ORIGINAL

Municipality of Iqaluit
Water Licence N5L3-0087
Application for Renewal

March 1, 1999

Municipality of Iqaluit Water Licence Renewal

1. Project Summary in English and Inuktitut
2. Water Licence Application
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4. Proposed changes to water licence
5. Proposed changes to SNP stations and monitoring
6. List of Attached Drawings
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1. PROJECT SUMMARY

English Summary

The Town of Iqaluit is applying to the Nunavut Water Board for a renewal of Water Licence # N5L4-0087 which expires June 30, 1998. A six month extension for the renewal date was granted by the Nunavut Water Board.

This licence allows for the use of water, disposal of waste water, disposal of solid waste, and abandonment of facilities for municipal purposes in accordance with the provisions of Article 13 of the Nunavut Land Claims Agreement.

Significant improvements to the municipality of Iqaluit's infrastructure have been completed since the water licence was last renewed in 1996. The elevation of the dam at Lake Geraldine was raised in 1996 to increase the storage capacity of the water supply. The Raw Water intake lines were upgraded in 1998 to increase their capacity and respond to changes made by NTPC in their pipe system. An additional treated water storage reservoir was constructed in 1996 to provide the storage necessary for daily use plus fire flow. The water distribution system and sewage collection systems are continually being upgraded. A spill contingency plan has been completed and implemented.

There are several important projects currently underway and planned for the near future. All of which will be submitted to the Nunavut Water Board for approval prior to implementation. A request for proposals has gone out to design an upgrade for the water treatment plant. Design will be completed in the spring of 1999 and construction completed in 2000. The new sewage disposal facility is currently being designed, construction will begin in 1999. A new solid waste facility will be planned, designed and constructed. Also several improvements to the water distribution and sewage collection systems are identified in the capital plan.

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ᐃᖃᓗᐃᑦ ᓄᓇᓕᖓᑕ ᒐᕙᒪᖓᑦ ᑐᓐᓯᕋᐅᑎᖃᕐᒪᑕ ᓄᓇᕗᒥ ᐃᒪᓕᕆᔨᒃᑯᑦ ᑲᑎᒪᔨᖏᓐᓄᑦ ᓄᑖᙳᕆᐊᕈᑎᒥᒃ ᐃᒥᕐᒧᑦ ᓚᐃᓴᓐᓴᓄᑦ ᓈᓴᐅᑎᖃᖅᑐᖅ N5L4-0087-ᒥᒃ ᓄᖅᑲᕐᐱᖃᖅᑐᖅ ᔪᓂ 30 1998ᒥ. ᑕᒃᑯᓄᑦ ᐱᖓᔪᔭᖅᑐᓄᑦ (6-ᓄᑦ) ᐅᖓᕙᕆᐊᕈᑎᖓᑕ ᐅᓐᓗᖓ ᐊᖏᖅᑕᐅᓚᐅᖅᓯᒪᖕᒪᑦ ᓄᓇᕗᒥ ᐃᒪᓕᕆᔨᒃᑯᑦ ᑲᑎᒪᔨᖏᓐᓄᑦ.

ᑖᓐᓇ ᐱᔭᓐᓇᐅᑎ ᓚᐃᓴᓐ ᐱᐱᖃᖅᑎᑦᓯᔭᓐᓇᖅᐳᖅ ᐊᑐᑎᖃᕆᐊᖅ ᐃᒥᕐᒥᒃ, ᑯᔭᓈᕐᓯᓂᕐᒧᑦ ᓱᕋᕐᒥᒃ ᐃᒥᕐᒥᒃ ᑭᓈᓗᖓᓂᑦ, ᑯᔭᓈᖅᓯᓂᕐᒧᑦ ᑕᖏᖃᖏᕐᑐᓂᒃ ᓴᓂᕐᓂᒃ ᐊᓪᓚᓗ ᕿᒪᐃᓂᕐᒧᑦ ᐱᓕᕆᕕᖕᓂᑦ ᑕᐅᓐᓇᑦ ᐱᔾᔪᑎᒥᓐᓗᒥᑦ ᐅᖃᖅᓯᒪᔪᒃ ᒪᓕᒃᓗᒥᑦ ᐃᓚᒃᑰᖓᔪᑦ 13ᖓᓃᑦᑐᖅ ᓄᓇᐳᑦ ᓇᖏᓕ-ᖅ ᓄᓇᑖᕐᓂᕐᒧᑦ ᐊᖏᕈᑎᖓᓂᑦ.

ᐊᖏᔪᒥᒃ ᐊᖅᑭᒋᐊᕈᑎᑦ ᑕᐅᓐᑯᖏᑕ ᐃᖃᓗᐃᑦ ᓄᓇᓕᖓᓄᑦ ᐊᐅᓚᔾᔪᑎᖏᑕ ᐱᑯᒍᖏᓐᓄᑦ ᐱᔭᕇᖅᑕᐅᓯᒪ-ᓕᖅᐳᑦ ᑕᐃᒪᓐᖓᓂᑦ ᐃᒥᕐᒧᑦ ᐱᔭᓐᓇᐅᑎ ᓚᐃᓴᖓ ᑭᖑᓪᓕᖅᐸᖓᓂᑦ ᓄᑖᙳᕆᐊᕐᖅᑎᑕᐅᓚᐅᖅᑎᓪᓗᒍ 1996ᒥ. ᑯᑦᑎᖓᓂᖓ ᐃᒥᖅᑕᕐᐱᐅᑉ ᓴᕘᓚᑕᖓ ᑯᐊᖅᑎᓯᒪᔪᖅ (ᑰᔭᐃᒃᑯᑎᖓ) ᖃᑦᑎᒃᓯᒋᐊᖅᑕᐅᓚᐅᕐᒪᑦ 1996ᒥ ᐃᑎᓂᖅᓴᐅᓕᕐᑯᓐᓗᒍ ᐃᒥᖅᑕᕐᐱᒃ ᐃᒪᖃᕐᓂᖅᓴᐅᓕᕈᓐᓇᕐᑯᓐᓗᒍ ᐃᒥᒃᓴᐅᔪᑉ ᓄᓇᓕᖕᒥᐅᓄᑦ. ᐃᓚᓯᒪᖏᑦᑐᒧᑦ ᐃᒥᕐᒧᑦ ᓱᓐᓗᓕᖏᑦ ᐋᖅᑭᐊᖅᑕᐅᓚᐅᕐᒥᔪᑦ 1998ᒥ ᑯᑉᐸᕆᐊᖅᑐᑕᐅᕐᑯᓐᓗᒥᑦ ᖃᓄᑎᒥ ᐃᒥᖃᕈᓐᓇᕐᓂᖏᑦ ᐊᓪᓚᓗ ᑭᐅᔭᑎᐅᕐᑯᓐᓗᒥᑦ ᐊᓯᔾᔨᕐᑯᔭᐅᓚᐅᖅᓯᒪᔪᓂᑦ ᓄᓇᕐᓯᐅᔫᒥ ᐃᑯᒪᖅᑯᑎᓕᕆᔨᓄᑦ ᓱᓐᓗᓕᖏᑕ ᐱᖅᑯᓯᖏᓐᓄᑦ. ᐃᓚᒃᑲᓐᓂᖏᑦ ᐃᓚᓯᒪᔪᓄᑦ ᐃᒥᕐᒧᑦ ᑐᖅᑯᐃᕕᒃ ᐃᒥ ᑲᕐᕕᒃ ᓴᓇᔭᐅᓚᐅᕐᒥᔪᖅ 1996ᒥ ᑐᖅᑯᐃᐱᖃᕆᐊᖃᖅᑐᒥᒃ ᐱᑕᖃᕐᑯᓐᓗᒍ ᖃᐅᑕᒫᑦ ᐊᑐᖅᑕᐅᓂᕆᕙᒃᑕᖏᓐᓄ ᓛᓗᒥᓪᓗ ᐃᑯᐊᓪᓚᒃᑐᓄᑦ ᐊᑑᑎᒃᓴᓄᑦ. ᐃᒥᕐᒧᑦ ᑐᓂᐅᖅᑲᐃᓂᖅ ᐱᖅᑯᓯᖓ ᐊᓪᓚᓗ ᑭᓈᓗᖓᓂᑦ ᑲᑎᖅᓱᐃᔾᔪᑎᖏᑦ ᐱᖅᑯᓯᖓᑦ ᑕᐃᒪᓐᖓᓕᒫᖅ ᐋᖅᑭᐊᖅᑕᐅᖏᓐᓇᖅᐳᑦ. ᑯᐱᔪᖅᑲᓪᓚᖕᓂᖅᐸᑦ ᐸᕐᓇᐃᔾᔪᑎ ᐱᔭᕇᒃᑕᐅᓯᒪᓕᖅᐳᑦ ᐊᑐᓕᖅᑎᑕᐅᓯᒪᓪᓗᓂᓗ.

ᐊᒥᓱᓪᓗᑕ ᐱᓪᒪᕆᐅᔪᑦ ᐱᓕᕆᐊᑦ ᐅᓪᓗᒥᐅᔪᖅ ᑲᒪᒋᔭᐅᒋᐊᓕᖅᓯᒪᔪᑦ ᐸᕐᓇᐅᑕᐅᓯᒪᓪᓗᑎᒃᓗ ᖃᖓᑦᓯᐊᖅ ᓯᕗᓂᒃᓴᒥ. ᐃᓗᓐᓇᑎᒃ ᑐᓂᔭᐅᓃᑦᑐᑦ ᓄᓇᕗᒥ ᐃᒪᓕᕆᔨᒃᑯᑦ ᑲᔫᑎᑦᓯᓂᐊᕐᒪᑕ ᓯᕗᓂᐊᒍᑦ ᐊᑐᓕᖅᑎᑦᓯᓚᐅᖏᓐᓂᖏᓐᓂᑦ. ᐊᐱᖅᑯᑎ ᑐᔅᓯᕋᐅᑎᓄᑦ ᓴᖅᑭᑕᐅᓯᒪᓕᖅᑐᖅᑦ ᐋᖅᑭ ᓱᕐᓯᒪᓂᐊᕐᓂᒃᓴᖓᓄᑦ ᐃᒥᓕᕆᕕᒃᓴᖅ. ᐋᖅᑭᒃᓯᒪᓂᐊᕐᓂᒃᓴᖓ ᐱᔭᕇᖅᑕᐅᒋᐊᖅᑐᖅ 1999 ᐅᐱᕐᖔᖓᓂ ᐊᓪᓚᓗ ᓴᓇᓂᖏᑦ ᐱᔭᕇᒐᖅᓯᑎᒃ 2000 ᐊᕐᕌᒍᖓᓂ. ᓄᑖᖅ ᑭᓈᓗᓕᕆᕕᒃᓴᖅ ᐅᓐᓗᒥᐅᔪᒥ ᐋᖅᑭᒃᓱᖅᐅᕙᓪᓕᐊᔪᖅ ᓴᓇᔭᐅᒋᐊᓕᕐᓂᐊᖅᓯᓂᓗ 1999ᒥ. ᓄᑖᖅ ᑕᖅᑭᕐᑐᓄᑦ ᐊᕐᓯᕕᒃ ᐸᕐᓇᐅᑕᐅᓯᒪᔪᑦ. ᐋᖅᑭᒃᓯᒪᓂᐊᕐᓂᖓᓄᓐᓗ ᐱᓕᕆᔾᔭᐅᓯᒪᔪᖅ ᐊᓪᓚᓗ ᓴᓇᔭᐅᕙᓪᓕᐊᓪᓗᓂ. ᐊᓪᓚᕐᑕᐅᖅ ᐊᒥᓱᑦ ᐋᖅᑭᒋᐊᖅᓯᒋᑦ ᐃᓪᒥᖃᖅᑎᑦᓯᓂᕐᒧᑦ ᑭᓈᓗᓕᕆᓂᕐᒧᓐᓗ ᐱᓕᕆᔾᔪᑎᖏᑦ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᓪᓗᑎᒃ ᐱᕐᑎᖅᔪᐊᑦ ᐊᑭᑐᔪᑦ ᐸᕐᓇᐅᑎᖓᑎᒍᑦ.

2.Water Licence Application

P.O. Box 119
Gjoa Haven, NT X0E 1J0
Tel.: (867) 360-6338
Fax: (867) 360-6369

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

APPLICATION FORM

Application for licence, amendment to licence, or renewal of licence

APPLICATION/LICENCE NO: (Amendment or renewal only) N5L3-0087

1. NAME AND MAILING ADDRESS OF APPLICANT/LICENSEE

MUNICIPALITY OF IQALUIT
P.O. BOX 460
IQALUIT, NT, X0A 0H0
Phone: 979-5600 Fax: 979-5910

2. ADDRESS OF HEAD OFFICE IN CANADA IF INCORPORATED

N/A
Phone:_____ Fax:_____

3. LOCATION OF UNDERTAKING (describe and attach a map, indicating watercourse and location of any proposed waste deposits)

Latitude: 63° 44' N Longitude: 68° 31' W

4. DESCRIPTION OF UNDERTAKING (describe and attach plans and drawings)

WATER LICENCE RENEWAL

5. TYPE OF UNDERTAKING

- ☐ Industrial
- ☐ Power
- ☐ Agricultural
- ☐ Mining and Milling
- ☐ Conservation
- ☐ Recreation
- ☑ Municipal
- ☐ Other (describe): _____

6. WATER USE

- ☑ To obtain water
- ☐ Flood control
- ☐ To cross a watercourse
- ☐ To divert water
- ☐ To modify the bed or bank of a water
- ☐ To alter the flow of, or store, water
- ☐ Other (describe): _____

7. QUANTITY OF WATER INVOLVED (litres per second, litres per day or cubic metres per year, including both quantity to be used and quality to be returned to source.)

1,100,000 cubic metres per year

8. **WASTE DEPOSIT** (type, quantity, quality, treatment, and disposal)

Please see Supplementary Questionnaire

9. **OTHER PERSONS OR PROPERTIES AFFECTED BY THIS UNDERTAKING** (give name, mailing address and location; attach if necessary)

none

10. **PREDICTED ENVIRONMENTAL IMPACTS OF UNDERTAKING AND PROPOSED MITIGATION MEASURES**

none

11. **CONTRACTORS AND SUB-CONTRACTORS** (name, address and functions)

none

12. **STUDIES UNDERTAKEN TO DATE** (list and attach copies of studies, reports, research, etc.)

please see Supplementary Questionnaire

13. **THE FOLLOWING DOCUMENTS SHALL BE INCLUDED WITH THE APPLICATION**

Land Use Permit

DIAND	[ ] Yes [x] No	Date Expected NOT REQUIRED
Regional Inuit Association	[ ] Yes [x] No	Date Expected NOT REQUIRED
Supplementary Questionnaire	[x] Yes [ ] No	Date Expected _____
Inuktitut Summary of Project	[x] Yes [ ] No	Date Expected _____
MAP @ 1 : 250,000 (with camp, drill sites, etc.)	[ ] Yes [x] No	Date Expected see attached maps

14. **PROPOSED TIME SCHEDULE**

Start Date: July 1, 1999 Completion Date: July 1, 2005

Denis Bedard	Director Engineering + Planning		March 1, 1999
Name (Print)	Title (Print)	Signature	Date

For Nunavut Water Board use only

APPLICATION FEE	**Amount: $**_____	**Receipt No.:**_____
WATER USE DEPOSIT	**Amount: $**_____	**Receipt No.:**_____

3.Water Licence Application Supplementary Questionnaire for Municipalities

Water Licence Application Supplementary Questionnaire for Municipalities

I. GENERAL

1. Date: November 30, 1998

2. Applicant: Iqaluit
Municipality

3. Contacts: Denis Bedard
Name of Contact

Director, Engineering and Planning
Position

(867) 979-5633
Telephone #

(867) 979-5910
Fax #

4. Municipal Status: ☐ Village ☒ Town
☐ Hamlet ☐ Settlement Corporation

5. Is this a ?
☐ New Application
☒ Renewal -▸ Water Licence # N5L4-0087

II. ATTACHMENTS

1. Attach up- to- date detailed map(s) showing the locations of the:

a. water intake; (Dillon, Town of Iqaluit Water Licence Renewal, Overall Plan, Figure 1)
b. water storage and treatment facilities;
c. fuel and chemical storage;
d. sewage treatment facilities (lagoon, honey bag pit, wetland);
e. wastewater treatment area and discharge outlets;

Please see attached: Dillon, Town of Iqaluit Water Licence Renewal, Overall Plan, Jan 99,Figure 1

f. solid waste disposal areas and drainage patterns;

Please see attached: UMA, New Landfill Site Plan, July 1994, DWG 100

g. hazardous waste disposal area;
h. access roads;
i. existing water bodies/courses and any changes to these water bodies/courses that have or may occur as a result of water use or waste disposal facilities, locations of environmental monitoring sites. (Outline drainage basin);
j. Areas around the community used for recreation, camping, fishing, etc.

Please see attached: Dillon, Town of Iqaluit Water Licence Renewal, Overall Plan, Jan 99,Figure 1

k. abandoned and/or restored water treatment, sewage, and solid waste disposal facilities.

Please see attached: UMA, Existing Waste Disposal Sites, Figure 1.

Are maps attached? ☒ Yes ☐ No
If no, please indicate when they will be available.

Who has provided or prepared these maps ?

Dillon Consulting Ltd., Municipality of Iqaluit, Nunavut Water Board,

III. WATER SUPPLY

Water Source

1. Type of source: ☒ Lake ☐ River ☐ Well ☐ Other _____

2. Name of water source and alternative, if any.

Lake Geraldine	
Primary Source	Secondary Source

3. Usual break-up & freeze-up period: Late May (Break-up) October (Freeze-up)

Water Storage

1. Type of water storage facility. (check where applicable)

☒ Reservoir/Pond (untreated) ☒ Storage tank (treated water) ☐ None
☐ Other _____
Description

2. If "reservoir" checked:

Is the reservoir lined? ☐ Yes ☒ No
What type of liner? _____ When was it installed? _____

Water Treatment

1. What is the quality of the water, and provide water quality results.

Summer:	☒ good	☐ fair	☐ poor
Fall:	☒ good	☐ fair	☐ poor
Winter:	☒ good	☐ fair	☐ poor
Spring:	☐ good	☒ fair	☐ poor

Describe.

Although the quality is adequate during spring runoff, aesthetics are not as good. In the upgrade to the water treatment plant, powdered activated carbon will likely be used at certain times of the year to help alleviate this problem. This is generally very effective in treating taste and odour problems.

Water quality results can be found in the Municipality of Iqaluit's Annual Reports, which are on file with the Nunavut Water Board.

3. Type of water treatment.

☒ Filtration and chlorination (Pre-chlorination, PH control, settling tanks, filtration, fluoridation, backwash)

☐ Chlorination only

☐ None

☐ Other _____

Description

Water Use And Distribution

1. Volume of water use:

Distribution	Estimated number of people on the system **A**	Estimated average water consumption (Litres/capita/day) **B**	Total water consumption (Litres/day) **A x B**
PIPED	1600	400	640,000
TRUCKED	1876	300	562,800
		TOTAL	1,202,800

General Condition of the water supply facilities

1. General condition of the:

a. Water supply facility

☒ Satisfactory ☐ Unsatisfactory

If unsatisfactory, explain.

b. Storage facility

☒ Satisfactory ☐ Unsatisfactory

If unsatisfactory, explain.

c. Distribution system

☒ Satisfactory ☐ Unsatisfactory

If unsatisfactory, explain.

Modifications

1. Are there any changes *planned* for the water supply system?

☐ No ☒ Yes

If yes, please attach a copy of the plan, or describe changes. Provide information on the implementation schedule.

Water Treatment Plant Upgrade - The treatment plant output will be increased to meet future demand and many minor deficiencies will be corrected. Details can be found in the "Water Treatment Plant Design Brief" which was submitted to the Nunavut Water Board May 29,1998. The design life of the upgraded plant will be 20 years, that is, until the year 2017. Once the final design is completed, it too will be submitted to the Water Board for approval. There is funding identified in MACA's and the Town's capital plans. 1998/99- Design, 1999/00- Construction

Uivvaq Recirculation Facility Upgrade - This project is to design and construct modifications and upgrading of the recirculation facilities and plant. Funding is identified in MACA's and the Town's capital plans. 1998/99 - Design, 2000/01 - Construction

Fire Pumping Facility - This project is to assess the need for a pumping facility with respect to the revised fire flow, design and construct a new facility. Funding is identified in MACA's and the Town's capital plans. 2000/01 - Design, 2001/02 - Construction

Astro Hill Trunk Main Re-route - Remove final asbestos, review and upgrade lines in downtown core. Funding is identified in MACA's and the Town's capital plans. 1999/00 - Construction

Upgrade Forcemain/Lift Station - Increase Capacity of Forcemain and upgrade lift station. Funding is identified in MACA's and the Town's capital plans. 2000 - Design, 2001/02 - Construction

222 Recirculation Facility Upgrade - This project is to upgrade Building 222 in its capacity as a heating and recirculation facility. Funding is identified in MACA's and the Town's capital plans. 2000/01 - Design, 2001/02 - Construction

Replace Water Main to Federal Building Area - This project is to replace above ground cast iron watermain with underground insulated main in a looped system. Funding is identified in MACA's and the Town's capital plans. 2001/02 - Design, 2002/03 - Construction

Replace Trigram Building Reheat Station - This project is to design and construct a new reheat station and to assess all recirculating heating systems in that area. Funding is identified in MACA's and the Town's capital plans. 2001/02 - Design, 2002/03 - Construction

Improve Capacity of Existing Piped System - An influx of people into Iqaluit is expected due to the creation of Nunavut. This project is designed to respond to the needs of water supply and sewer systems as a direct result of this increase in population. This project includes an assessment of servicing requirements based on expansion and development plans, analysis of capacity and utilization of existing system, schematic of future systems with cost analysis, and design and tender documents for upgrading the system. There is funding identified under the Nunavut Incremental Infrastructure Program and MACA's Capital Plan. 1998/99 - Design and Construction, 1999/00 - Construction

2. Are changes needed to the water supply, storage or treatment facilities? Describe.

See #1 for list of projects.

Identification

Are there signs identifying drinking water sources presently used by the municipality ?

☐ No ☒ Yes

IV. SEWAGE DISPOSAL

1. What type(s) of sewage treatment is used ?

☒ Lagoon

☐ Mechanical system

☐ Wetland

☐ Honey bag

☐ Combination/Other: describe

_____

_____

***Lagoon** (if applicable)*

1. Has there been any operating problems with the lagoon?

☒ Yes ☐ No

If yes, describe

In 1997 there was seepage through the West Dyke. The Town retained a consultant to study the problem. As a result the lagoon level was lowered, the level is now being closely monitored.

Prior to the last water licence renewal:
In 1987, the lagoon overflowed during spring runoff and a portion of the west berm washed away. In June 1991, 15 m of the west dyke breached, washing out the control structure. In December 1991, the concrete and culvert overflow structure washed out.

***Mechanical System** (if applicable)*

1. Describe (type, specifications, operation and maintenance program for the mechanical wastewater treatment system).

_____

N/A

_____

2. Are sludges produced ?

☐ Yes ☐ No

If yes, describe how the sludges are disposed of:

_____

N/A

Wetland*(if applicable)*

1. Describe the Wetland wastewater treatment system.

N/A

Honey Bag Pit

1. Does the municipality use a honey bag pit?

☐ Yes ☒ No

If yes, describe the location, drainage, and operation/maintenance of the site:

N/A

Commercial, Industrial and/or Hazardous Wastes

1. Are there any sources of commercial or industrial *liquid* waste being discharged or deposited to the wastewater treatment system that may affect the quality of the effluent or leachate produced? *(The municipality should be aware that any commercial or industrial discharge has to be approved by the municipality)*

☐ Yes ☒ No

If yes, indicate sources, types and quantities.

N/A

Sewage Discharge

1. Are fish, shell fish and other wildlife harvested in or near the discharge area ?

☐ Yes ☒ No

If yes, indicate species harvested, and level of harvest.

People tend to avoid the sewage lagoon area. The closest people fish is at the causeway for Arctic Char with gillnets. This is domestic harvest probably low level during open water only, there are no numbers available. People also fish for Arctic Char where the Sylvia Grinnell River empties into Koojessee inlet.

General Condition of the sewage treatment facilities

1. General condition of the:

   a. Sewage collection system

   ☒ Satisfactory ☐ Unsatisfactory

   If unsatisfactory, explain.

   b. Discharge control system

   ☒ Satisfactory ☐ Unsatisfactory

   If unsatisfactory, explain.

   c. Dams, diversion dykes, berms

   ☒ Satisfactory ☐ Unsatisfactory

   If unsatisfactory, explain.

   There have been no berm or dyke failures since the water licence was last renewed. In 1997 there was seepage through the West Dyke. The Town retained a consultant to study the problem. As a result the lagoon level was lowered, the level is now being closely monitored.

Modifications

1. Are there any changes *planned* in the sewage treatment facilities?

   ☐ No ☒ Yes

   If yes, please attach a copy of the plan, or describe changes. Provide information on the implementation schedule.

   New Sewage Treatment Facility - A new sewage treatment facility is required to meet the basic level of service for the growing number of people in Iqaluit. The Nunavut Water Board has also increased the effluent quality criteria that the sewage treatment facility must meet.

   A sewage Treatment Planning Study was completed in July of 1997. After weighing it's options the Town has decided to pursue a membrane/bioreactor facility located near the south end of the runway, close to the existing sewage lagoon. Please see location on Dillon Figure 1.

   This project is currently in the design stage. Please see the pre-design report and drawings which are included in this application.

   Implementation Schedule - Design Early 1999, Construction 1999/2000

2. Does the municipality or residents believe changes are needed to the sewage treatment facilities? Describe.

In general the public may perceive that the retention time and treatment of sewage is not adequate, i.e. that the quality of discharge could be improved. The lagoon was designed to provide only primary treatment. The new facility will address these issues.

Abandonment and Restoration

1. List and describe abandoned or restored sewage treatment facilities. Indicate their location on a map.

Prior to the lagoon being built in 1978 trucked sewage was discharged at the shoreline behind the Northen Store, and honey bags were disposed of on a hill between West Forty Road and Koojesse Inlet.

An abandonment and restoration plan for the existing sewage lagoon will be submitted to the Water Board prior to the commissioning of the new Sewage Treatment facility. It will likely include de-watering, drying, sludge removal, infilling, and possibly follow up monitoring.

Identification

Are there signs identifying past and present sewage disposal sites ?

☐ No ☒ Yes (present)

V. SOLID WASTE DISPOSAL

1. Briefly describe how solid wastes are collected and delivered to the disposal area.

Municipal Solid Waste is picked up by the Municipality in 25 cubic yard compaction trucks two times per week for residential users and five times per week for commercial users. Residents and contractors can dump during certain hours.

2. Is the solid waste site fenced? ☒ Yes ☐ No

3. Is the fence adequate? ☒ Yes ☐ No

If no, describe

N/A

Waste Reduction

1. Does the municipality burn garbage ?

☒ Yes ☐ No

If yes, describe how and when this is done.

As outlined in the approved Town of Iqaluit Landfill Operation and Maintenance Manual for Site 3 in West 40, controlled burning occurs under the favourable conditions with respect to the tank farm and the community.

Burning does not take place during the following circumstances:
- air temperature is above 15 C
- wind is from the northwest between May1st and September 30th
- the tanks are being filled
- a spill occurs at the tank farm
- venting the tanks during high wind

Further a 5 m buffer zone is maintained around combustion area. The combustion area is kept reasonably small and is monitored by the operator throughout the day.

2. Has the municipality considered measures for waste reduction such as recycling or reuse?

☒ Yes ☐ No

If yes, describe

Reusable materials are separated at the site for future use. A local contractor operates a recycling program to handle aluminum cans and glass bottles. Both are crushed to reduce the volume. The Municipality has also considered implementing a blue box program that would encourage more recycling.

A new group has recently been formed in Iqaluit called the Iqaluit Environmental Beautification Society. High on their list of priorities is further reduction of waste in the community, more re-use and recycling.

Animal Carcasses Pit

1. Does the municipality have an area for the disposal of animal carcasses ?

☐ Yes ☒ No

If yes, describe the location, drainage and operation/maintenance of the site

Animal carcasses are burned.

Bulky Scrap Metal Waste Disposal Area

1. Does the municipality have a scrap metal or bulky waste disposal area?

☒ Yes ☐ No

If yes, briefly describe its location and operation plan.

The bulky waste area is located on the south side within the existing landfill facility. Cars, empty barrels, appliances, and other bulky metals that can not be salvaged are stacked and collapsed. Fill material is placed to advance the driving surface of the area.

Commercial, Industrial and/or Hazardous Wastes Disposal Area

1. Are there any commercial or industrial waste being discharged or deposited in the solid waste disposal area? *(The municipality should be aware that any discharge of commercial or industrial waste has to be approved by the municipality)*

☒ Yes ☐ No

If yes, please indicate sources, types and quantity.

Commercial waste from hotels, restaurants, retail stores, contractors, and other private business is deposited in the landfill. This would include food waste, cardboard and paper, construction materials, cans and other metal, plastic and rubber. No hospital waste is deposited at the site. Only household hazardous waste is accepted.

2. Will the municipality use a hazardous waste disposal area?

☒ Yes ☐ No

If yes, describe its:

a. Location

Inside the fenced Solid Waste Facility on the north east side.

b. Structure

Steel, locked Sea Lift Containers.

c. Operation and maintenance (describe special handling/disposal methods for these wastes)

A Household Hazardous waste collection program takes place twice a year, individuals may also bring it to the facility through out the year. After each collection the waste is neutralized or recycled. Every 2-4 years waste that can not be neutralized or recycled, it is shipped south for proper disposal. For more detailed information please see the attached Town of Iqaluit Landfill Operation and Maintenance Manual for Site 3 in West 40.

General Condition of the Solid Waste Disposal Area

1. General condition of the:

   a. Solid waste disposal area

   ☒ Satisfactory ☐ Unsatisfactory

   If unsatisfactory, explain.

   N/A

Modifications

1. Are there any changes planned for the solid waste disposal area?

   ☐ No ☒ Yes

   If yes, attach a copy of the plan, or describe changes. Provide information on the implementation schedule.

   A new Solid Waste Facility is being planned. The present facility is nearing the end of its useful life. Funds have been identified in both the Town's and MACA's 5 year Capital Plans. A planning study and design will be done in 1999/00, and construction in 2000/01.

2. Are changes needed to the solid waste disposal area? Describe.

   Regulatory agencies would like to see a further segregation of wastes prior to burning.

Abandonment and Restoration

1. List and describe abandoned or restored solid waste facilities.
   Indicate their location on a map.

   Please see attached: UMA, Existing Waste Disposal Sites, Figure 1.

   There are currently three reports relating to Abandonment and Restoration Plans under review by the Nunavut Water Board. Remediation Plan Iqaluit Landfill and Apex Dump Dec 1997, Drainage Plan Apex Dumpsite Oct 1997, and Drainage Plan Iqaluit Landfill Site West 40, Site 4, Oct 1997.

   Please also see the Solid Waste Management Study prepared for the Municipality of Iqaluit, August 14, 1998, on file with the Nunavut Water Board.

Identification

Are there signs identifying past and present solid waste disposal sites ?

☐ No ☒ Yes (present site)

VI. INSPECTION AND MONITORING

1. When were municipal facilities inspected by:

☒ Indian and Northern Affairs Inspector Date: October 14, 1998

☐ Municipal and Community Affairs Date: Does not inspect

☒ Other: Baffin Regional Health Date: January 4, 1999

2. Is there a system in place for reporting spills?

☒ Yes ☐ No

If yes, describe.

The Town of Iqaluit hired a consultant to prepare The Municipality of Iqaluit Spill Contingency Plan. It was submitted to the Nunavut Water Board in June 1998. Please refer to this document for detailed information.

3. Is there a contingency plan for clean up of spills?

☒ Yes ☐ No

If yes, describe.

Please see above.

4. Have any spills occurred in the past five years?

☒ Yes ☐ No

If yes, describe and show on a map the locations of the spills. What action has been taken to clean the affected areas?

Please see the attached Hazardous Materials Spill Database Summary of spills since the last water licence renewal in 1995. Details of spills are reported to the Nunavut Water Board annually in the Town of Iqaluit annual report.

Monitoring Program

1. Is water sampling and analysis done ?

☐ No ☒ Yes

If Yes, answer the questions a to e

a. Briefly describe how samples are taken and sent to the laboratory.

Water is sampled as per the Water Licence Requirements. "All sampling, sample preservation, and analyses shall be conducted in accordance with the methods prescribed in the current edition of the 'Standard Methods for Examination of Water and Wastewater." A copy of the sampling procedures is included in this application.

b. Briefly describe any monitoring done for wastewater effluent and leachate.

As per the current water licence, Surveillance Network Program, Section B, Sampling and Analysis Requirements.

c. Who is responsible for water sampling ?

Rock Burton
Name

Director of Public Works
Position

(867)979-5668
Telephone #

(867)979-4166
Fax #

Registered C.E.T., Class 1 Water Distribution, DIAND Training
Level of training

d. Laboratory performing analysis of samples.

Taiga Environmental Laboratory, DIAND
Name

Box 1500, 4601-52nd Avenue
Yellowknife, N.W.T.
X1A 2R3
Address

(867)669-2788
Telephone #

(867)669-2718
Fax #

e. Are any changes planned in the water quality monitoring program?

☒ Yes ☐ No

If yes, describe.

There will likely be additional monitoring of abandoned waste facilities once abandonment and restoration plans are finalized.

Please refer to the section of this application entitled "Proposed changes to water licence" for additional changes to the monitoring program.

VII. PUBLIC CONCERNS

1. What concerns does the municipality or residents have regarding the municipal water supply or waste disposal facilities? List the concerns and describe what steps have been taken to address those concerns.

Concern	Action
Smoke and debris from open burning	Further restricting the hours of burning. More segregation of waste prior to burning.
Inadequate sewage disposal facility, pollution	A new facility is being designed and constructed. A higher level of treatment will take place.
Water taste and odour occasionally poor in spring	The water treatment plant will be upgraded.
Not enough recycling	Further separation of wastes at solid waste site. More re-use and recycling encouraged.

VIII. PUBLIC HEALTH *(To be filled by the Regional Environmental Health Officer)*

1. Date: _____

2. Municipality: IDAULT

3. Contact:
NICOLE RITCHIE
Environmental Health Officer Contact
867-979-7654
Telephone #
867-979-7659
Fax #

4. Have there been any problems or health/environmental concerns with drinking water ?
☑ Yes ☐ No
If yes, describe
AGE + CAPACITY OF TREATMENT PLANT FOR GROWING COMMUNITY. ONSITE PLANT SAFETY + REGULATORY COMPLIANCE - AS PER INSPECTION REPORT.

5. Have there been any problems or health/environmental concerns with sewage disposal/treatment?
☑ Yes ☐ No
If yes, describe PROXIMITY OF LAGOON TO COMMUNITY + RESIDENCES, AGE + CAPACITY. PREVIOUS INCIDENTS OF UNCONTROLLED DISCHARGE. PROXIMITY TO AIRPORT. DEGREE OF TREATMENT IS QUESTIONABLE.

6. Have there been any problems or health/environmental concerns with solid waste disposal?
☑ Yes ☐ No
If yes, describe AS PER RECENT HEALTH INSPECTION/ OPERATIONAL REVIEW CONDUCTED + SUBMITTED JAN./99. PLEASE REFER TO THIS REPORT. FOR DETAILS.

Monitoring Program

1. Does the Regional Health Board perform water quality sampling?

WE DO NOT SAMPLE UNLESS SUSPICIOUS OF WATER QUALITY. REGULAR SAMPLING IS A MUNICIPAL RESPONSIBILITY UNDER PUBLIC HEALTH ACT.

☑ No ☐ If Yes, answer questions (a) to (e)

a. Briefly describe the sampling methodology.

WE DO, HOWEVER, PROVIDE ANALYTICAL SERVICES WHICH ARE LIMITED TO COLIFORM DETECTION.

b. Briefly describe any monitoring of wastewater effluent and leachate.

NONE - MUNICIPAL RESPOSIBILITY, + ALSO CONDUCTED BY DIAND - COPIED TO THIS OFFICE.

c. Who is responsible for sampling? ?

ROCK BURTON + MUNICIPALITY.
Name

Position

Telephone # 979.5968

Fax #

Level of training

d. Laboratory performing analysis of samples.

~~ENVIRONTEST~~ UNKNOWN.
Name

DIAND LAB. OR
Address

POSSIBLY NOVAMANN.
Telephone #

Fax #

e. Are any changes planned in the water quality monitoring program?

☑ Yes ☐ No

If yes, describe. MUNICIPALITY RECENTLY STARTED WATER SAMPLING FROM BUILDING OUTLETS TO ENSURE Cl_2 LEVELS + SAFETY FOR ANALYSIS AT THE PLANT - BENEFICIAL, HOWEVER IT MUST BE NOTED THAT THEIR LAB IS NOT 'CERTIFIED' IN ANY WAY.

** TOTAL PAGE.03 **

IX. TECHNICAL INFORMATION *(Assistance from the Regional Municipal and Community Affairs Office)*

1. Date: December 10, 1998

2. Municipality: Iqaluit

3. Contact: Doug Sitland, P.Eng./Municipal Planning Engineer
MACA Representative/Position

(867) 979-5020
Telephone #
(867) 979-4779
Fax #

4. Population (according to most recent census results): 4220 (1996)

5. Estimated growth rate over next 5 years: 3.7 % per year (4706 in 1999, 5578 in 2004)

6. Has any baseline data collection and evaluation been undertaken with respect to the physical, biological, and chemical characteristics of the main water bodies in the area?

☐ No ☒ Yes
If yes, provide details below:

If no, are such studies being planned?
☐ No ☐ Yes (If yes, when and by whom):

7. Have Elders been consulted in the collection of baseline data on main water bodies in the area?

☒ No ☐ Yes.
If yes, specify.

8. Has any baseline data collection and evaluation been undertaken with respect to the various biophysical components of the environment potentially affected by the project?

☐ No ☒ Yes
If yes, provide details below.

If no, are such studies being planned?

☐ No ☒ Yes. If yes, specify:

Below is a list of studies which have looked at environmental components of the area. Little has been done since the licence was last renewed in 1995.

Coleman, T.S. and T. Nesbitt. 1985. An investigation of contaminants in locally harvested bivalves in the eastern Arctic, 1983-1985. Environmental Protection, Conservation, and Protection, Iqaluit, NWT.

Dillon, 1997. Iqaluit Sewage Treatment Planning Study, Final Report.

Dillon, 1997. Iqaluit Sewage Treatment Planning Study: Fisheries Issues.

Environment Canada, Department of Natural Defence Environmental Sciences Group, Natural Resources Canada, Geological Survey of Canada, Atlantic Geoscience Centre. 1995. Baffin Region Ocean Disposal Investigation: Seabed Debris and Contaminant Inputs near Iqaluit, Resolution Island, Cape Dyer and Kivitoo. (Provided by Steve Harbicht, Environment Canada)

Iqaluit Shellfish Monitoring Program, 1990-1996 (this summary provided by Margaret Keast, DFO), contaminant levels have always been below guidelines.

UMA Engineering Ltd. 1995. Iqaluit, NWT: Sewage Treatment Improvements, Preliminary Engineering Report, Final Report (this report includes a dye oceanographic evaluation of sewage flow).

Samuelson, G.M. 1998. Water and Waste Management Issues in the Canadian Arctic: Iqaluit, Baffin Island.

The Amorok Hunter's and Trappers Organization is planning a study on Inuit Traditional Ecological Knowledge about the arctic char in the Sylvia Grinnell River and possibly the surrounding waters.

Attachments

1. Attach detailed plan or drawing(s) of the present *solid waste disposal area*. Include the following information:

   a. details of pond size and elevation;
   b. details of all retaining structures (dimensions, materials of construction, etc.);
   c. details of the drainage basin, and existing and proposed drainage modifications;
   d. details of all decant, siphon mechanisms etc., including sewage treatment facilities;
   e. details regarding direction and path of wastewater flow from the area;
   f. distance from watercourses and fish bearing waters;
   g. location and construction of liners;
   h. leachate and groundwater collection systems; and
   i. control structures.

   Please see attached: UMA, New Landfill Site Plan, July 1994, DWG 100

2. Attach detailed plan or drawing(s) of the present *sewage treatment system*. The drawing(s) should include the following:

a. details of all retaining structures (dimensions, materials of construction, etc.);
b. details of the drainage basin, and existing and proposed drainage modifications;
c. details regarding direction and path of wastewater flow from the area;
d. indications of the distance from watercourses and fish bearing waters;
e. all sources of seepage presently encountered near these areas, including volumes (m^3/day) and directions.

Please see attached: UMA, Lagoon Reconstruction and Drainage Improvements 1991 DWGs 101, 102, and 103.

Are drawings for the solid waste disposal area and sewage treatment system attached?

☒ Yes ☐ No

If Yes, who has provided them ?

The Municipality of Iqaluit, MACA Yellowknife,

If no, indicate when they will be available

N/A

Hydrology

1. Effects on surface water flow:

Are any stream channels altered? ☒ Yes ☐ No

Flow has been diverted around the existing solid waste facility as part of the original design and construction in 1995.

Is the natural storage or water level of any lake or pond changed? ☒ Yes ☐ No

Lake Geraldine has been dammed to provide water storage as part of original construction. The elevation of the dam has been raised in subsequent projects to provide more storage.

Are there changes in water flow downstream of the project? ☒ Yes ☐ No

Water that would have flowed from Lake Geraldine to the ocean is being drawn for the community water supply. Therefore the downstream flow is reduced.

Is a storage reservoir created in a natural channel? ☐ Yes ☒ No

If yes to any of the above, briefly describe the expected change in flow or storage:

No expected changes, all are from previous projects that have been approved and in operation for several years.

2. Drainage Area:

What is the drainage area? 385 hectares (for the water supply, Lake Geraldine)

What is the average elevation of the drainage basin? 110 metres

Is the drainage basin outlined on an attached map? ☐ Yes ☒ No

This documentation was not readily available, however a plan and profile of Lake Geraldine is provided, please see attached OMM, Plan and Profile Lake Geraldine 1984 DWG No 84-4221-P1.

Describe the drainage basin characteristics, (vegetation, general soil type, lakes, swamps and permafrost areas, etc.)

A rolling terrain surrounds the community. The subsoil is made up of glacial drifts over a predominantly granite Precambrian bedrock. The layer of overburden, silty sand, gravel, and boulders varied from 0 to 18 m thick and has numerous surface depressions. As a result ponds are prevalent in summer months. The depth of thaw in the permafrost ranges from 1 to 1.8 m. The water table is very high and segregated lenses may be found. The vegetation consists of lichens, mosses, hardy flowers, and grasses.

3. Channel characteristics:

Is the course of any channel changed? ☐ Yes ☒ No

If yes, describe measures to maintain stream bed and bank stability.

N/A

4. Will the cross-section of any watercourse be changed? ☐ Yes ☒ No

If yes, describe the change and its effect on the flow capacity of the channel.

N/A

Water Supply

1. What is the rate of withdrawal from the source? Up to 7000 m^3/day.

2. Is water drawn from the source ☐ intermittently ☒ continuously

3. If it is drawn intermittently, during what month(s) is it drawn? N/A

4. For what period is it drawn (days/weeks/months)? N/A

5. What is the rate of flow of source (if river) or size (if lake)? Lake Geraldine - 1,100,000 m^3

6. At the intended rate of water usage, describe the effects on the river or lake from which water will be drawn.

No effect.

Water Intake

1. Please provide short descriptions of the following:
   a. freshwater intake facility

The raw water intake system consists of the following major components:
-Lake Geraldine which has been dammed to increase storage volume.
-Raw intake line, 360m long 250 mm diameter ductile iron, insulated with 50mm of blown glass and a spiral gauge metal jacket.
-A 150 mm tempered water line injects water from the treatment plant into the intake system at the dam in order to prevent freeze up.

   b. operating capacity of the pumps

Water flows from the lake by gravity. Capacity of the intake is in excess of 7000 m^3/day.

   c. intake screen size

This information is not readily available. There will be an attempt to determine the intake screen size during a planned dive in 1999.

Water Storage

1. Type of water storage facility (check where applicable)

☒ Reservoir/Pond (untreated) ☒ Storage tank (treated) ☐ None

☐ Other _____
Description

2. If "reservoir":

Is the reservoir lined? ☐ Yes ☒ No

What type of liner? _____ When was it installed? _____

3. Is a dam or dyke being used to store or alter the flow of water? ☒ Yes ☐ No

4. What are the dimensions of the dam or dyke?

Length: 117.3 m Width: 1.63 m Height: 8.14 m

U/S slope: 2:1 D/S slope: 2:1

5. Does the proposed dam create a reservoir in a natural watercourse? No proposed dam.

☐ Yes☐ No

If yes, what is the storage capacity and surface area of the reservoir?

_____ m^3 _____ ha.

6. Will the dam or dyke affect fish migration or movement ? No proposed dam.

☐ Yes ☐ No

If yes, describe all measures for compensation of fish habitat lost due to the dam or dyke, and mitigations for fish migration or movement.

Water Treatment

1. Indicate the capacity of the treatment facility. Useful design output1050 m^3/day

2. What is the capacity of the water storage facility. 2280 m^3

3. Describe the method of water treatment (i.e., backwash, flocculation, sedimentation, chemicals used), and provide the results of the most recent bacteriological and chemical analysis. Attach a diagram, if possible.

Pre-chlorination, PH control, settling tanks, filtration, fluoridation, backwash. Chemicals used are chlorine, fluoride and lime. See attached flow chart of process.

4. Are there any changes planned in the water treatment facilities?

☐ No ☒ Yes

If yes, attach a copy of the plan or indicate changes and include an implementation schedule. Include excerpt from MACA Capital Plan if available.

Please see above Section III WATER SUPPLY, Modifications, 1 of this application.

Sewage Disposal

1. Indicate the level of sewage treatment:

☒ primary ☐ secondary ☐ tertiary

Pre-treatment (if applicable): ☐ screening ☐ maceration

Lagoons (if applicable): ☐ anaerobic ☐ aerobic ☒ facultative

2. Indicate the capacity of the sewage treatment facility 25,000 m^3

3. Based on current population projections, the facility will meet the needs of the community until the year 2000 .

4. Average depth of the wastewater lagoon 2.0 m.

5. What is the design freeboard? 1 m.

6. Indicate the retention time of the sewage while in the treatment facility 7 days.

7. Indicate the estimated rate of discharge of wastewater 15-20 L/sec.

8. Indicate the location of the discharge point West Dyke at Koojesse Inlet.

9. Is the discharge: ☐ seasonal ☒ continuous
If the discharge is seasonal, during what month(s) is it done? _____
What is the duration of the discharge (days/weeks/months) ? _____

10. Are there any changes planned in the sewage disposal facilities?
☐ No ☒ Yes
If yes, attach a copy of the plan or indicate changes and include an implementation schedule.

Include excerpt from MACA Capital Plan if available.

Please see above Section IV SEWAGE DISPOSAL, Modifications, 1 of this application.

Solid Waste Disposal

1. Indicate the capacity of the disposal area 44,000 m^3.

2. The *average* depth of the solid waste disposal site 3.0 m.

3. The current facility will meet community needs until the year 2001.

4. Do any natural watercourse enter the solid waste disposal area? What methods are used to decrease the amount of runoff water entering these areas?

A drainage ditch has been constructed to divert water around the facility.

5. Indicate the volume of water that may enter these areas from any source(s) and attach all pertinent details of the diversions.

Source	Volume (m^3/day)
_____	_____
_____	_____
_____	_____

The source is melting snow during spring runoff and has not been measured.

6. Please describe any diversions of watercourses:

Flow has been diverted around the existing solid waste facility as part of the original design and construction in 1995. Please see attached: UMA, New Landfill Site Plan, July 1994, DWG 100.

7. Are there any changes planned in the solid waste disposal facilities?

☐ No ☒ Yes

If yes, attach a copy of the plan or indicate changes and include an implementation schedule. Include excerpt from MACA Capital Plan if available.

Please see above Section V SOLID WASTE DISPOSAL, Modifications, 1 of this application.

Other

1. Describe any additional details on the existing municipal facilities which should be considered by the Nunavut Water Board during it review.

The Municipality of Iqaluit is committed to being responsible environmentally to the community and complying with the regulatory requirements set out in the water licence. It strives to provide the best level of service possible to the rapidly growing community. It not only responds to the current needs but is devoted to solid planning for the future. The Municipality is committed to continuously improving the infrastructure associated with the water supply system, solid waste facilities, and sewage facilities. The Municipality relies on both the local taxpayers and the Federal Government for funding its infrastructure projects. Unfortunately it is most often due to insufficient funding that important projects get delayed. It is necessary to prioritize projects to make the most effective use of available funds.

4. PROPOSED CHANGES TO WATER LICENCE

Part B: General Conditions

5. Surveillance Network Program signs have been posted to identify stations. Recommend this reads " All Surveillance Network Program signs shall be maintained to the satisfaction of an Inspector."

6. Signs to inform the public of Water Supply and Waste Disposal Facilities have been erected. Recommend this reads " All Water Supply and Waste Disposal Facilities signs shall be maintained to the satisfaction of an Inspector."

Part D: Conditions Applying to Waste Disposal

2. Once the new sewage treatment facility is commissioned the effluent quality standards will change to meet the requirements set by the Nunavut Water Board in letter sent to the Municipality of Iqaluit on March 18, 1998:

Parameter	Maximum Average Concentration
BOD	30 mg/L
Suspended Solids	35 mg/L
Faecal Coliform	10 000 CFU/dL

6. No longer applies.
7. No longer applies.
8. No longer applies.
9. No longer applies.
10. Spill Contingency Plan has been completed and submitted to the Nunavut Water Board.
11. Waiting for approval by the Board.
13. A Waste Management Plan has been completed and submitted to the Nunavut Water Board.
14. Waiting for approval by the Board.

Part F: Conditions Applying to Abandonment and Restoration

3. A remediation plan for the West Forty area has been submitted to the Nunavut Water Board.
4. Waiting for approval by the Board.
5. A remediation plan for the Apex Waste disposal site area has been submitted to the Nunavut Water Board.
6. Waiting for approval by the Board.

5. PROPOSED CHANGES TO THE SURVEILLANCE NETWORK PROGRAM

The Municipality applies to discontinue monitoring at SNP stations 0087-6 and 0087-4. These sites have been dry the majority of the time that attempts have been made to draw samples during the past 3 years.

The Municipality also requests the monitoring of PAHs and PCBs at SNP stations 0087-5, 0087-6, and 0087-7 be reduced to just PCB monitoring of SNP 0087-5 and 0087-7, and the frequency be reduced to every two years.

6. LIST OF ATTACHED DRAWINGS

Town of Iqaluit Water Licence Renewal, Overall Plan, Figure 1, Dillon Consulting Ltd.

New Landfill Site Plan, July 1994, DWG 100, UMA

Existing Waste Disposal Sites, Figure 1, UMA

Lagoon Reconstruction and Drainage Improvements 1991 DWGs 101, 102, and 103, UMA

Plan and Profile Lake Geraldine 1984 DWG No 84-4221-P1, OMM

Iqaluit Water Treatment Process, Flow Chart

Municipality of Iqaluit, N.W.T. 1999 Wastewater Reclamation Facility Project 0199, Drawings D-0199-G000 to D-0199-G005, D-0199-A001 to D-0199-A003, D-0199-E001 to D-0199-E002

7. LIST OF ATTACHED REPORTS

Hazardous Materials Spill Database, Iqaluit Spill Summary Report, 1995 to present.

Municipality of Iqaluit Log of Reports and Drawings

Town of Iqaluit Landfill Operation and Maintenance Manual for Site 3 in West 40

Response to Request for Qualifications and Proposals for Sewage Treatment Options for The Municipality of Iqaluit, Hill Murray & Associates Inc.

Standard Methods for Examination of Water and Wastewater. Section 1060 Collection and Preservation of Samples.

8. BIBLIOGRAPHY

Nunavut Wildlife Management Board, Johnny McPherson

Department of Fisheries and Oceans, Margaret Keast

Municipality of Iqaluit Spill Contingency Plan, June 1998, Dillon Consulting Ltd.

Lagoon Liquid Level Assessment, March 1998, Dillon Consulting Ltd.

Iqaluit Sewage Treatment Planning Study, July 1997, Dillon Consulting Ltd.

Municipality of Iqaluit Lake Geraldine Storage Study Report, April 1995, Oliver, Mangione, McCalla and Associates Ltd.

Http://www.infonorth.org

Samuelson, G.M. 1998, Water and Waste Management Issues in the Canadian Arctic: Iqaluit, Baffin Island, Canadian Water Resources Journal Vol.23, No.4

Municipality of Iqaluit Water Licence 1994 Annual Report

Municipality of Iqaluit Water Licence 1995 Annual Report

Municipality of Iqaluit Water Licence 1996 Annual Report

Municipality of Iqaluit Water Licence 1997 Annual Report

Municipality of Iqaluit Water Licence 1998 Annual Report

Review of 1996 Annual Report and 1996 Compliance Review, DIAND

Review of 1997 Annual Report and 1997 Compliance Review, DIAND

Performance Evaluation for Iqaluit Sewage Lagoon in Iqaluit, NWT for the Period of 1990 to 1992, December 1992, UMA Engineering Ltd.

Proposal for Upgrading of the Sewage Lagoon, December 1990, UMA Engineering Ltd.

Preliminary Engineering Report Iqaluit Solid Waste Disposal Site, November 1991, UMA Engineering Ltd

Iqaluit Sewage Treatment Planning Study, July 1997, Dillon Consulting Ltd.

Seepage from a Sewage Lagoon - What is a Reasonable Rate, February 1998, Ferguson Simek Clark Engineers and Architects

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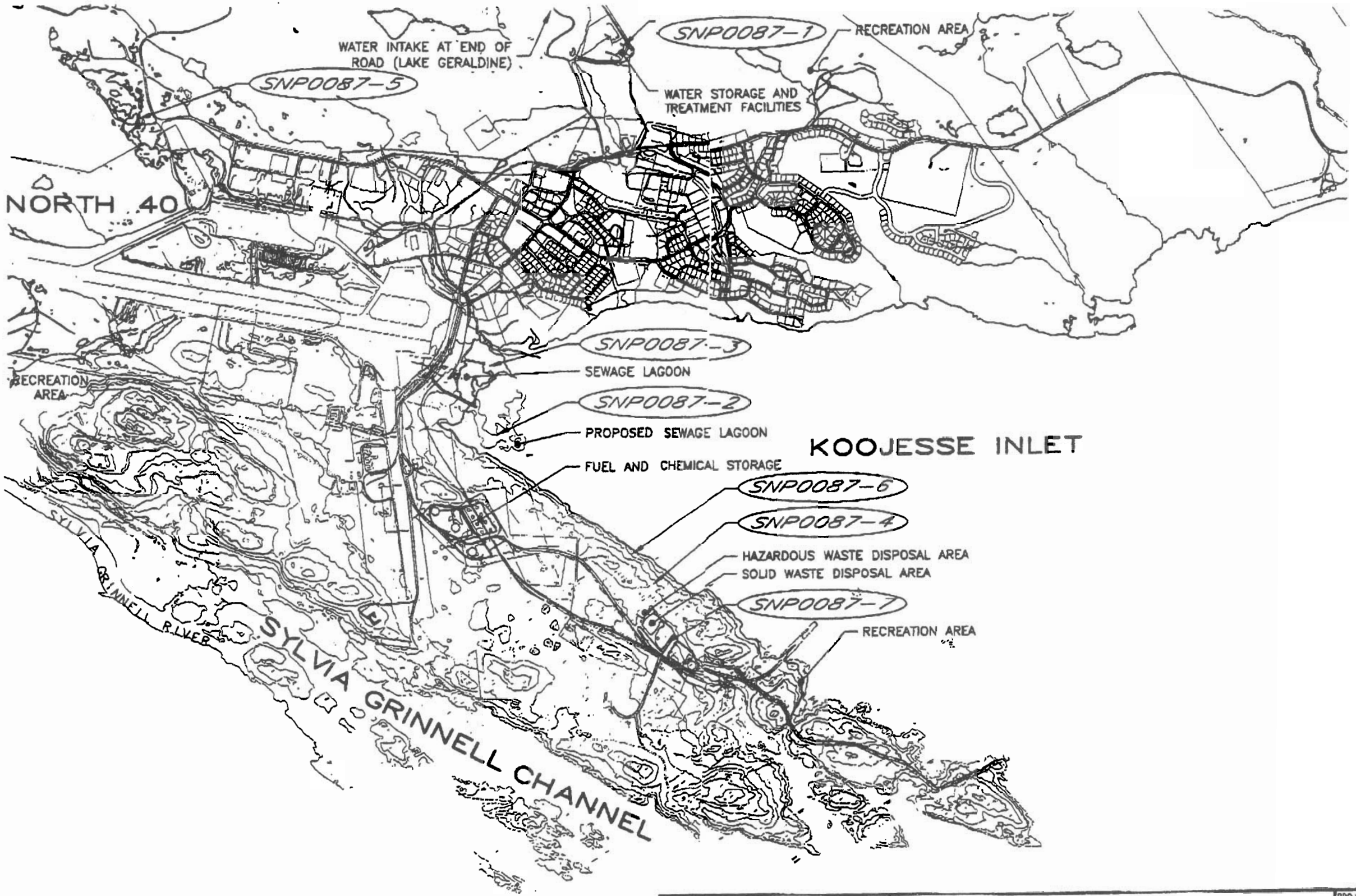
Environmental As-Is Condition Report, Bulk Fuel Storage and Pipeline Distribution System, December 1997, Dillon Consulting Ltd.

Raw Water Intake Design Brief, May 1998, Reid Crowther and Partners Limited Consulting Engineers

Water Treatment Plant Design Brief, May 1998, Reid Crowther and Partners Limited Consulting Engineers

Town of Iqaluit Landfill Operation and Maintenance Manual for Site 3 in West 40, December 1994, UMA Engineering Ltd.

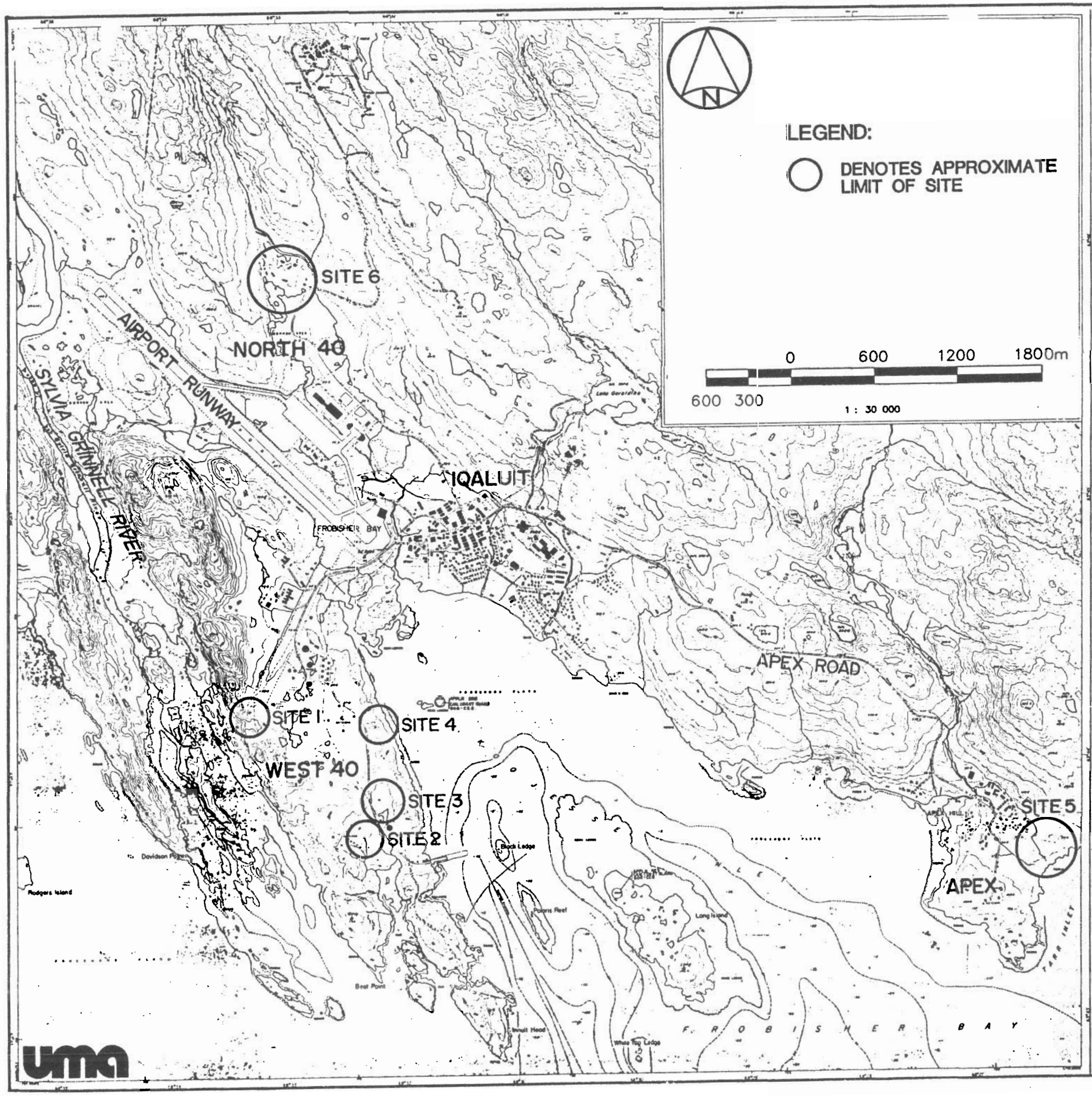
Standard Methods for Examination of Water and Wastewater.



DILLON CONSULTING

PROJECT	TOWN OF IQALUIT WATER LICENSE RENEWAL
TITLE	OVERALL PLAN
PROJECT NUMBER	98-5583-01
DATE	JAN 99
FIGURE NUMBER	FIGURE 1

PLOT DATE: 01/17/97
BASE NAME: o.dwg
ACAD FILE: 41grs g:\98555a01\5583-fig1.dwg
LOG FILE: no



SITE EXPLANATIONS

SITE 1 Inactive metal waste site used by the military. The exposed areas consist mostly of scrap metals, barrels and truck bodies.

SITE 2 Inactive municipal waste site used for less than a one year period, subsequent to the closure of Site No. 5.

SITE 3 Inactive metal waste site of unknown origin.

SITE 4 Active municipal waste site situated on old honey bag disposal area presently used for all municipal wastes, with the exception of large bulky wastes. Waste is burned at this site, therefore the exposed wastes are mainly non-organic. This site has been developed beyond capacity.

SITE 5 Inactive municipal waste site used until 1979. Substantial amounts of gravel were used to cap the site, however the face is still exposed.

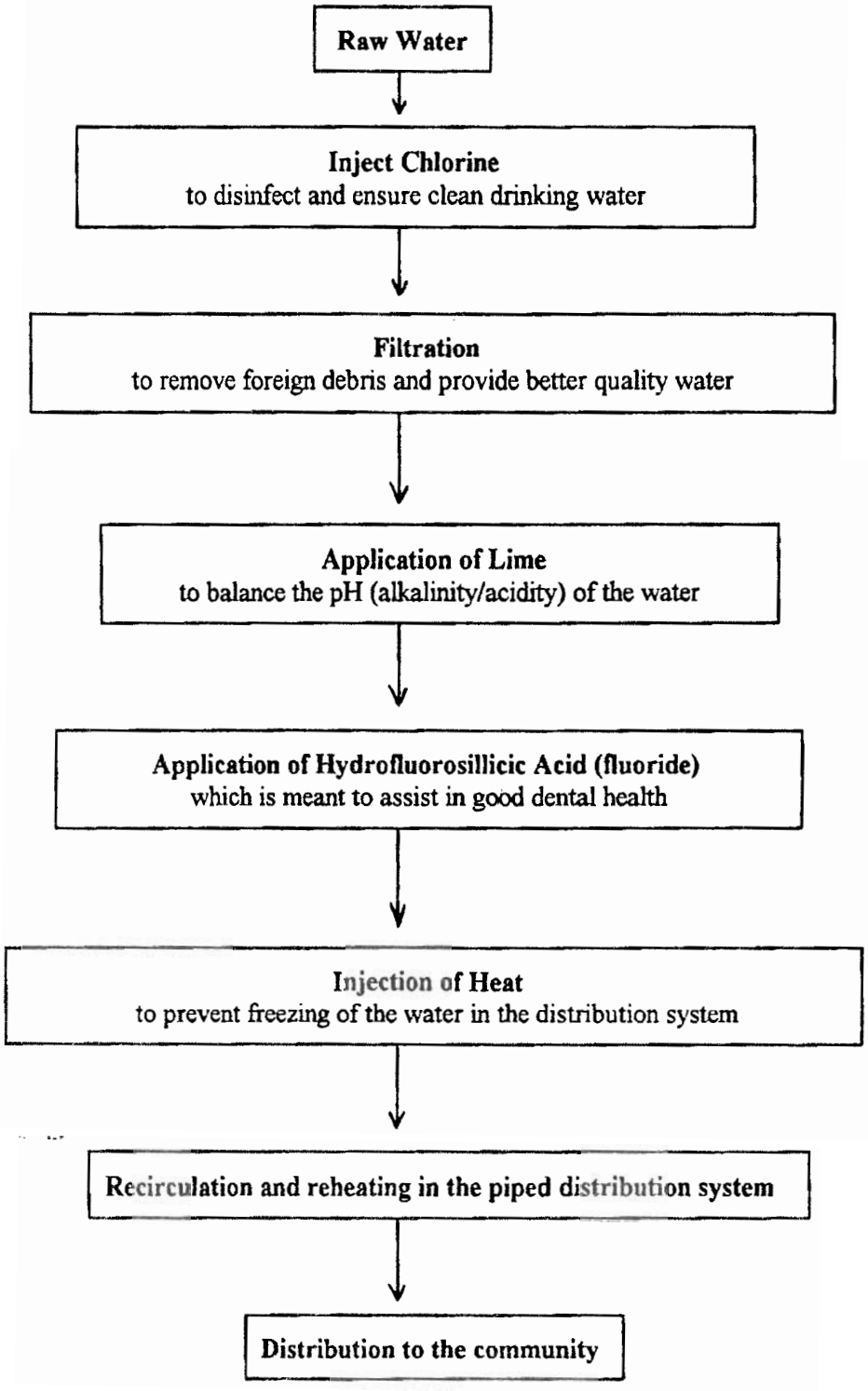
SITE 6 Active bulky waste site currently used for disposal/ storage of scrap metal, bulk materials and 45 gallon steel drums. The gravel extraction and waste disposal operations are in conflict on this site.

TOWN OF IQALUIT
WASTE MANAGEMENT PLAN

EXISTING WASTE DISPOSAL SITES

Figure 1

Iqaluit Water Treatment Process



Northwest Territories

Hazardous Materials Spill Database

Department of Resources, Wildlife & Economic Development

21 Jan 1999

Search Criteria: Iqaluit Spills (1995 to Present)

Spill #	Spill Date	Region	Community	Description	Commodity	Quantity (L or Kg)	Party	Source	Agency
95003	16 Jan 1995	BAF	Iqaluit	Building 2017 West 40	Heating Fuel	91	Joe Morneau	ST<	EPS
95009	24 Jan 1995	BAF	Iqaluit	Water Booster Station	Furnace Oil	10	Town of Iqaluit	ST>	INAC/NAP
95018	10 Feb 1995	BAF	Iqaluit	Behind Northern Store	Propane/Acetylene	0	Northern Store	ST<	GNWT
95029	22 Mar 1995	BAF	Iqaluit	Between House #105 & 107	Fuel Oil	136	Iqaluit Housing Authority	ST>	GNWT
95049		BAF	Iqaluit	Building 900 East Side	Oil & Gas Products	0	Unknown	UK	GNWT
95050	24 Apr 1995	BAF	Iqaluit	Television Northern Canada Building 1085B	Heating Fuel	45	Unknown	ST<	GNWT
95084	12 Jun 1995	BAF	Iqaluit	Shell Compound	Fuel	40	Shell Canada	PL	GNWT
95086	14 Jun 1995	BAF	Iqaluit	Apex Building 3042	Heating Oil	100	Canada North Travel	ST<	GNWT
95092	20 Jun 1995	BAF	Iqaluit	Apex House #3142	Heating Oil	227	Kim Lindsay	ST<	GNWT
95093	23 Jun 1995	BAF	Iqaluit	Federal Building	Marking Dye (Non-Toxic)	5	DPW (Canada)	ST<	EPS
95112	16 Jul 1995	BAF	Iqaluit	Apex	Hydraulic Fluid	0	Baffin Building Supplies	TRU	GNWT
95132	18 Aug 1995	BAF	Iqaluit	Upper Base Site	Diesel Fuel	1300	Upper Base Site Clean Up Crew	ST<	INAC/NAP
95173	25 Oct 1995	BAF	Iqaluit	Airport	Jet A	68	Aero Services Executive Ltd (Fal Air)	AIR	EPS
95175	31 Oct 1995	BAF	Iqaluit	Airport Cabinet #1	Diesel	8	DND	AIR	EPS
95179	07 Nov 1995	BAF	Iqaluit	Airport Shell Cabinet No. 1	Jet A	30	Universal Airways	AIR	EPS
95183	15 Nov 1995	BAF	Iqaluit	Airport Apron	Jet A	10	Earthstar Falcon 50	AIR	EPS
95186	19 Nov 1995	BAF	Iqaluit	Airport	Jet A-1	10	Aeromar Airways of Mexico City	AIR	EPS
95201	23 Dec 1995	BAF	Iqaluit	Airport Cabinet #1	Jet A-1	30	Fowler Fuel Services	AIR	EPS

Search Criteria: Iqaluit Spills (1995 to Present)

Spill #	Spill Date	Region	Community	Description	Commodity	Quantity (L or Kg)	Party	Source	Agency
96006	23 Jan 1996	BAF	Iqaluit	Airport Apron Area #5 Fuelling Cabinet	Jet A Fuel	40	Unknown	UK	EPS
96015	01 Feb 1996	BAF	Iqaluit	Airport Fuelling Cabinet #1	Jet A	12	Ross Investments	AIR	EPS
96025	20 Feb 1996	BAF	Iqaluit	Boardwalk Behind Nakasuk School to Manhole #51	Sewage	2500	Municipality of Iqaluit	PL	INAC/NAP
96027		BAF	Iqaluit	West Side of Nakasuk School Yard	Sewage		DPW	UK	INAC/NAP
96031	12 Jan 1995	BAF	Iqaluit	Nakasuk School West	Sewage	0	Town of Iqaluit	PL	INAC/NAP
96032	04 Jan 1996	BAF	Iqaluit	Nakasuk School West	Sewage	0	Town of Iqaluit	PL	INAC/NAP
96034		BAF	Iqaluit	Roch Lessard Garage West 40	Fuel Oil	0	Roch Lessard	ST<	GNWT
96043	22 Mar 1996	BAF	Iqaluit	Airport Main Ramp	Jet A-1	15	Alpha Tech (Billington, Wash.)	AIR	EPS
96048	31 Mar 1996	BAF	Iqaluit	Manhole #100 Top of One Way Road	Sewage		Municipality of Iqaluit	PL	INAC/NAP
96073		BAF	Iqaluit	Airport Corner of Apron & Taxiway Delta	Oil	3	Unknown	UK	EPS
96083	31 May 1996	BAF	Iqaluit	Airport Fueling Cabinet	Aviation Gasoline	300	Atlantic Airways (747)	ST>	EPS
96088	04 Jun 1996	BAF	Iqaluit	Airport Cabinet #1 Apron	Jet A	1	Shell	ST>	EPS
96097	11 Jun 1996	BAF	Iqaluit	Airport Cabinet No. 1 Main Apron	Jet A	5	Unknown	AIR	EPS
96117	30 Jun 1996	BAF	Iqaluit	Behind Public Health Building	Fuel Oil	1137	Unknown	ST<	GNWT
96124	03 Jul 1996	BAF	Iqaluit	Airport Cabinet #1	Jet A-1	10	Transport Canada	ST>	EPS
96153	13 Aug 1996	BAF	Iqaluit	Tank Farm Pumphouse	Jet A-1	10	Shell Canada	PL	GNWT
96165	27 Aug 1996	BAF	Iqaluit	Airport Between ATB & First Air Hanger	Aviation Fuel	2	Unknown	UK	EPS
96194	14 Aug 1996	BAF	Iqaluit	Airport End of Runway	Jet Fuel	200	DND	AIR	EPS
96206	02 Oct 1996	BAF	Iqaluit	House #3007B	Heating Oil	45	Unknown	ST<	GNWT
96217		BAF	Iqaluit	Airport Main Ramp (Taxiway "Charlie")	Jet A-1	5	Wildoro Air of Norway	AIR	EPS
97028	06 Mar 1997	BAF	Iqaluit	AV 300 to AV 203 - In Front of Firehall	Sewage	10000	Municipality of Iqaluit	PL	INAC/NAP
97029	02 Mar 1997	BAF	Iqaluit	Behind House 1000 - Sewage Lift Station #2	Effluent (Sewage)	2000	Municipality of Iqaluit	PL	INAC/NAP
97031	11 Mar 1997	BAF	Iqaluit	Airport Apron #3	Jet A Fuel	20	American Aircraft - N663MN	AIR	EPS
97032	03 Jun 1997	BAF	Iqaluit	#1306 Malibu Grill Restaurant	Sewage	1000	Restaurant Owner - Randy Eaton	PL	GNWT
97035	14 Mar 1997	BAF	Iqaluit	Airport Apron Area	Jet A-1	100	Interface Group	AIR	EPS
97076	05 May 1997	BAF	Iqaluit	Along Beach Between MH 63A and 63B	Sewage	2500	Municipality of Iqaluit	PL	INAC/NAP
97087	04 May 1997	BAF	Iqaluit	Anglican Cathedral	Heating Fuel	350	Unknown	PL	GNWT
97092	21 May 1997	BAF	Iqaluit	Behind Parnaivik Building	Heating Fuel	91	Nunavut Construction Co.	ST<	GNWT

Search Criteria: Iqaluit Spills (1995 to Present)

Spill #	Spill Date	Region	Community	Description	Commodity	Quantity (L or Kg)	Party	Source	Agency
97182		BAF	Iqaluit	Airport - Old US Air Force Tank Farm	Waste Solvents & Fuels		Nunasi Corporation /Transport Canada	OTH	EPS
97193	16 Aug 1997	BAF	Iqaluit	Main Tank Farm	Jet A-1	150	Uksuq Co.	UK	GNWT
97198	19 Aug 1997	BAF	Iqaluit	Atmospheric Environmental Services Bldg.	Home Heating Fuel	91	Vandals	DRUM	EPS
97219	15 Sep 1997	BAF	Iqaluit	Water Treatment Plant	Chlorine	85	Municipality of Iqaluit	OTH	INAC/NAP
97258	22 Nov 1997	BAF	Iqaluit	Airport Apron	Jet A-1	300	Uqsuq Corp	ST<	EPS
97265	01 Dec 1997	BAF	Iqaluit	Lift Station #1 along Municipal Beach to Ocean	Sewage	6000	Municipality of Iqaluit	OTH	INAC/NAP
97268	10 Dec 1997	BAF	Iqaluit	Nakasuk Sewer Line - HS 650	Sewage	500	Municipality of Iqaluit	PL	INAC/NAP
97271	20 Dec 1997	BAF	Iqaluit	MH 6 - MH 7, NorthwesTel Building	Sewage	7000	Municipality of Iqaluit	PL	INAC/NAP
98002	10 Jan 1998	BAF	Iqaluit	MH- 68 - 77 in front Netcher Clinic	Sewage	1000	Municipality of Iqaluit	PL	INAC/NAP
98028	28 Feb 1998	BAF	Iqaluit	A.V. 223 - A.V. 224	Sewage	1000	Municipality of Iqaluit	PL	INAC/NAP
98039	24 Mar 1998	BAF	Iqaluit	MH6-MH7, Front of Northwestel Building	Sewage	2000	Municipality of Iqaluit	PL	INAC/NAP
98086	29 May 1998	BAF	Iqaluit	Nakasuk School Boardwalk	Grey Water		DPW&S	PL	INAC/NAP
98096		BAF	Iqaluit	House 802	Home Heating Fuel		NAV Leasing	ST<	GNWT
98185	03 Dec 1998	BAF	Iqaluit	Airport	Aviation Fuel		First Air	AIR	EPS

This report contains information regarding spills that were ***reported*** to the 24 Hour Spill Line. The absence of information on any particular location in no way guarantees that contamination has not occurred at that location.

ocation No.			Date	Project	Consult	Notes
..0	a		Jun-83	Alteration 2 six Nordair Staff Houses	Smith Anderson	Specification
1.0	b		May-84	Construction of an Air Terminal, Weather and Flight Service Station	Transport	Specification Book 2/3
1.0	c		May-84	Construction of an Air Terminal, Weather and Flight Service Station	Transport	Specification Book 1/3
1.0	d		May-84	Construction of an Air Terminal, Weather and Flight Service Station	Transport	Specification Book 3/3
1.0	e		May-84	Construction of an Air Terminal, Weather and Flight Service Station	Transport	Tender Form
1.0	f		May-84	Construction of an Air Terminal Weather and Flight Service Station	Transport	Addendum
1.0	g		Aug-94	Development Plan 94/99 Iqaluit Airport	Transport	Report
1.0	h		Apr-97	Noble House Condos	FSC	Mechanical Contract Documents
2.1	a		Nov-88	Wastewater Lagoon Systems	Heinke	O&M Manual
2.1	b		Nov-88	Wastewater Lagoon Systems	Heinke	Planning and Design
2.1	c		Dec-90	Upgrading of the Sewage Lagoon	UMA	Proposal
2.1	d		Jul-91	Report on Repairs to Sewage Lagoon	UMA	Prelim Eng. Report
2.1	e		Dec-91	Report on Repairs to Sewage Lagoon	UMA	Supplement
2.1	f		Dec-92	Sewage Lagoon	UMA	Performance Evaluation
2.1	g		Jan-98	Iqaluit Sewage Lagoon Investigation	FSC	Preliminary Report
2.1	h		Jan-98	Draft Memo to Nunavut Water Board	FSC	Report
2.1	i		Jan-98	Draft Discussion Paper - Seepage From Lagoon. What is a reasonable rate?	FSC	Draft Memo
2.1	j		Feb-98	Seepage fron Lagoon - What is a reasonable rate?	FSC	Final Report
2.1	k		Feb-98	Iqaluit Sewage Lagoon investigation -	FSC	Final Report
2.1	L					
2.2	a		Jan-80	Utilities Extensions Phase 5	DPW	Specification
2.2	b		Feb-85	Servicing Extensions	OMM	Pre Eng. Assessment
2.2	c		Feb-86	Sewer and Water Extension Phase 7	DPW	Specification
2.2	d		Dec-88	Extension of Buried Services	Hardy	Geotechnical Repairs
2.3	a	A	Nov-90	Development of a Community Drainage Plan	Town	Proposal Call
2.3	b	A	Nov-90	Community Drainage Plan	Reinders	Proposal
2.3	c	A	Nov-90	Community Drainage Plan	UMA	Proposal
2.3	d	A	Dec-90	Community Drainage Plan	Dillon	Proposal
2.3	e	B	Dec-90	Community Drainage Plan	JLR	Proposal
2.3	f	B	Dec-90	Community Drainage Plan	RC	Proposal
2.3	g	B	Feb-92	Community Drainage Plan	Reinders	Final Study
2.4	a		Feb-79	Municipal Services Phase 4	DPW	Specification
2.4	b		Jun-87	Sewer and water Service Connections Summer 87	OMM	Specification
2.4	c		Mar-88	Building Lateral Service Connections	OMM	
2.4	d		May-88	Sewer and Water Service Connections Summer 88	OMM	Review Copy Specification
2.4	e		Jul-90	Extension to Services of Northern Staff Housing	UMA	Contract documents
2.5	a	A	Jan-81	Water and Sanitation	Town	Proposed Interim Service Rates
2.5	b	A	Oct-83	Sewer and Water System	OMM	Interim Tech Review
2.5	c	A	Jan-84	Sewer and Water System	OMM	Technical Review
2.5	d	A	May-89	Sewer and Water System	OMM	Operation Manuals
2.5	e	A	Nov-90	Preliminary Eng. to Plan for the Upgrading of Sewage Treatment	Town	Proposal Call
2.5	f	B	Nov-90	Sewage Treatment	Reinders	Proposal

2.5	g	B	Nov-90	Sewage Treatment System Evaluation	FSC	Proposal
2.5	h	B	Dec-90	Preliminary Plan for Upgrading Sewage Treatment	RC	Proposal
2.5	i	B	Jun-93	Sewer Monitoring Program	AGRA	Draft Report
2.5	j	B	Mar-95	Sewage Treatment Improvements	UMA	Final Report
2.6	a		Apr-89	Sewer and Water Rehabilitation	OMM	Addendum#3
2.6	b		Apr-92	Sewer Rehabilitation Inspection Manhole 80-81	AGRA	Summary of Construction
2.6	c		Nov-92	Sewer Rehabilitation Manhole 62-63	AGRA	Summary of Observations
2.7	a	A	Sep-80	Macerator Assessment	Heinke	Study
2.7	aa	D	Oct-96	Primary Sewage Treatment Facility	FSC	Proposal
2.7	ab	D	Oct-96	Utilization of Wetlands for Secondary Sewage Treatment	FSC	Proposal
2.7	ac	E	Oct-96	Wetlands Study and Primary Treatment Design	UMA	Proposal
2.7	ad	E	Oct-96	Sewage and Solid Waste Disposal	MACA	O&M Preparation
2.7	ae	E	Oct-96	Wetlands Study and Secondary Sewage Treatment	OMM	Proposal
2.7	af	E	Jan-97	Municipal Wastewater Treatment Using Residual Heat	TN conseil	Final Report
2.7	ag	E		Problems with Buried Sewers	AGRA	Study
2.7	b	A	May-81	Evaluation of Conversion from Trucked to Piped Sewer and Water	Town YK	Detailed Report
2.7	c	A	Mar-82	Water and Sanitation Program	Town	Capital Summary
2.7	d	A	Oct-82	Sewage System Evaluation	Reinders	Final Report
2.7	e	A	Jun-83	Evaluation of Piped Water, Sewage and Solid Waste Disposal	Reinders	Proposal
2.7	f	A	Jun-83	Piped Services Assessment Study	AESL	Proposal
2.7	g	A	Sep-84	The Impact of Industrial Wastewater on Municipal Facilities	RJK	Presentation Paper
2.7	h	A	Aug-85	Water Distribution and Sewage Disposal Systems	RC	Study
2.7	i	B	May-86	Dawson City Sewer and Water Installation	UMA	Technical Review Report
2.7	j	B	Dec-86	Water Sanitation Series Study	MACA	Terms of Reference
2.7	k	B	Jul-88	Sewer and Water Requirements	RC	Study
2.7	l	B	Jan-89	Sewer Collapse Problems	Hardy	Assessment
2.7	m	B	Jun-89	Sewer and Water Study	RC	Study
2.7	n	C	Jul-89	Buried Sewer Trunk Main		
2.7	o	C	Aug-89	Sewer Flushing and TV Inspection	OMM	Review Copy
2.7	p	C	Sep-89	Minor Remedial Works Sewer and Water Systems	OMM	Specification
2.7	q	C	Oct-89	Examination of Failed HDPE Stub Ends	Hanson	
2.7	r	C	Oct-90	Snowfluent Sewage Treatment	Delta	General Info
2.7	s	C	Nov-90	Engineering Plan for the Upgrading of Sewage Treatment	Town	Design Proposal Call
2.7	t	C	Jan-92	Marine Wastewater Discharge	Seaconsult	Dye Dispersion Study
2.7	u	C	Feb-92	Happy Valley Sewer Main Collapse Inspection	AGRA	Summary of Construction
2.7	v	D	Sep-93	Remediation of Collapsed HDPE Sewer Pipes	AGRA	Draft Guidelines
2.7	w	D	Feb-95	Apex Road Trunk Sewer Upgrade	UMA	Design Brief
2.7	x	D	May-95	Pang Sewage Treatment Facility	OMM	Site Review
2.7	y	D	Aug-95	Water and Sanitation Systems	DPW	Standards and Guidelines
2.7	z	D	May-96	Apex Road Sewer Trunk Main Upgrading	UMA	Contract Doc
2.8	a		Jul-87	Sewer and Water System Turnover	OMM	Study and Data Summary
2.8	b		Jan-89	Sewer and Water System Turnover	OMM	Revised Data Summary
2.8	c		Jan-89	Sewer and Water System Turnover	OMM	Revised Study
2.8	d		Apr-75	Water/Sewer and Solid Waste Collection	JLR	Interm Report

2.7 GH

2.7 & OTHER

2.8	e		May-81	Ecoomic Evaluation: Convert Trucked Services to Piped	GNWT	Report
3.1	a		Jun-83	HTHW Phase 3	WPLondon	Modification
3.1	b		Sep-89	HTHW Cost Distribution	BM	Study Final Report
3.1	c		May-92	HTHW Asbestos Abatement	BM	Specification
3.1	d		May-92	HTHW	BU	Specification
3.1	e		Jun-92	HTHW Abandonment	BM	Specification
3.2	a	A	Jan-84	Water Supply Improvements and Modifications to Lake Geraldine Dam	UMA	Specification
3.2	b	A	Aug-84	Lake Geraldine Water Supply Phase 1	OMM	Study
3.2	c	A	Jan-90	Inspecion of Dam and Water Treatment Plant for Blast Damage	Hardy	
3.2	d	A	Jun-90	Concrete Reservoir Dam	Arctic Divers	General Diving Report
3.2	e	A	Jul-90	Dam InSpecificationtion and Leakage Repair Lake Geraldine Dam	Acres	Study
3.2	f	A	Dec-94	Lake Geraldine Storage	OMM	Proposal
3.2	g	A	Feb-95	Lake Geraldine Storage	OMM	Study Report
3.2	h	B	Mar-95	Water Reservoir	RC	Design Brief
3.2	i	B	Apr-95	Lake Geraldine Storage	OMM	Revised Study Report
3.2	j	B	Apr-95	Water Reservoir	RC	Contract Doc.
3.2	k	B	Jun-95	Lake Geraldine Storage Rock Anchors	OMM	Specification
3.3	a		Apr-89	Water Booster Pumphouse Facility	UMA	Specification
3.4	a	A	Aug-77	Existing Utilidor Systems	Tom May	Report
3.4	b	A	Oct-84	Water Supply Improvements Alternatives Cost Analysist	Smyth	
3.4	c	A	Mar-87	Above Ground Water Main to Federal Building	OMM	Thermal Hydraulic Analysis
3.4	d	A	Nov-88	Fluoridation of Water Supply	Heinke	Research Report
3.4	e	A	Apr-89	Water Meter Installation	OMM	Preliminary
3.4	f	A	Apr-89	Water Meter Selection Report	OMM	
3.4	g	B	Jun-89	Utilidor Upgrade Brown Row Housing	DPW	Specification
3.4	h	B	Jan-91	Water Quality Study	Smith	Study
3.4	i	B	Dec-94	Uivvaq Recirculation Facility	RC	Proposal
3.4	j	B	Apr-95	Uivvaq Recirculation Facility	RC	Predesign Report
3.5	a	A	Sep-86	Water Treatment Plant	DPW	Evaluation Report
3.5	b	A	Nov-90	Expansion of Water Treatment and Storage Facility	RC	Proposal
3.5	c	A	Nov-90	Water Treatment Plan	Reinders	Proposal
3.5	d	A	Nov-90	Treated Water Storage and Upgrading Water Treatment Plant	Town	Proposal Call
3.5	e	A	Dec-90	Treated Water and Water Treatment Plant	UMA	Proposal
3.5	f	A	Dec-90	Treated Water Storage and Upgrading Water Treatment Plant	Stanley	Proposal
3.5	g	B	Dec-90	Treated Water Storage and Upgrading Water Treatment Plant	ADWilliams	Proposal Transmittal
3.5	h	B	Jan-94	Water Treatment Plant and Water Storage Expansion	RC	Planning Brief
3.5	i	B	Aug-94	Utilidor Water Treatment Plant to Apex Road	RC	Final Report
3.5	j	B	Apr-95	Water Treatment Plant	RC	Contract Doc
3.5	k	B	Apr-95	Water Treatment Plant Utilidor Replacement	RC	Contract Document
4.1	a		Nov-90	Road Improvements	Reinders	Proposal
4.1	b		Nov-90	Road Improvements Eng.	Associated Eng.	Proposal
4.1	c		Dec-90	Road Improvements Eng.	UMA	Proposal

4.1	d		Sep-93	Road Improvements	Reinders	Planning Study
4.2	a		Sep-88	Pedestrian Design	OMM	Specification
4.3	a		Sep-70	Surface Treatment of Roads	Nesco	Report
4.3	b		Oct-93	NWT Community Road Traffic Survey	Bryant	Executive Summary
4.3	c		Jun-83	Soils Report For Proposed Roads - Happy Valley	FSC	Report
5.1	a		Dec-80	The Design and Construction of a Sanitary Landfill	KJ	Report
5.1	b		May-91	Environmental & Geotechnical Investigation Proposed Waste Site	Hardy	Confidential
5.1	c		Aug-94	New Landfill Construction	UMA	Contract Doc
5.2	a		Feb-92	Preliminary Stage of Cleanup of Waste Sites	Town	Proposal
5.2	b		Feb-92	Decommissioning and Cleanup of Waste Site #3 in West 40	Town	Proposal
5.2	c		Nov-92	Cleanup of Waste Disposal Sites	UMA	Draft Final
5.2	d		Apr-94	Cleanup of Waste Disposal Sites	UMA	Prelim Report
5.3	a	A	Sep-77	Solid Waste Disposal	JLR	Study Prelim
5.3	b	A	Dec-83	Evaluation of Solid Waste Disposal	OMM	Report
5.3	c	A	Sep-89	Solid Waste Composition for Iqaluit, Pangnirtung and Broughton Island	MACA	Draft Study
5.3	d	A	Nov-91	Solid Waste Disposal Site	UMA	Prelim Eng. Report
5.3	e	A	Dec-91	Hazardous Waste Management Strategy	Bryant	Study
5.3	f	B	Nov-92	Abandoned Base and Waste Disposal Sites	Environ Services	Literature Review
5.3	g	B	Aug-93	Abandoned US Base and 5 Waste Sites	Northern Development	Environ Site Assessment
5.3	h	B	Aug-93	Abandoned US Airforce Base and 5 Waste Sites	Avati	Environ Site Assessment
5.3	i	B	Dec-94	Landfill Site 3 in West 40	UMA	O&M Manual
5.4	a	A	Feb-90	Solid Waste Management in Canadian Municipalities	Wallace	Survey Report
5.4	b	A	Nov-90	Solid Waste Management Plan	RC	Proposal
5.4	c	A	Nov-90	Solid Waste Management Plan	Reinders	Proposal
5.4	d	A	Nov-90	Solid Waste Management Plan	Town	Proposal Call
5.4	e	A	Dec-90	Solid Waste Management Plan	UMA	Proposal
5.4	f	B	Mar-94	Remediation Facility for Contaminated Hydrocarbon Materials	Bryant	Generic Plans
5.4	g	B	Jun-95	Waste Facility	Town	
5.4	h	B	Jun-95	Waste Facility	Town	First Report
6.0	a	A	Nov-76	Gravel Sources Phase Baffin Island	JLR	Report
6.0	b	A	Mar-85	Granular Supply	OMM	Proposal
6.0	c	A	May-85	Potential Borrow Sites Identified	OMM	Interim Report
6.0	d	A	Jan-87	Tower Arctic Claim Rock Excavation	OMM	
6.0	e	A	Jul-89	Granular Development	Hardy	Request for Proposal
6.0	f	A	Jul-89	Granular Development Planning	Hardy	Proposal
6.0	g	A	Oct-89	Refocusing of Granular Development Study	Hardy	
6.0	h	B	Nov-89	Granular Development Planning	Hardy	Prelim Draft
6.0	i	B	Jan-90	North 40 Deposits	Hardy	Prelim Development Concepts
6.0	j	B	Feb-90	Granular Management Plan	Hardy	Sources Recommended
6.0	k	B	Dec91	20 Year Granular Management Plan	Hardy	Data Report
6.0	l	B	Dec91	Granular Management Plan Winter 1990 Field Report Program	Hardy	Data Report
6.0	m	B	Jan-89	Review and Terrain Assessment Areas of Future Development	Hardy	Report

7.1	a	A	Mar-86	New Federal Building Sewer Outfall	OMM	Specifications
7.1	b	A	Jun-88	Federal Outfall Sewer Installation	OMM	Proposal
7.1	c	A	Nov-88	New Federal Building Sewer Outfall	OMM	Supply of Piping
7.1	d	A	Jan-89	Federal Building Sewer Outfall Delivery and Installation of Piping	OMM	Specifications
7.1	e	B	Mar-89	Federal Building Sewer Outfall Delivery and Installation of Piping	OMM	Master Copy Specifications
7.1	f	B	Feb-90	Federal Building Sewer Outfall Phase 2	OMM	Specification
7.1	g	B	Apr-93	Federal Building Sewer Outfall	AGRA	Geotechnical Investigation
7.2	a		Aug-87	Federal Building Sewer and Water Servicing Improvements	OMM	Draft
7.2	b		Nov-91	Federal Building Area Water and Sewage Services	RC	Economic Analysis
7.2	c		Apr-93	Federal Building Area Sewer and Water Extension Phase 2	OMM	Specification
7.4	a		Jan-82	BCC Architechtural Vol1	BF	Specification
7.4	b		Jan-82	Baffin Correctional Centre Mechanical & Electrical Vol 2	BF	Specification
7.4	c		Mar-82	BCC	BF	Project Brief
9.1	a	A	Jan-82	Arena Insulation and Liner	CCDC	
9.1	b	A	Aug-84	Roof System - Arena	CCDC	Stipulated Price Contract
9.1	c	A	Jul-85	Renovations to Municipal Arena	OMM	Plans/Specifications
9.1	d	A	Jul-89	Arena Insulation and Liner	BM	Design Proposal
9.1	e	A	Jul-89	New Floor and Ice Piping System	BM	Design Tender
9.1	f	A	Jul-89	Roof System - Arena	BM	Design Proposal
9.1	g	B	Aug-89	New Floor and Ice Piping System	BM	Specification
9.1	h	B	Oct-89	Roof System - Arena	CCDC	Stipulated Price Contract
9.1	i	B	Feb-90	Arena Renovation	BM	Specifications
9.1	j	B	Jun-90	Arena Renovations	BM	Electrical Tender Set
9.1	k	B	Jun-91	Arena Masonry Wall Evaluation	ADWilliams	Study
9.2	a	A	Jul-85	Renovations to Municipal Buildings	OMM	Specification
9.2	b	A	Aug-87	Recreational Facilities	BM	Predesign and Cost Estimate
9.2	c	A	Jan-88	Arnaitok Ipeelie Recreation Facility	FSC	Proposal
9.2	d	A	Jan-88	Arnaitok Ipeelie Recreation Facility	Barr Ryder	Proposal
9.2	e	A	Jan-88	Design of The Arnaitok Ipeelie Recreation Centre	BM	Proposal
9.2	f	A	Mar-88	Iqaluit Recreation Complex	Hardy	Site Investigation
9.2	g	B	Aug-89	Refurbishing Town Office	CCDC	Stipulated Price Contract
9.2	h	B	Sep-89	Refurbishing of Town Office	BM	Tender Set
9.2	l	B	Mar-92	Iqaluit Gymnasium	Honco	Specification
9.2	j	B	Mar-92	Iqaluit Gymnasium	Honco	Specification
9.2	k	B	Apr-97	Municipal Office Building Report and Class D Estimates (3 Copies)	ACL	Study
9.3	a		Sep-88	Road and Drainage for Mobile Home Park	Reinders	Proposal
9.3	b		Mar-90	Industrial Subdivision and Mobile Home	UMA	Proposal
9.3	c		Nov-90	Industrial Subdivision and Mobile Home Subdivision	Reinders	Proposal
9.3	d		Dec-90	Industrial Subdivision and Mobile Home Subdivision	OMM	Proposal Secondary Doc
9.3	e		Dec-90	Industrial Subdivision and Mobile Home Subdivision	SNC	Proposal
9.3	f		Dec-90	Industrial Subdivision and Mobile Home Subdivision	RC	Proposal
9.3	g		Dec-90	Industrial Subdivision and Mobile Home Subdivision	Town	Proposal Call

9.4	a		Jan-88	Qullik Business Centre	RPA	Geotechnical Evaluation
9.4	b		Apr-89	Lower Base Area	RC	Predesign Report
9.5	a		May-88	Lower Base Area Piped Services	Dillon	Proposal
9.5	b		May-88	Lower Base Area Servicing	Reinders	Proposal
9.5	c		May-88	Lower Base Area Servicing	RC	Proposal
9.5	d		May-88	Lower Base Overall Design Stage 1 Water and Sewage Servicing	UMA	Proposal
9.5	e		Jul-88	Water/Sewer Servicing Requirements and Lower Base Servicing	OMM	Proposal
9.5	f		Mar-89	Lower Base Sewer and Water Extension Phase 1	RC	Contract Doc
9.5	g		Feb-90	Lower Base Sewer and Water Extension Phase 2	RC	Contract Doc
9.6	a	A	Feb-87	Arctic College, Iqaluit Campus and Adult Education	FSC	Specification
9.6	b	A	Mar-87	Arctic College Service Extension	OMM	Design Brief
9.6	c	A	Oct-87	Arctic College Sewer and Water Servicing	DPW	Specification
9.6	d	A	Feb-90	Arctic College Site Drainage	UMA	Final Draft Report
9.6	e	B	Feb-90	Nunatta Campus	DPW	Master Plan Reports
9.6	f	B	Jul-90	Arctic College Road and Drainage Improvements	UMA	Contract Doc
10.2	a		Oct-82	Piling, Foundations, Slab and Converter Building Astro Hill	WPLondon	Specification
10.2	b		Jan-83	Proposed Town Centre Complex	Safdie	Planning Report
10.2	c		Sep-84	Space Demand Studies for Commercial and Retail Activities	RMC	Proposal
10.2	d		Aug-85	Proposal Town Center Complex	RMC	Study
10.2	e		Aug-86	Office Complex		Specifications
10.2	f		Feb-87	Geotechnical Investigation and Site Survey of Lot Near Northern	Canadrill	Drawing Incl.
10.2	g		Jun-88	CBC	CBC	Specification
11.0	a		Jun-83	Happy Valley Subdivision	FSC	Soils Report
11.0	b		Nov-85	Happy Valley Subdivision Sewer and Water Main Extension	OMM	Design Brief
11.0	c		Jan-88	Joamie School	FSC	Specification
11.0	d		Apr-83	Hillside Co-op Housing Limited	Paley-Eskilsen	Tender
12.2	a		Mar-88	New Library	Bowron	Site Selection Study
13.2	a		Mar-95	Apex Subdivision	OMM	Proposal
13.2	b		May-95	Apex Subdivision	OMM	Tender Doc
13.3	a		Sep-83	Alterations to IQDE Hall	DPW	Specification
14.0			Mar-00	Economic Baseline	ED&T	Study
14.0			Mar-00	Rural and Remote Program	NWTHC	Tender
14.0			Mar-00	Fire Marshal's Report	Town	
14.0			Mar-00	Arctic Environmental Strategy	Northern Affairs	Discussion Guide
14.0			Mar-00	Baffin Region Salinity, Pile Design Basis and Recent Pile Modifications.	Hardy	
14.0			Aug-78	Renewal of Water License	Water Board	Public Hearing
14.0			Oct-83	Renewal of Water License	Water Board	Public Hearing
14.0			May-84	District Office for the Northern Program	DPW	Specification
14.0			May-84	District Office for the Northern Program	DPWcan	Specification

14.0	Sep-84	Five Year Leisure Development Plan	UMA	Study
14.0	Mar-85	Measures for Energy Efficient Northern Housing	Energy	Commentary 3 Copies
14.0	Mar-85	Measures for Energy Efficient Northern Housing	Mines	Draft Report
14.0	Oct-85	Measures for Energy Efficient Northern Housing	Energy	Overview 3 Copies
14.0	Feb-86	Frobisher Bay General Plan	UMA	Background Report
14.0	Dec-86	Interim Data Summary	OMM	Draft
14.0	Nov-87	Land Development Process	MACA	
14.0	Apr-88	Lake Harbor Gymnasium *	BR	Specification
14.0	Oct-88	Short Range Radar Field Pile Load Test Program *	U of A	Load Test Results
14.0	Oct-88	Municipal Funding Conference	Town	Report
14.0	Nov-88	Dental Health and Fluoridation *	Heinke	Research Report
14.0	Jan-89	Terrain Assessment for Areas of Future Development	Hardy	Report
14.0	Sep-89	Interim Rates Submission	NTPC	Study
14.0	Feb-90	Polar 8 Icebreaker *	Coast Guard	Initial Environ Evaluation
14.0	Apr-90	Comparison Study of Municipalities	Gillis	Student Work
14.0	May-90	Proposed Student Hostel *	Thurber	Geotechnical Investigation
14.0	Jul-90	Executed Architectural Agreements	RC	Plans?
14.0	Dec-90	Community Infrastructure	UMA	Study
14.0	Nov-91	Partnering Proposal Between the Town and UMA	UMA	
14.0	Dec-91	Hazardous Waste Management Strategy	Bryant	Study
14.0	Aug-92	Evaluation of Canada-NWT Cooperation Agreement on Language	NWT	Data Collection
14.0	Nov-92	Recreation Master Plan	Town	Final Report
14.0	Feb-93	Conference and Trade Show on Water Conservation	Environ Can	Report
14.0	Aug-93	Community Plan and Zoning By Law Review	UMA	Proposal
14.0	Oct-93	1994 Draft Budget — NUNAVUT 16.1 K	YK	O&M Capital
14.0	Mar-95	Foot Prints in New Snow	NIC	
14.0	Jun-95	Funding Directory for Municipal Governments and Community Groups	Environ Can	
14.0	Jul-95	Zoning By-Law	Town	Draft
14.0	Aug-95	NWT Water Board Application for Renewal of License	Town	Submission
14.0	Nov-95	Gravity Water Treatment Plant Level 1 Lab-Math Course	Vista	Training Program
14.0	Dec-95	Community District Heating	Town of FS	
14.0	Dec-95	Community Works Operator	Vista	Training Program
14.0	May-96	This Month On the Municipal Scene	NWT	Report
14.0	Sep-96	Clean Burning Solutions for Global Problems	Eco Waste	Pre-Qualification Doc
14.0	Oct-96	Wetlands Study and Primary Treatment Design	OMM	Proposal
14.0	Oct-96	General Plan By Law No 370	UMA	
14.0		Arctic Foundations and Structures	FSC	Study
14.0		Water Storage Facilities in Cold Regions	DPW	Dynamic Drawdown Analysis
14.0		General Specifications	DPW	
14.0		Law Dept Overview	BF	Summary
14.0		Planning and Engineering Report Hamlet of Frobisher Bay	RC	Report
14.0	Oct-97	Byer's Gas Bar Environmental Site Assessment Phase 1/11	OMMA	Report
14.0		O & M Manual - High temp. hot water abandonment reheat stn. (book 1)		
14.0	Apr-89	O & M - Water booster pump house facility - electrical		

14.0	Apr-89	O & M - Water Booster pump house facility - Mechanical
14.0	Jun-05	O & M - Public Works Garage
14.0		O & M - Water Reservoir, Manual 6 and 1 of 6.
14.0		O & M - New Federal Building - Sewer outfall (2 copies)
14.0		House building regualtions simplified.
14.0		NBC 1990
14.0		Supplement to National Building Codes 1990
14.0		Canadian Law of Planning and Zoning
14.0		Information Manual for Consulting Engineers (Volume 2)
14.0		Safety Acts and Regulations
14.0		Guidelines for disposal of hazardous waste materials
14.0		Volker Stevin - Accident Prevention & Safety Policy
14.0		Municipal Water & Sanitation Trucked Service Contracts
14.0		Municipal Water and Wastewater rate manual.
14.0		Life Cycle costing for water storage facilities
14.0		Federal Building water and sewer extensions - Phase ii
14.0		Apex road sewer trunk main upgrade (1996)
14.0		Apex road second book.
14.0		Minor remedial works - water and sewer systems.
14.0		Sewer and water rehabilitation
14.0		Guidelines for the prep. and admin of Mun. water & san. Trucked serv. Contracts.
14.0		Coping with Guidelines in the 1990's - 4th Annual conference on Drinking Water
14.0		Water and Waste water Treatment in Canada
14.0		Guildline for Canadian Drinking Water
14.0		Stepping forward - a guide for community leaders
14.0		MACA Capital standards and criteria (2 copies)
14.0		Consolidated inuit employment plan - GNWT
14.0		Community works procedures manual
14.0		GNWT - Contract administration manual - guidelines and procedures
14.0		Baffin region ocean investigation: Contamination, chlorine, design & disinfection.
14.0		Environmental site investigation abandoned air force bases and waste facilities
14.0		Various investigation reports - Public Works
14.0		Environmental Study - military installation & waste disposal sites, Iqaluit Vol. 1 & 2
14.0		NTPC - General rate Application 95/96, 96/97
14.0		H & R Northern Supply Ltd.
14.0		Raychem - Chemelex heat tracing systems
14.0		Metcon- chemical feeding, diinfection, analytical measurement, sluice gates.
14.0		Product information manual - igloo building supplies.
14.0		Arena, Firehall and Hamlet Office - Plumbing
14.0		Arena, Firehall and Hamlet Office - Electrical
14.0		Emergency Measures
14.0		Municipality of Iqaluit - General Information
14.0		NTA Annual review
14.0		Contruction photos -lagoon reconstruction and drainage improvements 1991

14.0			Photos - 1990 - New Expansion area phase ii		
14.0			Miscellaneous project photos (1995)		
14.0			Photos - 1994 Construction		
15.2	a	Mar-89	Expansion of Buried Sewer Systems to New Expansion Area	Hardy	Report
15.2	b	Mar-89	New Expansion Area Development Phase 1	UMA	Contract Doc
15.3	a	Dec-89	New Expansion Area Development Phase 2	UMA	Proposal
15.3	b	Feb-90	Buried Services and Roads New Expansion Area Phase 2	Hardy	Report
15.3	c	Feb-90	New Expansion Area Development Phase 2	UMA	Contract Doc
15.3	d	Apr-90	New Expansion Area Development Phase 2	UMA	Tender Analysis
15.4	a	Jan-91	New Expansion Area Development Phase 3	UMA	Proposal
15.4	b	Jan-91	New Expansion Area Phase 3 Buried Services and Roads	Hardy	Report
15.4	c	Jun-91	Expansion Area Development Phase 3	UMA	Contract Doc
15.4	d	Jun-94	New Expansion Area Development Phase 3 R&G	UMA	Contract Doc
15.5	a	May-95	New Expansion Area Phase 4	OMM	
15.6	a	Oct-96	New Expansion Area Phases 5 to 9	FSC	Proposal
15.6	b	Oct-96	New Expansion Area Phases 5 to 9	RC	Proposal
15.6	c	Oct-96	New Expansion Area Phases 5 to 9	OMM	Proposal
15.6	d	Oct-96	New Expansion Area Phases 5 to 9	UMA	Proposal
15.6	e	Feb-97	Preliminary Engineering Brief New Expansion Phases V to IX	FSC	
15.6	f	Mar-97	Final Submission Engineering Brief New Expansion Area Phases V to IX	FSC	
15.7	a	Oct-87	Eng. Services for New Expansion Area	UMA	Proposal
15.7	b	Feb-88	New Expansion Area	UMA	Concept Plan
15.7	c	Jan-89	New Expansion Area	UMA	Predesign Report
15.7	d	Mar-89	Expansion of Buried Services to New Expansion Area	Hardy	
15.8	a	Jul-94	VHF/DF Relocation	OMM	Specification
16.1	a	Oct-96	Footprints2 - Report of The Nunavut Implementation Commission	NIC	Report
16.1	b	May-92	Nunavut LandClaim Agreement in Plain English	Tungavik Fed. Of Nunavut	Report
16.1	c	Jun-95	Choosing A Capital	NIC	Report
16.1	d	Sep-95	Staff Housing Nunavut Government	NIC	Report
16.1	e	Feb-97	The Future of Work in Nunavut Conference - Funding Propsal	NIC	Report
16.1	f	Mar-95	Annual Report	NIC	Report
16.1	g	Jan-	Response to Footprints 2	GNWT	Report
16.1	h	Sep-94	NIC Final Report	Muskox Program Dev. Ltd.	Report
16.1	I		Agreement Between The Inut of Nunavut & Her Majesty in Right of Canada		
17.1	a	May-85	Leisure Developmet Plan	Marshall Macklin Monaghan	Report
17.1	b	May-87	General Development Plan	UMA	Report
17.1	c	Nov-92	Recreation MASTER Plan	Marshall Macklin Monaghan	Report
17.1	d	Aug-85	Commercial/Retail Study Town Center Complex	RMC	
17.1	e	Oct-85	Commercial/Retail Study Town Center Complex	RCM	
17.1	f		Commercial/Retail Study Town Center Complex	Moshie Safdie and Assoc.	

TOWN OF IQALUIT
LANDFILL OPERATION AND MAINTENANCE MANUAL
FOR SITE 3 IN WEST 40

Prepared by:

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1.0 OPERATING PROCEDURES

1.1 HOURS OF OPERATION

The summer hours of operation of the landfill (June through September) are:

Weekdays	8:00 a.m. - 8:00 p.m.
Weekends	10:00 a.m. - 6:00 p.m.

TUES TO SAT
9:00 TO 6:00

The winter hours of operation (October through May) are:

Weekdays	9:00 a.m. - 5:00 p.m.
Weekends	12:00 noon - 4:00 p.m.

Access during off hours will not be permitted. The landfill will also be closed on public holidays, with the exception of December 26 (Boxing Day).

1.2 SITE SECURITY

The landfill is surrounded by a 3 metre chain link fence to catch windblown litter and control access. The landfill has access through one gate which must be locked when the landfill is closed. Within the landfill area the public sorting of waste or scavenging at the dumping area will not be permitted under any circumstances.

The site operator may designate other areas for sorting or scavenging.

1.3 EMERGENCY PROCEDURES

Non-routine operational response may be expected for the following events:

- uncontrolled burning;
- accidental injury;
- site closure;
- accidental disposal of hazardous waste in the landfill area;
- slope instability.

The procedures for action in the event of an emergency must be available in the site building at all times. A review of all emergency procedures and preparedness should be part of the regular safety audit (every 6 months) and changes should be made where appropriate.

1.3.1 Uncontrolled Burning

Uncontrolled burning may be defined as when burning extends beyond a 10 metre width of the dumping face.

In the event that uncontrolled burning takes place at the landfill, the operator will assess the potential danger of the burning and contact the Fire Department and/or Town Roads Department to control the fire as required.

The burning area of the landfill is located in the north cell of the site. No burning shall occur in the south cell.

During the following conditions the operator should be alert to potential danger to the adjacent tank farm and fuel line as follows:

- warm summer days when the temperature is above 15°C;
- all days between May 1st and September 30th when the wind is blowing from the northwest toward the tank farm;
- the period when the tanks are being filled.

1.3.2 Accidental Injury

If a serious accident occurs on the landfill site, the operator should report it to the Town dispatch who will decide the appropriate response. This may include requesting assistance from the Fire Department, Town Roads Department, Ambulance, Bylaw, the RCMP and/or Department of Renewable Resources.

The telephone number to report spills is: (403) 920-8130.

The operator should record the circumstances of the accident as a means for preventing reoccurrence. This information shall be reviewed as part of the regular safety audit.

1.3.3 Site Closure

It may be necessary to close the landfill for unscheduled periods. Reasons for closures may include:

- uncontrolled fires;
- discovery of hazardous waste in the landfill area;
- accidents on the site;
- severe weather.

The decision to close the facility will be made by the Town or by another appropriate authority. Where appropriate, a sign will also be posted at the gate giving the timing of the closure and public service announcements will be made on CBC radio.

1.3.4 Accidental Disposal of Hazardous Waste in the Landfill Area

In case of the accidental disposal of hazardous waste in the landfill, the operator shall contact the Town Dispatch and Supervisor and close the sluice gate at the southwest corner of the landfill. Further dumping in the area of the accidental disposal should not be permitted.

- The operator should also further investigate the waste including location and characterization.
- The Supervisor will notify other authorities if required.
- The Supervisor, in consultation with the Director of Public Works, Department of Health, and Department of Renewable Resources, will decide on how to best remove the hazardous waste and any contaminated material in a way that is in keeping with the waste type.

1.3.5 Slope Instability

Temporary slopes on the working face of the landfill should be no steeper than 2 (Horizontal) to 1 (Vertical) (34°).

1.4 NUISANCE AVOIDANCE

1.4.1 Litter Control

The control of litter is a priority in the operation of the landfill, however, litter will inevitably occur. Landfill operation will be directed towards minimizing the amount of litter generated.

Two means of litter prevention will be followed:

- All loads entering or moving on the site must be covered to reduce litter.
- At the tipping face, the portable barricades should be placed downwind to catch windblown litter.

The barricades should be cleared of litter daily. Additionally, any litter bypassing the barricades and catching in the perimeters fence should be collected monthly.

1.4.2 Noise

The landfill is located well away from the public, therefore noise is not considered to be a problem for the site.

1.4.3 Dust

The generation of dust on the landfill site should be minimized at all times.

Watering the road surface may reduce dust, but it may also increase runoff within the site if not used in the proper quantity. Site experience of the operator must be used regarding the quantity of water applied to the access roads to reduce dust. A road treatment such as calcium chloride may also be applied by the Town to stabilize the road surface.

All loads entering or travelling on the site will be covered to prevent dust or litter, and vehicles will be confined to designated haul roads.

1.4.4 Snow Accumulation

Most of the access roads within the site are perpendicular to the prevailing winds, therefore snow drifting may not be a problem. Snow collected from the site will be disposed of in the south cell adjacent to, but not blocking, the site drainage culvert. Snow will not be used as a temporary cover material.

Snow accumulation within the solid waste itself may reduce the volume available on site for disposal. Snow may mix with the solid waste and remain frozen once the waste is covered. The use of burning for the proposed site development will greatly reduce the likelihood of snow accumulation and a small burning area, will further reduce any snow accumulation because of the concentrated heat of combustion.

Drifting snow and frozen ground may also interfere with the operation of a landfill site. The following operating activities may improve winter operation:

- Portable snow fencing may be used in addition to the perimeter fencing to prevent drifting snow from interfering with the operations.
- Cover material should be stock piled for winter use.

The landfill site is graded so that melting snow will drain toward the southeast corner to exit the site at the sluice gate.

1.4.5 Pest Control

The operation of the landfill will be directed to ensure that the presence of animals is limited.

Attraction to animals will be minimized by compaction, burning and sufficient covering of waste at the end of each working day.

1.4.6 Odours

The operation of the landfill will be directed to minimize the odour from the waste where possible. Odours associated with rotting waste will be minimized by the immediate dumping and burning of waste, or the compaction of waste and primary cover material of waste.

The odours associated with burning will be managed by use of favourable wind directions during burning activities (northwest or southeast winds).

1.4.7 Bird Control

The operation of the landfill will be directed to minimize the nuisance due to the presence of birds. Bird control will be facilitated by prompt placing and burning of waste, further compaction of waste and the provision of primary cover material.

1.5 FIRE SAFETY

1.5.1 Fire Fighting Equipment

A 10 kg powder type ABC fire extinguisher will be available at the site operator's building and regularly maintained in accordance with manufacturer's recommendations.

1.5.2 Surface Fires

If the burning on site spreads rapidly beyond the designated limit (10 metre width), the area should be isolated and no one should be allowed to enter the area.

If the fire cannot be controlled, then the operator should contact the Fire Department.

The Fire Department Officer in attendance will be furnished with all known information and given assistance if required. The Fire Department will be given a copy of the manual and they will be furnished with access keys for the landfill.

The cause of any such fires will be investigated and steps taken to prevent any recurrence. The operator should keep a record of any such incident, giving details of the actions taken.

1.5.3 Subsurface Fires

Subsurface fires should be assessed for danger and may be treated as an emergency; the Fire Department should be notified immediately by the landfill operator if the fire is considered to be an emergency.

If a subsurface fire is suspected, it should be investigated immediately by excavation. If a fire is confirmed, remedial action will depend on the depth and extent. It may be possible to excavate the burning materials and extinguish them on the surface. Other measures to extinguish fires may require the isolation of the burning waste with cut-off trenches and flooding the area with water.

1.6 WASTE RECEPTION

1.6.1 Reception Procedures

The orderly reception of waste carrying vehicles is important to the operation of the facility. Upon arrival at the landfill, vehicles will form an orderly line. This will be assisted by adequate sign posting and markings.

The following information will be collected and recorded on the landfill transaction forms:

- date
- vehicle type
- mailing address (for billing purposes)
- time in
- vehicle inspection details
- driver identification
- type of waste or material
- estimated volume of waste.

1.6.2 Checking Procedures

The checking of waste entering the facility is crucial to the safe and correct operation of the landfill. The site operator will carry out random checking of waste entering the site. A minimum of 5% of the total number of loads from these sources will be inspected monthly.

The inspection will be carried out by politely asking the waste carrier to pull off of the access road. The operator will explain in more detail the purpose of segregating different wastes. The operator should then ask the waste carrier if any of his/her material fits into the category of being segregated. The operator should then request the opportunity to inspect the material.

In addition to random inspection, all waste deliveries which appear suspicious to the operator or where there is a discrepancy between the appearance and the description of the waste, the load will also be checked.

1.7 HAZARDOUS WASTE MANAGEMENT

Typical household hazardous wastes include: pesticides, paint, solvents, flammable liquids, corrosive cleaners, batteries, used oil, oil filters, and other toxic materials of unknown origin. For specific substances refer to Schedule II, List II of the Federal Legislation on the Transportation of Dangerous Goods.

1.7.1 Hazardous Waste Collection

A household hazardous waste collection program will consist of a series of collections, one in the spring and one in the fall, during which citizens will bring their household hazardous waste to designated areas for collection and preparation for disposal. The collection event will last 1 day. After each collection event, where feasible, the hazardous waste will be neutralized or recycled. Over a period of 2-4 years, the accumulated waste which cannot be neutralized or recycled will be shipped to an appropriate disposal facility in the south.

The accumulated household hazardous waste shall be placed in the on-site storage containers (sealift containers). Household hazardous waste dropped off by individuals at the landfill will be also be placed in on-site storage containers (sealift containers).

1.7.2 Hazardous Waste Storage

There are several factors to consider when storing hazardous waste, these factors include compatibility, segregation, ventilation, climate/environment, handling, security, labelling, and record keeping. The site operator should obtain WHMIS (Workplace Hazardous Material Information Sheet) information from the NWT Fire Marshall for the materials to be stored on-site.

- **Compatibility**

  The compatibility between different types of hazardous wastes must be considered before storage. The compatibility of wastes with their storage containers must also be considered. The compatibility of wastes with nearby materials and equipment is also very important, particularly when dealing with flammable wastes. The site operator should review the WHMIS for this information.

- **Segregation**

  The final destination of wastes should always be considered before storage. If recovery may be possible in the future, wastes should be stored in a manner that will allow such recovery.

- **Ventilation**

  Hazardous wastes should normally be well ventilated. Volatile materials in particular can present a serious health hazard in storage. The use of sealift containers will not accommodate good ventilation, therefore, the site operator must ventilate the storage container before entering.

  Ventilation will consist of opening the access doors one hour prior to entering, and not entering without an observer to ensure that the operator is not overcome by fumes. The observer will have communication access in the event of an emergency.

- **Climate/Environment**

If any hazardous material is stored outside, containers should be covered by a tarpaulin, and preferably placed on a impermeable base. This prevents contact of rainwater and soil, keeps of the direct sunlight, and makes clean-up of any spills or leaks easier and cheaper. The area should be curbed or diked to collect spills, leaks and precipitation. This containment area should be capable of holding at least 100% of the total volume of the stored product.

- **Handling**

The WHMIS (Workplace Hazardous Material Information Sheet) guidelines should be followed in all cases when handling hazardous materials. The site operator should obtain copies of WHMIS from the NWT Fire Marshall for the materials accepted at the site.

- **Security**

Security precautions are necessary to avoid theft, accidental discharge or harm to the public. Sealift waste containers must be closed and locked when access is not required.

- **Record Keeping**

Records must be maintained to achieve safe hazardous waste storage. If quantities and types of wastes are not recorded, serious problems may result in the future. Care should be taken to ensure that containers remain properly labelled during the entire time in Storage.

The record keeping should include the following information:

- material
- quantity total (ongoing)
- dates received.

Small quantities of materials are expected to be delivered to the site, therefore, an individual list for each material may be worthwhile.

1.8 WASTE DISPOSAL

1.8.1 Tipping Face

The operator should maintain a well defined tipping face using the portable signs and portable barricades. The width of the tipping face will be in keeping with the number of vehicles likely to be at the tipping face at any time. Waste will be placed at the brow of the tipping face, unless there are valid reasons otherwise.

At the tipping face, vehicles using different means of unloading may be segregated to reduce the turnaround time of each vehicle at the discretion of the landfill operator. The slope angle of the tipping face in each cell should be no steeper than 1(V) on 5(H).

The active areas of a solid waste disposal site should be as small as possible. This is important in providing a manageable and safe disposal site for the public and operating staff. The area for combustible wastes requires particular attention because of the potential hazards of a large fire.

Minimizing the active areas of the solid waste disposal site will also reduce the exposure of the wastes to water within the site, and reduce the potential contamination of water within the site.

1.8.2 Compaction of Waste

Compaction of waste will be undertaken to fulfil the following objectives:

- Maximize waste density, thereby ensuring the optimum use of the available air space.
- Minimize primary cover requirements.
- Reduce problems of birds.
- Assist in the reduction of odour.

On a regular basis the waste should be spread into an even layer with a bulldozer equipped with a blade or bucket and then compacted by running the bulldozer over it several times. The compacted waste should be covered with suitable cover material.

The need for compaction for the proposed site development may be reduced because of the proposed volume reduction by burning of combustible wastes. Some compaction may be necessary as the working face of the disposal areas advance from the access road in order to prepare a drivable area for vehicles. This compaction could be accomplished by heavy equipment such as a bulldozer.

1.8.3 Cover Material

The waste will be deposited within a series of clearly defined cells in order to ensure concentration of disposal operations. Material for cover will be available off-site adjacent to the landfill.

The primary covering layer should be at least 0.15 m (6 inches) thick and compacted with a bulldozer. Each layer of cover material should have a slight slope so water can drain.

1.8.4 Burning

At the beginning of each day, the combustible wastes in the disposal area may be burned if the winds and weather are favourable with regard to the tank farm adjacent to the site. Unfavourable conditions are:

- when the air temperature is above 15°C;
- when the wind is blowing from the northwest between May 1st and September 30th;
- when the tanks are being filled.

The operator will monitor the fire over the course of the day and extinguish any areas of open flame before closing the site for the day.

Fire control is an important part of the operation of the site. In order to further reduce the risk of fire at the tank farm site from sparks created by combustion at the solid waste disposal site, an operating protocol will be utilized during periods of higher risk for the tank. These periods would include:

1. filling of the tank;
2. a site spill;
3. venting of the tank during high wind.

Filling of the tank may occur between August 1, and October 31, of any year. During the months of August, the winds are predominantly from the southeast, while during the months of September and October, the winds are predominantly from the northwest. The operator will maintain contact with the tank farm operator through the Town so that he knows when the tank is filling, and when burning on the site should be temporarily suspended.

A spill on the tank farm site would be contained by the containment berm, but this open fuel would be at a greater risk of combustion. The operator will also maintain contact with the tank farm operator so that burning on the solid waste disposal site may be temporarily suspended until the spill is cleaned up.

Further burning control practices should include:

1. a minimum buffer zone of 5 m around the combustion area;
2. maintaining a reasonably small combustion area;
3. restricted public access to the burning area.

1.8.5 Waste Slope Stability

The maximum angle for waste slopes will be 5(H) on 1(V) (11°) for active areas. This slope accommodates equipment access for spreading and compacting.

The maximum angle of any slopes will be 1.5 (H) on 1 (V) (37°). These slopes may comprise a temporary condition during the initial operation of a cell.

1.8.6 Recycling

A local contractor presently operates a recycling program which processes aluminum cans and glass bottles, and serves as a means of volume reduction in addition to burning at the current site. The aluminum cans and liquor bottles will be segregated and sold to the local recycling contractor.

Recycling within the site, in addition to the current program, may entail salvaging of certain construction materials brought to the site for disposal. This material may be reused by the Town or sold. Additional recycling operations may also be feasible at some time in the future.

Lumber in lengths greater than two metres will be segregated for reuse. Shorter lengths will be segregated and cut into lengths for sale as firewood.

1.8.7 Bulky Waste Area

Bulky wastes shall be deposited in a separate area of the site. These wastes do not need to be covered, however, fill material will be required to advance the driving service of the bulky waste area.

Stacking and collapsing of cars, barrels and appliances will be undertaken where possible. Hazardous materials associated with bulky waste such as fuel must be removed, by the waste generator, prior to bringing the material to the land site.

Where feasible, bulky waste items such as appliances, barrels and waste metal shall be segregated for recycling or reuse.

1.9 ADDITIONAL LANDFILL ACTIVITIES MANAGEMENT

1.9.1 Surface Water Management

Surface water will be controlled within the site to minimize the possibility of discharging contaminated runoff. Steps have been taken to intercept possible water courses outside the landfill using ditches to move surface water away. The ditching on the site will be maintained by the Town to provide positive drainage. The site operator should observe when ponding is not draining away.

1.9.2 Scavenging Management

Uncontrolled scavenging by local residents will not be allowed at the disposal site. Uncontrolled and unauthorized scavenging is dangerous and unnecessary. Controlled access to the storage area adjacent to the landfill operator building will be allowed.

1.9.3 Spring Cleanup Operations

Once a year, after the snow has melted, the Town will organize a spring clean-up to collect loose waste around the landfill that has accumulated and was once buried by the previous winter snow.

1.10 SITE RECORDS

1.10.1 Waste Records

Details of each waste delivery will be kept in the form described in 1.6.1. Transaction forms shall be submitted to site supervisor on a biweekly basis.

1.10.2 Site Monitoring

The landfill is subject to monitoring by the Town, the NWT Water Board and the Baffin Region Health Board. These records will be maintained in a current state at the site and the Town office. The monitoring data will be shared to all these parties as it becomes available.

Sampling of runoff from the landfill site shall take place on a monthly basis (May through October) at the inlet to the discharge culvert at the southwest corner of the site. Samples shall be taken in accordance with instructions of Supervisor.

1.10.3 Site Development

Weekly records of the progress of the landfill will be maintained on site by the operator. These will chart the progress of the landfill within the planned development of each landfill cell.

An annual topographic survey of the landfill will be undertaken by the Town to provide a continuous record of site usage and to assess the site utilization. The development will also be photo documented by the Town.

1.10.4 Landfill Audit

An audit of landfill operations will be undertaken by the Town annually. This will include a record of the following:

Access Routes/Signs	On-Site Drainage	Site Office
Gates and Fencing	Disposal Operation	Equipment Storage
Waste Handling	Waste Types	Safety
Segregation	Bulky Items	Site Records
Waste Handling Equipment	Lighting	Previous Audit Information
Staffing Levels	Depth of Tipping Face	Complaints
Litter Control	Width of Tipping Face	Dust
Birds	Primary Cover	Noise
Odour	Tidiness	
Fires	Hazardous Waste Collection Handling, Storage and Disposal	

The Town will remedy any part of the operations which is not in accordance with the Operating Plan, or accepted good standards for landfill operations.

1.10.5 Activity Summary Report

A bimonthly Summary Report will be compiled by the landfill operator. The report will include the following information:

- location of active landfilling area and the activities related to cell filling;
- summary of the weather for the month;
- summary of site maintenance and litter control activities;
- summary of infractions and problems and the measures undertaken to resolve;
- summary of surveillance network point (SNP) sampling.

1.11 SPECIFIC SAFETY ITEMS

- Personal Safety Equipment and Activities
  - Always wear coveralls, water-proof and puncture-proof gloves, and safety boots.
  - Never wear working clothes home.

- Your hands should always be washed thoroughly after work, before eating, or after contact with waste.
- Stand clear of burning wastes since toxic fumes, smoke and exploding aerosol cans can be harmful.
- Never leave burning wastes with open flames at the site.
- Check with your doctor to make sure that the appropriate vaccinations have been received and that they are up to date.
- Lift with your legs, not your back.
- Do not handle hazardous wastes if you are not properly trained to do so.
- Take appropriate precautions when operating the equipment.

- Occupational Health and Safety Requirements - **Refer to GNWT Safety Act and General Safety Regulations**
- Emergency Procedures - Refer to Section 1.3.

The operator has the responsibility to make sure that all aspects of solid waste disposal are conducted safely.

2.0 MAINTENANCE

The inspection maintenance of the following site facilities will be conducted on a routine basis according to a Schedule of Maintenance that is relevant to each aspect of the operation:

- site equipment (signs, barricades, building, storage containers);
- site infrastructure (roads, drainage, fencing, berms);
- site services (lighting, telephone).

This aspect of the solid waste disposal system is frequently neglected in most NWT communities. **The maintenance aspect is one of the most important components of an solid waste disposal site.**

2.1 SITE EQUIPMENT

2.1.1 Signs and Barricades

Signs within and adjacent to the site should be inspected by the operator on a monthly basis. Signs should be inspected for wear and breakage of the mounting systems and wear of sign lettering. Any signs requiring repairs should be reported to the Supervisor so that repair may be undertaken.

Site barricades should be inspected on a monthly basis and the need for repairs should be reported to the Supervisor.

2.1.2 Building

The operator should inspect the building exterior on a monthly basis to observe any signs of general building deterioration and advise the Town of necessary repairs. Any problems with the services within the building, such as heat, light, water and lavatory, should also be reported to the Supervisor.

2.1.3 Storage Containers

The operator should inspect the exterior of the storage containers on a biweekly basis to observe and record any signs of deterioration and advise the Supervisor of observations.

2.2 SITE INFRASTRUCTURE

2.2.1 Roads

The access road for the solid waste disposal site should be maintained properly at all times. The frequent use of heavy equipment may cause the road to deteriorate significantly. Adequate road maintenance should include the following points:

- Potholes can be filled with stockpiled material.
- Roads should be reshaped as required to provide proper drainage.
- Snow should be removed as necessary and deposited in the south cell.
- Wastes fallen from the collection vehicle during hauling should be collected from the roads and surrounding areas.
- In dry weather roads should be sprayed with water to control dust.
- A good granular base should be maintained on the road.

2.2.2 Drainage

Drainage from the disposal site should be checked monthly from June through October to ensure that blockages have not developed in the swale or discharge culvert. Any blockages or ponding should be recorded and reported to the Supervisor by the operator.

2.2.3 Fencing

The operator should examine the fencing for holes and check fence posts for frost heave. Wind blown material should be removed from the fence to reduce wind loading and improve the appearance of the site.

2.2.4 Perimeter Berms

The perimeter berms of the landfill site should be inspected on a monthly basis from May through October. Any signs of erosion to the berms should be recorded and reported to the Supervisor.

2.3 SITE SERVICES

Any problems related to electricity or telephone service to the site should be reported immediately to the Supervisor, who in turn will notify NorthwesTel or NWT Power Corporation.

1060 COLLECTION AND PRESERVATION OF SAMPLES

1060 A. Introduction

It is an old axiom that the result of any testing method can be no better than the sample on which it is performed. It is not practical to specify detailed procedures for the collection of all samples here because of varied purposes and analytical procedures. More detailed information appears in connection with specific methods. This section presents general considerations, applicable primarily to chemical analyses. See appropriate sections for samples to be used in toxicity testing and microbiological or biological examinations.

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and handled in the laboratory while still accurately representing the material being sampled. This objective implies that the relative proportions or concentrations of all pertinent components will be the same in the samples as in the material being sampled, and that the sample will be handled in such a way that no significant changes in composition occur before the tests are made.

A sample may be presented to the laboratory for specific determinations with the collector taking responsibility for its validity. Often, in water and wastewater work, the laboratory conducts or prescribes the sampling program, which is determined in consultation with the user of the test results. Such consultation is essential to insure selecting samples and analytical methods that provide a true basis for answering the questions that prompted the sampling.

1. General Precautions

Obtain a sample that meets the requirements of the sampling program and handle it in such a way that it does not deteriorate or become contaminated before it reaches the laboratory. Before filling, rinse sample bottle two or three times with the water being collected, unless the bottle contains a preservative or dechlorinating agent. Depending on determinations to be performed, fill container full (most organics determinations) or leave space for aeration, mixing, etc. (microbiological analyses). For samples that will be shipped, preferably leave an air space of about 1% of container capacity to allow for thermal expansion.

Special precautions are necessary for samples containing organic compounds and trace metals. Because many constituents may be present at concentrations of micrograms per liter, they may be totally or partially lost if proper sampling and preservation procedures are not followed.

Representative samples of some sources can be obtained only by making composites of samples collected over a period of time or at many different sampling points. The details of collection vary so much with local conditions that no specific recommendations would be universally applicable. Sometimes it is more informative to analyze numerous separate samples instead of one composite so as not to obscure maxima and minima.

Sample carefully to insure that analytical results represent the actual sample composition. Important factors affecting results are the presence of suspended matter or turbidity, the method chosen for its removal, and the physical and chemical changes brought about by storage or aeration. Particular care is required when processing (grinding, blending, sieving, filtering) samples to be analyzed for trace constituents, especially metals and organic compounds. Some determinations, particularly of lead, can be invalidated by contamination from such processing. Treat each sample individually with regard to the substances to be determined, the amount and nature of turbidity present, and other conditions that may influence the results.

It is impractical to give directions covering all conditions, and the choice of technique for collecting a homogeneous sample must be left to the analyst's judgment. In general, separate any significant amount of suspended matter by decantation, centrifugation, or an appropriate filtration procedure. Often a slight turbidity can be tolerated if experience shows that it will cause no interference in gravimetric or volumetric tests and that its influence can be corrected in colorimetric tests, where it has potentially the greatest interfering effect. When relevant, state whether or not the sample has been filtered. To measure the total amount of a constituent, do not remove suspended solids but treat them appropriately.

Make a record of every sample collected and identify every bottle, preferably by attaching an appropriately inscribed tag or label. Record sufficient information to provide positive sample identification at a later date, including the name of the sample collector, the date, hour, and exact location, the water temperature, and any other data that may be needed for correlation, such as weather conditions, water level, stream flow, post-sampling handling, etc. Provide space on the label for the initials of those assuming sample custody and for the time and date of transfer. Fix sampling points by detailed description, by maps, or with the aid of stakes, buoys, or landmarks in a manner that will permit their identification by other persons without reliance on memory or personal guidance. Particularly when sample results are expected to be involved in litigation, use formal "chain-of-custody" procedures (see ¶ B.1 below), which trace sample history from collection to final reporting.

Cool hot samples collected under pressure while they are still under pressure.

Before collecting samples from distribution systems, flush lines sufficiently to insure that the sample is representative of the supply, taking into account the diameter and length of the pipe to be flushed and the velocity of flow.

Collect samples from wells only after the well has been pumped sufficiently to insure that the sample represents the groundwater source. Sometimes it will be necessary to pump at a specified rate to achieve a characteristic drawdown, if this determines the zones from which the well is supplied. Record pumping rate and drawdown.

When samples are collected from a river or stream, observed results may vary with depth, stream flow, and distance from shore and from one shore to the other. If equipment is available, take an "integrated" sample from top to bottom in the middle of the stream or from side to side at mid-depth, in such a way that the sample is integrated according to flow. If only a grab or catch

sample can be collected, take it in the middle of the stream and at mid-depth.

Lakes and reservoirs are subject to considerable variations from normal causes such as seasonal stratification, rainfall, runoff, and wind. Choose location, depth, and frequency of sampling depending on local conditions and the purpose of the investigation. Avoid surface scum.

For certain constituents, sampling location is extremely important. Avoid areas of excessive turbulence because of potential loss of volatile constituents and of potential presence of toxic vapors. Avoid sampling at weirs because such locations tend to favor retrieval of lighter-than-water, immiscible compounds. Generally, collect samples beneath the surface in quiescent areas. If composite samples are required, take care that sample constituents are not lost during compositing because of improper handling of portions being pooled. For example, casual dumping together of portions rather than addition to the composite through a submerged siphon can cause unnecessary volatilization. When necessary refrigerate the composited portions to minimize volatilization[1].

Use only representative samples (or those conforming to a sampling program) for examination. The great variety of conditions under which collections must be made makes it impossible to prescribe a fixed procedure. In general, take into account the tests or analyses to be made and the purpose for which the results are needed.

2. Safety Considerations

Because sample constituents can be toxic, take adequate precautions during sampling and sample handling. Toxic substances can enter through the skin and, in the case of vapors, through the lungs. Inadvertent ingestion can occur via direct contact with foods or by adsorption of vapors onto foods. Precautions may be limited to wearing gloves or may include coveralls, aprons, or other protective apparel. Always wear eye protection. When toxic vapors might be present, sample only in well-ventilated areas or use a respirator or self-contained breathing apparatus. In a laboratory, open sample containers in a fume hood. Never have food near samples or sampling locations; always wash hands thoroughly before handling food.[1]

If flammable organic compounds may be present, take adequate precautions. Prohibit smoking near samples, sampling locations, and in the laboratory. Keep sparks, flames, and excessive heat sources away from samples and sampling locations. Avoid buildup of flammable vapors in a refrigerator storing samples because electrical arcing at contacts of the thermostat, the door-activated light switch, or other electrical components may trigger a fire or explosion. If flammable compounds are suspected or known to be present and samples are to be refrigerated, use only specially designed *explosion-proof* refrigerators.[1]

When in doubt as to the level of safety precautions needed, consult an appropriately trained industrial hygienist. Samples with radioactive contaminants require other safety considerations; consult a health physicist.

3. Types of Samples

a. Grab or catch samples: Strictly speaking, a sample collected at a particular time and place can represent only the composition of the source at that time and place. However, when a source is known to be fairly constant in composition over a considerable period of time or over substantial distances in all directions, then the sample may be said to represent a longer time period or a larger volume, or both, than the specific point at which it was collected. In such circumstances, some sources may be represented quite well by single grab samples. Examples are some water supplies, some surface waters, and rarely, some wastewater streams.

When a source is known to vary with time, grab samples collected at suitable intervals and analyzed separately can document the extent, frequency, and duration of these variations. Choose sampling intervals on the basis of the frequency with which changes may be expected, which may vary from as little as 5 min to as long as 1 h or more. Seasonal variations in natural systems may necessitate sampling over months. When the source composition varies in space rather than time, collect samples from appropriate locations.

Use great care in sampling wastewater sludges, sludge banks, and muds. No definite procedure can be given, but take every possible precaution to obtain a representative sample or one conforming to a sampling program.

b. Composite samples: In most cases, the term "composite sample" refers to a mixture of grab samples collected at the same sampling point at different times. Sometimes the term "time-composite" is used to distinguish this type of sample from others. Time-composite samples are most useful for observing average concentrations that will be used, for example, in calculating the loading or the efficiency of a wastewater treatment plant. As an alternative to the separate analysis of a large number of samples, followed by computation of average and total results, composite samples represent a substantial saving in laboratory effort and expense. For these purposes, a composite sample representing a 24-h period is considered standard for most determinations. Under certain circumstances, however, a composite sample representing one shift, or a shorter time period, or a complete cycle of a periodic operation, may be preferable. To evaluate the effects of special, variable, or irregular discharges and operations, collect composite samples representing the period during which such discharges occur.

For determining components or characteristics subject to significant and unavoidable changes on storage, do not use composite samples. Make such determinations on individual samples as soon as possible after collection and preferably at the sampling point. Analyses for all dissolved gases, residual chlorine, soluble sulfide, temperature, and pH are examples of this type of determination. Changes in such components as dissolved oxygen or carbon dioxide, pH, or temperature may produce secondary changes in certain inorganic constituents such as iron, manganese, alkalinity, or hardness. Use time-composite samples only for determining components that can be demonstrated to remain unchanged under the conditions of sample collection and preservation.

Take individual portions in a wide-mouth bottle having a diameter of at least 35 mm at the mouth and a capacity of at least 120 mL. Collect these portions every hour—in some cases every half hour or even every 5 min—and mix at the end of the sampling period or combine in a single bottle as collected. If preservatives are used, add them to the sample bottle initially so that all portions of the composite are preserved as soon as collected. Analysis of individual samples sometimes may be necessary.

It is desirable, and often essential, to combine individual samples in volumes proportional to flow. A final sample volume of 2 to 3 L is sufficient for sewage, effluents, and wastes.

Automatic sampling devices are available; however, do not use them unless the sample is preserved as described below. Clean sampling devices, including bottles, daily to eliminate biological growths and other deposits.

c. Integrated samples: For certain purposes, the information needed is provided best by analyzing mixtures of grab samples collected from different points simultaneously, or as nearly so as possible. Such mixtures sometimes are called integrated samples. An example of the need for such sampling occurs in a river or stream that varies in composition across its width and depth. To evaluate average composition or total loading, use a mixture of samples representing various points in the cross-section, in proportion to their relative flows. The need for integrated samples also may exist if combined treatment is proposed for several separate wastewater streams, the interaction of which may have a significant effect on treatability or even on composition. Mathematical prediction of the interactions may be inaccurate or impossible and testing a suitable integrated sample may provide more useful information.

Both natural and artificial lakes show variations of composition with both depth and horizontal location. However, under many conditions, neither total nor average results are especially significant; local variations are more important. In such cases, examine samples separately rather than integrate them.

Preparation of integrated samples usually requires special equipment to collect a sample from a known depth without contaminating it with overlying water. Knowledge of the volume, movement, and composition of the various parts of the water being sampled usually is required. Therefore, collecting integrated samples is a complicated and specialized process that cannot be described in detail.

4. Reference

1. WATER POLLUTION CONTROL FEDERATION. 1986. Removal of Hazardous Wastes in Wastewater Facilities—Halogenated Organics. Manual of Practice FD-11. Water Pollution Control Fed., Alexandria, Va.

1060 B. Collection of Samples

1. Chain-of-Custody Procedures

It is essential to ensure sample integrity from collection to data reporting. This includes the ability to trace possession and handling of the sample from the time of collection through analysis and final disposition. This is referred to as chain of custody and is important in the event of litigation involving the results. Where litigation is not involved, chain-of-custody procedures are useful for routine control of sample flow.

A sample is considered to be under a person's custody if it is in the individual's physical possession, in the individual's sight, secured in a tamper-proof way by that individual, or is secured in an area restricted to authorized personnel. The following procedures summarize the major aspects of chain of custody. More detailed discussions are available.[1,2]

a. Sample labels: Use labels to prevent sample misidentification. Gummed paper labels or tags generally are adequate. Include at least the following information: sample number, name of collector, date and time of collection, and place of collection.

Affix labels to sample containers before or at the time of sampling. Fill label out with waterproof ink at time of collection.

b. Sample seals: Use sample seals to detect unauthorized tampering with samples up to the time of analysis. Use gummed paper seals that include, at least, the following information: sample number (identical with number on sample label), collector's name, and date and time of sampling. Plastic shrink seals also may be used.

Attach seal in such a way that it is necessary to break it to open the sample container. Affix seal to container before sample leaves custody of sampling personnel.

c. Field log book: Record all information pertinent to a field survey or sampling in a bound log book. As a minimum, include the following in the log book: purpose of sampling; location of sampling point; name and address of field contact; producer of material being sampled and address, if different from location; and type of sample. If sample is wastewater, identify process producing waste stream. Also provide suspected sample composition, including concentrations; number and volume of sample taken; description of sampling point and sampling method; date and time of collection; collector's sample identification number(s); sample distribution and how transported; references such as maps or photographs of the sampling site; field observations and measurements; and signatures of personnel responsible for observations. Because sampling situations vary widely no general rule can be given as to the information to be entered in the log book. It is desirable to record sufficient information so that one could reconstruct the sampling without reliance on the collector's memory. Protect the log book and keep it in a safe place.

d. Chain-of-custody record: Fill out a chain-of-custody record to accompany each sample or group of samples. The record includes the following information: sample number; signature of collector; date, time, and address of collection; sample type; signatures of persons involved in the chain of possession; and inclusive dates of possession.

e. Sample analysis request sheet: The sample analysis request sheet accompanies sample to the laboratory. The collector completes the field portion of such a form that includes most of the pertinent information noted in the log book. The laboratory portion of such a form is to be completed by laboratory personnel and includes: name of person receiving the sample, laboratory sample number, date of sample receipt, and determinations to be performed.

f. Sample delivery to laboratory: Deliver sample to laboratory as soon as practicable. Accompany sample with chain-of-custody record and a sample analysis request sheet. Deliver sample to sample custodian.

g. Receipt and logging of sample: In the laboratory, the sample custodian receives the sample and inspects its condition and seal, reconciles label information and seal against the chain-of-custody record, assigns a laboratory number, logs sample in the labo-

ratory log book, and stores it in a secured storage room or cabinet until it is assigned to an analyst.

b. Assignment of sample for analysis: The laboratory supervisor usually assigns the sample for analysis. Once in the laboratory, the supervisor or analyst is responsible for the sample's care and custody.

2. Sampling Methods

a. Manual sampling: Manual sampling involves no equipment but may be unduly costly and time-consuming for routine or large-scale sampling programs.

b. Automatic sampling: Automatic samplers can eliminate human errors in manual sampling, can reduce labor costs, may provide the means for more frequent sampling,[3] and are used increasingly. Be sure that the automatic sampler does not contaminate the sample. For example, plastic components may be incompatible with certain organic compounds that are soluble in the plastic parts. If sample constituents are generally known, contact the manufacturer of an automatic sampler regarding potential incompatibility of plastic components. Manual sampling with a glass container and in accordance with appropriate safety procedures may be best.[3]

Program an automatic sampler in accordance with sampling needs. Carefully match pump speeds and tubing sizes to the type of sample to be taken.

3. Sample Containers

The type of sample container used is of utmost importance. Containers typically are made of plastic or glass, but one material may be preferred over the other. For example, silica and sodium may be leached from glass but not plastic, and trace levels of metals may sorb onto the walls of glass containers.[4] For samples containing organics, avoid plastic containers except those made of fluorinated polymers such as polytetrafluoroethylene (TFE).[3]

From samples containing volatile organics some compounds may dissolve into the walls of plastic containers or such compounds may even leach substances from the plastic. Container failure due to breakdown of the plastic is possible. Some organics are compatible with certain plastics (see manufacturer's literature). However, even if compatibility is assured, recognize that the walls of a plastic container can be porous to volatile organics. Glass containers generally are preferred with volatile organics.[3] Container caps, typically plastic, also can be a problem with organics. Use foil or TFE liners. Serum vials with TFE-lined rubber or plastic septa are useful.

4. Number of Samples

Given the random variations in both an analytical procedure and the occurrence of a constituent at a point of sampling, a single sample may be insufficient for a desired level of uncertainty. If an overall standard deviation is known, the required number of samples may be established by the following relationship:[4]

$$N \cong \left(\frac{ts}{U}\right)^2$$

where:

N = number of samples,
t = Student-t statistic for a given confidence level
s = overall standard deviation, and
U = acceptable level of uncertainty.

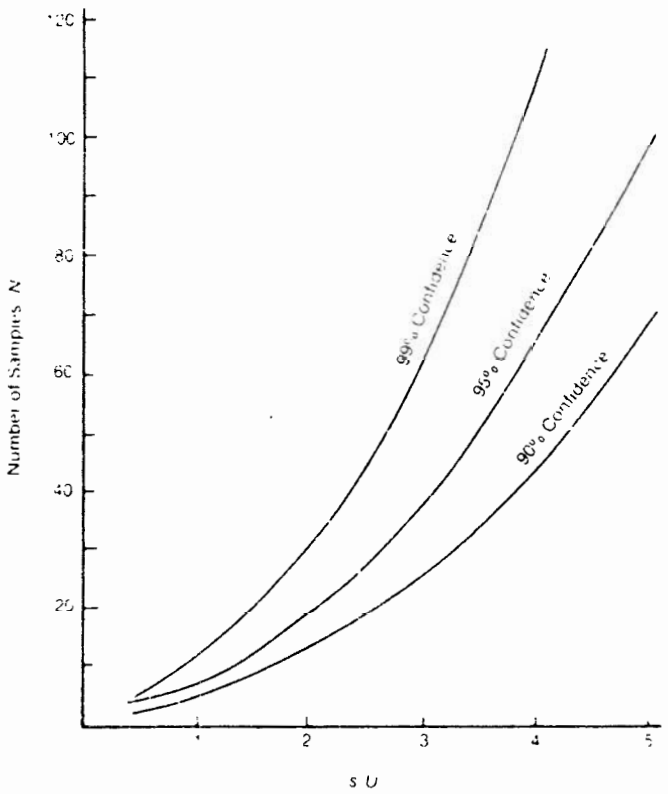

Figure 1060:1. Approximate number of samples required in estimating a mean concentration. Source: Methods for the Examination of Waters and Associated Materials: General Principles of Sampling and Accuracy of Results. 1980. Her Majesty's Stationery Off., London, England.

To assist in calculations, use curves such as those in Figure 1060:1. As an example, if s is 0.5 mg/L, U is ± 0.2 mg/L, and a 95% confidence level is desired, approximately 25 to 30 samples must be taken.

5. Quantity

Collect a 2-L sample for most physical and chemical analyses. For certain determinations, larger samples may be necessary. Table 1060:I shows the volumes ordinarily required for analyses.

Do not use the same sample for chemical (organic and inorganic), bacteriological, and microscopic examinations because methods of collecting and handling are different.

6. References

1. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1986. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd ed. Publ. No. SW-846. Office of Solid Waste and Emergency Response, Washington, D.C.
2. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1982. NEIC Policies and Procedures. EPA-330/9/78/001/-R (rev. 1982).
3. WATER POLLUTION CONTROL FEDERATION. 1986. Removal of Hazardous Wastes in Wastewater Facilities—Halogenated Organics. Manual of Practice FD-11. Water Pollution Control Fed., Alexandria, Va.
4. Methods for the Examination of Waters and Associated Materials: General Principles of Sampling and Accuracy of Results. 1980. Her Majesty's Stationery Off., London, England.

TABLE 1060:I. SUMMARY OF SPECIAL SAMPLING OR HANDLING REQUIREMENTS*

Determination	Container	Minimum Sample Size *mL*	Preservation	Maximum Storage Recommended/ Regulatory†
Acidity	P, G(B)	100	Refrigerate	24 h/14 d
Alkalinity	P, G	200	Refrigerate	24 h/14 d
BOD	P, G	1000	Refrigerate	6 h/48 h
Boron	P	100	None required	28 d/6 months
Bromide	P, G	—	None required	28 d/28 d
Carbon, organic, total	G	100	Analyze immediately; or refrigerate and add HCl to pH<2	7 d/28 d
Carbon dioxide	P, G	100	Analyze immediately	stat/N.S.
COD	P, G	100	Analyze as soon as possible, or add H_2SO_4 to pH<2; refrigerate	7 d/28 d
Chlorine, residual	P, G	500	Analyze immediately	0.5 h/stat
Chlorine dioxide	P, G	500	Analyze immediately	0.5 h/N.S.
Chlorophyll	P, G	500	30 d in dark	30 d/N.S.
Color	P, G	500	Refrigerate	48 h/48 h
Conductivity	P, G	500	Refrigerate	28 d/28 d
Cyanide:				
Total	P, G	500	Add NaOH to pH>12, refrigerate in dark	24 h/14 d; 24 h if sulfide present
Amenable to chlorination	P, G	500	Add 100 mg $Na_2S_2O_3$/L	stat/14 d; 24 h if sulfide present
Fluoride	P	300	None required	28 d/28 d
Hardness	P, G	100	Add HNO_3 to pH<2	6 months/6 months
Iodine	P, G	500	Analyze immediately	0.5 h/N.S.
Metals, general	P(A), G(A)	—	For dissolved metals filter immediately, add HNO_3 to pH<2	6 months/6 months
Chromium VI	P(A), G(A)	300	Refrigerate	24 h/24 h
Copper by colorimetry*				
Mercury	P(A), G(A)	500	Add HNO_3 to pH<2, 4°C, refrigerate	28 d/28 d
Nitrogen:				
Ammonia	P, G	500	Analyze as soon as possible or add H_2SO_4 to pH<2, refrigerate	7 d/28 d
Nitrate	P, G	100	Analyze as soon as possible or refrigerate	48 h/48 h (28 d for chlorinated samples)
Nitrate + nitrite	P, G	200	Add H_2SO_4 to pH<2, refrigerate	none/28 d
Nitrite	P, G	100	Analyze as soon as possible or refrigerate	none/48 h
Organic, Kjeldahl	P, G	500	Refrigerate; add H_2SO_4 to pH<2	7 d/28 d
Odor	G	500	Analyze as soon as possible; refrigerate	6 h/N.S.
Oil and grease	G, wide-mouth calibrated	1000	Add H_2SO_4 to pH<2, refrigerate	28 d/28 d
Organic compounds:				
Pesticides	G(S), TFE-lined cap	—	Refrigerate; add 1000 mg ascorbic acid/L if residual chlorine present	7 d/7 d until extraction; 40 d after extraction
Phenols	P, G	500	Refrigerate, add H_2SO_4 to pH<2	*/28 d
Purgeables by purge and trap	G, TFE-lined cap	50	Refrigerate; add HCl to pH < 2; add 1000 mg ascorbic acid L if residual chlorine present	7 d/14 d
Oxygen, dissolved:	G, BOD bottle	300		
Electrode			Analyze immediately	0.5 h/stat
Winkler			Titration may be delayed after acidification	8 h/8 h
Ozone	G	1000	Analyze immediately	0.5 h/N.S.
pH	P, G	—	Analyze immediately	2 h/stat
Phosphate	G(A)	100	For dissolved phosphate filter immediately; refrigerate	48 h/N.S.
Salinity	G, wax seal	240	Analyze immediately or use wax seal	6 months/N.S.
Silica	P	—	Refrigerate, do not freeze	28 d/28 d
Sludge digester gas	G, gas bottle	—	—	N.S.
Solids	P, G	—	Refrigerate	7 d/2–7 d; see cited reference
Sulfate	P, G	—	Refrigerate	28 d/28 d
Sulfide	P, G	100	Refrigerate; add 4 drops 2*N* zinc acetate/100 mL; add NaOH to pH>9	28 d/7 d
Taste	G	500	Analyze as soon as possible; refrigerate	24 h/N.S.
Temperature	P, G	—	Analyze immediately	stat/stat
Turbidity	P, G	—	Analyze same day; store in dark up to 24 h, refrigerate	24 h/48 h

* See text for additional details. For determinations not listed, use glass or plastic containers; preferably refrigerate during storage and analyze as soon as possible. Refrigerate = storage at 4°C, in the dark. P = plastic (polyethylene or equivalent); G = glass; G(A) or P(A) = rinsed with 1 + 1 HNO_3; G(B) = glass, borosilicate; G(S) = glass, rinsed with organic solvents; N.S. = not stated in cited reference; stat = no storage allowed; analyze immediately.

† Environmental Protection Agency, Rules and Regulations, *Federal Register* 49; No. 209, October 26, 1984. See this citation for possible differences regarding container and preservation requirements..

1060 C. Sample Preservation

Complete and unequivocal preservation of samples, whether domestic wastewater, industrial wastes, or natural waters, is a practical impossibility. Regardless of the sample nature, complete stability for every constituent never can be achieved. At best, preservation techniques only retard chemical and biological changes that inevitably continue after sample collection.

1. Sample Storage before Analysis

a. Nature of sample changes: Some determinations are more likely than others to be affected by sample storage before analysis. Certain cations are subject to loss by adsorption on, or ion exchange with, the walls of glass containers. These include aluminum, cadmium, chromium, copper, iron, lead, manganese, silver, and zinc, which are best collected in a separate clean bottle and acidified with nitric acid to a pH below 2.0 to minimize precipitation and adsorption on container walls.

Temperature changes quickly; pH may change significantly in a matter of minutes; dissolved gases (oxygen, carbon dioxide) may be lost. Determine temperature, pH, and dissolved gases in the field. With changes in the pH-alkalinity-carbon dioxide balance, calcium carbonate may precipitate and cause a decrease in the values for calcium and for total hardness.

Iron and manganese are readily soluble in their lower oxidation states but relatively insoluble in their higher oxidation states; therefore, these cations may precipitate or they may dissolve from a sediment, depending on the redox potential of the sample. Microbiological activity may be responsible for changes in the nitrate-nitrite-ammonia content, for decreases in phenol concentration and in BOD, or for reducing sulfate to sulfide. Residual chlorine is reduced to chloride. Sulfide, sulfite, ferrous iron, iodide, and cyanide may be lost through oxidation. Color, odor, and turbidity may increase, decrease, or change in quality. Sodium, silica, and boron may be leached from the glass container. Hexavalent chromium may be reduced to chromic ion.

Biological changes taking place in a sample may change the oxidation state of some constituents. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well-known nitrogen and phosphorus cycles are examples of biological influences on sample composition.

Zero head-space is important in preservation of samples with volatile organics. Avoid loss of volatile materials by collecting sample in a completely filled container. Achieve this by overfilling bottle before capping or sealing. Serum vials with septum caps are particularly useful in that a sample portion for analysis can be taken through the cap by using a syringe.[1]

b. Time interval between collection and analysis: In general, the shorter the time that elapses between collection of a sample and its analysis, the more reliable will be the analytical results. For certain constituents and physical values, immediate analysis in the field is required. For composited samples it is common practice to use the time at the end of composite collection as the sample collection time.

It is impossible to state exactly how much elapsed time may be allowed between sample collection and analysis; this depends on the character of the sample, the analyses to be made, and the conditions of storage. Changes caused by growth of microorganisms are greatly retarded by keeping the sample in the dark and at a low temperature. When the interval between sample collection and analysis is long enough to produce changes in either the concentration or the physical state of the constituent to be measured, follow the preservation practices given in Table 1060:I. Record time elapsed between sampling and analysis, and which preservative, if any, was added.

2. Preservation Techniques

To minimize the potential for volatization or biodegradation between sampling and analysis, keep samples as cool as possible without freezing. Preferably pack samples in crushed or cubed ice or commercial ice substitutes before shipment. Avoid using dry ice because it will freeze samples and may cause glass containers to break. Dry ice also may effect a pH change in samples. Keep composite samples cool with ice or a refrigeration system set at 4°C during compositing. Analyze samples as quickly as possible on arrival at the laboratory. If immediate analysis is not possible, storage at 4°C is recommended for most samples.[1]

Use chemical preservatives only when they are shown not to interfere with the analysis being made. When they are used, add them to the sample bottle initially so that all sample portions are preserved as soon as collected. No single method of preservation is entirely satisfactory; choose the preservative with due regard to the determinations to be made. Because a preservation method for one determination may interfere with another one, samples for multiple determinations may need to be split and preserved separately. All methods of preservation may be inadequate when applied to suspended matter. Because formaldehyde affects so many analyses, do not use it.

Methods of preservation are relatively limited and are intended generally to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce volatility of constituents.

Preservation methods are limited to pH control, chemical addition, the use of amber and opaque bottles, refrigeration, filtration, and freezing. Table 1060:I lists preservation methods by constituent.

The foregoing discussion is by no means exhaustive and comprehensive. Clearly it is impossible to prescribe absolute rules for preventing all possible changes. Additional advice will be found in the discussions under individual determinations, but to a large degree the dependability of an analytical determination rests on the experience and good judgment of the person collecting the sample.

3. Reference

1. WATER POLLUTION CONTROL FEDERATION. 1986. Removal of Hazardous Wastes in Wastewater Facilities—Halogenated Organics. Manual of Practice FD-11, Water Pollution Control Fed., Alexandria, Va.

4. Bibliography

KEITH, L.H., ed. 1988. Principles of Environmental Sampling. ACS Professional Reference Book, American Chemical Soc.