HAMLET of POND INLET
NUNAVUT TERRITORY

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May 5, 2005

Executive Director
Nunavut Water Board
PO Box 119,
Gjoa Haven, NU XOB 1JO

Att'n: Philippe di Pizzo

Re: Licence No. NWB3PON0409/As Built Drawing And O&M manual:

Please find one set of Operation and Maintenance Manual and AS Built Drawing submitted for your requirements as set out in the water license issued to the Hamlet of Pond Inlet in regards to Sewage Treatment Lagoon sub-Grade Drainage Modification (Part E, Item 1).

We have been notified that the facility is now ready for being used by the Hamlet for Domestic Sewage disposal at any time as per its convenience in accordance with the conditions set out in the license.

Please do not hesitate to contact our office should you need further informations.

Trust the foregoing is in order.

Sincerely

Jake Anaviapik
Interim Senior Administrative Officer.

Cc: David Qamaniq, Mayor
Jonathan Palluq, Asst. Regional Director, CGS, Pond Inlet
- WATER RESOURCES OFFICER, INAC /IQALUIT

Hamlet of Pond Inlet Operations and Maintenance Manual

Sewage Lagoon Facility

March 07, 2005

Final

Hamlet of Pond Inlet
Operations and Maintenance Manual
Sewage Lagoon Facility

02-1089

Dave Darch - Project Manager

Submitted by

Dillon Consulting Limited

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1.0 INTRODUCTION

1.1 Purpose

This manual has been produced to assist the Hamlet of Pond Inlet personnel in the proper operation and maintenance of the Hamlet's sewage disposal facilities. The manual has been developed based on the "Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities" (MACA, 1996). It fulfils Item C of Part II of the current Pond Inlet Water License (#NWB3PON0409). A copy of the water license is found in Appendix A.

1.2 Site Setting

The community of Pond Inlet is located at the northern end of Baffin Island, in Eclipse Sound (Figure 1). The climate of Pond Inlet is cold, with mean temperatures of 16°C in July and -24°C in January. Precipitation is generally low to moderate, averaging between 250 and 500 mm per year. For approximately 8 months of the year, snow and ice cover persist. Pond Inlet is located in a zone of permafrost.

1.3 Population Projection

The current population of Pond Inlet is approximately 1400 people. Population projections were accessed through the Government of Nunavut website (http://www.gov.nu.ca/popprojections.pdf), and can be found in Table 1.

Table 1: Population of Pond Inlet

Year	2000	2005	2010	2015	2020
Population	1314	1532	1761	1999	2233

1.4 Contact List

The Hamlet of Pond Inlet has a Maintenance Management Operation System (MMOS) in place. Regular maintenance will be conducted as outlined in this manual, and specific work orders for the sewage and solid waste facility will be passed through the MMOS. The individuals responsible for the operation of the sewage waste disposal facilities in Pond Inlet are the following:

Senior Administrative Officer	867-899-8934
Public Works Supervisor	867-899-8813
Hamlet of Pond Inlet Maintenance (shop)	867-899-8939

2.0 BACKGROUND

2.1 General

2.1.1 Sewage Treatment Facility

The Pond Inlet sewage lagoon was commissioned in 1996, and is located approximately 1.6 road km south-east of the Hamlet (figure 2). The municipal solid waste and bulky waste sites are situated at this site as well.

The Pond Inlet lagoon is an irregular shaped, six-sided earthen fill structure, with overall dimensions of approximately 300m by 150 m. It is classified as an annual retention lagoon, and operates with the fill and draw method. When the lagoon is full, it is discharged (draw-down) over a period of a few days to a point where it will take one year to fill again. The lagoon is usually decanted in the fall, just before freeze-up.

Since it was commissioned in 1996, the lagoon has had problems with seepage and longitudinal cracking. Problems with the pond base are attributed to the soil type in which the structure was built. The original design called for the lagoon to be built over soil which had been scarified to a depth of 150 mm to 200 mm. The site chosen is a glacial rubble field, covered with 300 mm+ rocks layered over each other. The rubble made it impossible to scarify the soil prior to construction. This divergence from the original design has resulted in the seepage and cracking of the lagoon structure.

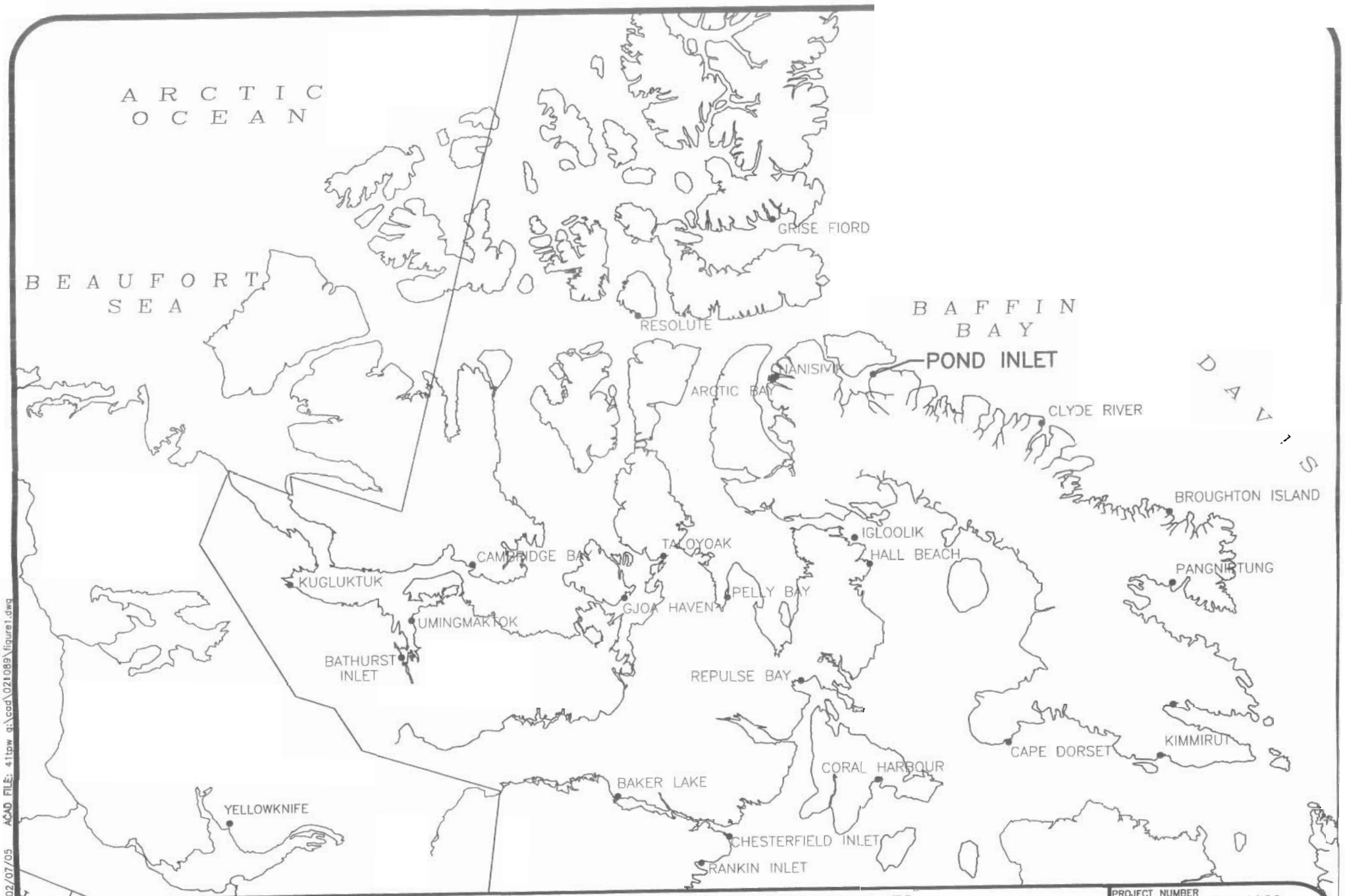
Extensive rehabilitation of the site was undertaken in the summer of 2003/2004 (Appendix B). A variety of measures were taken to repair and rehabilitate the integrity of the lagoon. These included:

- Drainage of lagoon
- Placement of GCL
- Re-compact existing north dyke and raise all perimeter dykes
- Install French drain system and trenches
- Improve turn-around area

The lagoon was lined with a Bentomat® ST liner, which is a standard GCL consisting of a layer of Volclay® sodium bentonite encapsulated between two geotextiles, needlepunched together for maximum performance under a wide variety of field conditions. This integrated matrix of bentonite and needlepunced fibers provides high shear strength and allows Bentomat to maintain low permeability. Bentomat ST has a woven, slit-film upper geotextile for maximizing intimate contact in composite liner systems (Appendix D).

2.1.2 Sewage Collection and Transport

Sewage is collected from the community by vacuum truck seven days a week and disposed at the sewage lagoon. The number of trips to and from the community during those days can vary from one to four. The trucks discharge the sewage using the off-load chute located at the southwest corner of the lagoon (photo in Appendix B). The off-load chute consists of two halves of 800 mm diameter nestable culverts, and to avoid scouring of the lagoon base due to sewage discharge at the off load chute, rip-rap of 600 mm thickness has been laid over a galvanized sheet (figure 3).



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DILLON CONSULTING

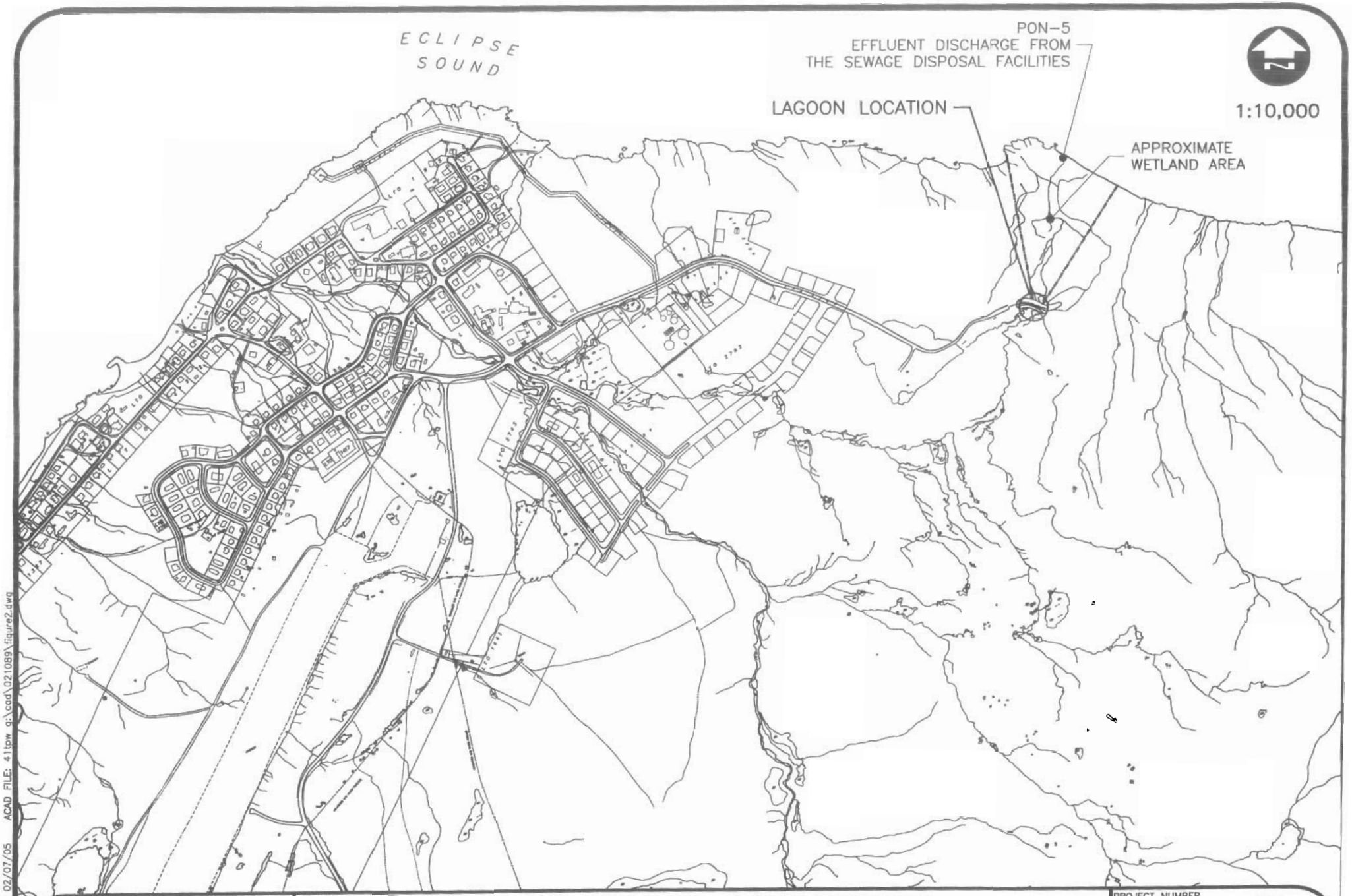
PROJECT: POND INLET SEWAGE LAGOON UPGRADES
POND INLET, NUNAVUT

TITLE: LOCATION MAP

PROJECT NUMBER: 02-1089

DATE: FEBRUARY 2005

FIGURE NUMBER: FIGURE 1



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DILLON CONSULTING

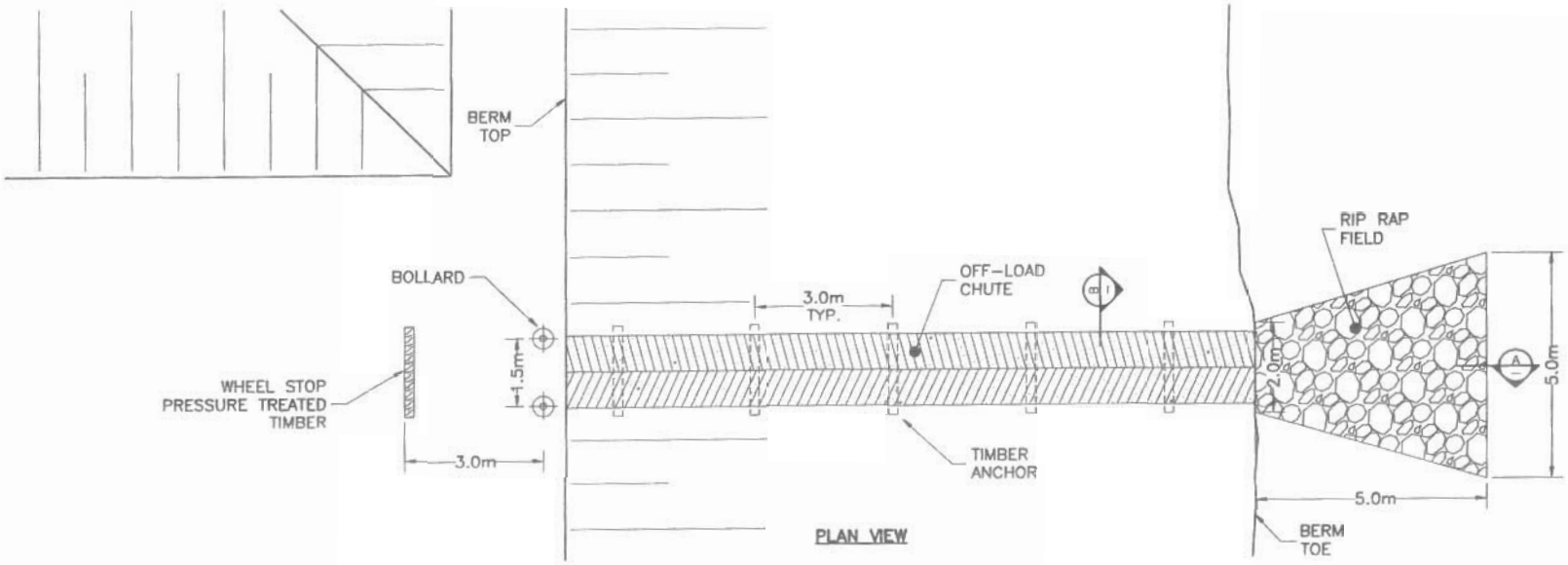
PROJECT: POND INLET SEWAGE LAGOON UPGRADES
POND INLET, NUNAVUT

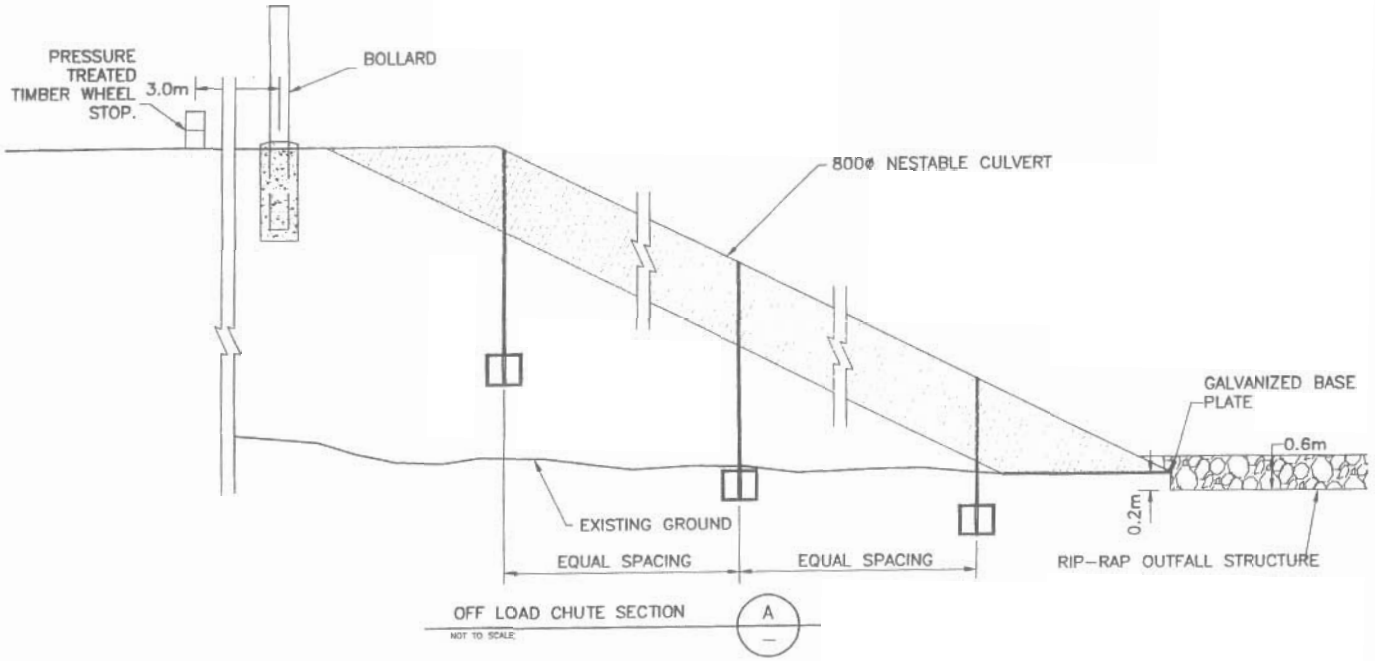
TITLE: LAGOON LOCATION MAP

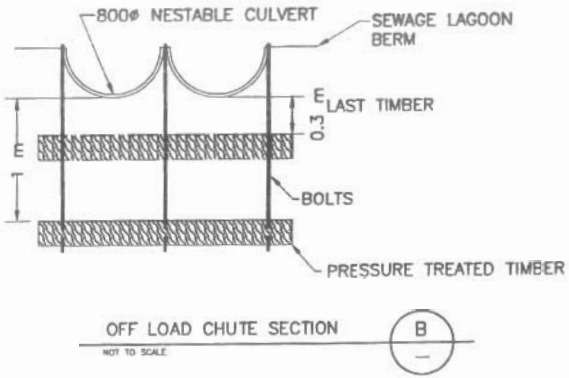
PROJECT NUMBER: 02-1089

DATE: FEBRUARY 2005

FIGURE NUMBER: FIGURE 2







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DILLON CONSULTING

PROJECT	POND INLET SEWAGE LAGOON UPGRADES POND INLET, NUNAVUT
TITLE	OFF LOAD CHUTE DETAILS
PROJECT NUMBER	02-1089
DATE	FEBRUARY 2004
FIGURE NUMBER	FIGURE 3

2.2 Sewage Production

In smaller communities where water delivery is provided by trucks, it can be assumed that sewage generation is equal to water consumption. Therefore, the daily and annual sewage generation rates for Pond Inlet are approximately equal to water consumption rates. The following equation was used to estimate the water consumption in communities of less than 2000 with trucked water (used by Dillon in the 2000 Planning Study, provided by MACA). The base rate of 90 L/c/d is based on residential trucked water delivery and sewage pumpout collection for communities in the Northwest Territories (Heinke et al., 1988).

$$\text{Water use (L/c/d)} = 90 \text{ L/c/d} \times (1.0 + 0.00023 \times \text{Population})$$

Using the projected population estimates in Table 1, the projected sewage generation rates are shown below, in Table 2.

Table 2: Projected Sewage Generation Rates

Year		Population	Sewage Generation Rate (L/c/d)	Annual General Rate (m^3/yr)
2000		1314	117.2	56,000
2005		1532	121.7	63,000
2010		1761	126.5	81,000
2015		1999	131.3	96,000
2020		2233	136.2	111,000

The physical, chemical and biological characteristics of sewage are referred to as its composition. In communities where water delivery/sewage collection is by truck, the ratio of residential or commercial/industrial input is very high. Sewage composition is essentially "domestic" in nature. As no samples have been collected from the untreated effluent at the existing treatment lagoon at Pond Inlet, the exact composition of the sewage is currently unknown. However, the composition can be inferred from the published data on "typical" domestic sewage generated in small communities, as presented in Table 3. The data were obtained from Tchobanoglous and Burton (1991), but similar values were quoted in the Vista report (1994) and in a 1995 report by Dillon, entitled "Sewage Treatment Using Tundra Wetlands". Based on these concentrations, the trucked domestic sewage can be considered strong.

Table 3: Typical Residential Wastewater Composition

Parameter	Concentration (mg/L)
5-day Biological Oxygen Demand (BOD_5)	400
Total Suspended Solids (TSS)	350
Volatile Suspended Solids (VSS)	275
Ammonia (NH_3)	50
Total Phosphorous (TP)	15
Total coliforms (TC)	$10^8 - 10^9$ CFU/dL

3.0 SEWAGE SYSTEM

3.1 Manual Organization

This section of the manual was developed to present operational and maintenance procedures to designated operators of the wastewater treatment facility in Pond Inlet. Each set of procedures is explained individually. The final section of the manual provides a summary of operational and maintenance procedures broken down into daily, weekly, monthly and annual tasks.

3.2 Equipment

The equipment required to operate the Pond Inlet sewage treatment system consists of four freighter liner, tandem axel sewage trucks.

3.3 Site Personnel

The Senior Administrative Officer (SAO) has the overall responsibility for the waste disposal site, and oversees the employees working at the site. The day-to-day operation and maintenance of the facility is the responsibility of the Public Works Supervisor. Several people are employed by the Hamlet to operate the sewage collection vehicles.

3.4 Operational Procedures

These procedures must be carried out frequently to ensure smooth operation of the treatment system.

3.4.1 Basic Operations

Sewage Collection

Wastewater in Pond Inlet is collected from privies/holding tanks at each residence or commercial building. The truck operator is responsible for sewage collection along a certain route. At each destination, the operator uncoils the intake hose located at the rear of the truck. This hose is then connected to the outlet pipe, where it is clamped in place. Once the clamp is secured, the operator activates the intake pump, removing the wastewater from the storage tanks. Once the storage tank is empty, the operator loosens the clamp and recoils the intake hose.

Sewage Disposal

Throughout the year, the wastewater is discharged into the southwest corner of the lagoon, at the off load chute. The sewage truck backs up to the lagoon (two bollards are present for safety purposes) and the valve is opened. Wastewater is discharged into the lagoon, at the off-load chute. To avoid the splashing of sewage during disposal, the sewer truck operator must ensure that the outlet hose is positioned in the centre and inside of either 800 mm nestable culverts.

Decanting

The effluent remains in the lagoon for approximately 12 months (allowing the natural break-down of organic waste). Discharge occurs once a year, with the decanting of the lagoon onto a nearby wetland. Because of the lagoon design, it is very important that the operator follow the decanting procedures outlined under section 3.6 (Operational and Maintenance Summary).

The Nunavut Water Board (NWB) requires notification at least 10 days prior to initiating any decant of the sewage lagoon. All effluent discharged from the Sewage Disposal Facility at "Monitoring Program" Station Numbers PON-4 and PON-5 must meet the following effluent quality standards:

Parameter	Maximum Average Concentration
Faecal Coliforms	1 x 10^6 CFU/dl
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	between 6 and 9

3.4.2 General Sampling Guidelines

Monitoring the wastewater effluent is an important step in the efficient operation of the wastewater treatment system in Pond Inlet and is required by the NWB. All sampling, sample preservation and analyses shall be in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*.

All routine samples containers, labels and preservation chemicals will be provided by the Environmental Lab. Appropriate precautions must be taken when using chemical preservations. In general, avoid inhaling fumes and contact with skin, eyes and clothing.

Water Samples

- Fill the bottles leaving enough room to add the preservatives, if required, an allow for mixing, unless "No Headspace" is specified.
- For parameters where "No Headspace" is required, it is important to minimize air bubbles in the sample. Fill each container carefully until the meniscus forms above the lip. Tighten the lid down over the meniscus. If any significant air bubbles are visible, the sample should be recollected using a fresh container.
- Sample preservation should be performed immediately upon collection. If preservation is not possible, keep samples cold (4°C) and deliver them to the lab as soon as possible.
- **If preservatives have already been added to the container (this will be indicated on the label) DO NOT RINSE the containers prior to filling them.**

For All Samples

- Seal sample containers well
- Label all sample containers clearly with non-removable markings.
- **Keep all water, soil and sediment samples cold (4°C) but avoid freezing unless otherwise instructed. Biota samples should be frozen.**
- Complete sample submission or chain of custody forms with all information requested.
- Pack the samples carefully in a transport cooler or box, to avoid sample breakage.
- Send the samples to the lab as soon as possible after collection.

3.4.3 Record Keeping

Records should be kept to assist in planning for yearly operations and to assist in the evaluation of the effectiveness of the sewage treatment facility. Sample log sheets are available in Appendix C. The records should be stored in the Hamlet Office and be maintained by the Municipal Works Supervisor. As a minimum, the following information should be recorded:

- The number of trips the sewage truck makes to the site per day and the approximate volume of sewage discharged to the system,
- The dates any monitoring is conducted,
- The results of the monitoring program,
- Any maintenance activities carried out on the facility.

3.4.4 Special Considerations

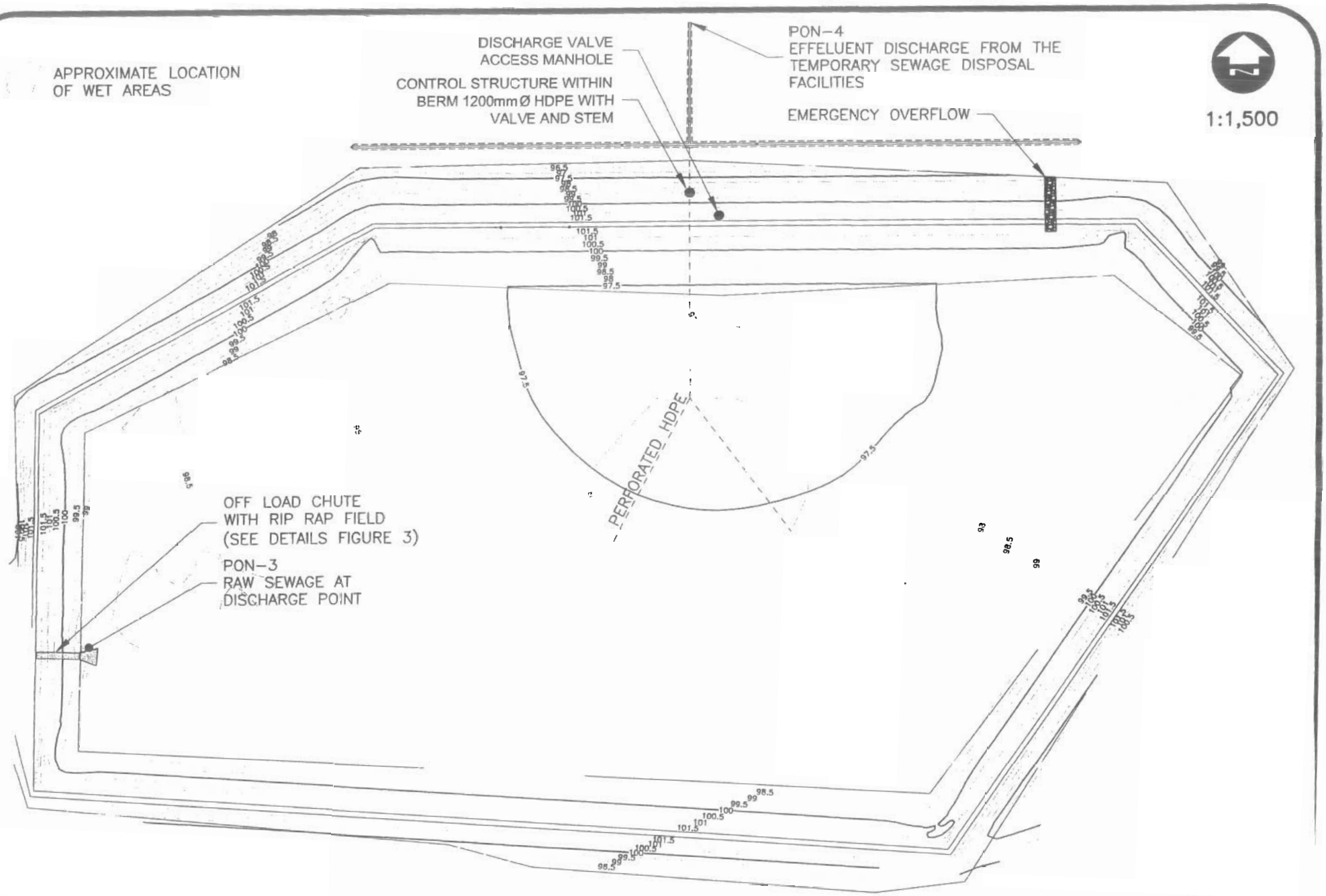
The NWB requires that surveillance stations be in place at the following locations (figure 4):

Station Number	Description
PON-1	*Raw Water supply prior to treatment*
PON-2	*Runoff from the Solid Waste Disposal Facilities*
PON-3	*Raw Sewage at Discharge point*
PON-4	*Effluent discharge from the Temporary Sewage Disposal Facility*
PON-5	*Effluent discharge from the Sewage Disposal Facilities*

Monthly samples must be taken at Surveillance Stations PON-2, PON-4 and PON-5 during the months of May to August inclusive. Samples taken from these stations must be analyzed for the following parameters:

BOD	Faecal Coliforms	pH	Conductivity
Sodium	Potassium	Magnesium	Total Suspended Solids
Total Iron	Total Chromium	Total Lead	Total Cadmium
Total Copper	Ammonia Nitrogen	Total Phenols	Total Nickel
Total Mercury	Oil and Grease (visual)	Total Arsenic	Total Zinc
Sulphate	Calcium	Nitrate-Nitrite	

All sampling, sample preservation and analyses must be conducted in accordance with methods prescribed in the current edition of *Standard of Methods for the Examination of Water and Wastewater*. Samples should be sent out to a Canadian Association of Environmental Analytical Laboratories (CAEAL) Certified Laboratory, or as otherwise approved by an Analyst (Taiga Laboratories).



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DILLON CONSULTING

PROJECT: POND INLET SEWAGE LAGOON UPGRADES
POND INLET, NUNAVUT

TITLE: LAGOON SITE PLAN

PROJECT NUMBER: 02-1089

DATE: FEBRUARY 2005

FIGURE NUMBER: FIGURE 4

3.4.5 Health and Safety

Due to the potential health hazards associated with sewage handling and treatment, the following safety precautions should be taken by sewage treatment personnel:

- Equipment is to be kept clean,
- Hands are to be washed frequently, as a minimum after work and before eating,
- Work clothes should not be worn home.
- Works gloves and boots should be worn at all times,
- Personnel should receive appropriate vaccinations and ensure they are kept up to date.

3.5 Maintenance Procedures

The following maintenance procedures should be carried out to ensure that wastewater treatment infrastructure operates efficiently.

3.5.1 Sewage Trucks and Holding Tanks

The transport of sewage to the treatment facility is critical to the whole process. As such, it is important that the sewage trucks be kept in good repair.

- Repairs to sewage trucks should be completed as a priority,
- Sewage trucks should not sit full for long periods in the winter,
- Holding tanks must be kept in good working order and prevented from freezing during the winter.

3.5.2 Access Road and Truck Pad

Basic road maintenance must be done on a regular basis:

- At least twice per year, the road and truck pad is to be graded to smooth and the surface is to be reshaped,
- As necessary during the winter, snow is to be removed to ensure unrestricted access to the sewage discharge point is maintained,
- During snow removal, care is to be taken not to damage the berms and surrounding area,
- Any spilled and frozen wastewater should be removed with the snow,
- The discharge point should be monitored for erosion problems.

3.5.3 Fence Signs

Signs are to be posted at the discharge location informing the public of the presence of the sewage treatment area and warning of the potential health risks associated with it. A sign is also to be posted at accessible monitoring stations, identifying them as wastewater discharge monitoring stations.

- On a monthly basis, the signs are to be checked to ensure they are present, have not become obstructed and are readable.

3.5.4 Drainage

The truck pad at the sewage discharge point should be graded such that any wastewater spilled during the off-loading procedure will flow into the sewage system.

3.6 Operational and Maintenance Summary

Daily

- Collect wastewater from the holding tanks and transport it to the sewage truck discharge point,
- Clean up any spills immediately,
- Clear snow from road, truck pads and off-load chutes as required,
- Record O&M information. Logs are provided in Appendix C

Weekly

- Inspect berms, dykes and drainage courses,
- Inspect down gradient collection ditch for seepage (during non-freezing months), seepage water needs to be collected and pumped back into lagoon.
- There are two 500 mm diameter catchment basins located on either side of the cut-off ditch. These catchment basins facilitate pumping if so required.
- Remove non-sewage floating materials (i.e. plastic bags) from the lagoons,
- Ensure significant erosion is not occurring at the truck and cell discharge locations,
- Record O&M information. Logs are provided in Appendix C.

Monthly

- Grade and maintain the access road and truck pads if required,
- Check signs to ensure they are present and in readable condition,
- Conduct the monthly monitoring program,
- Record O&M information. Logs are provided in Appendix C.

Yearly

The Pond Inlet lagoon design include the use of a under drain system. The under-drain system is present to protect the integrity of the Granular Clay Liner (GCL).

There are a few issues to be aware of with respect to the installation of the under-drain system. The basic points of consideration are;

- When the base is fully drained and the lagoon is full, there is approximately 4 meters of static head acting across the GCL. The clay liner will leak to some degree with this hydrostatic head, and eventually could rupture.
- When the lagoon is decanted, there is a possibility for there to be an uplift force equal to the pore pressures that develops in the lagoon base material when the drains are closed. This will occur at each lagoon decanting (annually), if the under-drain system is not operated correctly.

The under-drain and decant system has the following components;

- Under-drain system;
    - A series of perforated collection pipes located under the GCL to collect ground water from under the liner,
    - A carrier pipe located under the lagoon berm wall,
    - A control manhole located in the lagoon berm wall. The manhole has a control valve located on the carrier pipe,
    - A discharge pipe that is located under the berm of the lagoon and exits in to a discharge ditch. See figure 4 for the site layout and location, and drawing C-5 for the manhole details.

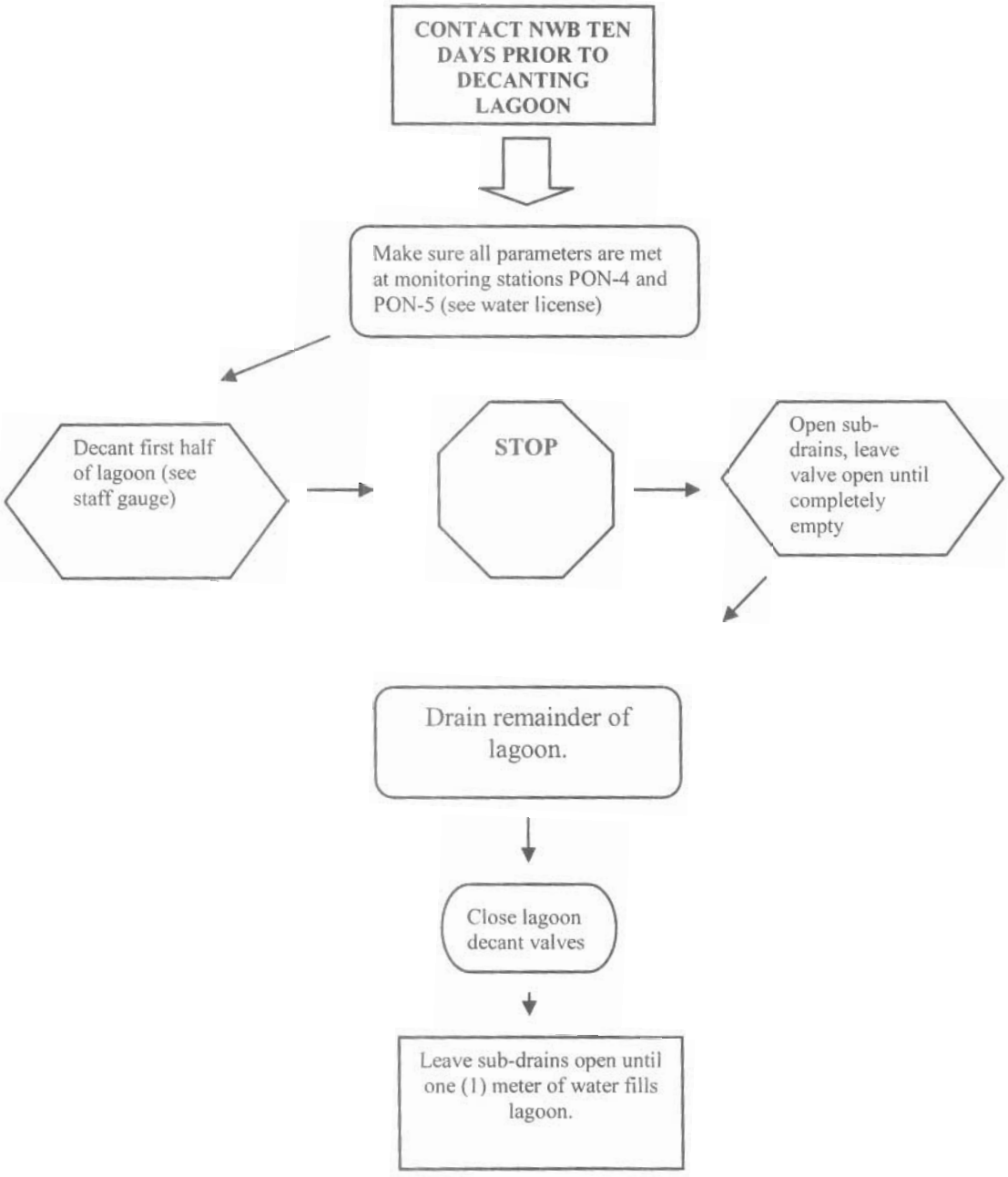
- Lagoon decant system;
    - An intake screen located in the lagoon, approximate 0.5 meters from the bottom of the lagoon.
    - A carrier pipe from the intake through the lagoon berm
    - A control manhole located in the lagoon berm wall. The manhole has a control valve located on the carrier pipe.
    - A discharge pipe that is located under the berm of the lagoon and exits in to a discharge ditch. See figure 4 for the site layout, and drawing C-5 for the manhole details.

During annual discharge the lagoon operator needs to monitor the level of the sewage in the lagoon and the level of the water in the under drain system. Opening and closing the valve on the under drain system to lower the pore pressures under the lagoon liner is required annually prior to decanting the lagoon completely. This needs to be done carefully to maintain sufficient back pressure under the liner to prevent the build up of static head pressures exceeding the liners capacity. Also the operator would need to make sure that the valve on the under drain system is closed once the level of the lagoon reaches 1.0 meters when it is being recharged. The operations of the decant procedure is as follows;

- At the start of the decant operation the valve for the under-drain system is in the closed position.
- At the start of the decant operation the valve for the discharge is in the closed position.
- Open the access hatch to both manholes.
- If there is any water in the manhole, pump the manholes dry prior to starting the decant operation.

- Entering into the manhole is considered a confined space entry. The operators must be trained in confine space entry and have all the required Personal Protective Equipment (PPE) on hand, and in working condition. Appropriately trained support staff must be on hand.
- Using proper confined entry methods, access the manhole and verify that both valves are operational by opening and closing each valve prior to starting the decant procedure.
- Record lagoon height on the stage gauge.
- Open the discharge valve.
- Observe the discharge flow. Regulate the discharge valve so that the discharge flow is contained in the discharge ditch. If the flow is overtopping he ditch reduce the flow by partially closing the discharge valve.
- Monitor the staff gauge.
- When the staff gauge indicates that there is 1.5 meters of liquid remaining in the lagoon, close the discharge valve.
- Open the under-drain valve.
- Observe the discharge of the under-drain valve. If no discharge occurs, verify that the discharge line in thawed using a sewer snake. The snake should be able to enter the under-drain pipe for approximately 30 meters. Thaw the under-drain system if required.
- Once the under-drain system has been shown to be operating, open the lagoon discharge valve again.
- Leave both valves open until the lagoon is decanted.
- Close the lagoon discharge valve.
- On a daily basis observe the staff gauge. When the gauge shows that there is 1.0 meters of sewage in the base of the lagoon, close the under-drain system valve.

A flow chart has been developed to assist the operator with the dewatering procedure:



This operation works to minimize the risk of a liner breach due to the hydrostatic head, and minimize the risk of the liner being lifted by the base pore water pressure; there are some operational issues to be considered.

- There is the risk that the under drain system freezes or is blocked by silt. The drains would then be inoperable. The use of a hot water flusher system to verify the drains are operating on an annual basis is recommended.
- Should the lagoon operator neglect to operate the under drain system correctly, this could result in a failed liner system, and ultimately an unplanned release of sewage to the environment. Particular attention is to be focused on the operation of this lagoon.

Some amount of seepage out of the base of the lagoon liner system, and through the sub soils should be expected as part of the operation of the system. A down gradient collection/inspection ditch is locate on the down gradient side of the lagoon berms. The monitoring should be weekly during the first few years of operation in the non- freezing months. Once the lagoon system has stabilized (3 to 5 years) monitoring can be monthly. Should seepage paths develop, a qualified geotechnical engineer should be retained to inspect the dams and provide guidance on remedial actions.

Seepage water needs to be collected, and pumped back into the lagoon.

Conduct the annual monitoring program,

Review the O&M records to evaluate the effectiveness of the sewage treatment system and plan for the upcoming year.

4.0 EMERGENCY REPONSE

Due to the nature of the facility, uncontrolled fires and spills of unknown or hazardous materials should be treated with extreme caution. Hamlet personnel responsible for the sewage disposal facility should be trained in Workplace Hazardous Materials Information System (WHMIS), Transportation of Dangerous Goods Act and Regulations (TDGA and TDGR) and First Aid, and should ensure that appropriate vaccinations of employees are kept current.

4.1 Fire

A contingency plan should be developed by the Hamlet Fire Department for responding to a fire at the solid waste disposal site. Special precautions should be implemented as burning of refuse can produce poisonous vapors. The following procedures should be used in case of uncontrolled fire:

- Evacuate area around landfill immediately,
- Keep all personnel up-wind of the site,
- Notify the Hamlet Fire Department at 899-8791 or 899-8880.