

APPENDIX C

**(SUMMARY OF OPERATIONS AND MAINTENANCE PROCEDURES FOR DRINKING
WATER, SEWAGE, SOLID WASTE DISPOSAL AND WASTE TREATMENT FACILITIES)**

— Eureka High Arctic Weather Station —

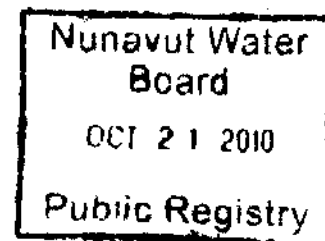
SUMMARY OF OPERATIONS AND MAINTENANCE PROCEDURES FOR DRINKING WATER, SEWAGE, SOLID WASTE DISPOSAL AND WASTE TREATMENT FACILITIES

— Eureka High Arctic Weather Station —

In support of the
Nunavut Water Board License
No. 3BC-EUR0611

Prepared by Environment Canada
Assets, Contracting and Environmental Management Directorate (ACEMD)

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Control Page

On receipt of revisions and/or amendments, the Assets, Contracting and Environmental Management Directorate (ACEMD) shall complete this control page to ensure that the Summary of Operations and Maintenance Procedures for Sewage, Solid Waste Disposal and Treatment Facilities at Eureka High Arctic Weather Station (HAWS) is always current and consistently reflects the operations and activities taking place on site.

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Acronyms and Symbols

ACEMD	Assets, Contracting and Environmental Management Directorate
BOD	Biochemical oxygen demand
CFC	Chlorofluorocarbon
DIAND	Department of Indian Affairs and Northern Development
HAWS	High Arctic Weather Station
L	Liter
m	Metre
m ³	Cubic metre
N	North
PCBs	Polychlorinated biphenyls
PEARL	Polar Environment Atmospheric Research Lab
pH	Measure of acidity or alkalinity
PWGSC	Public Works and Government Services Canada
UV	Ultraviolet
W	West

1. Introduction

This document has been produced to satisfy the requirement of the Nunavut Water Board for the terms of water license number 3BC-EUR0611, part G, section 1:

“1. The Licensee, shall, within sixty (60) days of the issuance of this License, submit to the Board for approval, an Operation and Maintenance Manual in accordance with the “Guidelines for Preparing an Operational and Maintenance Manual for Sewage and Solid Waste Disposal Facilities”, October 1996. The scope of the Plan shall be expanded to include the operation and maintenance of the Water Supply Facilities”.

The Eureka High Arctic Weather Station (HAWS) is located on the north side of Slidre Fjord, at the north-western tip of Fosheim Peninsula on Ellesmere Island at 80° 0' N and 85°56' W.

The Eureka HAWS is a weather monitoring facility. It is operated by Environment Canada, and has been in operation since 1947. The Eureka HAWS is a centre of activity for Environment Canada, the Department of National Defence, the Polar Continental Shelf Project, and the Polar Environment Atmospheric Research Lab (PEARL). Most of the work is carried out in the short Arctic summer – June, July and August. The number of people located on-site varies between 8 and 40 (this includes the members of the Department of National Defence).

2. Operational Practices for Drinking Water

At Eureka HAWS, drinking water is obtained from a fresh water lagoon located near Station Creek, which is a stream, located immediately to the west of the main Station that carries melt water from ice and snow in the Arctic spring (May and June). No inhabitants reside in the Station Creek watershed.

Some concern has been raised in the past with regards to the runoff from the abandoned dump site that is located at the west end of the runway. The runoff from this part of the airport runway does flow into the Station Creek drainage basin during the spring season. But the potential for any contaminants affecting the water quality of the Creek is very low.

The Creek flows for about three to four months in an average year. The water lagoon is filled by pumping water from the Creek, after the spring runoff has slowed down and the water is running clear of suspended solids. The volume of the water in the impoundment must be sufficient to supply the Eureka HAWS needs throughout the year. It is estimated that the impoundment holds approximately 12,000 m³ of water. Daily consumption of water for a location such as Eureka HAWS has been estimated to be 290 L per person per day (Smith and Nahir, 2000). The volumes of water used in 2005 to 2007 by the Eureka HAWS are shown in Table 1.

Table 1. Volume of water used by Eureka HAWS from 2005 to 2008.

Month	Volume (m ³)			
	2005	2006	2007	2008
January	104.9	22	131.9	126.9
February	109.9	136.5	106.3	178.0
March	187.5	102.1	222.6	271.4
April	63.7	73.6	209.2	236.3
May	220.6	196.6	273.8	410.7
June	266.9	191.3	325.6	499.7
July	309.6	102.4	319.3	423.3
August	234.3	84.4	167.7	163.3
September	234.9	77.8	153.9	221.1
October	69.4	106.7	n/a	183.1
November	71.5	106.4	n/a	103.9
December	78.1	107.9	n/a	159.9
Annual Total	1951.3	1307.7	1910.3	2977.6

n/a = not available

Periodic (yearly and monthly) analysis of water samples collected from the impoundment, holding tanks and from inside the Eureka HAWS indicate that the chlorination, filtration, ultraviolet (UV) and reverse-osmosis treatments of the raw water provides good quality water to the station.

Monthly drinking water sampling and analysis is carried out on-site to assess the acceptance of the treated water and to ensure no threat to the staff's health.

A schematic of the water distribution system is shown in Figure 1.

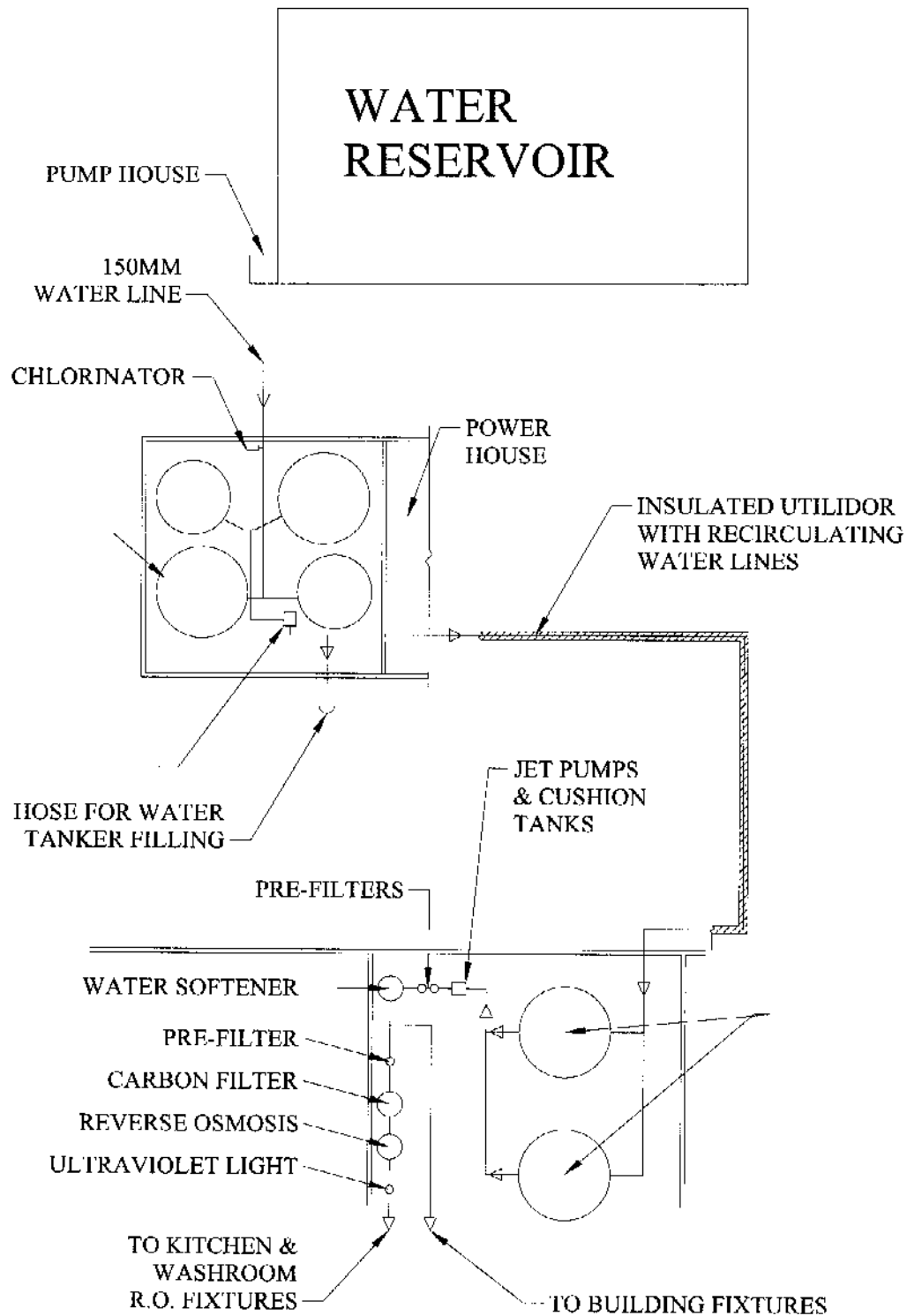


Figure 1. Water distribution system at Eureka HAWS.

3. Management of Wastewater

The following section describes the management of wastewater at Eureka HAWS.

3.1 General Description of the System

The wastewater and sewage lagoon at the Eureka HAWS is a single cell, engineered retention lagoon and is located to the south of the complex in the immediate vicinity of the Fjord (Figure 2). The volume of the lagoon was estimated as follows, by using the known dimensions and by integrating these in a formula by Smith and Nahir, 2000 (Table 2):

Table 2. Lagoon Dimensions at Eureka HAWS.

Length	
Length – South Side	100.6 m
Length – North Side	89.8 m
Average Length	95.2 m

Width	
Width – East Side	19.7 m
Width – West Side	24.9 m
Average Width	22.3 m

Depth	
Average Depth	2.0 m

Estimation of volume of the lagoon

$$\begin{aligned}\text{Volume} &= \text{Length} \times \text{Width} \times \text{Depth} \\ &= 95.2 \text{ m} \times 22.3 \text{ m} \times 1.05 \text{ m} \\ &= 2229 \text{ m}^3 \\ &= 2.23 \times 10^6 \text{ L}\end{aligned}$$

$$\begin{aligned}\text{Maximum Daily Flow Rate (to fill the lagoon)} &= \frac{\text{Volume}}{365 \text{ days}} \\ &= \frac{2.23 \times 10^6 \text{ L}}{365 \text{ days}} \\ &= 6109.6 \text{ L/day}\end{aligned}$$

It is estimated that a person will use 290 liters per day of water and therefore:

$$\begin{aligned}&= \frac{6109.6 \text{ L/day}}{290 \text{ L/day}} \\ &= \text{waste from 21 people will fill the lagoon}\end{aligned}$$

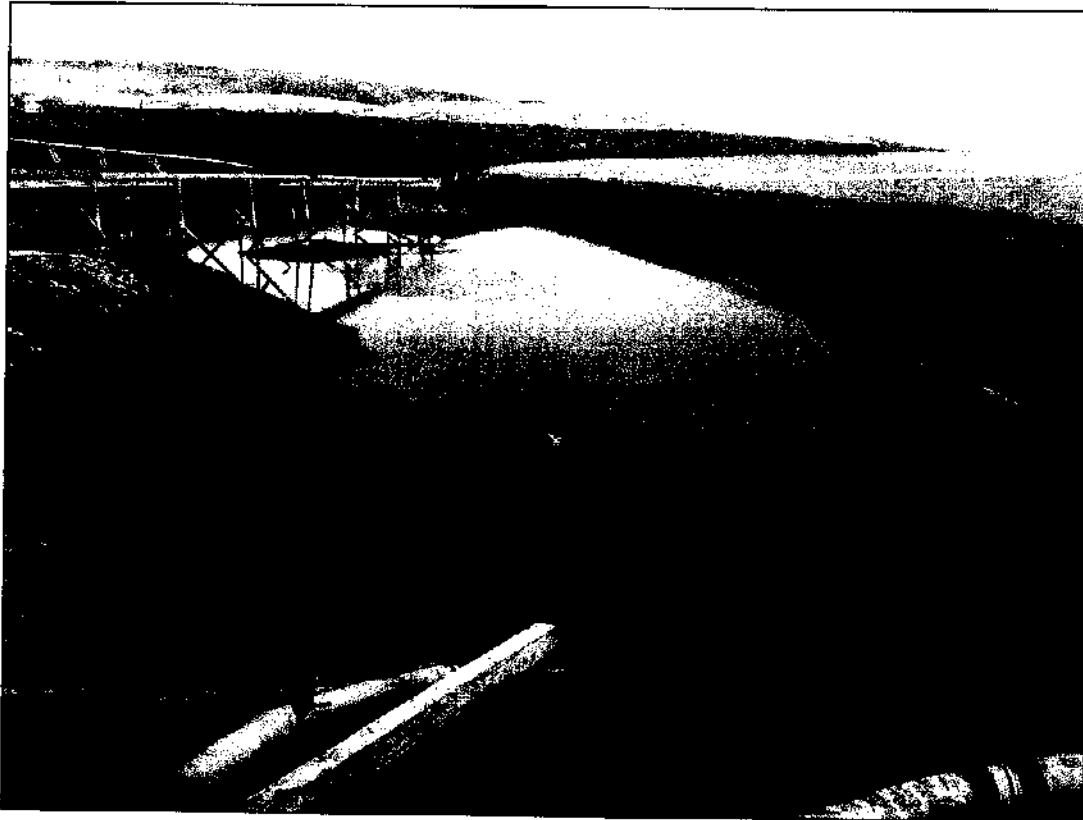


Figure 2. Wastewater treatment cell at Eureka HAWS.

3.2 Collection into the System

Due to the closed nature of the system, it is expected that the volume of wastewater produced will be virtually the same as the volume of the water used.

The collection of the wastewater throughout the Station occurs by gravity. All piping is located within warm portions of the facility. The wastewater is then collected in a storage tank in a separate building at the northeast corner of the complex. The collected wastewater is intermittently pumped to the lagoon when the volume of the liquid in the holding tank reaches a preset level.

3.3 Treatment and Discharge of the System

Wastewater is pumped to the lagoon where solids are allowed to settle and limited decomposition takes place. A sump area was excavated in the bottom of the lagoon. This allows a large pump to be placed below the level of the actual bottom of the lagoon and pump out the content into the Fjord. The sewage lagoon is usually emptied twice a year – at the beginning of July and the end of August. In early July, the sewage lagoon needs to be emptied as it is filled to capacity. Lagoon is decanted a second time at the end of August prior to freezing to ensure that the lagoon is completely empty prior to entering the winter season.



Figure 3. Lagoon Prior to emptying.



Figure 4. Sampling of effluent.

The decanting process normally takes about 48 hours. Wastewater samples are collected at the discharge pipe. Samples of wastewater are taken when lagoon is 2/3 (16 hours) & 1/3 (32 hours) decanted and sent to lab for analysis within 24 hours.

The samples are analyzed for biochemical oxygen demand (BOD₅), total suspended solids, ammonia, fecal coliforms, pH, metals, oil and grease and total phenols.

4. Landfill Strategy

4.1 Introduction

4.1.1 Purpose

This manual has been produced to assist Eureka personnel in the proper operation and maintenance of the Weather Station's land fill disposal facilities.

4.1.2 Site Setting

The Eureka HAWS is located on the north side of Slidre Fiord, at the south-western tip of Fosheim Peninsula, Ellesmere Island, Nunavut at site coordinates 79° 59' 41"N and 85° 48' 48"W (see Appendix1¹). It is located in the Eureka Hills Eco-region, within the Northern Arctic Eco-zone and the topography of the area is rolling and ridged, reaching altitudes of no more than 1000 m above sea level. Soils in the Site area are primarily a sand/gravel fill underlain by silty, sandy clays. Permafrost is present with an active layer ranging between 0.6 and 1.2 m in thickness. The climate is cold and dry; mean annual temperatures range from -30.5°C in winter to 0.5°C in summer. Annual precipitation ranges between 50 to 75 mm. The prevailing winds are from the west.

The main portion of the Site occupies an area immediately east of Station Creek and contains approximately 17 buildings with associated infrastructure. An airstrip is located approximately 1.5 km northeast of the main site. The Site is located on a hillside sloping down from the airstrip, levelling out where most facilities are located before sloping down further to the ocean. A 20 km road to the north connects the Site with an experimental facility, the former ASTRO Lab, now known as the PEARL Facility (Polar Environment Atmospheric Research Laboratory).

The total area of the occupied Site is approximately 2.23 hectares and is held under INAC Land Use Permit #1021. The permit was initially established in 1955 and was apparently expanded to its current size of approximately 4744 hectares in 1972.

4.1.3 Population Projection

While the population varies, particularly in the summer, the average population is about 10 and is not expected to change in the foreseeable future.

4.1.4 Contact List

Rai LeCotey/AI Gaudet Eureka Wx Stn, eurekawxstn@ec.gc.ca
Station Program Manager
Eureka Weather Station
Nunavut, NU
Tel: 613.945.3145 Ext 4460

4.2 Background

4.2.1 Context

Solid waste management at Eureka is a challenge for the following reasons:

- Extreme cold;
- Isolation;
- High cost of transportation; and
- Tiny population

Eureka is a weather station located at 80° N with, as indicated above, a population of approximately 10 people. The site is only accessible by air and sea. Personnel, mail, freight and food are flown in to Eureka on a monthly basis. Once a year, a Canadian Coast Guard ice breaker brings supplies in late August. Any materials sent out from Eureka for disposal or recycling on the return trip of the Coast Guard must remain in the Arctic port of Nanisivik for one year before it can be sent south.

Notwithstanding the constraints that the above place on normal waste management practices, Eureka is committed to practices of procurement of green products, diversion from land fill sites, reuse and recycling.

4.2.2 Solid Waste Generation

- 10-12 bags of kitchen wastes are generated weekly. Based on an evaluation of the garbage log of 2006, each person in Eureka generates approximately 8 kg of waste per day.
- Significant volumes of cardboard boxes and wooden pallets are generated from the packaging material that accompanies the food.
- Currently approximately 1000 L of waste oil is produced each year on site, and together with other miscellaneous petroleum products, are currently stored in empty 205 L drums in a storage compound between the airstrip and main complex.
- Miscellaneous chemicals such as solvents and glycols are placed in empty barrels until filled.

4.3 Landfill Locations

(See Appendix 2²)

4.3.1 East Landfill

This landfill is used to contain non-organic/non-hazardous waste that cannot be incinerated and is located at the east end of the landing strip (79° 59.484'N and 85° 46.335'W). Ash from the incinerator is also landfilled at this location.

4.3.2. Ash Landfill

The ash landfill also receives ash from the incineration of kitchen wastes although since 2000 there has been little ash deposited at this site. It is located south of the airstrip and slightly west of the South Landfill (79° 59.534'N and 85° 47.865'W).

4.3.3 Asbestos Landfill

The asbestos landfill is adjacent to the ash land fill (79° 59.531'N and 85° 46.838'W). This landfill receives any asbestos removed from buildings on site.

4.3.4 West Landfill

This site is closed (79°59.844'N and 85°51.125'W). It contains kitchen waste and buried fuel drums.

4.3.5 Crushed Barrel Landfill

This site is located south of the runway (79° 59.374'N and 85° 55.586'W) but west of the South Landfill.

4.3.6 History of Existing Landfills

An extensive, but unsuccessful, effort was undertaken to locate historical plans and drawings of the landfills at Eureka.

4.4 Operation and Maintenance of Solid Waste

4.4.1 Site Description

As previously noted, the major active landfills are just south of the east end of the landing strip. They are approximately 1.3 km from the Fjord. As the drainage from the above disposal grounds flows in the direction of the Fjord, there is concern that the surface runoff and leachate could reach the Fjord. As required by the Surveillance Monitoring Program, pursuant to Eureka's water licence, Eureka monitors the runoff during periods of flow.

4.4.2 Waste Separation

Eureka's waste is separated into organic (kitchen waste), non-organic (cans, bottles, old vehicles, etc.), construction and demolition (wood, asbestos, etc.) and hazardous (waste oil, hydraulic fluids, batteries, oxygen depleting substances, old window and door frames with lead paint, etc). It should be noted that Eureka uses green products (nonhazardous and biodegradable) when possible (See Appendix 3³).

4.5 Disposal Procedures

4.5.1 Organic Waste

Organic and burnable waste is disposed of in a state of the art incinerator which was installed in 2008 and which meets the latest Environment Canada requirements. As mentioned previously, two to three times a week, the heavy equipment operator takes between 10-12 bags to the incinerator for burning which includes food cans. The ash generated by the burning is packaged in clean 205 L barrels (approximately 24/year) and moved with heavy equipment to the storage compound where it is free from disturbance. In the summer months, the ash (without the barrels) is deposited in a cell of the East Landfill and capped with 0.3 m of gravel/capping material at a 3:1 slope.

4.5.2 Non-Organic, Non-Hazardous Waste

Non-organic and non-hazardous waste that cannot be incinerated is deposited in the East Landfill. The waste deposited in this land fill includes tires, construction materials (drywall, siding, wood, steel, tin, ash from incinerator), old vehicles and equipment (drained of fluids and batteries removed), wire, cable, tin, steel, copper, aluminum, empty compressed gas cylinders, plastics. Capping consists of 0.3 m of compacted native soils scraped from the surrounding gully.

4.5.3 Asbestos Waste

The limited amount of asbestos generated is double-bagged, placed in the Asbestos Landfill and covered with 1.5 m of gravel capping material and its location recorded so that subsurface soils will not be disturbed in the future.

4.5.4 Empty Drums

Any remaining liquid in empty drums is collected as hazardous material; the drums are then crushed, placed in the Crushed Barrel Landfill and covered with 1.5 m of gravel capping material

4.5.5 Hazardous Waste

- Secondary containment of hazardous materials awaiting disposal is provided in the form of salvage drums, crates, constructed with plastic lining or secondary containment pallets.
- Used oil is shipped as retrograde cargo on the annual sea lift to a certified recycling depot in the south.
- Used jet fuel is shipped as retrograde cargo on the annual sea lift to a certified recycling depot in the south. EC is currently seeking a waste fuel burner which is capable of burning fuel that contains water.
- When sufficient batteries are collected (~ 2-3 pallets), they are shipped as retrograde cargo on the annual sea lift to a certified recycling depot in the south.
- Waste glycol is shipped out on sealifts or flights of "opportunity" to Safety-Kleen (Quebec) Ltd. 85 rue de Hambourg, Saint-Augustin-de Desmaures, QC, G3A 1S6.
- Ozone depleting substances are shipped out on flights of "opportunity" to a certified depot in the south.

4.6 Maintenance

There is not a problem with windblown debris because most material subject to being carried by the wind is either incinerated or fully covered in the summer.

Appropriate signage is posted.

Odour control is also not a problem because all organic waste is incinerated.

Outdoor burning is not carried out in Eureka in conformity with the Nunavut Water Board's direction unless the incinerator breaks down or a "bulk" burning {eg. sealift crates & pallets (non pressure treated wood), cardboard} is carried out. In both of the preceding situations, DIAND's Inspector is informed.

4.7 Records

- Quantities of garbage generated are recorded monthly.
- MSDS sheets are available for viewing by personnel.
- Maintenance of landfills are recorded and described under Progressive Reclamation Work Undertaken in Eureka's Annual Report to the Water Board.
- Manifests are obtained and filed for shipments of hazardous material.
- Annual inspections by DIAND are recorded and a response is forwarded to DIAND and the Water Board.

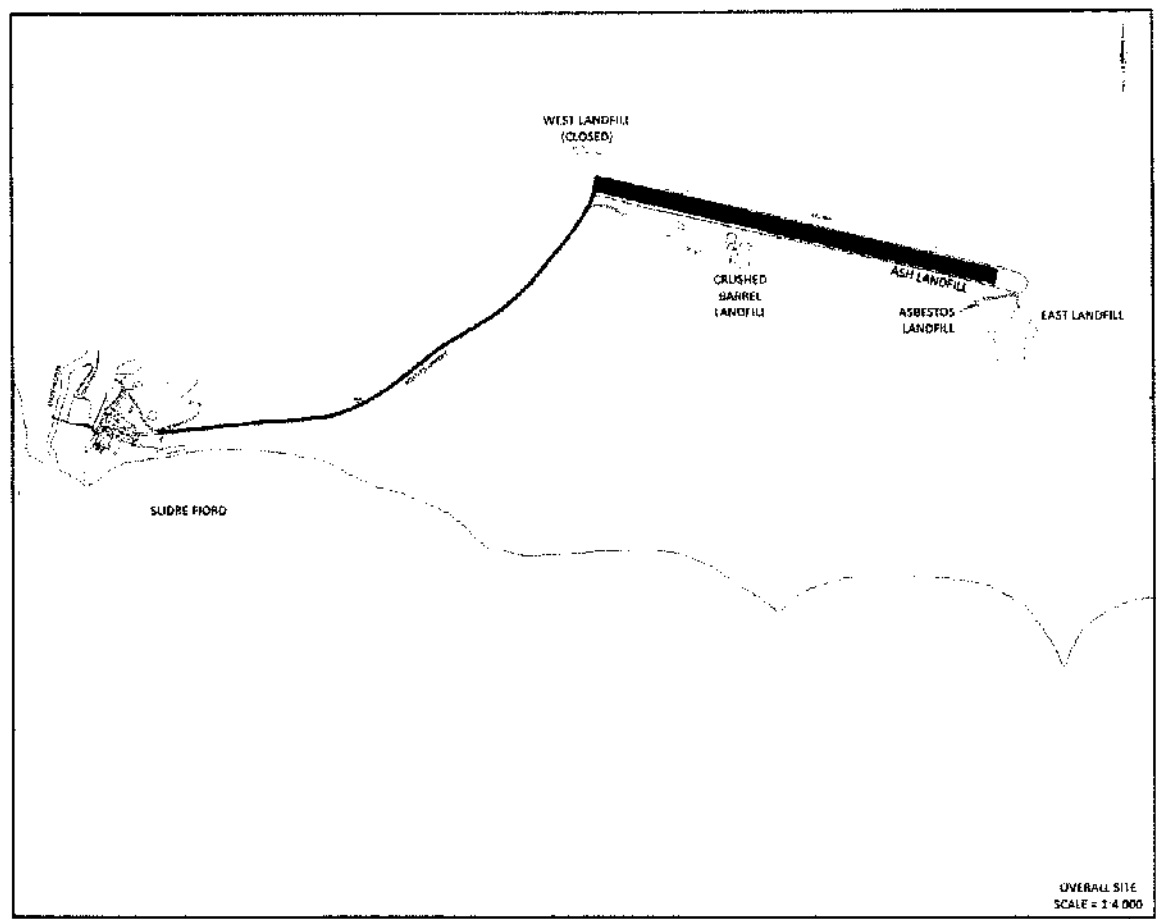
Appendix 1: Eureka Weather Station, Nunavut



1. STATION CREEK
2. WATER SUPPLY LAGOON
3. SEWAGE LAGOON
4. ROAD TO RUNWAY

5. RUNWAY
6. EAST, ASBESTOS, ASH LANDFILLS
7. SLIDRE FIORD

Appendix 2: Locations of Eureka's Landfills



5. References

- Duong, D. and R. Kent (1996). *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories*. Government of the Northwest Territories, Municipal and Community Affairs Community Development.
- Environmental Services, Public Works and Government Services Canada (Western and Northern Region) (1998). *Waste Management Plan for Eureka High Arctic Weather Station*. A report prepared for Atmospheric Environment Services, Environment Canada, Prairie and Northern Region.
- Smith, D.W. and M. Nahir (2000). *Study of the Wastewater and Water Supply systems at the Eureka Weather Station*. A report prepared for Atmospheric Services, Environment Canada by Public Works and Government Services Canada, Western Region.