An Environmental Assessment of Radio Island, NWT

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EXECUTIVE SUMMARY

An environmental assessment of Radio Island was conducted by the Environmental Sciences Group from the Royal Military College (RMC), Kingston Ontario in August 1996. The site assessment was at the request of Indian and Northern Affairs Canada (DIAND) under the Action on Waste (AOW) component of the Arctic Environmental Strategy (AES). The purpose of the assessment was three-fold: to determine whether there was any chemical contamination on the island, to determine whether any contamination found was having an impact on the environment, and to identify cleanup requirements for the site.

Radio Island, located off the southern extremity of Resolution Island at the southeastern tip of Baffin Island (see Map I-1), was operated as a navigational aid and weather station from 1929 to 1961. The island is about 1 km long, north by south, and 0.5 km wide. It is situated on Canadian shield bedrock and consists of parallel rock ridges with soil restricted to isolated pockets in the gullies. There are no roads or airstrip. There is a beaching area on the north side of the island (Acadia Cove) in a natural bay. At the time of the ESG visit, there were two buildings left from the original site, and the remains of four others, as well as a light beacon tower located to the southwest of the main site. There was a fair amount of debris, which had been scattered over the island, presumably by winds over the past thirty-five years, and had accumulated in the gullies.

A total of 82 soil, 12 plant, 8 water, 2 paint, and 2 miscellaneous samples were collected from various locations around the island. All samples were analyzed for inorganic elements, and half of the samples were analyzed for PCBs. The results were compared to the DEW Line Cleanup Criteria (DCC), as well as to results for the background samples and the Canadian Council of Ministers of the Environment (CCME) Assessment Criteria. No samples contained PCBs in excess of the DCC. However, 46 samples contained inorganic elements in excess of the DCC. In addition, a few samples were analyzed for PAHs, pesticides, chlorinated hydrocarbons, TPH, asbestos and leachable inorganics. One sample contained PAHs at concentrations in excess of the Criteria for Managing Contaminated Sites in British Columbia. Three samples exceeded both the Ontario Leachate Criteria and the British Columbia Leachate Criteria for lead.

In conclusion, there is extensive inorganic contamination at Radio Island, which should be remediated according to the DEW Line Cleanup Protocol (the general approach used for the cleanup of contaminated northern sites). Non-hazardous debris should be

placed in a properly engineered landfill, and soil containing contaminants in excess of DCC Tier II (estimated volume 310 m^3) should be removed from contact with the ecosystem. Hazardous debris and leachate toxic soil (estimated volume 20 m^3) should be disposed of according to appropriate regulations.

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A. Location and History of Radio Island

Radio Island is located on the southern tip of Resolution Island (see Map I-1), off the south eastern tip of Baffin Island. Its location is 61°18'N and 64°52'W, as determined by a Trimble Ensign GPS (Global Positioning System). The island is approximately 1.0 km long and 0.5 km wide. Approaches are by sea at Acadia Cove and air only by helicopter. The site is relatively small and consists of two intact structures, the remains of four other structures and a light beacon tower. Map I-2 shows the general site layout. Photograph I-1 shows the Main Site and Photograph I-2 shows the light beacon tower situated on the southwest end of the island.

The station, originally known as Resolution Island even though it was on Radio Island, was set up in 1929 by the Canadian Department of Transport. It operated year round as a navigational aid and weather station until October 1961 when the personnel were evacuated to Frobisher Bay. The station was moved to Cape Warwick on the northeast corner of Resolution Island in March 1962 and finally closed in 1975 (K. O'Rielly, pers. comm.).

B. General Site Characteristics

The site is situated on Canadian Shield bedrock. The surrounding terrain consists of tilted bedrock with parallel rock ridges, knolls and shallow gullies forming a series of ledges. Soil is restricted to isolated pockets in these gullies and valleys and is virtually nonexistent in other areas. A few minor till deposits occur on the site.

The climate is classified as sub-Arctic and there is considerable moisture in the form of rain, fog, ice and snow. Vegetation at Radio Island is limited to the valleys and other low-lying areas where there is sufficient soil for growth. However, moss covers most of the low-lying areas.

Resolution Island (and hence Radio Island) has been reported in previous studies to be a denning area for polar bears, and these animals have been known to frequent the site (1 CEU 1990). During the site visit, at least 19 polar bears were spotted in the vicinity, and two were seen on Radio Island. The island is also along the migration routes of whales; other marine mammals including whales, seals and walruses are attracted to this area by the numerous species of fish living in nearby waters (ESG 1994).

C. Assessment Objectives

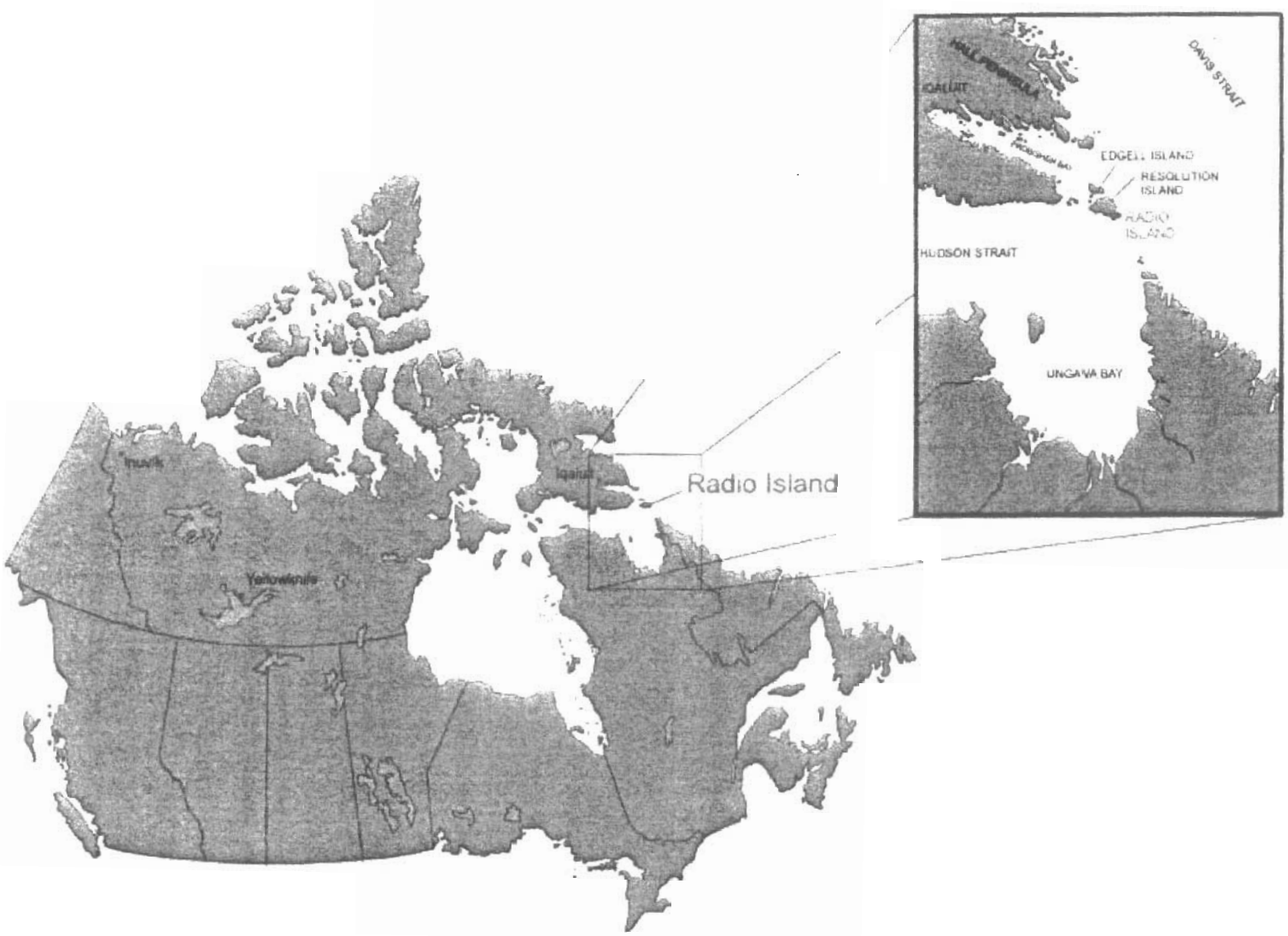
The Environmental Sciences Group (ESG) at Royal Military College in Kingston was asked by Indian and Northern Affairs Canada (DIAND) to conduct an environmental assessment of the site. The objectives of the assessment were to determine whether there was any chemical contamination on the island resulting from past human activities, to determine whether any contamination was having an impact on the ecosystem and to identify any cleanup requirements.

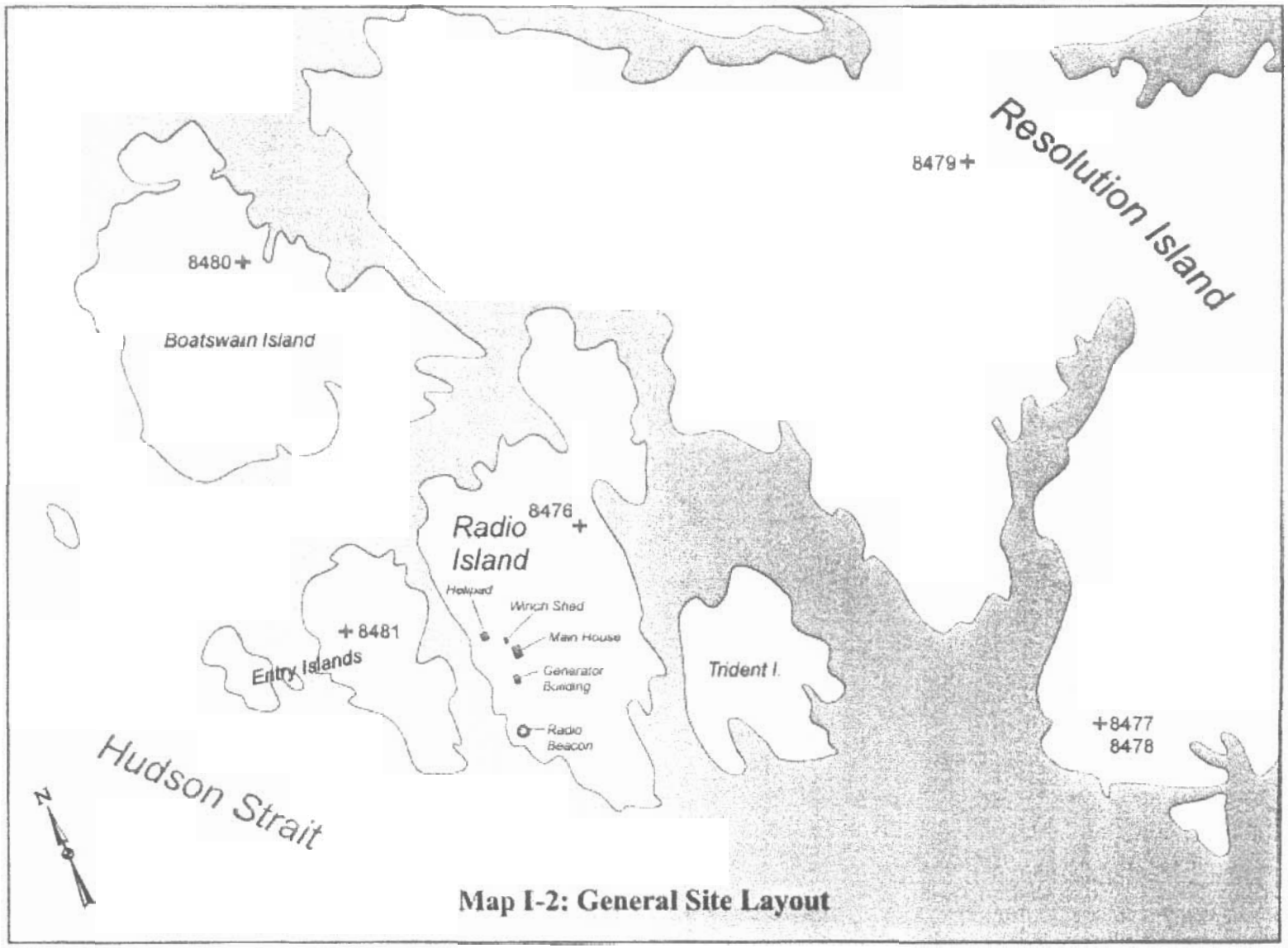
The first objective was accomplished by collecting soil and water samples from various locations around the island. The choice of sampling locations was dictated by the past use of the site. Samples were collected around buildings or building remains, dump areas, drainage pathways. As well, locations were chosen based on previous experience with patterns of chemical contamination found at former military sites. The objective was to identify all areas of concern. The samples were analyzed subsequent to the field program for inorganic and organic contaminants.

The second objective of the assessment was to determine the impact of any contamination on the ecosystem. It can be difficult to determine at what level a given substance will have a deleterious impact on the ecosystem. In this study, two methods were employed to help make this decision. First, the analytical results for soil and water samples were compared to the established criteria, as discussed in Chapter II. The second approach to determining the impact on the ecosystem is to examine the plants. Since plants are at the base of the foodchain they can be very good indicators of uptake of contaminants into the foodchain. Plant samples were collected at the same locations as some of the soil samples and analyzed for the same contaminants.

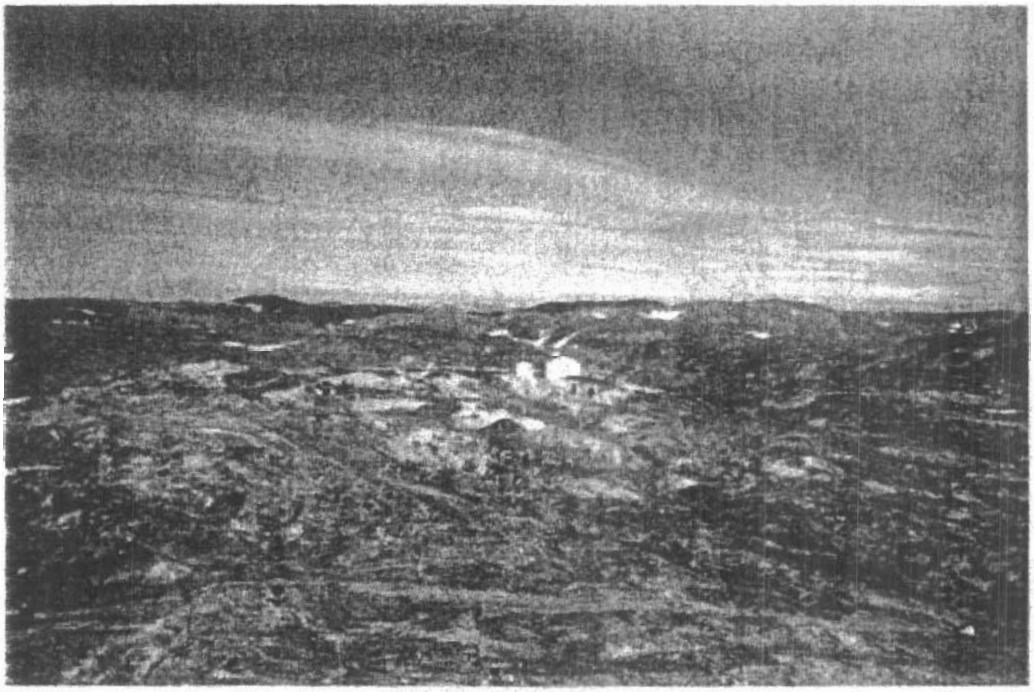
The third objective of the assessment was to identify any cleanup requirements. This was accomplished by the information obtained in the first two objectives. The analysis of soil, water and plant samples and the assessment of the impact of these contaminants have been interpreted based on a protocol developed for the Arctic, and a realistic cleanup strategy that will result in the protection of the environment has been developed for the Radio Island site.

Map I-1: Location of Radio Island

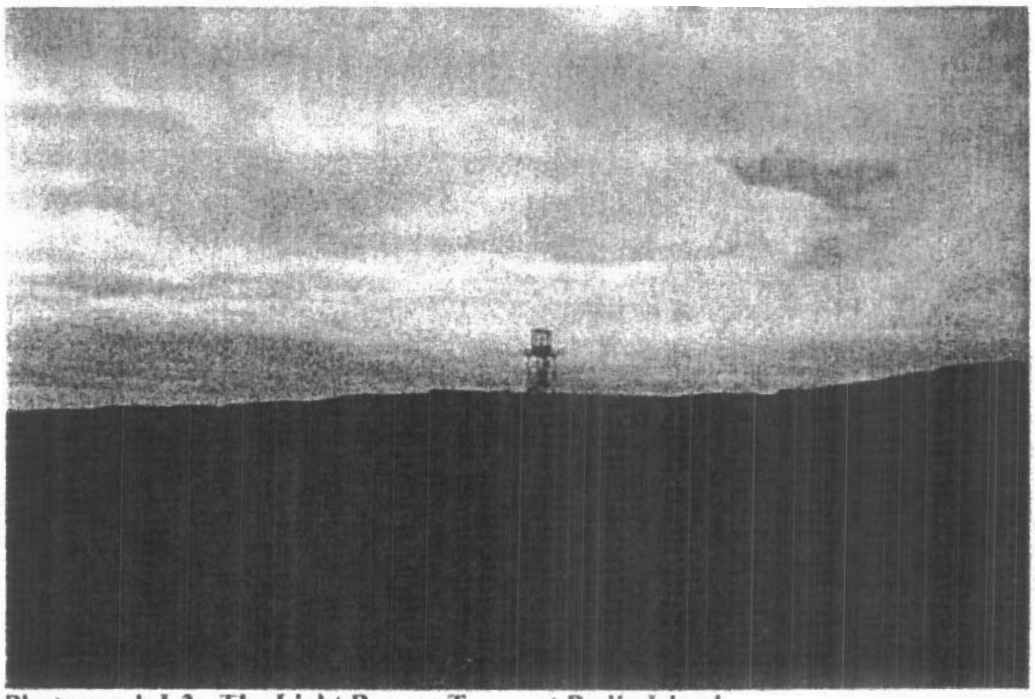




Map I-2: General Site Layout



Photograph I-1: The Main Site at Radio Island as seen from the south. The Generator Building Foundation is seen in the foreground.



Photograph I-2: The Light Beacon Tower at Radio Island.

II. Background Information and Cleanup Criteria

A. Related Environmental Studies Conducted by the ESG

The Distant Early Warning (DEW) Line was a series of United States military installations built across the Arctic, mostly in Canada, at the height of the Cold War to provide surveillance. With the end of the Cold War and advances in technology, the sites have been closed over a period of years, and control transferred to the Canadian government.

In 1989, the Department of National Defence sponsored a series of scientific studies to assess the environmental impact of the military installations in northern Canada. This work, conducted at representative DEW Line sites over a two year period by the Environmental Sciences Group (ESG) of Royal Military College[1] provided the foundation for new environmental standards designed to protect the uniquely fragile Arctic ecosystem. A protocol for assessing and remediating Arctic sites to meet these standards was proposed. The results were reviewed by representatives from Indian and Northern Affairs, Environment Canada, Government of the Northwest Territories, and the Department of Fisheries and Oceans, and in October 1991 the DEW Line Cleanup Protocol was adopted (See Annex II-A and C for further details). Sites at Horton River, Pearce Point, and Iqaluit have been cleaned up using plans developed from the DEW line Cleanup Protocol (ESG/ASU 1994, ESG 1996, ASU 1996b, ASU 1997). Elements of the protocol, which addresses visible debris, landfills and contaminated soil, have been used for the Radio Island site assessment.

B. Cleanup Criteria and Methods

While it is generally acknowledged that the potential threats posed by contaminants at a given site must be reduced to an acceptable level, defining "acceptable" is not a simple task. Two approaches are used to evaluate environmental quality - absolute and relative.

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[1] ESG relocated from Royal Roads Military College, Victoria, B.C. to Royal Military College, Kingston, Ontario in 1995.

1. 'Absolute' Cleanup Criteria

An "absolute", or criteria-based, method defines numerical values or limits that can be compared with measured environmental levels. It establishes baseline concentrations for various substances below which the impact on the environment is assumed to be minimal. Environmental samples containing concentrations above this limit may indicate the need for further investigation and/or remediation of the sampling area, depending on the extent to which the level is exceeded. This approach has certain advantages such as the relative ease with which it can be used and administered, a common base for communication between interested parties, and reduction in confusion. It suffers, however, from the assumption that the concentration limits apply equally in all circumstances.

a) CCME Criteria

The Canadian Council of Ministers of the Environment (CCME) Interim Canadian Environmental Quality Criteria include Assessment Criteria and Remediation Criteria. Assessment criteria are either approximate background concentrations or approximate analytical detection limits which provide a starting point for examining data. In the current study, efforts were made to obtain samples from locations that were removed from any direct influence of the previous station activities and were representative of the site geomorphology. Data from these background samples were compared to the CCME Assessment Criteria (Table II-1). Results obtained from other soil samples at the sites were, in turn, interpreted in the context of the background levels.

CCME Remediation Criteria are applied as guidelines for cleaning up contaminated sites, depending on whether the land use is agricultural, residential/parkland, or commercial/industrial. Soil samples from potentially contaminated areas of Island could be compared to these criteria, but in this case a more conservative set of criteria were used, as discussed below.

Water samples were collected in order to determine whether there has been any migration of contaminants. Data from these samples were compared to the CCME Assessment Criteria for water (Table II-1).

Some soil samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) and pesticides. Results for these samples were compared to various sets of criteria, including CCME and Canadian provincial as well as international criteria. These criteria are assembled in Tables II-2 and II-3 at the end of this section.

b) DEW Line Cleanup Criteria

The Arctic and the sub-Arctic have many characteristics which distinguish them from more forgiving southern environments. The presence of permafrost and the restrictions of light and temperature contribute to limited biodiversity and a generally fragile ecology. Consequently, the approach to solving environmental problems in the South is not necessarily applicable in the North. In order to take appropriate remediation measures at any northern site, a set of environmental objectives is required that is cognizant of the unique nature of the environment of the North. The ESG has developed such a set of criteria, the DEW Line Cleanup Criteria, presented in Table II-4; the development of these criteria is outlined in Annex A of this chapter. For these reasons, the DEW Line Cleanup Criteria have been used instead of the CCME Remediation Criteria in order to provide lower concentration triggers for cleanup.

2. 'Relative' Cleanup Criteria

In developing relative cleanup criteria, the focus is on the potential for the movement of contaminants from the substrate in which they contained, to humans or other parts of the environment. It is therefore necessary to examine the pathways for this movement in a *site-specific* context, and to assess the impact that this will produce. This was accomplished at Radio Island through the use of plant samples collected from areas where soil samples were taken. The contaminant concentrations in these plants were compared to contaminant concentrations in plants from background areas. This provided a means of measuring the risk that these contaminants pose to the ecosystem, which is a critical part of the environmental assessment. For more discussion of the use of plants as environmental indicators, refer to Annex B.

3. Cleanup Measures

The most comprehensive model for the cleanup of a northern environment is that provided by the Distant Early Warning (DEW) Line Cleanup Project. The cleanup recommendations proposed for Radio Island are therefore based on the objectives outlined in the DEW Line Cleanup Protocol, which addresses three main categories of waste: contaminated soil, visible debris, and landfills. It should be stressed that the general protocol is designed to prevent the migration of contaminants from sources (either in landfills, sewage outfalls and lagoons, and stained areas) to other parts of the ecosystem (vegetation, watercourses and the ocean). In each case where contaminant migration is

detected, at any concentration, specific measures are designed to deal with it. Details of the Protocol can be found in Annex C.

Table II-1: Some CCME Interim Criteria for Soil and Water[a]

	Assessment Criteria		Remediation Criteria	
	Soil	Water	Soil	
	µg/g or ppm dry weight	µg/L or ppb	µg/g or ppm dry weight	
			Residential/ Parkland	Commercial/ Industrial
Inorganic Elements				
Arsenic (As)	5	5	30	50
Cadmium (Cd)	0.5	1	5	20
Chromium (Cr)	20	15	250	800
Cobalt (Co)	10	10	50	300
Copper (Cu)	30	25	100	500
Lead (Pb)	25	10	500	1000
Mercury (Hg)	0.1	0.1	2.0	10
Nickel (Ni)	20	10	100	500
Zinc (Zn)	60	50	500	1500
Polychlorinated Biphenyls	0.1	0.1	5	50
Chlorinated Hydrocarbons				
Chlorinated aliphatics[b] (each)	0.1	0.1	5	50

a. This is only a partial list; a complete list may be found in Canadian Council of Ministers of the Environment (CCME) "Interim Canadian Environmental Quality Criteria for Contaminated Sites" Report CCME EPC-CS34, September 1991.

b. Aliphatic chlorinated hydrocarbons include:
chloroform
dichloroethane (1,1- 1,2-), dichloroethene (1,1- 1,2-),
dichloromethane
1,2-dichloropropane, 1,2-dichloropropene (cis and trans)
1,1,2,2-tetrachloroethane, tetrachloroethene
carbon tetrachloride
trichloroethane (1,1,1- 1,1,2-), trichloroethene

Table II-2: Criteria for Polycyclic Aromatic Hydrocarbons (PAHs) in Soils

Substance	Assessment Criteria	Remediation Criteria		
		Agricultural	Residential/ Parkland	Commercial/ Industrial
	ng/g or ppb dry weight			
Naphthalene	100[a]	100	5000	50000
Acenaphthylene	*100*[b]	*10000*	*10000*	*100000*
Acenaphthene	*100*	*10000*	*10000*	*100000*
Fluorene	*100*	*10000*	*10000*	*100000*
Phenanthrene	100	100	5000	50000
Anthracene	*100*	*10000*	*10000*	*100000*
Fluoranthene	*100*	*10000*	*10000*	*100000*
Pyrene	100	100	10000	100000
Benz(a)anthracene	100	*1000*	*1000*	*10000*
Chrysene	*100*	*1000*	*1000*	*10000*
Benzofluoranthenes	*100*	*1000*	*1000*	*10000*
Benzo(a)pyrene	100	100	1000	10000
Dibenz(a,h)anthracene	100	100	1000	10000
Indeno(1,2,3-c,d)pyrene	100	100	1000	10000
Benzo(ghi)perylene	--	--	--	--

a. Non-italicized figures are the CCME Interim Remediation Criteria for Soil.

b. Figures in italics are equivalent values from "Criteria for Managing Contaminated Sites in British Columbia" (BC Ministry of Environment, Land and Parks).

Table II-3: List of Criteria for Pesticides in Soils

Criteria	Total Pesticides[a] (ng/g or ppb)		
	Level A	Level B	Level C
Clean-Up Criteria for British Columbia[b]	100	2000	20000
Soil Guidelines Recommended by MENVIQ[c]	100	2000	30000
Soil Guidelines Recommended by the Netherlands[d]	-	3000	30000

Notes

a. Pesticides analyzed include:

Hexachlorobenzene	o,p'-DDE	Mirex
alpha BHC	p,p'-DDE	Heptachlor Epoxide
beta BHC	trans-Nonachlor	alpha-Endosulphan
gamma BHC	cis-Nonachlor	Aldrin
Heptachlor	o,p'-DDD	Dieldrin
Oxychlordane	p,p'-DDD	Endrin
trans-Chlordane	p,p'-DDT	Methoxychlor
cis-Chlordane		

b. From "Criteria for Managing Contaminated Sites in British Columbia, Ministry of Environment, waste Management Program, November 1989". Level A represents background levels or achievable detection limits; Level B is the remediation criteria for residential, recreational and agricultural land use; and Level C represents significant soil contamination and is the remediation criterion for commercial or industrial land use.

c. Ministère de l'Environnement du Québec (MENVIQ), 1988. " Contaminated Sites Rehabilitation Policy" . Prepared by the Direction des Substances Dangereuses. Level A indicates background concentrations or analytical detection limits; concentrations between A and B are slightly contaminated; Site investigation is needed if concentrations exceed Level B; Concentrations between B and C are considered to be "contaminated; Concentration above C indicate serious contamination.

d. From "Review and Recommendations for Canadian Interim Environmental Quality Criteria for Contaminated sites". The National Contaminated Sites Remediation Program. Scientific Series No.197. The A level marks the boundary between contaminated and uncontaminated soil; B level indicates the relative extent of contamination and potential seriousness of the risk that the contamination might pose; and C level represents concentration above which a soil was considered to be polluted to such an extent that all potential exposure routes present an intolerable risk to man or the environment.

Table II-4: DEW Line Cleanup Criteria

Substance	Units	DCC Tier I	DCC Tier II
Inorganic Elements			
Arsenic	ppm		30
Cadmium	ppm		5.0
Chromium	ppm		250
Cobalt	ppm		50
Copper	ppm		100
Lead	ppm	200	500
Mercury	ppm		2.0
Nickel	ppm		100
Zinc	ppm		500
Polychlorinated Biphenyls	ppm	1.0	5.0

Table II-5: List of Criteria for Leachable Compounds

Substance	Ontario Leachate Criteria[a]	British Columbia Leachate Criteria[a]
	mg/L or ppm	
Arsenic	5.0	5.0
Barium	100	100
Cadmium	0.5	0.5
Chromium	5.0	5.0
Lead	5.0	5.0
Mercury	0.1	0.1
Selenium	1.0	1.0
Silver	5.0	5.0
Boron	500	500
Cyanide	20	20
Fluoride	240	150
PCBs	0.3	-

a: Substrate with leachate values exceeding these criteria would be considered as hazardous or special waste in Ontario and British Columbia, respectively.