I. OVERVIEW

A. Project Rationale

Canada and the United States signed a Memorandum of Understanding (MOU), in March 1985, agreeing to modernize the North American Air Defence System. The memorandum sets out the requirements for replacement of the Distant Early Warning (DEW) Line with an upgraded system to be called the North Warning System (NWS). The DEW Line facilities in Canada include 21 radar stations located in the Arctic as shown on Map I-1 and listed in Table I-1. The DEW Line stations are situated on lands that are located in two land claim regions (Map I-2). As seen from Table I-1, 6 stations are located in the Inuvialuit Settlement Region (ISR), with the remaining 15 stations located in the Nunavut Settlement Area (NSA). An agreement was reached between the Department of National Defence (DND) and Nunavut Tunngavik Incorporated (NTI) regarding the requirements for the physical restoration of sites located within the NSA (see Annex I-A).

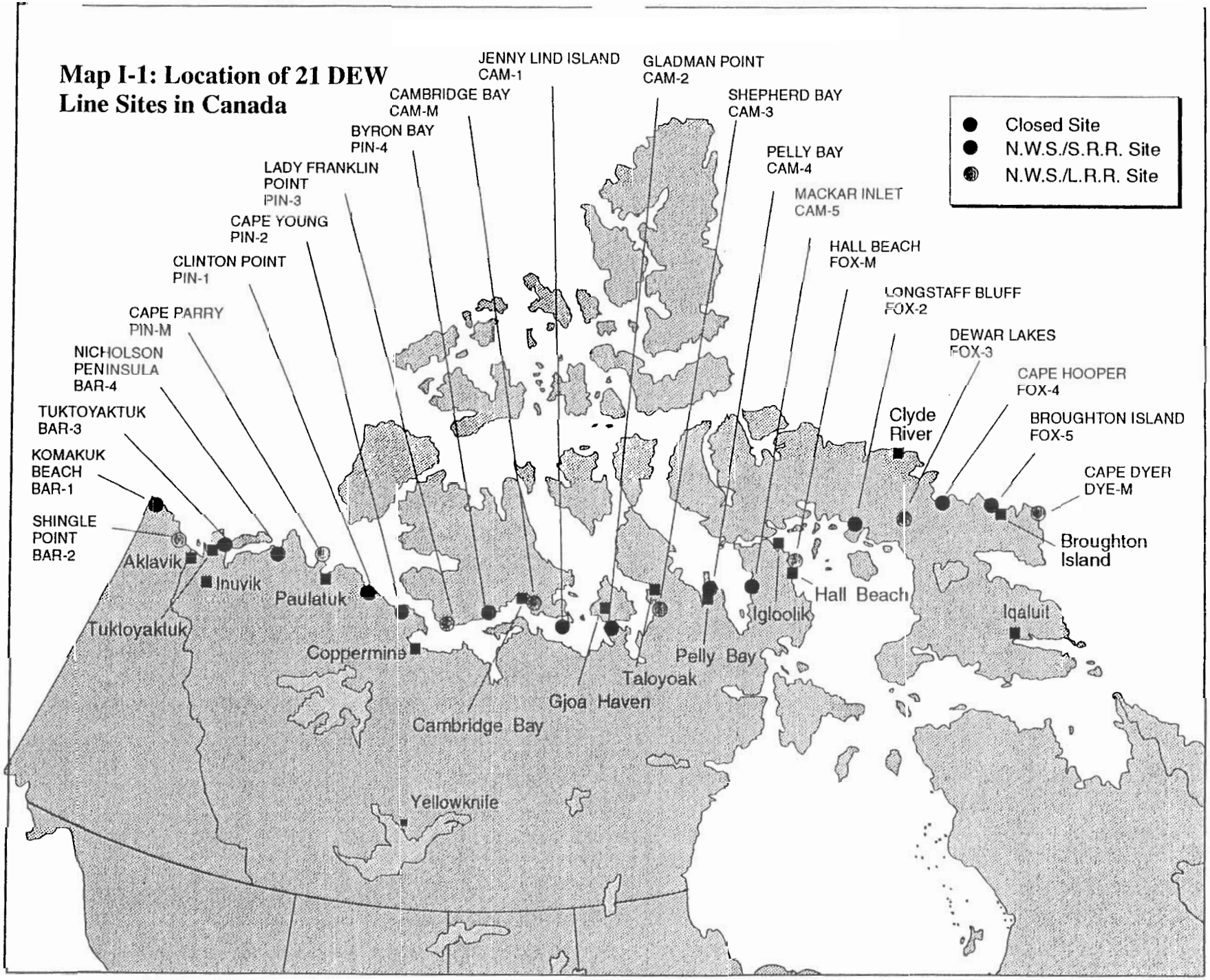
Eight of the DEW Line sites have been downsized and operate as NWS Long Range Radar (LRR) sites. Only two LRR sites, CAM-M and FOX-M, continue to be staffed on a permanent basis (Logistics Support Site - LSS). The DEW Line facilities not required for the operation of the NWS LRR sites will be dismantled and those portions of the site restored.

Closure of the remaining thirteen DEW Line sites began in 1991 and was completed in 1993. North Warning System involvement continues at eight of these sites as Short Range Radar (SRR) stations, either at the former operations site or nearby. The SRR stations are remotely operated and personnel will be on-site only for short periods for maintenance and inspection. The remaining five DEW Line sites have been decommissioned and are to be closed.

The cleanup and restoration activities associated with the partial or total closure of the 21 DND DEW Line sites are subject to environmental screening. As the initiating agency under the federal *Environmental Assessment and Review Process* (EARP), DND is required to conduct an initial assessment of work proposed for the cleanup and restoration of the sites. Screening is the first stage of initial assessment, and consists of a systematic, documented assessment of the environmental implications of a proposal, including the determination of the significance of potential environmental effects. Screening identifies the need for mitigation or monitoring programs, or modification of the project as proposed to reduce potential environmental effects. Screening also determines whether further study is required to fully evaluate potential environmental effects (Duffy 1986).

The objective of this report is to document the environmental screening of cleanup activities proposed for the DEW Line sites which are located within the NSA. It will focus on 14 sites within the NSA. It will not address the Cape Hooper (FOX-4) site, as an environmental screening report was previously completed for this site. This report has been prepared in accordance with the Interim DND Environmental Assessment Manual (DND 1991), an internal document prepared by DND to facilitate compliance with the federal EARP Guidelines Order and with EARP Implementation Guidelines.

Map I-1: Location of 21 DEW Line Sites in Canada


Map I-1: Location of 21 DEW Line Sites in Canada
JENNY LIND ISLAND CAM-1
GLADMAN POINT CAM-2
CAMBRIDGE BAY CAM-M
SHEPHERD BAY CAM-3
BYRON BAY PIN-4
PELLY BAY CAM-4
LADY FRANKLIN POINT PIN-3
MACKAR INLET CAM-5
CAPE YOUNG PIN-2
HALL BEACH FOX-M
CLINTON POINT PIN-1
LONGSTAFF BLUFF FOX-2
CAPE PARRY PIN-M
DEWAR LAKES FOX-3
NICHOLSON PENINSULA BAR-4
CAPE HOOPER FOX-4
TUKTOYAKTUK BAR-3
BROUGHTON ISLAND FOX-5
KOMAKUK BEACH BAR-1
CAPE DYER DYE-M
SHINGLE POINT BAR-2
Closed Site
N.W.S./S.R.R. Site
N.W.S./L.R.R. Site
Clyde River
Broughton Island
Aklavik
Inuvik
Paulatuk
Hall Beach
Igloolik
Iqaluit
Tuktoyaktuk
Coppermine
Pelly Bay
Taloyoak
Gjoa Haven
Cambridge Bay
Yellowknife

Map I-2: Land Claim Regions

Map I-2: Land Claim Regions

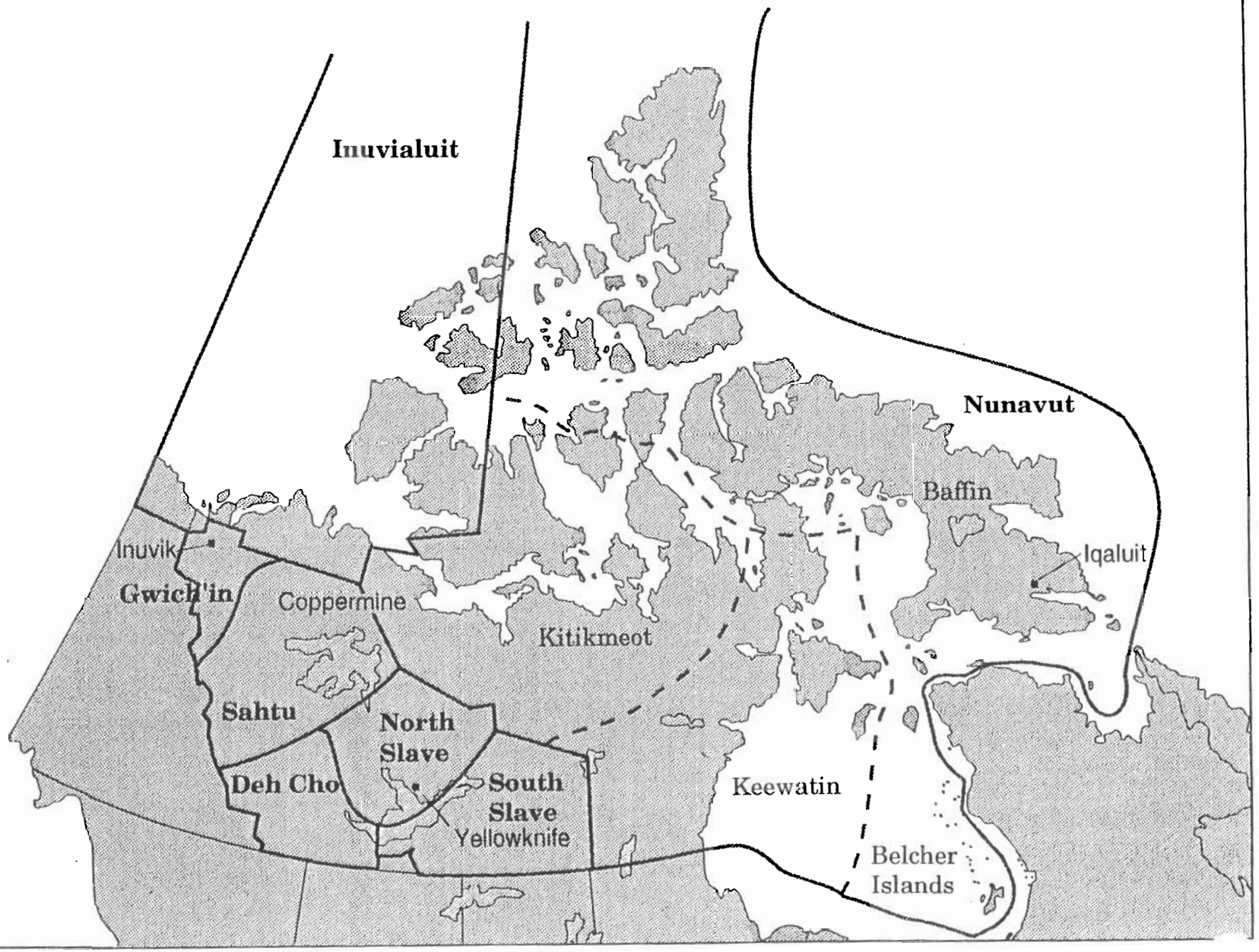


Table I-1: Locations and Present Status of the 21 DEW Line Sites.

Location	Site	Coordinates	Territory/Region	Status
Komakuk Beach	BAR-1	69° 35'N, 140° 11'W	Yukon/Inuvialuit	Closed in 1993, SRR in vicinity
Shingle Point	BAR-2	68° 55'N, 137° 15'W	Yukon/Inuvialuit	LRR
Tuktoyaktuk	BAR-3	69° 26'N, 133° 00'W	NWT/Inuvialuit	Closed in 1993, SRR in vicinity
Nicholson Peninsula	BAR-4	69° 55'N, 128° 58'W	NWT/Inuvialuit	Closed in 1993, SRR in vicinity
Cape Parry	PIN-M	70° 10'N, 124° 43'W	NWT/Inuvialuit	LRR
Clinton Point	PIN-1	69° 35'N, 120° 47'W	NWT/Inuvialuit	Closed in 1993
Cape Young	PIN-2	68° 56'N, 116° 55'W	NWT/Nunavut	Closed in 1993
Lady Franklin Point	PIN-3	68° 28'N, 113° 13'W	NWT/Nunavut	LRR
Byron Bay	PIN-4	68° 45'N, 109° 04'W	NWT/Nunavut	Closed in 1993
Cambridge Bay	CAM-M	69° 06'N, 105° 07'W	NWT/Nunavut	LRR/LSS
Jenny Lind Island	CAM-1	68° 40'N, 101° 43'W	NWT/Nunavut	Closed in 1992
Gladman Point	CAM-2	68° 40'N, 97° 48'W	NWT/Nunavut	Closed in 1992, SRR in vicinity
Shepherd Bay	CAM-3	68° 48'N, 96° 26'W	NWT/Nunavut	LRR
Pelly Bay	CAM-4	68° 27'N, 89° 45'W	NWT/Nunavut	Closed in 1992, SRR in vicinity
Mackar Inlet	CAM-5	68° 17'N, 85° 07'W	NWT/Nunavut	Closed in 1992
Hall Beach	FOX-M	68° 45'N, 81° 11'W	NWT/Nunavut	LRR/LSS
Longstaff Bluff	FOX-2	68° 54'N, 75° 10'W	NWT/Nunavut	Closed in 1992, SRR in vicinity
Dewar Lakes	FOX-3	68° 45'N, 109° 04'W	NWT/Nunavut	LRR
Cape Hooper	FOX-4	68° 26'N, 66° 44'W	NWT/Nunavut	Closed in 1991, SRR in vicinity
Broughton Island	FOX-5	67° 33'N, 63° 49'W	NWT/Nunavut	Closed in 1991, SRR in vicinity
Cape Dyer	DYE-M	66° 39'N, 61° 21'W	NWT/Nunavut	LRR

LRR = Long Range Radar - under the new North Warning System
SRR = Short Range Radar
LSS = Logistics Support Site

B. Environmental Assessment Process Overview

As a federal proponent, the Department of National Defence is required to conduct an environmental assessment for the clean up of each DEW Line site. As an early planning tool, these assessments were drafted in 1991 by the Department of National Defence under the auspices of the *Environmental Review Process Guidelines Order*. Subsequent changes to overall project planning have been assessed from time to time and the assessment document updated.

A similar environmental assessment was completed in 1996 for the clean up of the six DEW Line sites in the Inuvialuit Settlement Region. Through an ongoing project program of quality assurance and post assessment/implementation monitoring, conclusions and predictions have been validated or modified from the lessons learned in the ISR sites and incorporated into the assessment for the Nunavut sites.

These assessments have been preceded by extensive on-site environmental and engineering investigations completed by the Environmental Sciences Group at Royal Military College and UMA Engineering Limited. The initial investigations, which took place from 1989 to 1994 were used to provide a baseline study of the existing environment (both biological and physical) and ecological pathways and possible transport mechanisms that will exist during the clean up. Detailed socio-economic analysis, including a detailed archaeological survey of the sites, were completed during this time. Since 1996, DND has conducted a series of further site investigations in order to update the original information and to address further data and analysis requirements.

The environmental assessment undertaken in support of this project has used a process in which potential environmental impacts have been assessed on Valued Ecosystem Components identified during an initial scoping exercise.

The following sections provide a summary of the activities that were undertaken in conducting this environmental assessment:

Scoping

As a self directed environmental assessment, the initial step taken was to conduct a series of social and ecological scoping exercises designed to:

- Determine the temporal and spatial boundaries of the assessment; and

- Focus the analysis on the environmental issues directly related to the clean up project itself (i.e. identification of Valued Ecosystem Components).

In scoping the project, clean up activities to be assessed were identified. Possible additional activities were examined using the Canadian Environmental Assessment Agency's "Principal Project/Accessory" test, which is used to determine if other activities demonstrate an interdependence, linkage and/or geographical/ecological proximity with the primary clean up.

The assessment scope included a determination of the environmental effects to be assessed and the effects that are to be considered in making decisions regarding the project. The following chart outline the scope of the project and of the assessment:

Scope of the Project: **Project:** Clean Up of 15 DEW Line sites in the Nunavut Settlement Area **EA Trigger:** Funding from Department of National Defence **Scope of the project:** Principal Project: physical clean up of the 15 DEW Line sites within the Nunavut Settlement Area. Accessory physical works: Transportation of waste (including hazardous) materials, debris disposal, mobilisation and demobilisation of contractors equipment and personnel Other undertakings in relation to the physical work: None.
Scope of the Assessment: **Project:** Clean Up of 15 DEW Line sites in the Nunavut Settlement Area **EA Trigger:** Funding from Department of National Defence **Scope of the assessment:** The environmental assessment is to consider the effects of all project related activities (i.e. those related to the clean up of the site) and associated physical works on both biophysical (terrestrial, aquatic) and socio-economic assessment factors.

As a result of scoping, the following factors were identified for assessment:

- The need to evaluate environmental effects of the project, including those relating to cumulative effects that are likely to result from carrying out this project.

- Project undertakings performed in conjunction with other off site projects/activities that have been or will be carried out.

- The relative levels of significance.

- Public comments.

- Mitigation measures deemed to be technically and economically feasible.

Interested parties were identified and consulted during the assessment process including:

- 'Expert' federal departments (Environment Canada, GNWT Natural Resources, GNWT Health, DIAND);
- 'Other' federal departments (DND, Defence Construction Canada, Parks Canada);
- Aboriginal organisations (Nunavut Tunngavik Incorporated, Nunavut Planning Commission); and
- The community leadership of the various eastern Arctic hamlets and the general public.

Assessment of Environmental Effects

The initial step following the scoping exercise was to undertake a determination of the possible environmental effects of the project. This assessment involves providing a detailed overview of the project, a description of the existing environment (including inventories and ecological processes) and, finally, the identification of project-environment interactions.

The aim of describing the project was to clearly outline the constituent components and activities that were to occur on each of the DEW Line sites. Activities include mobilisation, project layout and design, plans and scheduling, specifics related to each of the activities (i.e., how would contaminated soil be identified, excavated, transported and disposed of), operating procedures, control procedures and demobilisation plans. Detailed data concerning each of the activities (i.e., material volumes) was included with this description.

During the scientific studies described above, the site teams collected all relevant information concerning the existing environment components of the study area. This information included a description of the physical, biological and social characteristics of the study area.

Using the information that was obtained on the project and the existing environmental setting, the assessment study determined interactive links between these two components. Particular concern was focused on the location, sensitivity, seasonal presence and abundance of these components. In general, these interactions were shown using a matrix table which are shown in the environmental assessment reports that accompany this submission.

Also included in the assessment of environmental effects were possible impacts relating to socio-economic factors (heritage, culture, archaeological, employment and business opportunities), land use and human health.

During the assessment stage, conclusions were made as to the type of impact (i.e. level of adversity) and its level of significance, based on comments received during public consultation sessions.

Identification of mitigation options

The third stage of the assessment process was to undertake the identification of mitigation measures that would result in a reduction or elimination of likely environmental effects associated with the clean up of each of the sites. In the case of this project, all potential adverse effects were addressed and not simply those deemed to be significantly adverse, the minimum required by assessment legislation. Mitigative actions now form part of the overall project design and planning documentation, which resulted in the Environmental Protection Plan. The requirement for on-site personnel to

adhere to these mitigative measures is contractual in nature as the Environmental Protection Plan forms part of the clean up contract.

C. Structure of the Environmental Screening Reports for the 14 DEW Line Sites

This Environmental Screening Report (ESR) is structured to reflect the requirements outlined in the *Environmental Assessment and Review Process Guidelines Order* and the Interim DND Environmental Assessment Manual. The remainder of this section includes a brief description of environmental elements common to each of the 14 sites, a general description of the cleanup and restoration activities to be carried out at each site, a regional environmental overview, potential impacts as related to the generic cleanup and restoration activities, as well as monitoring and mitigation requirements. This overview chapter also includes the following:

- A brief summary of the site investigations - Section D
- A regulatory overview – Section E
- A summary of the community consultations that have taken place in communities that are located in proximity to the DEW Line sites - Section F
- Concept and rationale for the new Tier II Disposal Facilities – Section G
- A summary of the cumulative effects of the project as a whole - Section H
- Site specific summaries - Section I
- The project summary - Section J
- Sources of information used for the completion of the ESRs - Section K

Chapters II through XV present information specific to individual sites. The layout for each site specific chapter is the same in order to ensure that the same type of information is presented for each of the 14 DEW Line sites. The Registration and Decision Form, used to record the initial assessment decision, as well as for reporting purposes within DND and to the Federal Environmental Assessment Review Office (FEARO), is included as an annex at the end of each site chapter. Appropriate environmental personnel within the Project Management Office have completed this form. The responsibility for the initial assessment decision and subsequent reporting procedures are detailed in the Interim DND Environmental Assessment Manual.

The first section (A) of each site specific chapter deals with a general project description that is specific to that particular site. The location of the site is indicated, as well as a brief discussion on the past and present uses of the site. Cleanup activities are also outlined in the first section as follows:

Landfill Development:

- New landfills may be developed for non-hazardous material and Tier I soils (see Annex I-A).
- Tier II soils (see Annex I-A) will be placed in an engineered, lined, containment facility (Tier II Disposal Facility) constructed at each site. In some cases Tier II soils may be transported from one DEW site to another depending on soil volumes and project economics.
- Siting new landfills includes consideration of drainage paths from the landfill, proximity to drainage courses, proximity to waste materials and borrow sources, and overall topography.

Landfill Closure:

- Landfills closed during the USAF departure from several sites have not been surveyed by the engineering team; this will occur during initial stages of contractor activities.
- Existing landfills were classified according to the scoring system outlined in the DND/NTI Agreement (see Annex I-A). This classification was developed by the DEW Line Cleanup Environmental Working Group (EWG), which is comprised of members representing NTI, DND and DCC. The EWG convened on several occasions in 1997 and 1998 with its primary objective being to provide scientific and technical input related to cleanup requirements in the Nunavut Region. One of the EWG specific tasks was the development of a landfill risk evaluation matrix. The scores obtained through the application of this matrix resulted in existing landfills being classified as: Class A – high environmental risk, Class B – moderate environmental risk, or Class C – low environmental risk.

- **Class A Landfills:** These landfills will be excavated and all material will be transported to a secure sorting area. Debris will be separated from the soil matrix and classified as hazardous, non-hazardous or potentially hazardous. Potentially hazardous materials will be tested and classified as hazardous or non-hazardous. Excavated soils will be tested in accordance with the DND/NTI Agreement, (see Annex I-A) to determine the disposal requirements.
- **Class B Landfills:** These will be closed using an engineered leachate containment system. This system to consist of synthetic liners (geocomposite clay liners and/or geomembrane liners) and promotion of permafrost aggradation through the landfill contents. In specific cases where a leachate containment system cannot be constructed, the Environmental Working Group will recommend whether complete excavation or partial excavation with a leachate containment system is required.
- **Class C Landfills:** The remediation for these landfills will be the placement of an engineered cover following collecting, sorting, and appropriate disposal of debris where it may impact on the integrity of the landfill. Hazardous debris will be removed and disposed of in accordance with federal regulations. Generally, final thickness of cover material will be approximately 0.75 metres, but may vary depending on site specific conditions.

Landfill Monitoring (detailed in Annex I-A)

- Monitoring programs will occur at landfills.
- Annual monitoring will be adjusted according to the Post Construction Monitoring Regime.
- New landfills constructed for the disposal of non-hazardous demolition wastes, site debris and Tier I soils pose a low potential environmental risk. The monitoring program for these landfills will be limited to visual inspection to evaluate the stability of the landfill.
- Existing landfills that are to be regraded will be monitored for leachate periodically by the collection of soil and/or water samples from test pits at the toe of landfill, in addition to visual inspections.

- The monitoring program for Class B Landfills and the proposed Tier II Disposal Facilities will include thermal monitoring of the ground temperatures in and around the landfill, collection and analysis of soil and water samples, and visual inspections.
- Issues arising from the monitoring program will be dealt with according to the established DND/NTI Agreement.

Disposal of Site Debris:

- Visible site debris will be collected and sorted. Hazardous debris will be disposed of in accordance with Federal regulations. Non-hazardous debris will be buried in a professionally engineered landfill, provided there is a suitable location and sufficient gravel available.
- Underwater debris below two metres of the low tide mark or within two metres of the surface of an island water body will also be collected, sorted and disposed of according to the DND/NTI Agreement (see Annex I-A).

Disposal of Contaminated Soils:

- Contaminated soil areas were identified in the site specific cleanup protocols developed for each site. For this project, the definition of contaminated soil has been established in accordance with the DND/NTI Agreement (see Annex I-A). Soil has been classified into two tiers, Tier I and Tier II. Tier I soils will be disposed of in a new engineered landfill. Tier II soils will be disposed of in a Tier II Disposal Facility constructed at each site. This facility will incorporate a leachate containment system and promote permafrost aggradadation. It will be monitored over time both visually, and with thermistors and monitoring wells. This methodology was selected over the alternative of containerizing and shipping Tier II soils off-site for the following reasons:
  - an evaluation of cost differences revealed that off-site disposal was prohibitively expensive.
  - environmental advantages of on-site disposal versus transportation and off-site disposal.

- Hydrocarbon contamination is evaluated on a guideline of 2500 ppm, however, each instance of hydrocarbon contamiantion is considered individually and evaluated useing a risk management approach.

Removal of Hazardous Materials:

- Hazardous wastes and materials refer to wastes or materials that are designated "hazardous" under Northwest Territorial, Yukon Territorial or Federal legislation; or as "dangerous goods" under the *Transportation of Dangerous Goods Act* (TDGA).
- Wastes encountered may include tank bottom sludge, industrial solvent, radioactive materials, domestic and industrial hazardous materials, mercury containing instruments, refrigerants, batteries, and waste and transformer oil containing polychlorinated biphenyls (PCBs), PCBs and lead contained in painted building materials.
- Hazardous materials may be encountered during landfill excavation, and sorting of site debris or demolition waste. Hazardous materials will be collected and sorted using personal protective equipment suitable for the task. These materials will be containerized, labeled, and stored temporarily in a secure location in accordance with Federal or Territorial Legislation until manifested and shipped off-site for disposal.
- There are a few exceptions to the treatment of hazardous materials and these include the following:
  - Abestos may also be encountered and will be double bagged and landfilled on-site.
  - Creosote-treated timber will wrapped in plastic and landfilled on-site.
  - Some fuel, alcohol and other flammable liquids are to be incinerated.
  - Unknown barrel contents will be treated in accordance with the Barrel Contents Criteria and Disposal (see Annex I-A).

PCB Painted Materials:

- 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.

The ultimate disposal requirements for the materials painted with PCB amended paint currently being decided by the CCME and Environment Canada. If a timely decision is not received, these materials will be temporarily stored in accordance with the *Storage of PCB Regulations* under CEPA until a decision is reached as to their ultimate disposal. If a decision is rendered that this material may be landfilled, a PCB Amended Painted Material landfill will be constructed at each site for the disposal of the materials from that site.

Transportation of Hazardous Materials Off-site:

- Transportation of hazardous materials and contaminated soils will conform to the relevant *Transportation of Dangerous Goods Regulations*, which dictate all aspects of shipment of these materials.

Demolition of Facilities:

- Existing facilities not required for the operation of the North Warning System (LRR and SRR sites) will be sold through the Crown Assets Disposal Corporation or demolished and/or removed down to their foundations. Facilities at each site are similar in construction and are described in the following bullets.
- Modular Structures (Module Trains and Dormitories) - typically wood frame with insulated wood or metal panels, exterior metal sheathing founded on post and timber sill foundation, or concrete footings. Asbestos insulation common in fire barriers, hot water supply, heating components. Possibly batteries in emergency lighting system.
- Hangars - steel frame structure with exterior metal panels with insulation. Founded on concrete footings. Potential for asbestos in insulation of heating components.
- Warehouses - steel frame with insulated or non-insulated metal panels. Founded on concrete footings. Asbestos may be found in insulated buildings.
- Storage Buildings - wood frame with plywood exterior, non-insulated. Steel frame with exterior metal panels, insulated/non-insulated.
- Communication Dishes - approximately 9 metre diameter parabolic dish, attached to support tower set on concrete footings.

- Communication Billboards - approximately 18 metre high, 21 metre wide and 10 metre deep, steel frame construction with sheet metal surface. Associated with each billboard are waveguides, feed horns, creosote-treated timbers, cables and metal cable conduit that also require removal.
- HF Air - Ground Antenna – each consisting of five creosote treated wood poles, approximately 20 metres high, each anchored with three guy wires.
- Fuel Storage Tanks - varying capacity, steel construction.
- Non-hazardous demolition waste will be landfilled on-site. Hazardous materials, with the exception of asbestos and creosote-treated timbers, will be containerized for shipment off-site. Asbestos containing materials will be double bagged and landfilled on-site. Creosote-treated timbers will be bagged and landfilled on-site.

General Site Grading:

- Grading operations at each site will consist of the shaping and regrading of disturbed areas to blend in with the natural contours. The disturbed areas include:
  - contaminated soil excavation areas, including sewage outfalls and sewage lagoons no longer in use;
  - existing and proposed landfill areas;
  - debris areas;
  - areas disturbed during demolition operations;
  - granular borrow areas; and
  - any area disturbed during the establishment and operation of the cleanup camp,
  - equipment storage and maintenance facilities.

Development of Borrow Sources:

- Granular borrow materials are required for development of landfills and Tier II Disposal Facilities, as well as for general site grading purposes. Typically, each site has several borrow sources where material has been extracted. Where possible, existing sources of borrow material will be used during cleanup. Otherwise, new

sources will be exploited. At the completion of this project, all borrow areas are to be regraded to match surrounding topography.

Contractor Support Activities:

- Site Access and Supply - most of the sites are accessible by water and air transport. One site (Dewar Lakes, Fox-3) is an interior location that can only be accessed by air.
- Cleanup Camp and Equipment Storage Areas - for the implementation of the cleanup plans, a Contractor will establish a camp and storage areas on-site. Where possible, these will be located in areas of previous disturbance such as borrow areas or storage areas, to avoid or minimize new disturbances.
- Camp Operation - domestic refuse will be incinerated and disposed of in the currently open landfill on-site. Where no landfill is active, a new disposal site will be selected. Sewage will be handled by a portable septic system. Existing water supply locations will be used if tested and found satisfactory. The size of camp required, including personnel and Cleanup equipment, will vary from site to site and is dependent on the scope of work at each location.
- Vehicle Operation - access to work areas is generally available via existing roads and/or the airstrip.
- Fuel Handling and Storage - fuel will be transported to site by the Contractor and stored in approved facilities.

The second section (B) of the site specific chapters presents a regional environmental overview with general information on the flora, fauna, and heritage resources within the project area. The outline includes the following:

Flora:

- Flora across the DEW Line sites varies according to the ecoclimatic regions. The western sites, within the low Arctic ecoclimatic region, are characterized by nearly continuous cover consisting of dwarf shrub tundra vegetation.

- In the mid Arctic region, as mean temperatures are lower, vegetation cover decreases correspondingly. Sites generally have 40 to 60 percent vegetation cover decreasing to less than 15 percent ground cover on dry sites.
- The high Arctic and oceanic high Arctic sites are characterized by discontinuous to sparse vegetation cover. Species diversity decreases in the oceanic high Arctic region.

Fauna:

- The diversity of species varies between ecoclimatic regions, with the greatest diversity recorded within the low Arctic ecoclimatic region. Species identified at the specific sites are described in each site chapter.

Heritage Resources:

- Heritage resources are described as prehistoric and historic, depending on the time of occupation. Prehistoric resources date to the early occupation of the high Arctic, and are commonly represented by the Thule culture. Sites of the Thule phases are most widespread and best recognized. Historic resources refers to the European exploration phases from the sixteenth century onwards.
- As documented in UMA (1991), a reconnaissance archaeological study was conducted on 21 DEW Line sites in 1990. Previously recorded sites were revisited and new sites were documented. In general, archaeological sites along the coast tend to be associated with sand spits, raised beaches and/or points of land. Sites with local ridges, rivers, interior lakes, bays and islands appear to have been favoured as occupation sites. Specific details of the heritage resources identified at the sites is given in UMA (1991). The archaeological potential of the individual sites is described in each site chapter.
- For cleanup operations occurring in the vicinity of some of the known archaeological sites, the appropriate permits will be obtained in accordance with the Nunavut *Historical Resources Act*.
- The discovery of archaeological sites during cleanup operations is a possibility at many of the DEW Line sites. If an archaeological site is discovered the Nunavut

Historic Resources Act and *Historical Sites Declaration Regulations* - operations in that particular area will be suspended pending investigation.

The third section (C) in the site specific chapter describes potential impacts as well as the mitigation and monitoring requirements for each impact. A summary of the potential impacts as related to the generic project activities and the regional biophysical environment is presented in Table I-2. Monitoring and mitigation requirements are also outlined for each of the potential impacts identified.

Table I-2: Summary of Potential Impacts and Monitoring/Mitigation Requirements for 14 DEW Line Sites in the Nunavut Settlement Region

Description	Significance	Monitoring/Mitigation Requirements
Impacts of Landfill Development and Closure		
1. Potential risk to soils, surface water, terrestrial and aquatic habitat from development and closure of landfills.	Potentially significant	- Design of landfill development and closure to prevent leachate; - Implementation of a monitoring program; - Landfills to be contoured to match existing drainage patterns.
Impacts of Demolition/Regrading Activities		
1. Potential risk to existing habitat from demolition and regrading activities.	Potentially significant in previously unimpacted areas.	- Demolition areas to be recontoured to match existing drainage patterns. - Regrading to be limited to specified areas.
Impacts of Removal and Transport of Hazardous Materials/Fuel/Contaminated Soil		
1. Potential risk to soils, surface water, terrestrial and aquatic habitat and species, and human safety from accidental events such as fuel or hazardous materials spills.	Potentially significant in the worst case (i.e. large spill volume).	- Development of a contingency plan outlining procedures to follow in the event of an accidental spill; - Training and education of Contractor's employees in emergency procedures; - Storage of fuel in diked tanks; - Proper fuel handling techniques, particularly when refueling equipment.
2. Hazards to human health and safety during cleanup (inhalation).	Significant due to contaminated nature of material on-site.	- Proper procedures for handling hazardous materials. - Removal of hazardous materials from site.
Impacts of General Cleanup Activities		
1. Elimination of potential hazards and sources of contaminants through remediation of existing landfills, removal of physical debris, discontinued use of sewage outfalls and removal of contaminated soil.	Improvement of overall environmental conditions.	- Compliance and monitoring requirements for engineering performance are detailed in Contract Specifications.

Description	Significance	Monitoring/Mitigation Requirements
2. Disruption of heritage sites due to new development, regrading and/or activities of Contractors' personnel.	Potentially significant (prior to mitigation) at sites with high potential for archaeological resources.	- Report and record any features of potential interest, ensure areas are clearly marked. - Avoidance or controlled excavation of features. - Monitor excavations for additional features. - All personnel to be discouraged from visiting archaeological and other heritage sites.
3. Degradation of permafrost due to cleanup operations.	Potentially significant in excavations in ice rich ground.	- Avoid patterned ground and ice rich areas when siting new facilities or borrow sources. - If possible, backfill excavations as soon as practical. - Replace vegetation cover or topsoil as soon as possible after excavation. - Exploit existing borrow sources to minimize disturbed areas. - Monitor for evidence of soil erosion, subsidence or development of thermokarst.
4. Effect of Contractors' activities (e.g. noise or disturbance) and/or personnel on terrestrial wildlife species.	Potentially significant (prior to mitigation) on sites where wildlife is noted.	- Minimize activity in sensitive areas. - Scheduling of work activities to avoid nesting, calving or migration periods. - Education of employees to prevent on-site personnel from harassing wildlife.
5. Effect of Contractors' activities (e.g. noise or disturbance) on marine wildlife species.	Potentially significant (prior to mitigation) at sites where marine wildlife is known to occupy off shore waters.	- Scheduling of shipping to minimize disturbance to marine environment. - Sea mammals to be avoided by all shipping. - Vessel traffic to be restricted to traditional shipping lanes.
6. Effect of cleanup operations and contractor's activities on terrestrial habitat, vegetation.	Potentially significant, at sites where vegetation covers a major portion of the site, for example in the low Arctic Ecoclimatic Region.	- Siting of cleanup camps or new development (landfills) to be on disturbed ground, wherever possible. - Vehicle and equipment traffic is to be confined to existing access roads.

Description	Significance	Monitoring/Mitigation Requirements
7. Effect of cleanup activities on appearance of site.	Improvement. Surface debris will be collected and disturbed areas regraded.	- None required. (Note: some sites may have more extensive cleanup.)
Other Environmental Impacts		
1. Use of local services and hiring of northern residents during implementation of cleanup plans.	Positive impact on northern socio-economic environment.	- Tender documents for DEW Line Clean Up contracts will include clauses requiring Contractors to maximize employment and business opportunities in the North, in accordance with DND/NTI Agreement; - Training and Educational programs will be funded and supported for northern residents, in accordance with DND/NTI Agreement.
2. Disruption of heritage sites due to new development, regrading and/or activities of Contractors' personnel.	Potentially significant (prior to mitigation) at sites with high potential for archaeological resources.	- Report and record any features of potential interest, ensure areas are clearly marked. - Avoidance or controlled excavation of features. - Monitor excavations for additional features. - All personnel to be discouraged from visiting archaeological and other heritage sites.
3. Effect of cleanup operations on local resource use.	Potentially significant (prior to mitigation) at sites near year round communities or seasonal camps.	- Consultation with local residents to minimize conflicts. - Scheduling of activities to avoid hunting and fishing activities.

The fourth section (D) of the site specific chapters provides an environmental impact summary table listing cleanup activities and their impact on various environmental components. The fifth (E) section provides a concluding statement summarizing the overall impact of decommissioning and cleanup activities at each site. The final section (F) lists the sources of information that were used to complete each site specific chapter.

D. Site Investigations

1. Environmental Site Evaluations

An investigation of the 21 DEW Line sites, which include the 14 sites located in NSA, was conducted in 1990 by a consortium of Canadian engineering consulting firms lead by UMA Engineering Ltd. on behalf of the United States Air Force (USAF). The objectives of this study were to address the following:

- a description of the biophysical environment, including climate, geology and hydrology of the sites, and flora and fauna;
- identification of cultural resources, including current and historic land use;
- an inventory and assessment of facility decommissioning requirements;
- identification of contaminated areas;
- evaluation of chemical remediation alternatives; and
- development of order-of magnitude cost estimates for the cleanup.

The final report was submitted in the summer of 1991(UMA, 1991).

Conclusions related to contaminant distribution were limited given the lack of environmental objectives to which the results could be applied; however, the report provided background information related to the biophysical and cultural resources potentially impacted by the proposed cleanup activities.

At the request of the Director, North Warning System Office (DNWSO), a two year study was conducted, in 1989 and 1990, by the Environmental Sciences Group at Royal Roads Military College (now at the Royal Military College) on ten of the 21 DEW Line sites. This study was subsequently expanded to include all 21 DEW Line sites, completed in 1993. The purpose of these investigations was to ascertain the environmental status of the sites and establish objectives and requirements for chemical remediation and physical restoration.

The evaluation of each site included a physical description of facilities, debris, landfills and dumps, stained/spill areas and drainage pathways. Soil and water samples were obtained from all potentially impacted areas; specifically landfills, sewage disposal areas, fuel and general storage areas, stained locations, as well as areas removed from the influence of station activities - these latter samples provided background or comparison values. Sampling focused primarily on potential contaminant migration courses, leading to or affecting components of the Arctic environment, such as the terrestrial food chain and marine/aquatic systems. The samples were analyzed for a range of contaminants including organic compounds, such as PCBs, and inorganic elements (metals) using the lowest possible detection limits to detect chronic low inputs. As the presence of a contaminant, in itself, does not indicate a deleterious impact, plant samples were also collected to determine whether the identified contaminants were entering the Arctic food chain. The results of these investigations were presented in two reports (Reimer et al., 1991 and Reimer et al., 1993) which were submitted to DNWSO.

The DND/NTI Agreement (see Annex I-A) outlines the requirements for physical restoration of the 14 DEW Line sites located within the NSA. This agreement will form the basis for the development of the site specific cleanup requirements.

2. Engineering Site Investigations

UMA Engineering Ltd., in association with Sheppard Green Engineering & Associates Ltd. (SGE) and Jacques Whitford Environment Ltd. carried out detailed engineering investigations at each of the sites (1992-1994). The objective of these investigations was to obtain site specific information required for the formulation of the cleanup design including:

- delineation of contaminated areas to determine areas and volumes of soil removal;
- provision of topographic survey information for work areas (i.e., existing landfills and landfill development areas);
- quantification of site debris;

- identification and characterization of granular borrow areas; and
- inventory and description of facilities to be decommissioned and demolished at each site.

E. Regulatory Overview

During the implementation of the DEW Line Clean Up Project, all applicable environmental laws, regulations and requirements of federal, territorial and other authorities, will be adhered to. The contractors effecting the work will acquire and comply with those permits, approvals and authorisations as may be required. The Contractor will be subject to and must comply with those permits and approvals obtained on behalf of and by DND to conduct this work. The Contractor, through all project phases, will work in close cooperation with regulatory authorities and DND to ensure compliance.

Federal Regulatory Overview

- The *Canadian Environmental Protection Act* regulates toxic substances from their production or import, to consumption, storage and disposal. Key Regulations associated with this *Act* are the *Chlorobiphenyl Regulations* and the *Storage of PCB Regulations*.

- The *Transportation of Dangerous Goods Act* and *Regulations* promote public safety in the transportation of dangerous goods. The Act applies to all handling, offering for transport and transporting of dangerous goods by any means of transport whether or not the goods originate from or are destined for any place or places in Canada.

- The *Fisheries Act* protects fish and fish habitat from pollution, negative alteration or disturbance, or impediments to fish movement. Fisheries and Oceans Canada will be given the opportunity to review permit applications or restoration plans.

- The *Arctic Waters Pollution Prevention Act* and *Regulations* govern development and shipping activity in Arctic waters adjacent to the mainland and islands of the

Canadian Arctic, to ensure the continuing welfare of the residents of the areas, and to protect the ecological balance in water, ice and land areas.

- The *Migratory Birds Convention Act* provides for the protection of designated migratory species, including birds of prey, their habitats, and the regulated harvest of certain species.

- The *Canada Wildlife Act* provides for the involvement of the Government of Canada in cooperative research and management programs involving wildlife species normally the responsibility of provinces or territories. This is particularly relevant to rare and endangered species or species such as caribou which seasonally move across regulatory boundaries.

- The *Canada Shipping Act* regulates shipping activities under the jurisdiction of Canada. Regulations cover technical standards of operation safety and pollution aspects related to shipping activities in Canadian waters.

- The *Constitution Act* is the enabling legislation for the Nunavut Land Claims Agreement. The Nunavut Land Claims Agreement in turn details the terms and conditions for developments and other uses of lands within the Nunavut Settlement Area.

- The *Navigable Waters Protection Act* pertains to the erection of structures or facilities used to enhance or impede navigation in waters under the jurisdiction of Canada.

- The *Territorial Lands Act* provides the authority for administering and protecting lands under the direct control of the Minister of Department of Indian Affairs and Northern Development (DIAND) (Territorial Lands). The following regulations are pursuant to this act:

- *The Territorial Land Use Regulations* provide regulatory control for maintaining sound environmental practices for any land use activities on Territorial lands. These regulations require that land use permits be issued for such operations as work involving the use of heavy equipment, establishment of camps, use of explosives, and clearing of lines, trails and rights-of-way, including construction of access roads.

- *The Territorial Quarrying Regulations* establish the fee schedule and procedures for extracting Crown-owned limestone, granite, slate, marble, gypsum, loam, marl, gravel, sand, clay or stone from Territorial Lands. The regulations specify permits, applications, staking and dimensions of quarries.

- The *Northwest Territories Waters Act* and *Regulations* provide for the conservation, development and use of the water resources. The Nunavut Water Board is estblished by the Nunavut Land Claims Agreement to license all water usage and waste disposal activities.

- *Atomic Energy Control Act* and *Regulations* describe the packaging requirements and approvals needed for the transportation of radioactive materials.

- *Explosives Act* and *Regulations* define explosives, the permitting requirements needed to use explosive substances, packaging, handling and transporting requirements, and safety requirements.

- *National Fire Code (NFC)* establishes the standard for fire prevention, fire fighting and life safety in buildings in use, including standards for the conduct of activities causing fire hazards, maintenance of fire safety equipment and egress facilities, standards for fire extinguishers, etc. In addition, the NFC establishes the standard for prevention, containment and fighting of fires originating outside buildings which may

present a hazard to a nearby community and sets the standards for the storage and handling of dangerous goods, flammable liquids and combustible liquids.

Nunavut Regulatory Overview

The Territorial Government and DIAND jointly administer the Nunavut Territory that contains DEW Line sites. The DIAND regional office is in Yellowknife. DIAND district offices within the Nunavut Settlement Area and the Territorial seat of government are located in Iqaluit.

In addition to the Federal and Territorial Acts and Regulations above, the clean up of the DEW Line sites in Nunavut is also governed by:

- The *Explosive Use Act* provides controls for surface blasting other than for mining purposes.

- The *Wildlife Act* provides for the protection of wildlife and wildlife habitats as well as regulated harvest of selected species.

- The *Environmental Protection Act* provides for protection of the environment from the discharge of contaminants, clean up of contaminants and unsightly premises. In addition, the powers of inspectors as well as offences and penalties are defined. The Act applies only to situations not authorised by other Canadian Acts in Nunavut.

- The *Spill Contingency Planning and Reporting Regulation* outline requirements for filing of a contingency plan and for reporting of spills.

- *Safety Act* and *Regulations* outline the health and safety standards to be maintained at workplaces to ensure the health and safety of persons.

- The *Public Health Act* and *Regulations*, particularly the *General Sanitation Regulations* and the *Camp Sanitation Regulations*, outline the health standards to be maintained at workplaces and any camp facilities.

- The *Historical Resources Act* protects archaeological sites from disturbance and prohibits the removal of speciments, except under permit.

Environmental Guidelines

- *National Guidelines for Decommissioning Industrial Sites* provides the recommended process for undertaking site assessment studies.

- *Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments* indicate the degree of treatment and effluent quality that will be applicable to all wastewater discharged from existing and proposed Federal installations.

- *National Guidelines for the Landfilling of Hazardous Waste* (CCME Report, April 1991) are to be used by regulators, designers, owners, and operators of hazardous waste facilities. They cover site selection, design, construction, closure and post-closure care, monitoring, and operation. They are intended for new, not existing facilities.

- *Guidelines for Preparation of Hazardous Material Spill Contingency Plans* identify factors that should be considered in the development of hazardous material spill contingency plans and the information that should be incorporated into a comprehensive contingency plan.

- *Code of Good Practice on Dump Closing or Conversion to Sanitary Landfill (1977)* outlines the guidelines to improve operation and properly close existing dumps. It is intended to promote a consistent approach to the clean up of existing dumps to

prevent contamination of water, air and land and to ensure that the best particular control technology is used.

- *Code of Practice for Used Oil Management in Canada* describes environmentally sound options for the handling, storage, collection, transportation, recycling, reuse and disposal of used oils in Canada. It is intended to provide guidance for used oil generators and to regulatory authorities in the formulation of provincial or regional used oil management strategies.

- *Canadian Drinking Water Guidelines* are compiled by CCME for Canadian Drinking Water Quality for specified uses of water likely of concern at contaminated sites.

- *NWT Guidelines for Removal of Materials Containing Friable Asbestos* outline guidelines to be used to remove friable asbestos.

- *NWT Guidelines for Municipal Type Wastewater Discharges* outline requirements for water quality effluent from these facilities.

- *NWT Guidelines for Discharge of Treated Municipal Wastewater* outline requirements for water quality effluent from these facilities.

F. Community Consultations - Public Participation

1. Purpose

A Public Consultation Program was carried out in communities across the north in August of 1992, in May and June of 1993, and again in 1994 to inform the public of the status of the DEW Line Cleanup project at each of the 21 sites and to obtain input regarding specific concerns of the people.

2. Process

Meetings were held in communities across the north in the vicinity of DEW Line sites and information sessions were held with government officials in Cambridge Bay, Iqaluit and Inuvik. The action plan was prepared by UMA with the consultation team comprised of representatives from DND, DIAND, Environmental Sciences Group/RRMC, UMA and SGE.

Information packages were provided to the communities in English as well as Inuktitut, Inuinaktun and Inuvialuktun where applicable. Minutes were recorded at each of the meetings and a number of action items were identified and passed on to the responsible agencies.

3. 1992 Community Consultations

Sixteen communities were visited in 1992; the locations and dates are listed in Table I-3. The objectives of the initial meetings included the following:

- Inform the community of the status and schedule for the project.
- Provide information regarding the process for closure and cleanup of the sites as well as overall objectives for maximizing northern benefits.

- Present environmental information regarding the DEW Line Clean Up (DLCU) project.
- Provide general information regarding the demolition/disposal of facilities.
- Obtain information regarding public concerns through discussions at the meetings and through questionnaires.
- Obtain information regarding local labour and contracting capabilities to assist in developing implementation strategies.

A report prepared by UMA and its associates outlines the information provided to the public and summarizes questions and concerns which arose during the meetings. Three of the meetings scheduled in the Western Arctic were either canceled at the request of the Hamlet (Tuktoyaktuk and Paulatuk) or simply boycotted due to instructions to the communities from the Inuvialuit Regional Corporation (IRC). Their position was based on their interpretation of certain aspects of the Inuvialuit Final Agreement and land claim settlements. One western meeting, held in Inuvik in 1992, was well attended.

Many questions and concerns were raised regarding various aspects of the project and almost half of these dealt with two main areas: employment opportunities and environmental protection. There is a serious desire among the people in the communities to obtain training and to be involved in the cleanup of the sites. The second major issue of environmental impact and protection was expressed as concern about the short and long-term impact on the food chain. Perhaps the most serious concerns expressed centered on previous disposal practices, particularly ocean dumping.

The appearance of the sites, particularly those adjacent to communities, was a concern. The proposed cleanup protocol was generally accepted to be the most practical especially after assurances that the Federal Government would assume long term responsibility.

In general, the meetings were well attended, the project team was well received and discussions were wide ranging and lively. People seemed to appreciate the initiative taken by DND to inform the communities regarding DLCU and the public provided valuable insights into the project.

4. 1993 Community Consultations

Thirteen communities were visited in May and June 1993. The locations, dates, and attendance figures are listed in Table I-4. The objectives for this second round of meetings were as follows:

- Report to the community on the current status of the project.
- Present information on the site investigations and the 80% Design Submission for the ten sites studied in 1992.
- Provide information on the 11 DND sites to be studied in 1993.
- Present information on the plans for the 21 DIAND sites.
- Obtain information regarding community concerns with the cleanup plans.

The communities were generally pleased to host the meetings and assisted with pre-meeting preparations. This was not the case in Tuktoyaktuk, where the Hamlet refused to assist with advertisement or preparation. This, again, was due to direction from the IRC, which was involved with ongoing negotiations with DND. The meeting in Tuktoyaktuk was eventually canceled due to lack of participation. The other Western Arctic meetings were much more successful than those of the previous year. Residents from two communities chose to attend the meetings despite a request from the IRC to boycott. These meetings were relatively well attended and appeared to have re-opened the lines of communication.

Other community meetings were generally well attended. Overall, the residents were pleased that the meetings were held and were usually satisfied with the cleanup

plans. The exception to this was Broughton Island, where several local residents did not like the northern landfill concept and were skeptical about the realization of local benefits due to previous experiences with government projects.

The main issues of concern continue to be potential local benefits; with respect to employment as well as training opportunities, and environmental issues. The environmental questions were addressed through discussions during the meetings and most residents' fears were alleviated with the exception of Broughton Island again. DEW Line buildings were also of considerable interest to local residents. The residents of most communities were also generally interested in being kept informed on the status of the cleanup.

5. 1994 – 1998 Community Consultations

The topic of the meetings held during 1994 – 1998 were general project presentations, a review of the scientific investigations, engineered landfill, employment opportunities and site prioritization methodology. Table I-5 provides a summary of the public consultation program.

Table I-3: 1992 Community Consultations

Location	Date	Type of Meeting	Attendance
Iqaluit	4 August	Technical	4
Broughton Island	4 August	Public	50+
Clyde River	5 August	Public	55+
Igloolik	6 August	Public	35+
Hall Beach	6 August	Public	50+
Taloyoak	10 August	Public	35+
Pelly Bay	10 August	Public	-
Gjoa Haven	11 August	Public	35+
Coppermine	12 August	Public	60+
Cambridge Bay	13 August	Public	18+
Aklavik	17 August	Public	-
Inuvik	18 and 19 August	Technical	3
Inuvik	18 August	Public	27+
Paulatuk	19 August	Public	-
Tuktoyaktuk	19 August	Public	-
Yellowknife	20 August	Technical	23

Table I-4: 1993 Community Consultations

Location	Date	Type of Meeting	Attendance
Iqaluit	9 May	Media	2
Iqaluit	10 May	Technical	7
Broughton Island	10 May	Public	35+
Clyde River	11 May	Public	30+
Igloolik	12 May	Public	10
Hall Beach	13 May	Public	30+
Pelly Bay	17 May	Public	30+
Taloyoak	18 May	Public	-
Gjoa Haven	19 May	Public	30+
Cambridge Bay	20 May	Public	5
Paulatuk	8 June	Public	19
Coppermine	8 June	Public	60+
Aklavik	9 June	Public	20+
Tuktoyaktuk	9 June	Public	-
Inuvik	10 June	Technical	4
Inuvik	10 June	Public	7

Table I-5: 1994 - 1998 Community Consultations

Location	Date	Type of Meeting	Attendance
Broughton Island	August 10, 1998	Public	15
Broughton Island	1997	Public	not available
Clyde River	1997	Public	not available
Broughton Island	Jan. 29, 1996	Council	18
		Public	50+
Clyde River	Jan. 30, 1996	Public	30+
Cambridge Bay	July, 1994	Public	15
Nunavut Planning Comm.	Oct. 19, 1994	Public	25
Kitikmeot Inuit Assn. AGM	Nov. 9, 1994	Public	---
Site Prioritization Methodology	July, 1995	Technical	20
	May 6, 1998	Council/Public	70 +
Tuktoyaktuk	May 4,1998	Public	14

G. Tier II Disposal Facility

1. Background/Rationale

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 (estimated at 30,200 m^3 for known contaminated soil and an undetermined quantity of PAH and chlorinated hydrocarbon contaminated soils for the 15 sites in Nunavut). These soils would require removal in a manner which precludes their continued contact with (and thereby protecting) the Arctic ecosystem. The costs of disposing (including transport) of these soils was also determined to contribute significantly to the total cost of DEW Line Cleanup. A number of disposal options were considered by the DEW Line Cleanup Project team; of these, the most viable (both economically and logistically) was determined to be the development of engineered Tier II Disposal Facilities (TDF) at each site. In some cases Tier II soils may be transported from one DEW site to another depending on soil volumes and project economics. These facilities utilize a leachate containment system, consisting of permafrost and synthetic liners which limit leachate generation and prevent contaminant migration.

2. Environmental Considerations in TDF Design

The TDFs are designed to provide a contained facility for the disposal of Tier II contaminated soil. One of the major concerns with respect to the facilities is the possible leakage of contaminants from soils placed in the facility and the potential impact on the surrounding ecosystem and nearby communities.

The leachate containment system developed for each TDF is designed to prevent contents from leaking and migrating into the surrounding environment. The design has been based on the characterization of the contaminants in the soils and the geothermal properties of the permafrost. Permafrost will provide the primary containment barrier in

which the frozen substrate will advance (freezeback) and encapsulate the contents in the facility. Extensive geothermal analysis on the time required for freezeback, thermal regime in the ground surrounding the facilities and the depth of the active layer in the cover material, has been used to determine the thickness of the cover and the time required to provide adequate permafrost encapsulation. Synthetic liners provide secondary containment. A PVC (polyvinylchloride) liner will be placed at the base and sides of the facility; this liner is chemically compatible with the contaminated soils, and will prevent the potential movement of moisture during the period required for permafrost aggradation. The second liner, a low permeability geocomposite clay liner (GCL), is incorporated into the cover of the facility to maximize run-off. The GCL also serves to reduce infiltration of surface water if thermal contraction cracks develop in the frozen soil. The GLC liner provides the required flexibility for accommodating settlement or disturbance. The location of a TDF at any site would result in an increase in total amount of gravel required at this site for capping of the facility.

Careful consideration has also been given to the characterization of waste soils being placed in the TDFs. Contaminated soils which contain levels of contaminants in violation of the *Canadian Environmental Protection Act* (CEPA) are considered hazardous material and will not be placed in the TDFs; these are to be removed from the site to a licenced hazardous material disposal facility along with other hazardous wastes. Some of the soils may also contain petroleum hydrocarbons - often where lead and PCB contamination has occurred as a result of waste oil and/or fuel spills. These hydrocarbons should be contained within the soil matrix and should not exist as free liquids which could potentially leach. Leachate testing has also been conducted on most of the more highly contaminated soil samples as set forth in Ontario *Regulation 347*. None of these have leached levels of contaminants which correspond to the definitions for hazardous wastes.

Selection of the areas for TDF development at each site are also based on a number of technical factors including:

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

H. Cumulative Effects

For the purposes of the DEW Line Clean Up Project, cumulative effects have been defined as changes to the biophysical, social, cultural or economic environments caused by a project component in combination with any on-going, past or future activities. In undertaking environmental assessments, the project management office has included an evaluation of possible cumulative effects, including:

- Impacts over a larger (regional) area including the crossing of jurisdictional boundaries;
- Temporal boundaries beyond the time frame required to complete the clean up work;
- Interactions with Valued Ecosystem Components (both biophysical and socio-economic); and/or
- With other past, ongoing (i.e., operation of the North Warning System, mining activities, existing hamlet operations) or known future (i.e., construction related to the build up of the Nunavut government infrastructure) activities.

This evaluation also included an evaluation of levels of significance.

Cumulative effects arising from the DEW Line Clean Up Project can occur as interactions between project components (either from the same or more than one site) and/or between environmental components. Effects can occur in one of four ways:

- Physical or chemical transport mechanisms;
- "Nibbling loss" (i.e., gradual disturbance);

- Spatial or temporal crowding;

- Growth induction initiated by the project.

An analysis of cumulative environmental effects has been undertaken for this project. In doing so, four steps have been undertaken to date:

1. Scoping, including identifying issues of potential concern, VEC;s that could be affected and boundary setting;

2. Analysis of effects, including an evaluation of baseline data and possible effects on VEC's. Methods could include the use of overlays to identify where the geographic and temporal extent of various projects' effects may interact;

3. Identification of mitigation options and recommending measures to be undertaken; and

4. Evaluating significance of these effects, after mitigation actions have been applied.

Other activities that may affect the cleanup project include the following:

- Cleanup activities that may be taking place at the Intermediate DEW Line sites for which DIAND is responsible - these activities may occur at the same time as for the 14 DND DEW Line sites.

- The periodic maintenance visits to the short range radar stations.

- The continued operation of the long range radar stations.

- The periodic use of the sites by local hunters and trappers.

As a result of this analysis, it can be concluded that, for the most part, both the clean up of each site and the individual components will not lead to significantly adverse cumulative impacts. As a result of initial overlay studies, the clean up of each site can be considered as a short term, distinct individual event that will not have any form of additive effect with past, existing or known future activities. All of the activities listed above will affect the 15 site cleanup project to some extent. An Environmental Protection Plan (EPP) will be developed to ensure that each of the on-site activities will be carried out in a manner that will preclude further damage to the Arctic environment. All on-site activities will be monitored and carried out in accordance with the EPP and the overall effect of the cleanup will be a positive impact, i.e., the site will be restored as much as possible to a natural state.

I. Site Specific Summaries

At each of the 14 Nunavut sites, there is the possibility that some of the proposed cleanup activities have the potential to impact adversely on the environment - particularly heritage resources, Arctic habitat, flora, fauna, and human and ecosystem health. Nevertheless, with the integration of proper mitigation procedures that will be established in the Environmental Protection Plan (EPP) and the positive impacts such as the overall improvement in the physical condition and environmental health of the site, the restoration of ecosystem components lost during cleanup and previous site activities, as well as Northern economic benefits, will more than outweigh the potential negative effects in the long term.

1. Cape Young, PIN-2

Three landfills at the site - beach and two south (east and west) - are to be cleared of visible surface debris and regraded to match existing contours and drainage patterns. A new landfill will be developed by the station to accommodate non-hazardous visible and building demolition debris removed from the station proximity, existing landfills, three pallet storage areas and the beach. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Soils contaminated with PCBs and inorganic elements will be excavated from the station proximity and sewage outfall, in addition to an isolated stained location at the beach fuel tanks. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All buildings and facilities in the Station and Beach Areas will be removed and/or demolished. Specified locations of the site will also be recontoured to natural drainage patterns. A cleanup camp will be set up in the vicinity of the station area and subsequently demobilized or demolished at the end of the project. The total area affected by cleanup operations is approximately 26 hectares.

2. Lady Franklin Point, PIN-3

The existing landfill at the station, the Main Landfill, will be used for disposing of site debris, demolished structures and Tier I soils. In addition to the Main Landfill, two other landfills will be regraded. Contaminated soil will be excavated from several locations around the main station and from the sewage lagoon. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. A cleanup camp and equipment storage areas will be established and then demobilized or demolished when cleanup activities have been completed. The total area affected by cleanup activities is approximately 18 hectares.

3. Byron Bay, PIN-4

Six landfill areas have been identified at this site, one which requires leachate containment. One new landfill is to be developed in the station area to accommodate non-hazardous site and demolition debris as well as all Tier I soils. Surface debris is to be removed from all the landfill areas prior to being covered with granular fill material and regraded to match the natural contours of the surrounding terrain. Contaminated soils will be excavated from the station proximity, the sewage outfall, the airstrip area and the beaching area. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. All structures and facilities will be demolished. A contractor camp to accommodate personnel for these cleanup activities is to be set up in proximity to the former station; this camp will be demobilized or demolished when the project is completed. The total area affected by cleanup activities is approximately 82 hectares.

4. Cambridge Bay, CAM-M

Two existing landfills at the site - south shore and west - are to be cleared of visible surface debris (as required), and regraded according to natural contours and drainage patterns. The third, referred to as the Main Landfill (including north and south lobes), will require a leachate containment system to prevent further leakage from the facility. This facility will be used to accommodate additional non-hazardous surface and building demolition debris removed from the Station and South Shore Areas, and will be subsequently regraded, during closure, to redirect surface drainage from the area. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. Soils contaminated with PCBs and inorganic elements will be excavated from the station proximity and sewage outfall. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. All buildings and facilities in the Station and South Shore Areas which are not required for the operation of the LRR/LSS will be removed and/or demolished and specified locations of the site will also be recontoured to natural drainage patterns. A cleanup camp will be set up in the vicinity of the Station Area for the above purpose and subsequently demobilized at the end of the project, or the contractor may use community facilities as required. The total area affected by clean up operations is approximately 19 hectares.

5. Jenny Lind Island, CAM-1

Two landfills have been identified at this site. The main landfill, located 300 m east of the station, will be extended to accommodate non-hazardous site and demolition debris, as well as Tier I soils. Surface debris is to be removed from the other landfill. Both landfills will be covered with granular fill and regraded to match the surrounding terrain. Contaminated soils (TCC-II) will be excavated from the station proximity and the sewage outfall area. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All hazardous materials (with the exception of asbestos and creosote-

treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. All structures will be demolished. A contractor camp to accommodate personnel for the cleanup activities will be established near the former station; this camp will be dismantled when the project has been completed. The total area affected by cleanup activities is approximately 45 hectares.

6. Gladman Point, CAM-2

Three existing landfills at the site - airstrip and two west (north and south portions) - are to be cleared of visible surface debris and subsequently covered and reshaped according to natural contours and drainage patterns. A new landfill will be developed at the station to accommodate non-hazardous visible and building demolition debris removed from the station proximity, existing landfills, three pallet storage areas and the beach. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Soils contaminated with PCBs and inorganic elements will be excavated from the station proximity, and isolated stained locations at the airstrip hangar and beach fuel tanks; Tier I soils will be disposed of in the engineered landfill on-site; Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All buildings and facilities in the Station, Airstrip and Beach Areas will be removed and/or demolished. Specified locations of the site will also be recontoured to natural drainage patterns. A cleanup camp will be set up in the vicinity of the station area for the above purposes and subsequently demobilized or demolished at the end of the project. The total area affected by cleanup activities is approximately 13 hectares.

7. Shepherd Bay, CAM-3

Cleanup at this site will involve the demolition of several structures; the excavation of the sewage outfall, which is contaminated with PCBs and inorganic elements in excess of Tier II; the closure of four existing landfills in the station area

(these are stable and require proper burial only); and the excavation of other contaminated soil, either for placement in an extension of the Northeast Landfill (Tier I) or in a new Tier II Disposal Facility constructed on-site. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. A cleanup camp will be established in the Station Area and demobilized or demolished when the cleanup has been completed. The total area affected by cleanup activities is approximately 55 hectares.

8. Pelly Bay, CAM-4

Five landfills at the site - station, construction camp (abandoned), lower site, Barrow Lake and airstrip - are to be remediated. Remediation may include clearing of visible surface debris, partial or complete excavation and installation of a leachage containment system. The areas will be reshaped according to natural contours and drainage patterns. A new landfill will be developed near the station will be developed to accommodate non-hazardous visible and building demolition debris removed from the station, existing landfills, lower site, three pallet storage areas, lake near the construction camp, and the airstrip. Underwater debris will also be removed from the bottom of Barrow Lake along the west shore. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal.

Soils contaminated with PCBs and/or inorganic elements will be excavated from locations in the station proximity, sewage outfall, existing station landfill, lower site landfill and airstrip. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All buildings and facilities in the Station and Airstrip Areas will be removed and/or demolished. Specified locations of the site will also be recontoured to natural drainage patterns. A landfill for the disposal of materials painted with PCB amended paint has been proposed for this site, pending a decision from Environment Canada.

A cleanup camp will be set up just northwest of the station area for the above purposes and subsequently demobilized at the end of the project. The total area affected by cleanup operations is approximately 12 hectares.

9. Mackar Inlet, CAM-5

A new landfill will be developed to accommodate Tier I soils, demolition debris and general site debris. The existing station landfill requires leachate containment. There are three landfills to be closed at the lower site, one of which requires erosion control. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Soils contaminated with PCBs and inorganic elements will be excavated, primarily from areas within the station proximity, the sewage outfall and the Upper Site Landfill. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. A cleanup camp will be established in the station proximity and demobilized or demolished when the cleanup is complete. The total area affected by cleanup activities is approximately 39 hectares.

10. Hall Beach, FOX-M

Two landfills have been identified at this site. Surface debris is to be removed from these landfill locations prior to being covered with granular fill material and regraded to the natural contours of the surrounding terrain. The West Beach Landfill is proposed for the engineered landfill to accommodate non-hazardous site and demolition debris as well as all Tier I soils. Contaminated soils will be excavated from the station proximity, the sewage outfall and the beaching area. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. All structures that are not associated with the LRR/LSS facilities will be demolished. A contractor camp to accommodate personnel for

these cleanup activities is to be set up in proximity to the former station; this camp will be demobilized when the project is completed. The total area affected by cleanup activities is approximately 19 hectares.

11. Longstaff Bluff, FOX-2

Three landfills at the site - beach, west beach and airstrip - are to be cleared of visible surface debris (if present) and subsequently covered and reshaped according to natural contours and drainage patterns. The fourth existing landfill near the station (upper site) will also be cleared of visible surface debris and a leachate containment system will be put in place to prevent further leakage from this facility; portions will be regraded to redirect surface drainage. Two new engineered landfills - one in the station proximity and the other by the airstrip hangar - will be developed to accommodate non-hazardous visible and demolition debris removed from the upper (Station Landfill) and lower (Hangar Landfill) areas of the site. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Soils contaminated with PCBs and inorganic elements will be excavated from locations in the Station Area and sewage outfall, Beach Area, Upper Site Landfill drainage, (West) Beach Area, and old storage area northeast of the station. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. All buildings and facilities at the Station, Airstrip and Beach Areas will be removed and/or demolished. Specified locations of the site will also be recontoured to natural drainage patterns. A cleanup camp will be set up in the vicinity of the Station Area for the above purpose and subsequently demobilized or demolished at the end of the project. The total area affected by cleanup operations is approximately 15 hectares.

12. Dewar Lakes, FOX-3

Four landfill areas requiring closure have been identified at this site; three areas in the station proximity and one area adjacent to the airstrip. The Main Landfill, which requires leachate containment, will be used to accommodate site and demolition debris, as well as Tier I soils. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Contaminated soils will be excavated from the station proximity, sewage outfall and isolated areas near the airstrip. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. A contractor camp to accommodate personnel for these cleanup activities is to be established in the station proximity; this camp will be demobilized or demolished when the project is completed. The total area affected by cleanup activities is approximately 12 hectares.

13. Broughton Island, FOX-5

A new landfill will be developed for the disposal of site debris, demolished buildings and Tier I contaminated soil. A landfill for the disposal of materials painted with PCB amended paint has been proposed for the station area. In addition, two landfills must be properly closed and regraded, one requiring leachate containment. Cleanup and restoration activities are confined primarily to the Main Station Area, the Airstrip Area and locally disturbed areas which were used historically for waste disposal and borrow extraction. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. A cleanup camp and equipment storage area will be established and then demobilized or demolished once cleanup activities have been completed. The total area affected by cleanup activities is approximately 12 hectares.

14. Cape Dyer, DYE-M

Two landfills will be developed at DYE-M at the lower camp, for the disposal of non-hazardous demolition and site debris, and Tier I contaminated soil. One landfill at the lower site will also receive non-hazardous waste materials from landfill excavations. The Pallet Line Landfill at the upper site will be extended to accommodate non-hazardous site and demolition debris, as well as Tier I soil, from the upper camp.Two landfills require leachate containment. All hazardous materials (with the exception of asbestos and creosote-treated wood) will be shipped off-site to a licensed hazardous material facility for disposal. Contaminated soils will be excavated - Tier I soils to the engineered landfill on-site, Tier II soils will be contained in a new Tier II Disposal Facility constructed on-site. A contractor camp to accommodate personnel for these cleanup activities is to be established in the station proximity; this camp will be demobilized or demolished when the project is completed. The total area affected by cleanup activities is approximately 36 hectares.

Table I-6: Summary of Cleanup Activities at 14 DEW Line Sites in the Nunavut Settlement Region

Activity	PIN-2	PIN-3	PIN-4	CAM-M	CAM-1	CAM-2	CAM-3
Landfill Closure/Remediation							
Regrading/Reshaping	3	3	9	2	1	3	4
Leachate Containment	-	-	1	2	-	-	-
Excavation	-	-	-	-	-	-	-
Landfill Development							
New Landfill Development	1	-	1	-	-	1	-
Existing Landfill Extension	-	1	-	1	1	-	1
New Tier II Disposal Facility	1	1	1	1	1	1	1
Contaminated Soil Excavation							
Tier I (m^3)	140	110	110	350	1450	310	710
Tier II(m^3)	120	2200	50	14010	1780	1450	2180
CEPA Soils [3]	✓	✓	✓	✓	✓	✓	✓
Demolition							
All DEW Line Facilities (m^3)[1]	3800	-	4400	-	3200	4400	-
Partial Demolition (m^3)[1] (LRR Sites)	-	1430	-	2900	-	-	2400
Borrow Excavation Volume (m^3)[1]	18,700	55,000	36,700	191,100	13,700	29,900	86,700
Debris Volume (m^3)[1]	25	600	2	50	5	29	170
HazMat[2] Shipment Off-Site	✓	✓	✓	✓	✓	✓	✓
Contractor Camp Development	✓	✓	✓	✓	✓	✓	✓
Area Affected by Cleanup Activities (ha)[1]	26	18	82	19	45	13	55

1. Values are approximate; 2. Hazardous Materials; 3. These are soils which exceed the Chlorobiphenyl Regulations (i.e., 50 ppm)

Table I-6: Summary of Cleanup Activities at 14 DEW Line Sites in the Nunavut Settlement Region (Cont.)

Activity	CAM-4	CAM-5	FOX-M	FOX-2	FOX-3	FOX-5	DYE-M
Landfill Closure/Remediation							
Regrading/Reshaping	5	2	3	2	3	-	7
Leachate Containment	-	1	-	1	1	1	2
Excavation	-	-	-	-	-	-	2
Landfill Development							
New Landfill Development	2 (1 proposed)	1	1	2	-	2 (1 proposed)	2
Existing Landfill Extension	-	-	-	-	1	-	-
New Tier II Disposal Facility	1	1	1	1	1	1	1
Contaminated Soil Excavation							
Hydrocarbon Type A	-					235	
Hydrocarbon Type B	6000					1800	
Tier I (m^3)	1920	530	730	640	600	190	800
Tier II(m^3)	3700	430	5870	410	720	50	440
Tier I/Type A	480					1900	
Tier I/Type B	55					-	
Tier II/Type A	500					205	
Tier II/Type B	270					800	
CEPA Soils [3]	140	✓	✓	✓	✓	✓	✓
Demolition							
All DEW Line Facilities (m^3)[1]	3400	4100	-	4000	-	5100	-
Partial Demolition (m^3)[1] (LRR Sites)	-	-	7300	-	1400	-	17950
Borrow Excavation Volume (m^3)[1]	225,000	60,300	74,000	43,200	34,000	170,000	220,000
Debris Volume (m^3)[1]	680	80	1890	387	870	200	14,600
HazMat[2] Shipment Off-Site	✓	✓	✓	✓	✓	✓	✓
Contractor Camp Development	✓	✓	✓	✓	✓	✓	✓
Area Affected by Cleanup Activities (ha)[1]	12	39	19	15	12	12	36

1. Values are approximate; 2. Hazardous Materials; 3. These are soils which exceed the Chlorobiphenyl Regulations (i.e., 50 ppm)

J. Project Summary

The purpose of the proposed cleanup activities is to improve existing environmental conditions at the 14 DEW Line sites located within the NSA by restoring those areas that have been adversely affected from activities and facilities associated with the past operation of the stations. The proposed cleanup activities are anticipated to have an overall positive effect on the biophysical environment, as well as improving the general appearance of the site. Northern residents stand to benefit from opportunities provided by the cleanup project. The use of local services and the hiring of Northern residents, as well as the opportunities for education and retraining are anticipated to have a beneficial effect on the socio-economic environment. It is recognized, however, that the activities involved in the actual cleanup may, if not properly mitigated, have potential adverse environmental effects primarily related to the sensitivity of the Arctic environment to disturbance from cleanup activity.

Potential risks to soils, surface water, terrestrial and aquatic habitat and species, as well as human safety from accidental events such as fuel and hazardous materials spills can be mitigated or eliminated by the development of control procedures, contingency plans and proper response procedures. The risk of creating hazards to human health and safety are minimized by implementing correct procedures for the handling of hazardous materials encountered during cleanup. Hazardous materials will be removed from site and transported in accordance with the requirements of the *Transportation of Dangerous Goods Act*.

Disturbance to terrestrial, aquatic and marine wildlife species can be avoided through the implementation of Contractor education programs, engineering controls and the scheduling of activities to avoid ecologically sensitive areas and times (for example nesting or calving areas). Terrestrial habitat and vegetation are very sensitive components of the Arctic ecosystem. Damage to habitat is to be avoided or minimized by confining cleanup operations to areas that have been previously disturbed. Some sites are

considered to have high archaeological potential, based on the number and variety of known historic and prehistoric features. Archaeological monitoring measures are expected to prevent disturbance to heritage features in the area.

An Environmental Protection Plan (EPP) will be developed to facilitate the implementation of specific mitigative measures. The EPP will form part of the contract documents for the cleanup of the 14 sites.

K. Sources of Information

DND. 1991. Interim DND Environmental Assessment manual. A-LM-007-009/AX-000. OPI:DEP. Department of National Defence. October 1991.

Duffy, P.J. B. (ed.). 1986. Initial Assessment Guide, Federal Environmental Assessment and Review Process. Federal Environmental Assessment Review Office. Ottawa. April 1986.

Environmental Sciences Group. 1991. North Warning System Environmental Study. Prepared at Royal Roads Military College, Victoria, B.C. June 1991.

Environmental Sciences Group. 1993. The Environmental Impact of the DEW Line on the Canadian Arctic. Prepared at Royal Roads Military College, Victoria, B.C. February 1993.

Environmental Sciences Group. 1993. Environmental Study of Eleven DEW Line Sites. Prepared at Royal Roads Military College, Victoria, B.C. June 1993.

Environmental Sciences Group. Unpublished. DEW Line Cleanup Design Summary Report. Prepared at Royal Roads Military College, Victoria, B.C. 1994.

Fedirchuk, McCullough & Associates (FMA) Ltd. 1991. Environmental Clean-Up Study - 21 DEW Line Sites in Canada: Heritage Resources Study. DRAFT prepared for UMA Engineering in association with Hardy BBT Limited and Jacques Whitford Group. January 1991.

INAC. no date. The Western Arctic Claim, the Inuvialuit Final Agreement. Indian and Northern Affairs Canada. Ottawa.

UMA. 1991. Environmental Study of 21 DEW Line Sites in Canada. 24 Volumes. Prepared by UMA Engineering Ltd., in association with Hardy BBT Limited and Jacques Whitford Group. June 1991.

UMA. 1994. Design and Cost Estimating of the Clean Up of 21 DEW Line Sites: 90% Design Submission. Vol. No. 1 - Western Sites (BAR-1 to CAM-2). Prepared by UMA Engineering Ltd., in association with Sheppard Green Engineering & Associates Ltd. and Jacques Whitford Environment Limited. February 1994.

UMA. 1994. Design and Cost Estimating of the Clean Up of 21 DEW Line Sites: 90% Design Submission. Vol. No. 2 - Eastern Sites (CAM-3 to DYE-M). Prepared by UMA Engineering Ltd., in association with Sheppard Green Engineering & Associates Ltd. and Jacques Whitford Environment Limited. February 1994.

EWG. 1997. DEW Line Clean Up – Second Report. Prepared by the Environmental Working Group. December 1997.