5. IMPLEMENTATION AND DESIGN/ENGINEERING

The clean up plans and procedures are outlined in the following sections. Selected photographs of the clean up areas at DYE-M are in Appendix II. A more detailed description of construction activities in near-shore areas is provided in Appendix IV.

5.1 Site Access and Transportation Methods

Off site activities in support of this project will be in the form of transportation associated with the transport of materials, equipment and personnel to the site. These activities are described below:

- **Air transport** - most transportation by air is expected to utilize existing commercial and charter services in and out of the site.
- **Sealift transport** - it is anticipated that contractors will utilize sealift to transport bulk materials and equipment (vehicles, heavy equipment, etc) to/from DYE-M. This may potentially result in the increase in sealift traffic by one or two sailings per year (one early and one late summer). Otherwise, no additional vessel traffic is anticipated.
- **Land Transport** – it is anticipated that overland transport will be required between the site and beach landing area for mobilization/demobilization of materials and equipment

5.2 Development of Borrow Areas

Approximately of 800,000 cubic metres of granular material is required for the clean up. Granular fill is required for closure of landfills, upgrading of the access roads during construction, backfill contaminated soil areas and general site grading purposes. Additional granular fill is required for the development of the new Non-hazardous Waste Landfills and Tier II Disposal Facilities. Table 5-1 outlines the borrow areas and potential gravel volumes to be extracted from each area.

Table 5-1: Borrow Areas

Borrow Area	Location	Estimated Quantity of Granular Material (m^3)
1	Upper Camp, below the Tacan ridge	200,000
2	Adjacent to proposed Tier II Landfill	40,000
3	Middle Site (former POL pumping station)	120,000
4	Lower Site – adjacent to former water supply lake	75,000
5	N/A	N/A
6	Till plain 2.2 km west of Upper Site	30,000
7	Till plan 8 km from Upper Site	20,000
8	N/A	N/A
9	Lower Site, 1 km northeast of crossroads	90,000
10	Middle Site – north of former POL pumping station	30,000
11	Lower Site – north of NWS Landfill	35,000
12		4000
13		20,000

5.3 Proposed Construction

Several specialized facilities are to be constructed to dispose of waste generated on site due to the demolition of existing structures, removal of contaminated soil and site debris, and landfill excavation. Only materials exceeding CEPA standards will be disposed of off site.

The new facilities are sited following the completion of the detailed engineering investigation. Some areas may not have road access. The contractor will be required to make special provisions to protect tundra vegetation, if any. It is assumed that the contractor will have to provide adequate drainage for all excavations.

5.3.1 Non-Hazardous Waste (NHW) Landfill

The Non-Hazardous Waste (NHW) Landfills are designed on the premise that they will contain non-hazardous materials and will not generate leachate. Therefore, it is not necessary to eliminate all moisture migration into and out of the landfill. NHW landfill is also not designed to maintain the contents in a perennially frozen state.

Due to the amount of non-hazardous materials for disposal at DYE-M, two NHW Landfills will be constructed. The following materials are proposed for disposal in the Non-Hazardous Waste Landfills at DYE-M:

- Tier I and Type A Hydrocarbon Contaminated Soil;
- Non-hazardous demolition debris;
- Non-hazardous site debris;
- Non-hazardous debris and Tier I soils excavated from landfills;
- Creosote timbers wrapped in polyethylene sheeting; and
- Double-bagged asbestos.

The NHW Landfills at DYE-M will consist of a perimeter containment berm and granular cover to minimize erosion and infiltration in order to provide long-term stability. The NHW Landfills are to be established on native ground (stripped of any organic matter). No base cover or liner is required for this landfill. Development and closure of the NHW Landfills includes the following work:

- Construction of exterior berms;
- Placement of Tier I contaminated soil and non-hazardous demolition waste and site debris in the landfill;
- Compaction of landfill debris;

- Placement and compaction of intermediate granular cover in the landfill;
- Placement and compaction of final granular cover over the landfill;
- Grading to promote drainage away from the landfill;
- Supply and installation of groundwater monitoring wells in and around the landfill as indicated on the drawings.

For further design details of the NHW landfills, please refer to Drawings 103, 109 and 113 for the NHW Landfill at the Lower Site and Drawings 160, 167 and 171 for the NHW Landfill at the Upper Site in Appendix I.

5.3.2 Tier II Soil Disposal Facility

The design of the facility is based on the characteristics of the contaminants in the soils, the geothermal properties of the area and the local permafrost regime. The design utilizes permafrost as the primary containment barrier – both the Tier II contaminated soil and the Type 4 (wet, silty gravel) perimeter berms are designed to be continuously frozen Geothermal analysis has been conducted to determine the time required for freeze-back of the facility and the long term thermal regime in the facility. The thickness of the cover material has been calculated to prevent thaw of the contaminated soil even after 10 consecutive 1 in 100 warm years.

A high-density polyethylene (HDPE) liner will be placed at the base and side slopes of the facility to provide secondary containment. The liner is chemically compatible with the contaminated soils and will prevent the potential movement of contaminants during the period required for permafrost aggradation. A second HDPE liner is to be placed over the contaminated soils and seamed to the base liner to prevent precipitation from percolating down through the cover fill and into the Tier II contaminated soils

A Tier II Soil Disposal Facility is designed to contain contaminated soil exceeding Tier II Criteria. Due to the volume of the Tier II contaminated soils at DYE-M, two Tier II Disposal Facilities are to be constructed. The development and closure of two Tier II Disposal Facilities at the DYE-M site will include the following work:

- Construction of exterior berms with saturated silty gravel;
- Supply and installation of HDPE liners, as indicated on the Drawings;
- Placement of Tier II contaminated soils in the landfill;
- Placement and compaction of intermediate granular cover over the soil;
- Installation of the top HDPE liner
- Placement and compaction of final granular cover on the landfill;
- Grading to promote drainage away from the landfill; and
- Supply and installation of thermistor strings and groundwater monitoring wells in and around the landfill, as indicated on the Drawings.

During construction of this facility, the gradation and the moisture content of the materials and the compaction are monitored to ensure the compliance with the design.

Further details on the design of the Tier II Soil Disposal Facilities can be found in Appendix I on Drawings 103, 112, and 122-124 for the Lower Site Tier II Facility and Drawings 160, 165, and 174-175 for the Upper Site Tier II Facility.

5.3.3 Hydrocarbon Soil Treatment Facility

The hydrocarbon contaminated soil treatment facility at DYE-M consists of a landfarm. Development, operation and closure of the landfarm at the DYE-M site will involve the following work:

- Ground preparation, as required to facilitate treatment operations;
- Construction and maintenance of roadways required to support treatment operations;
- Construction of exterior berms and drainage ditches;
- Placement of Type B contaminated soil in the landfarm;
- Placement of Type B contaminated soils co-contaminated with Tier I contaminants in a separate area of the landfarm;
- Specific activities for landfarming operations, including nutrient application, tilling, and moisture conditioning.
- Final grading to promote drainage away from the site and to match the surrounding terrain.
- Closure and removal of all equipment and materials following confirmation that treatment has remediated the contaminated soil.

The landfarm will be located: at least 100 metres away from any water body, and in an area free of ponded water; to provide for the convenient access of equipment; at least 300 metres from the construction camp, offices and laboratory; and in an area that is relatively free of boulders and that is generally level.

Excavation of hydrocarbon-contaminated soils is not permitted within 2 m of any watercourse or within 2 m of the high water mark of the intertidal zone.

During the landfarm operation, granular nutrients are to be distributed evenly over the surface of the contaminated soil, at rates that will provide the minimum nitrogen loading. Moisture conditioning of the landfarm will be conducted as required by application of water spray to maintain optimum water content within the soil.

After application of nutrients, the full thickness of the soil is to be tilled. The contaminated soil will be tilled every 10 days. During periods of prolonged warm, dry weather, the tilling frequency will be

increased to every 5 days. During periods of precipitation, tilling of the soil will be delayed until the soil is considered damp to a depth of 100 mm.

All contact water in the perimeter collection system is to be collected and tested as required and prior to the end of each operational season. The water will be tested to meet the wastewater discharge guidelines. If the contact water does not meet these guidelines, it will be treated as hazardous material, and disposed of off-site.

At the conclusion of the third treatment season, the following tasks are to be completed to close the landfarm:

- Confirmatory testing of the soils to ensure the remediation objectives have been met;
- Place and compact granular material from the perimeter berms to provide a cover over the remediated hydrocarbon co-contaminated with Tier I contaminated soils area. Additional cover material is to be placed to provide a 300 mm minimum depth of compacted granular fill as cover over this soil area. All granular fill is to be compacted to 95% Maximum Dry Density;
- Grade the surface of the area, as required, to promote surface water runoff;
- Decommission the groundwater monitoring wells, including backfill with appropriate grout, removal of the protective casing, lockable cap and well pipe to within 300 mm from the ground surface; and backfill and compact all voids with granular fill material.

Further details on the design of the landfarm facilities are on Drawings 103, 108 and 113 in Appendix I.

5.4 Landfill Excavation

Complete or partial excavation of seven landfills will be completed as part of the clean up at DYE-M. Landfill excavation includes:

- Implementation of environmental and erosion protection measures;
- Excavation of the soil/debris matrix, and removal of debris, sorting into hazardous and non-hazardous components;
- Temporary stockpiling of soil to allow testing to determine the degree of contamination, if any;
- On-site disposal of non-hazardous and contaminated soil, after testing;
- Containerization of hazardous debris and hazardous contaminated soil, as required; and
- Placement and grading of gravel following landfill excavation to promote surface water runoff.

5.5 Landfill Closure and Grading

There are eight landfills at DYE-M that will be graded and closed. The following work will be completed as part of the closure:

- Removal of surface debris and compaction of the surface;
- Supply and installation of geomembranes and geotextiles on specific landfills;
- Supply, placement and compaction of additional gravel over the landfill;
- Grading to promote surface water run-off from the landfill; and
- Supply and installation of groundwater monitoring wells and thermistor strings (if required).

5.6 Description of Existing Landfills

There are thirteen landfills at the DYE-M site that require remediation or closure. Each landfill is described in the following sections.

5.6.1 Upper Site Landfills

South Landfill East: The South Landfill East is located approximately 300 m south of the upper camp station area, east of the access road (see Drawings 160, 164, and 172-173). The surrounding area generally slopes down to the southeast. The terrain is bouldery with outcropping bedrock visible northeast and southwest of the landfill. A northwest-southeast drainage channel borders the landfill on the east side. A well-defined crest and toe mark the south and east edge of the landfill area. There is a relatively flat area behind the crest.

This landfill is greater than 10,000 m^2, with an estimated depth of 1.5 m below ground surface. Contaminated soils, leachate, surface debris has been identified. Debris is exposed over 50% of the landfill surface. The cover material consists of sandy-gravel material, with some evidence of erosion and little to no vegetation noted on the landfill. The nearest water body is over 1 km distant from the landfill.

The South Landfill East is to be excavated as described in Section 5.4.

South Landfill West: The South Landfill West is located across and access road, west of the South Landfill East (see Drawings 160, 164, and 168). The terrain surrounding the landfill is bouldery with bedrock outcrops visible at several locations. The area surrounding the landfill slopes down to the southwest.

This landfill is approximately 7800 m^2, with an estimated depth of 1.5 m below ground surface. Contaminated soils, leachate, and surface debris have been identified. The debris is partially exposed. The cover material consists of gravel, with moderate evidence of erosion and little to no vegetation noted on the landfill. The nearest water body is over 1 km distant from the landfill.

The South Landfill West is to be excavated as described in Section 5.4.

Pallet Line Landfill: The Pallet Line Landfill is located approximately 800 m west of the Station Area, south of the access road to the Lower Site (see Drawings 160 and 166). The general gradient is to the west-southwest and the slope is shallower than the surrounding native terrain. The area of disturbed surface soils are comprised of sand and gravel with scattered boulders. Native terrain surrounding the landfill is typically bouldery.

This landfill is comprised of four lobes with an area of approximately 25,000 m^2, and an estimated depth of 1.5 m below ground surface. Contaminated soils and some surface debris have been identified. The debris is partially exposed throughout the landfill. The cover material consists of sandy-gravel material, with some evidence of erosion and little to no vegetation. The nearest water body is over 1 km distant from the landfill.

The pockets of contaminated soil identified at the landfill will be removed. The landfill will then be graded and closed as described in Section 5.5.

West Landfill: The West Landfill is located approximately 800 m west of the station area, on the north side of the access road (see Drawings 160, 165-166, and 169-170). The landfill area consists of three lobes: the West Lobe, the Centre Lobe and the East Lobe. The land slopes down to the north in the east lobe and centre lobe. The gradient slopes to the west and northwest in the West Lobe. Sand and gravel fill cover the majority of the landfill area. Native ground, where present, consists of cobbles and boulders.

The West Landfill is greater than 30,000 m^2 in size and is estimated to be 1.5 m in depth. Surface debris and contaminated soil pockets were identified throughout the landfill; however, leachate was only identified in the West and Centre Lobes. The surface debris covers approximately 50% of the landfill. The cover materials of the landfill consist of sand and gravel materials. There is some evidence of erosion and little to no vegetation. The closest water body to this landfill is greater than 1 km distant.

A portion of the West Lobe is to be excavated as per Section 5.4. The remainder of the landfill area will be remediated as described in Section 5.5.

DEW Drop Landfill: The DEW Drop Landfill is located approximately 475 m north of the station area (see Drawings 160 and 161). The landfill area and surrounding terrain slope down to the north at an approximate grade of 15%, although local topographical variations within the landfill perimeter exist.

The DEW Drop Landfill is approximately 8000 m^2 and is less than 1.5 m in depth. Leachate, contaminated soil and debris are present at the landfill. The cover material consists of sand and gravel. There is strong evidence of erosion and there is essentially no vegetation present. The nearest water body is more than 1 km distant.

Due to the location of the landfill and the evidence of high erosion, the DEW Drop Landfill is to be excavated and backfilled with gravel as described in Section 5.4.

5.6.2 Lower Site Landfills

Lower Camp Landfill East: The Lower Camp Landfill East is located approximately 2 km northwest of the lower site area (Drawings 103, 111, and 121). It is located adjacent to the road on

its west side and approximately 120 m from the river. The landfill is bordered to the south by a cliff rising up to original ground. The total landfill area is approximately 8000 m^2.

The landfill area slopes down to the southwest, from the road to the landfill crest, at a grade of approximately 10%. Several drainage and erosion channels were observed above the landfill crest. Shallow bedrock was exposed in many on the drainage channels. The channels continue over the crest to an outwash area below the landfill toe. A large drainage channel runs along the south side of the landfill, between the landfill area and the cliff to the south. The channel is highly eroded, with exposed debris at several locations. The area has sparse vegetation and bedrock is shallow, and is exposed in many locations.

Contaminated soil and leachate have been confirmed at this landfill. The landfill surface slopes at 2-5%, with the landfill toe at 40% over 5 m. The landfill is covered with gravel fill material, with very little surface debris present and little to no vegetation. Downgradient of the landfill, there is approximately 20% vegetative cover. There is evidence of erosion along the southeast edge of the landfill where it abuts against a bedrock slope; erosion likely occurs during periods of high runoff. Also, drifting snow has been observed along the toe of the landfill.

The landfill drains overland approximately 300 m into a stream, which discharges to Sunneshine Fiord, approximately 7 km distant. Habitat usage is low, with limited sightings of polar bears.

This landfill is to be excavated as described in Section 5.4.

Lower Camp Landfill West: The Lower Camp Landfill West is located west of the Lower Camp Landfill East, adjacent to the south side of the river (Drawings 103, 111 and 119-120). The landfill consists of three lobes that extend parallel to the riverbank over a distance of approximately 300 m. The total surface area of the landfill is approximately 12,000 m^2.

Contaminated soil has been identified and the landfill is known to be leaching. There is very little cover material and extensive debris is visible at surface. There is localized evidence of erosion along the toe of the landfill, with coarser grained materials and steeper slopes at periods of high runoff. There is evidence of surface water drainage through the landfill. The landfill drains directly to a stream, which discharges to Sunneshine Fiord, approximately 7 km downstream. The landfill has approximately 20% vegetative cover. Habitat usage is low, with occasional polar bear sightings.

This landfill is to be excavated as described in Section 5.4.

NWS Landfill: The NWS Landfill is located 60 m north of the South Landfill West on the west side of the access road (see Drawings 103 and 111). The topography generally slopes down to the southwest. Surface conditions are similar to those identified at the South Landfill West.

This landfill is approximately 4,700 m^2, with an estimated depth of less than 1.5 m below grade. Contaminated soils and some surface debris have been identified. The debris is partially exposed. The cover material consists of gravel, with moderate evidence of erosion and sparse vegetation. The nearest water body is over 1 km distant from the landfill.

Contaminated soils are to be excavated from the landfill and gravel will be backfilled in the excavation. The landfill will then be graded and closed as described in Section 5.5.

Crossroads Landfill: The crossroads landfill is located northwest of the lower camp in an area of tundra east of the lower site access road (see Drawings 103 and 108). The surface area of the landfill is 1,100 m^2.

Contaminated soil was confirmed at the landfill. Debris is visible over approximately 20% of the surface area of the landfill. The surface of the landfill is nearly level, with a grade of less than 5%.

Vegetation cover over the landfill is moderate, with 50% cover. Habitat usage is low, with limited sightings of polar bears.

This landfill is to be graded and closed as described in Section 5.5.

Foundation Landfill: The Foundation Landfill is located southeast of the Crossroads Landfill (see Drawings 103 and 108). The surface of the landfill is evident as a slightly mounded area of non-native fill, with boulders pushed off to the sides. The surface area of the landfill is 1,800 m^2.

Contaminated soil was identified at this landfill. The landfill is covered with gravel fill and approximately 40% of the surface area has exposed debris. The landfill surface has a slope of less than 10%. There are no major seasonal drainage channels in close proximity to the landfill. Overall drainage from the landfill is to the north-northeast.

Vegetation cover over the landfill ranges from approximately 30% in the immediate vicinity of the landfill to 50 - 60% in the surrounding area. Habitat usage is considered low, with limited sightings of polar bears, Arctic hare, Arctic fox and small birds.

This landfill is to be graded and closed as per Section 5.5.

Powerhouse Landfill: This landfill was formerly the location of an Inuit construction camp that included a number of buildings (Drawings 103, 108 and 117-118). The surface area of the landfill encompasses 2,700 m^2. Contaminated soil and leachate have been confirmed at this landfill. The landfill is covered with gravel fill, with surface debris evident over 50% of the landfill. Vegetation cover ranges from 40% cover in the immediate vicinity of the landfill to 80% cover in the surrounding areas. Erosion has occurred along the east and north edges of the landfill. The landfill toe is located within a seasonal drainage ditch with low runoff potential. Habitat usage is considered to be low, with limited polar bear sightings.

This landfill is to be leachate contained with a geomembrane liner and graded as per Section 5.5.

Beach Landfill - North: The Beach Landfill North is located at the northern end of the beach landing area, adjacent to a river (Drawings 102, 104, and 115). The landfill area has a well-defined crest on its north and west edges. A large pile of surface debris is located at the landfill crest. The topography generally slopes down to the southwest towards Exeter Bay. The surface area of the landfill is approximately 3000 m^2.

There was no contaminated surface soils identified; however, there was evidence of leachate from the landfill. The cover of the landfill consists of highly erodible, fine-grained materials. Exposed, partially buried debris is present over 50% of the landfill surface. The landfill grade is greater than 40% and is located immediately adjacent to a river, which is likely eroded during spring freshet. Drainage from the landfill enters the river approximately 80 to 100 m upgradient from where the rivers drain into Sunneshine Fiord. There is little vegetation at the north beach landfill. Habitat usage is low, with few polar bear sightings.

This landfill is to be excavated as described in Section 5.4.

Beach Landfill - South: The Beach Landfill South is located south of the existing fuel tanks and has five distinct lobes (see Drawings 102, 105 and 116). The area slopes down towards the beach. Partially exposed debris was visible at several locations.

The surface area of all five lobes of the landfill is 10,000 m^2. There is exposed debris over much of the surface area, which is partially covered with silty sandy materials that are subject to erosion. There is evidence of erosion over the entire landfill surface. No leachate was identified; however; surface soil contamination was noted. The landfill drains overland approximately 30-50 m directly

into Sunneshine Fiord. There is little to no vegetation in this area and habitat usage is low, with few polar bear sightings.

Lobes 1 - 5 are to be excavated as described in Section 5.4.

5.7 Removal of Site Debris

All site debris is to be disposed of in accordance with the DND/NTI Agreement. The debris will be sorted and classified as hazardous and non-hazardous debris. Hazardous materials will be shipped off-site for disposal, non-hazardous materials will be placed in the NHW landfill.

Creosote treated timbers will be wrapped in plastic and asbestos will be double-bagged and disposed of in the NHW landfill. Materials painted with PCB amended paint with concentrations above the CEPA criteria will be segregated, packaged and stored on-site as per the PCB Storage Area Regulations prior to transport and disposal.

Where scattered or embedded debris is removed, the area will be reshaped if necessary and any voids left by removal of debris will be backfilled with granular material. In areas where the debris is buried, the excavation will follow the same procedure as for landfill excavation, described in Section 5.4.

5.8 Barrel Disposal Requirements

In order to determine the correct disposal method for barrels and their contents, the contents must first be identified. All barrel contents will be sampled and analyzed.

Analytical data obtained for the samples collected from barrels located at the site will be compared to the criteria included in Table 5-2, 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.

Table 5-2: Barrel Protocol Criteria and Disposal Summary

Phase	% glycols or alcohols	PCB	Cl	Cd	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

5.8.1 Inspection

All barrels are to be inspected to address the following items, which shall be recorded and used as a guide prior to opening barrels.

- 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.
- 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.
- Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves.
- Spillage or discoloration on the top and sides of the barrel.
- Signs that the barrel is under pressure such as bulging and swelling.

5.8.2 Sampling

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.

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.

Barrels should only be opened using heavy equipment, according to accepted procedures and under qualified supervision.

Once open, barrels will be sampled by personnel wearing proper personal protective gear. Samples of the contents of all barrels shall be extracted using a drum thief.

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.

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.

The barrel locations and barrel sample descriptions should be recorded.

Samples should be kept at ambient temperatures and shipped by guaranteed freight to laboratories where they should be kept cold pending analysis.

5.8.3 Testing

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.

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.

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.

5.8.4 Disposal of Barrel Contents

Barrels containing only rust and sediment shall be treated as empty barrels.

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 m distance from natural drainage courses. Used oil absorbent material shall be treated as described in the following sections.

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 be not leachate toxic shall be disposed of as DCC Tier II contaminated soil. Leachate toxic material shall be treated as hazardous waste and disposed of off-site at a licensed disposal facility.

Barrel contents, which contain greater than 2 ppm PCBs, 1,000 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.

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 (< 1,000 ppm), cadmium (< 2 ppm), chromium (< 10 ppm) and lead (< 100 ppm), it may be incinerated on-site.

5.8.5 Disposal of Barrels

Empty barrels may be crushed or shredded and landfilled off-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.

5.9 Contaminated Soil Disposal Requirements

All contaminated soil found at DYE-M has been divided into one of five categories depending on the type and severity of the contamination. Generally, non-hazardous surface contaminants, if less

than three square metres, are graded whereas more extensive areas of contaminated soils are excavated. Excavations left by soil removal are backfilled with granular material.

The locations of contaminated soil are shown on the design drawings in Appendix I.

5.9.1 Contaminated Soil Types

There are a variety of contaminated soil types that require disposal at DYE-M. Definitions of the types of contaminated soils potentially found at the DYE-M site are as follows:

DCC Tier I Contaminated Soil: soils containing concentrations of any or all contaminants listed as follows: Lead – 200 to 500 ppm; PCBs - 1 to <5 ppm.

DCC Tier II Contaminated Soils: Soils containing concentrations equal to or in excess of any or all of the contaminants listed as follows:

Table 5-3: DCC Tier II Contaminated Soil Criteria

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

Site Specific Criteria: May be developed in areas where there are naturally occurring, high levels of copper, cobalt, chromium, and nickel that exceed the DCC Tier II criteria.

Hazardous Contaminated Soil: Contaminated soil is classified as hazardous in accordance with the Transportation of Dangerous Goods Act and Regulations (including CEPA and leachable soil).

CEPA Contaminated Soil: Soil containing concentrations of PCBs equal to or in excess of 50 parts per million. Materials contaminated with PCBs at concentration levels equal to or in excess of 50 ppm (mg/kg) are legislated as hazardous materials. Storage, handling and disposal of PCBs are regulated under the Canadian Environmental Protection Act and the Federal Transportation of Dangerous Goods Act. All applicable regulations must be adhered to.

Leachable Soil: Soil containing contaminants, that when subject to the leachate test prescribed in the TDGA and Regulations, leaches contaminants in excess of the concentrations listed in Part V of the regulations. Handling and disposal are regulated under Federal, Territorial, and Provincial Regulations. All applicable regulations must be adhered to.

Petroleum Hydrocarbons: Hydrocarbon products described by laboratory analyses as lubricating oil and grease, fuel oil, diesel and/or gasoline.

Hydrocarbon Contaminated Soil: Soil containing concentration of Total Petroleum Hydrocarbons (TPH) in concentrations considered to create a risk to the environment.

Type A Contaminated Soil: Hydrocarbon contaminated soil in which the primary petroleum hydrocarbon product present in the soil as determined by laboratory analysis consists of lubricating oil and grease. For remedial purposes, Type A contaminated soil shall be treated as Tier I contaminated soil containing hydrocarbon contamination.

Type B Contaminated Soil: Hydrocarbon contaminated soil in which the primary petroleum hydrocarbon product present in the soil as determined by laboratory analysis consists of fuel oil, and/or diesel, and/or gasoline.

Type B – Tier I Contaminated Soil: Type B contaminated soil containing concentrations of lead between 200 and 500 ppm and PCBs between 1 and <5 ppm. Type B and combinations of DCC Tier I and Type B contaminated soil shall be excavated and treated on site in a landfarm.

Type B –Tier II Contaminated Soil: Type B contaminated soil containing contaminants in excess of DCC Tier II criteria shall be treated as DCC Tier II contaminated soil containing hydrocarbon contamination.

Clean Soil: Soil that has been sampled, analysed, and determined to have contaminant concentrations below DCC Tier I contaminant levels, TPH less than 2500 ppm, and lead and PCBs at concentrations of less than 200 ppm and 1 ppm, respectively.

Table 5-4 provides a matrix outlining the disposal requirements for each type of contaminated soil.

Table 5-4: Contaminated Soil Disposal Requirements

Designation / Co-Designation	Tier I	Tier II	Type A	Type B	Hazardous
None (No Co-contaminants)	Non-Hazardous Landfill or Tier II Disposal Facility	Tier II Disposal Facility	Non-Hazardous Landfill or Tier II Disposal Facility	Hydrocarbon Contaminated Soil Treatment Area	Containerize for off-site transport and disposal by others.
Type A	Non-Hazardous Landfill or Tier II Disposal Facility	Tier II Disposal Facility			Containerize for off-site transport and disposal by others.
Type B	Hydrocarbon Contaminated Soil Treatment Area	Tier II Disposal Facility			Containerize for off-site transport and disposal by others with hydrocarbon resistant liners.

5.9.2 Tier I Contaminated Soil Disposal Requirements

Soils exceeding Tier I contamination criteria but not classified as Tier II contaminated soil are not considered to pose a leachate risk and may be disposed of in an on-site, non-hazardous waste (NHW) landfill. NHW landfills are also used to dispose of non-hazardous site debris and demolition materials. Typical construction of a NHW landfill consists of gravel perimeter berms surrounding layers of interbedded waste and intermediate cover soil. A layer of granular material, minimum one metre thick, is placed as final cover for the landfill and graded to promote positive drainage.

5.9.3 Tier II Contaminated Soil Disposal Requirements

Based on engineering field surveys conducted at the sites in 1992 and 1993, it became apparent that a potentially large volume of Tier II contaminated soil at the 21 DEW Line sites would require segregation in a manner which precludes their continued contact with the Arctic ecosystem. A number of disposal options/technologies were considered by the DEW Line Clean up Project team.

Of the options, the most environmentally and economically viable was determined to be the development of engineered Tier II soil disposal facilities. These facilities utilize a double containment system consisting of permafrost to limit leachate generation and synthetic liners to prevent migration of contaminants into the surrounding environment.

5.9.4 CEPA Contaminated Soil Disposal Requirements

Contaminated soils, which contain levels of contaminants in violation of the Canadian Environmental Protection Act (CEPA) and associated regulations, are considered hazardous material and will not be placed in the Tier II soil disposal facility. These materials are to be excavated, removed from the site and transported to a licensed disposal facility. Some of the soils may also contain petroleum hydrocarbons - often where lead and PCB contamination have also occurred as a result of waste oil and/or fuel spills. These hydrocarbons are contained within the soil matrix and do not exist as free liquids which could potentially leach. Leachate testing has also been conducted on the more highly contaminated soil samples as set forth in Ontario Regulation 347. Wastes determined to be "leachate toxic" under this test are not placed in the Tier II disposal facility, but are instead removed from the site to a licensed disposal facility.

5.9.5 Hydrocarbon Contaminated Soil Disposal Requirements

In 1998, the DEW Line Clean Up Protocol was revised to address hydrocarbon-contaminated soils at the Nunavut sites under the environmental provisions of the DND/NTI Agreement. Under the amended protocol, hydrocarbon contamination is divided into two types based on common sources at the DEW Line sites. In Type A hydrocarbon contaminated soil, the primary petroleum product present is lubricating oil and grease. Due to the low leachability of this type of hydrocarbon, these soils are generally deemed safe for disposal in a NHW landfill. Soils where the primary petroleum hydrocarbon contaminant was fuel oil are classified as Type B hydrocarbon contaminated soils. Due to the concern of leachate generation and migration from Type B contaminants, these soils are not

placed the NHW Landfill or Tier II Soil Disposal Facility. Several options for disposing of Type B contaminants have been employed based on location and site-specific factors. The most feasible and environmentally sound disposal options are placement in a secure, Tier II style landfill; passive land-treatment (landfarming); and containerization and transport off site to a disposal facility in the south.

5.10 Selection of Contaminated Soil Disposal Facility Locations

Selection of the areas for contaminated soil disposal facilities development is based on a number of technical factors including:

- Topography, drainage and geology;
- Availability of construction materials (gravel);
- Minimization of disturbance to natural drainage patterns;
- Appropriate distances from marine and freshwater systems and communities, as well as other biologically-sensitive areas;
- Ensure drainage away from ocean and domestic water supplies, distances from beaching areas and locations of contaminated soil, and
- Accessibility.

Another environmental concern during the development of these facilities is the possible requirement for use of explosives in some excavation activities. In addition to the obvious danger to human health, other possible impacts could include damage to surrounding areas (including waterbodies, environmentally sensitive areas and hazardous material storage facilities) from shock waves and blasting scatter, and the disturbance of nearby wildlife by sudden peak noise levels. Blasting, where required, will be conducted by authorized personnel in accordance with all required permits, licenses and applicable laws and regulations, and as dictated by regulatory authorities.

5.11 Demolition of Facilities

The work to be conducted at the DYE-M site includes the demolition, removal and disposal or containerization of all structures and utilities as shown on the demolition drawings (see Drawings 201-214) and includes the following:

- Removal and disposal of all contents of buildings identified for demolition, including storage tanks. Tanks and pipes containing fuel must be pumped out or drained prior to cleaning and disposal.
- Removal, segregation and containerization of building facility components coated with PCB-amended paint at PCB concentration levels in excess of 50 ppm.
- Removal and disposal of asbestos material in accordance with the asbestos abatement program. Asbestos must be removed and disposed of in a method that eliminates the risk of exposure to friable asbestos. Proper personal protective equipment and specialized equipment is required when removing asbestos. Asbestos materials are bagged in polyethylene prior to placement in a NHW landfill.
- Removal and disposal of concrete contaminated with PCBs at concentrations in excess of 1 ppm and less than 50 ppm.
- Removal and containerization of concrete contaminated with PCBs at concentrations in excess of 50 ppm.
- Removal and placement of hazardous demolition waste material in containers in accordance with the Hazardous Waste regulations. Hazardous demolition waste is segregated and disposed of according to CEPA guidelines.
- Removal, wrapping in plastic, and disposal of creosote treated timbers. Creosote treated timbers must be wrapped in polyethylene sheets before being placed in a NHW landfill. Creosote coated power poles or foundations are to be cut off 300 mm below ground level.
- Removal and disposal of drainage culverts.
- Disconnecting and capping of services, as required.

- Non-hazardous materials require no special treatment and can be crushed and placed in the NHW landfill.

Demolition debris to be disposed of on site will be cut into shapes and sizes, which will minimize void space when landfilled. Concrete foundations are largely left intact except where coated with PCB paints. Following the removal of site structures, demolition areas are reshaped or backfilled with granular fill to a height flush with the remaining foundations. All voids or holes that are left by foundation or structure removal are filled with gravel.

5.12 Removal of Hazardous Materials

"Hazardous" waste materials are defined as waste materials are wastes or materials that are designated as "hazardous" under Nunavut Territorial or Federal legislation; or as "dangerous goods" under the *Transportation of Dangerous Goods Act* (TDGA). The *Canadian Environmental Protection Act* (CEPA) regulates material containing PCBs at greater than 50 parts per million (ppm). Specifically identified hazardous materials include: batteries; asbestos; fuel tank bottom sludges; solvents; PCB-containing liquids; fuels and lubricating oils; alcohols and glycols; and heavy metal-contaminated liquids. Disposal requirements of these hazardous waste materials are presented in Table 5-5.

Table 5-5: Known Hazardous Waste Material Disposal Requirements

Hazardous Waste Material	Disposal Requirement
• Batteries • heavy metal-contaminated organic liquids: - Cadmium > 2 ppm - Chromium > 10 ppm - Lead > 100 ppm • liquids containing organic compounds with chlorine concentrations > 1000 ppm • liquids containing organic compounds with PCB concentrations > 2 ppm and < 50 ppm • liquids containing organic compounds other than those described above	Off-site licensed treatment/disposal facility (by separate contract).
• fuel tank bottom sludges • fuels, lubricating oils, alcohols and glycols	Off-site licensed treatment/disposal facility (by separate contract) OR on-site incineration in accordance with Sections 02090 of the Contract Specifications.
• liquids and solids containing organic compounds with PCB concentration > 50 ppm	Off-site licensed treatment and disposal facility; e.g. Alberta Special Waste Management System Facility – Swan Hills, Alberta.

All hazardous materials are to be shipped off-site to a licensed hazardous material disposal facility. The exceptions to this are asbestos and creosote treated wood. Asbestos will be double-bagged and placed in the NHW Landfills, and the location of the asbestos within the landfill will be marked on "as-built" drawings. Creosote-treated wood will be wrapped in plastic and placed in the NHW Landfills.

The paint on many of the building materials contains PCBs in access of 50 ppm. These construction materials will be collected using suitable equipment for the task, containerized and transported off

site for disposal. Temporary storage of these materials on-site will be in accordance with the Storage of PCB Waste Regulations under CEPA.

5.13 Transportation of Hazardous Materials Off-site

Hazardous materials are to be placed in environmentally suitable containers at an approved containment facility on-site. A storage area is established as per Environment Canada guidelines. The hazardous materials are removed by sealift in accordance with Transportation of Dangerous Goods Act.

5.14 Grading and Addition of Granular Materials

There were numerous areas identified that require grading and possibly addition of granular materials. These areas generally consist of piles of buried or partially buried, non-hazardous debris that will be covered with additional granular material and shaped to blend in with the natural terrain and promote positive drainage. These areas are identified on the design drawings provided in Appendix I.

5.15 Contractor Support Activities

The following activities will occur on-site to support the clean up work.

- Use of existing beach landing area, airstrip and roads at site for equipment transport, movement and access to work areas.
- Set-up of cleanup camp and equipment storage.
- Sewage from the camp will be handled with, at minimum, primary treatment (settling tank and lagoon) and discharged to ground surface. Sewage treatment and disposal will be in accordance with the Land Use Permit and Water Use License.

- Domestic wastes to be disposed of (as is, or incinerated as specified by the Land Use Permit) in the new Non-hazardous Waste Landfill.
- Demobilization of cleanup camp following end of project.
- Vehicle traffic to work areas is to be supported by the existing access roads that traverse the site.
- Labour and equipment requirements are anticipated to include approximately 50-80 personnel, 40 pieces of heavy construction equipment and 10 support vehicles.
- Duration of work is anticipated to be approximately 4 months, not including winter shutdown period, over a period of eight years.

5.16 Future Activities

The site is a North Warning System Long Range Radar Site, and there are no current plans to change this land use. In addition, an ongoing landfill-monitoring program was agreed to in the DND/NTI Agreement. The proposed landfill-monitoring program is updated after the completion of the clean up program.