbestos products		44
	POL Site Buried Debris	Mixture of PCB and lead amended paint products		Hazardous material potentially buried with non-hazardous wastes, sorting required, assumed 0.45 m^3 asbestos products		9
	East Station Site Buried Debris	Mixture of PCB and lead amended paint products		Hazardous material potentially buried with non-hazardous wastes, sorting required		0.3
Airstrip Area	Green Crane Paint	Lead Paint		60,500 mg/kg total lead		6
Pallet Line Area	Barrels of POL	POL	15			2.4
POL Area	Large Silver Storage Tank	POL	14			14
Various Locations	Batteries	Lead and Battery Acid	30			1
Various Locations	Compressed Gas Cylinders	Compressed Gas	20			2

Summary of Hazardous Materials by Category	Volume (m^3)
POL Fluids	16.4
Identified Asbestos	17
Potential asbestos in buried debris areas	3
Lead Acid Batteries	1
Identified lead and PCB painted materials	40
Potential lead and PCB painted materials in buried debris areas	53
Compressed Gas Cylinders	2

CAM-D DEW Line Site
Remedial Action Plan
Table E3: Detailed Summary of Painted Materials and Concrete Samples

Items	Earth Tech Samples		UMA Samples			Material Volume m^3	Hazardous	Non-Hazardous	Comments
	Total PCBs ppm	Total Lead ppm	Total PCBs ppm	Total Lead ppm	Leachable Lead ppm				
Grey Painted Wood (stockpiled under Warehouse concrete slab)	78.2	3900				3	X		Hazardous due to PCB concentrations
Grey Garage Interior Paint over exterior metal cladding	166.5	4500			0.214	5	X		Hazardous due to PCB concentrations
Grey Garage Deck Paint					0.194			X	Assumed to be non-hazardous based on the UMA 2007 Additional Assessment report
Orange/Grey Garage Interior Paint On Garage Structural Steel	19.5	128000				10	X		Assumed to be hazardous according to the UMA 2007 Additional Assessment report
Orange Antenna Paint / White Antenna Paint	1/1.5	91500/2700			0.11/0.048	35		X	Assumed to be non-hazardous based on the leachable lead concentration found to be less than the 5 mg/L limit
Silver POL Pump Shed	<0.5	84800			11.2	5		X	Assumed to be non-hazardous based on UMA 2007 Additional Assessment report
Silver POL Tank			139	428000	50.7	16	X		Hazardous due to PCB and Leachable lead concentrations. Location of second storage tank unknown
Green Crane			<0.005	60500		6	X		Assumed to be hazardous according to the UMA 2007 Additional Assessment report
Grader			<0.005		6.44	4		X	Assumed to be non-hazardous based on the UMA 2007 Additional Assessment report
Concrete - Partially buried in Modular Train Buried Debris Area		43						X	Non-hazardous due to concentration of Total PCBs. Sample included surface topcoat as well as underlying concrete. Recommend that additional samples be collected to confirm all material is non-hazardous.
Concrete - Warehouse Floor slab		4.3						X	Non-hazardous due to concentration of Total PCBs
Concrete - Garage Floor slab		<0.1						X	Non-hazardous due to concentration of Total PCBs