# P Lake Area Sewage Lagoon System

*Final Design Report*
*January 2006*



Cape Dorset Sewage Treatment System
Preliminary Design Report

Community and Government Services
Government of Nunavut

05-4319-1200

Gary Strong - Project Manager

*Submitted by*
**Dillon Consulting Limited**

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*(In reply, please refer to)*
**Our File: 05-4319-1200**
January 30, 2006

Department of C&GS, Capital Programs
Government of Nunavut
PO Box 100 Stn. 700
Iqaluit, NU X0E OHO

Attention: Todd Parsons
**Cape Dorset Sewage Treatment System**

Dear Mr. Parsons:

Please find enclosed a copy of the Final Design Report for the Cape Dorset P- Lake Lagoon. This report includes all your comments received on the earlier submissions. In accordance with our proposal, this is the final report submission for this task.

The intent of the report is to describe all the elements of the proposed system, and develop the Class "C" Cost Estimates for the construction phase.

This report includes the information obtained from the geotechnical assessment, the fisheries assessment, and the site survey and has been updated to include your changes.

Upon your approval, we will submit the report to the Nunavut Water Board.

Yours sincerely,

**DILLON CONSULTING LIMITED**

Gary Strong, P. Eng.
Project Manager
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**Dillon Consulting Limited**

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# 1 INTRODUCTION

## 1.1 General

Dillon Consulting Limited (Dillon) has been retained by the Department of Community and Government Services (C&GS), Government of Nunavut, Dillon Consulting Limited (Dillon) to design a new sewage treatment system for the Hamlet of Cape Dorset. This document outlines the preliminary design plans for a new sewage lagoon treatment system put forth by Dillon.

The Hamlet of Cape Dorset is located on Dorset Island, off the south shore of Baffin Island in Nunavut (**Drawing A**). Dorset Island, jutting southward into Hudson Strait, is part of a chain of islands connected to Baffin Island during low tide. By air, Cape Dorset is approximately 402 kilometers southwest of the city of Iqaluit.

The annual snowfall in Cape Dorset is approximately 118 cm and the annual rainfall is approximately 15 cm. The community experiences mild flooding during spring runoff. In January, temperatures range between a low of about $-29^0$C and a high of about $-23^0$C. In July the temperatures range between a low of $3^0$C to a high of about $7^0$C. Freeze up usually occurs during the month of November but may happen as early as September or October. In some years, early freeze up may thaw again before final freeze up. Spring thaw typically occurs during the month of July, but can vary as much as freeze up.

The community uses trucked services for both water delivery and sewage collection. The Hamlet is presently using a 3-cell sewage lagoon system, which will supply treatment for the short-term. Environment Canada has expressed concerns with the existing system. This system cannot be viably upgraded to provide for a long term sewage treatment system. The Hamlet is faced with the task of designing a sewage treatment system that will provide a long-term solution (20 years +) to meet the sewage treatment requirements of the community.

## 1.2 Background

Dillon was first retained by the Department of Community Government and Transportation (CG&T) in 2001 when the motion was made to produce a new sewage facility plan for the community of Cape Dorset. The motion was put forth due to a structural failure in the existing three-cell lagoon.

Over the course of four years, Dillon has been involved with this project, aiding CG&T and C&GS with planning studies, site selection studies, regulatory requirements and treatment alternatives. Several site options were identified for the new sewage lagoon, all of which were dismissed for various reasons:

**Q Lake Lagoon Option**– a small lake located to the north east of the community. The Mayor initially identified this site as a potential location for a lagoon. However, in the winter of 2001/2002, the community's water supply pipeline froze, and Q Lake was used as the emergency back-up water supply source. Subsequent to the pipeline freeze up the community stated that Q Lake should not be used as a sewage lagoon facility.

**P Lake Lagoon Option**– a small lake located south of the community. The community identified this site as a potential location for a lagoon. The road to P Lake would have a constant grade of 8 to 10% over a length of approximately 1 km.

**Site R Lagoon Option**– Site R is a flat area north east of the community. This site is currently used as the granular stockpile for CG&T. The site is also located at the end of the runway. The Airports Division has expressed concerns over this location and the potential for the increased bird strike hazard. The site may not meet regulatory approval because of the increased risk of bird strikes.

**Existing Site Mechanical Plant Option** - installation of a Mechanical Sewage Treatment Plant would be best at the existing lagoon site. The treated sewage effluent discharge is to the south of the tidal bridge. The proposed discharge location results in the effluent being directed away from the community. The effluent discharge location was an important issue to the community during the consultation period. This option carries with it the issue of higher operational costs and concern with hiring and training qualified operators in the community.

**Drawing B** shows the community location and the location of the alternative sites.

Based on the results of sewage treatment options and studies completed between 2001 and 2004, the Government of Nunavut has offered two possibilities, the use of "P Lake and wetlands" as a sewage lagoon and the use of a mechanical system for sewage treatment. At present, the Hamlet has identified a sewage lagoon and wetlands system at "P Lake" as their preferred sewage treatment option.

### 1.3 Scope of Report

The work program for the development of this report follows the terms of reference issued by C&GS and Dillon's proposal dated November 12, 2004. Briefly this includes the following;

- Develop the 5, 10 and 20 year sewage generation values
- Calculate the lagoon size based on the community requirements
- Looking beyond the 20 year horizon, identify the potential for expansion
- Develop the conceptual layout for P Lake Lagoon which would include;
    - Site access road
    - Site lay-out for lagoon cells
    - Location of the lagoon outfall
    - Complete an assessment of the expected lagoon treatment

Parallel to the development of the lagoon design requirements; Dillon undertook a consultation program with the stakeholders for this project. A tabulated list of the various regulatory agencies consulted and their comments is appended in **Appendix C**.

## 1.4 Report Layout

The purpose of this Feasibility Report is to document the preliminary design process and is a decision-making document. The sections of the report describe:

- The design requirements as laid out in the terms of reference and the background documentation
- The design criteria, assumptions, and calculations
- The objectives of the design
- A description of the design elements, including appropriate sketches and illustrations
- Cost estimates for the construction
- Construction schedule and implementation strategies.

Drawings and photos are located in **Appendix A and B**, respectively.

## 1.5 Design Criteria

The design criteria for this project will be completed in accordance with the parameters set out by the project terms of reference and the GNWT, Municipal and Community Affairs "*Capital Standards and Criteria, September 1993*". These are as follows:

**Table 1.1: Design Horizons**

| Facility | Design Horizon (Years) | Design Economic Life (Years) | Design Expected Life (Years) |
|---|---|---|---|
| Building | 20 | 20 | 40 |
| Pumps | 10 | 20 | 20 |
| Earth Works | 20 | 20 | 40 |

Where the:

- Design horizon is the period used to establish capacity requirements for a facility.
- Design economic life is the period used in the economic analysis to establish the present value (or equivalent capital cost) of a facility.
- Design expected life is the practical maximum expected life of a facility assuming no premature failure, destruction or obsolescence.

## 1.6 Design Standards

The following is a list of the design criteria to be used in the development of the water supply system. These are derived from the GNWT "*General Terms of Reference for Water and Sanitation*" (GTR), the "*National Building Code*" (NBC), "*Capital Standards Criteria, September 1993,*" MACA and the "*Good Engineering Practice for Northern Water and Sewer Systems, First Edition, April 2004*". Mechanical and building systems design should comply with the "*Good Building Practice for Northern Facilities*" as related to utility buildings.

**Table 1.2: Sewage Generation Rates**

| Water Consumption Rates | | |
|---|---|---|
| | | **Reference** |
| Domestic | 90 Lcd per day | MACA |
| Commercial | 0.00023 x population | MACA |
| Total Consumption per Capita | 90 * (1.0 + 0.00023 * pop.) | MACA |
| Discount Rates | 4%, 8% and 12% | MACA |

**Table 1.3: Environmental Conditions**

| Environmental Conditions | |
|---|---|
| Design Minimum Temperature | -43°C |
| Degree Days (18°C) | 10751 |
| Snow Load SS<br>SR | 3.5 kPa<br>0.2 kPa |
| Wind Pressures | 1.59 kPa |

1. Supplement to the National Building Code of Canada 1996 Third Revisions and Errata (Coral Harbour used, data for Cape Dorset not available).
2. Canadian Climate Normals (1961-1990). Yukon and Northwest Territories.

The facility is also to be designed to the current edition of;

- National Fire Prevention Act
- Electrical Code
- Public Health Act (including reference to the GCDWQ)

## 1.7 Design Parameters

The goals of the project are to treat sewage with effluent meeting the requirements of the Nunavut Water Board, and the requirements of other regulatory agencies. In meeting this goal, the following items are identified in the TOR as design parameters for the facility:

- The facility must be simple to operate and maintain by local forces with limited locally available equipment, parts and materials.
- Reliability of the facility is extremely important.
- The facility must be efficient and cost-effective.
- All equipment and pipes must be self-draining after each use cycle, where practical. When self-draining of any major component cannot practically be accommodated, some other means of frost protection should be incorporated.
- All major components must be capable of recovering from a frozen condition, in an operable state, if there is any possibility of freezing.

## 1.8 Cost Analysis

Throughout this document, there are cost analyses of various options. The analyses have been carried out as outlined in the General TOR as described below:

| Cost | Description |
|---|---|
| Capital Cost | Cost of construction for the facility. |
| Annual operation and Maintenance Costs | The cost of operation may include: manpower, energy requirements, fuel, general maintenance (light bulbs, paint), and equipment replacement. |
| Life Cycle Costs | The calculation of the total facility cost over a 20-year period includes the capital, operations and maintenance costs. The life cycle value is shown as a present value, which is calculated at a discount rate of 4%, 8% and 12%. |

# 2 SEWAGE QUANTITY

## 2.1 Sewage Generation Rates

The new sewage treatment system will be designed for a 20 year life span (2006-2026). In order to do so, the sewage generation rates per capita and the population of Cape Dorset for the year 2026 were determined. Predicted population values until the year 2020 were provided by Nunavut Bureau of Statistics (**Appendix D**). Population values beyond 2020 were predicted using both a linear growth rate similar to previous years (31 persons per year), and using a percentage growth rate (1.8%) as illustrated in **Chart 2.1**. The population for 2026 was predicted to be 2002 persons.

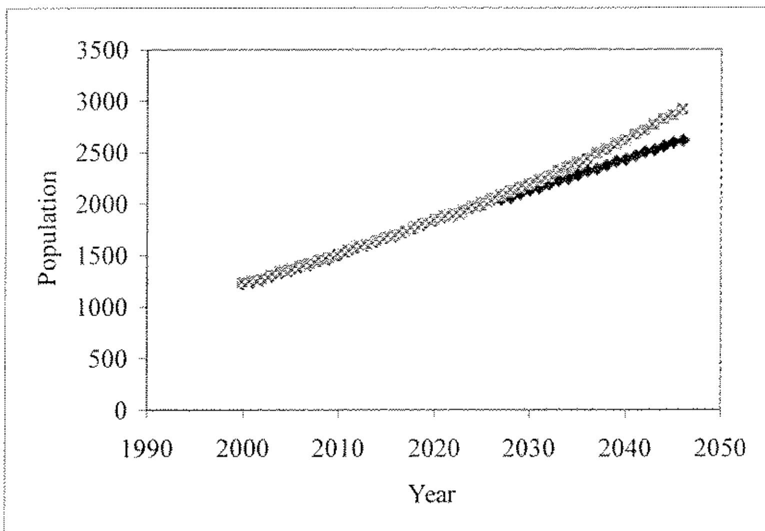


**Chart 2.1: Population Growth in Cape Dorset**

*Data prior to 2021 was provided by Nunavut Bureau of Statistics and data proceeding 2021 was predicted. Blue data points indicate data calculated using a linear growth rate of 31 persons per year. Pink data points indicate data calculated using a percentage growth rate of 1.8%.*

For communities with trucked sewage collection, the amount of sewage generated can be assumed equal to the amount of water consumed. The following formula (Department of Municipal and Community Affairs, Government of the Northwest Territories) is generally used to predict water consumption in Northern communities:

$$Water\ Usage\ (l/cd) = 90\ l/cd \times (1.0 + 0.00023 \times population) \qquad [1]$$

Based on this information, the lagoon will be designed to treat 96 100 $m^3$, the annual sewage volume for a population of 2002 persons. Table 2.1 shows the calculated sewage generation for years 2006 – 2026.

**Table 2.1: Predicted Sewage Generation 2006-2026**

| Year | Population | MACA Predicted Sewage Production (L) | MACA Predicted Sewage Production ($m^3$) |
|---|---|---|---|
| 2000 | 1213 | 50963978 | 50964 |
| 2001 | 1240 | 52351337 | 52351 |
| 2002 | 1268 | 53801714 | 53802 |
| 2003 | 1298 | 55368837 | 55369 |
| 2004 | 1327 | 56896649 | 56897 |
| 2005 | 1354 | 58330519 | 58331 |
| 2006 | 1382 | 59829131 | 59829 |
| 2007 | 1412 | 61447933 | 61448 |
| 2008 | 1441 | 63025702 | 63026 |
| 2009 | 1471 | 64671251 | 64671 |
| 2010 | 1501 | 66330399 | 66330 |
| 2011 | 1536 | 68283261 | 68283 |
| 2012 | 1570 | 70198052 | 70198 |
| 2013 | 1600 | 71902080 | 71902 |
| 2014 | 1632 | 73734700 | 73735 |
| 2015 | 1662 | 75466835 | 75467 |
| 2016 | 1692 | 77212569 | 77213 |
| 2017 | 1726 | 79207509 | 79208 |
| 2018 | 1757 | 81041649 | 81042 |
| 2019 | 1793 | 83189842 | 83190 |
| 2020 | 1829 | 85357618 | 85358 |
| 2021 | 1848 | 86529675 | 86530 |
| 2022 | 1879 | 88404583 | 88405 |
| 2023 | 1910 | 90293760 | 90294 |
| 2024 | 1941 | 92197208 | 92197 |
| 2025 | 1971 | 94114925 | 94115 |
| 2026 | 2002 | 96046912 | 96047 |

The annual sewage generation volume used for design purposes is set at 96,000 $m^3$.

## 2.2 Sewage Quality

Due to the low water usage of communities using trucked water delivery and trucked sewage collection, sewage tends to be concentrated when compared to typical municipal wastewater. Cape Dorset trucked sewage is assumed to have the following characteristics:

- Average raw Biochemical Oxygen Demand ($BOD_5$) concentration of 625 mg/L
- Average raw suspended solids (SS) concentration of 900 mg/L

# 3 LAGOON SITE

The following sections describe the P Lake site area. (**Drawing B**).

## 3.1 P Lake Fisheries

As part of the scope of work for this project Dillon conducted detailed fisheries investigations of P Lake, the results of which are included as Section 4.0 of this report.

## 3.2 P Lake Area Wildlife

The topography surrounding P Lake is characterized by rock outcrops and steep cliffs. In addition to various mammals and birds common to this part of Baffin Island, the P Lake area is know to support a local population of Common Ravens (*Corvus corax)*. It can be assumed that the Ravens are using this area for nesting as they commonly nest on cliffs and within rock crevices. It is not expected that the development of a sewage treatment lagoon at P Lake and the P Lake area would negatively impact the resident raven population or other wildlife of the area.

## 3.3 P Lake Bathymetry

A detailed bathymetric survey of P Lake was not completed. However, discrete soundings completed in 2003 found the lake to have a maximum depth of approximately 2.5 m. There is no connectivity between P Lake and other fresh water sources on the island. The single outlet from P Lake flows via a single-thread channel for approximately 370 m before entering Telik Inlet. There is no direct conductivity to the marine environment.

The Lake and has a surface area of roughly 1.3 ha, and a maximum depth of 2.75 m. Leon Neson, Director, Cape Dorset Housing Department provided Dillon with eight (8) measured depths of P Lake (**Appendix E**). These depths were used to approximate a volume of P Lake: 11 667 $m^3$ (**Drawing C).**

## 3.4 P Lake Watershed

P Lake is a natural system and is subject to natural water recharge. Using climatic data for Cape Dorset, NU, the water balance and recharge rates for P Lake have been determined and are illustrated in **Figure 3.1.**

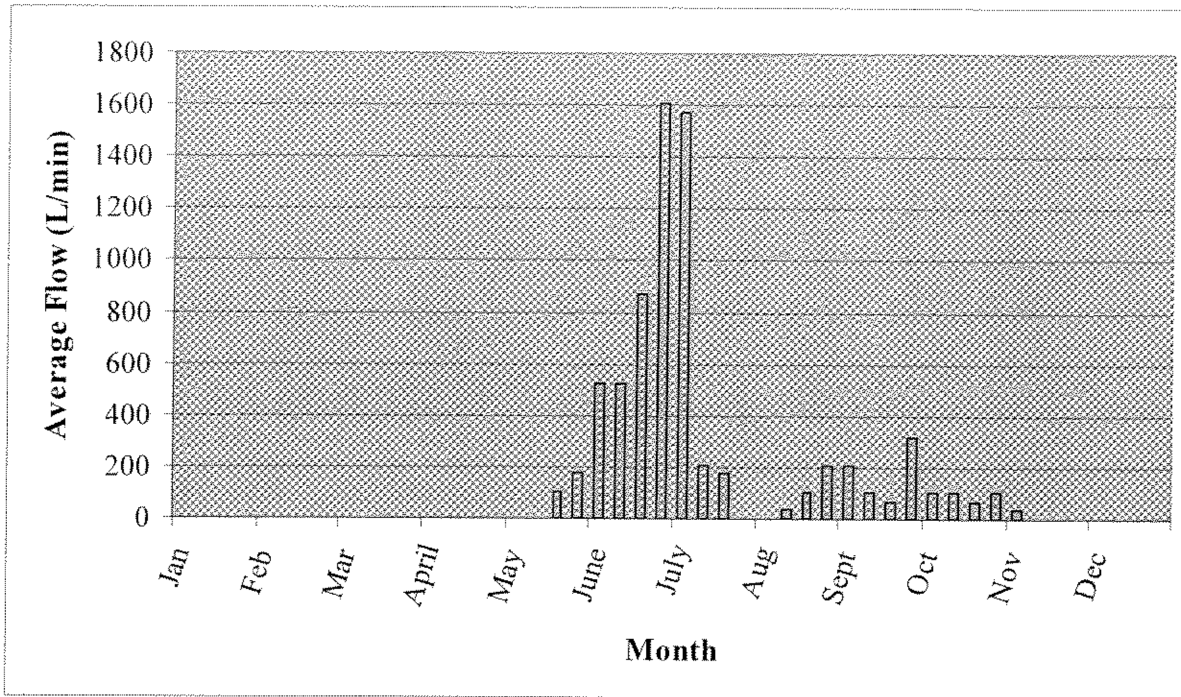


**Chart 3.1 Water Recharge in P Lake**

The method in which this data was determined is detailed in **Appendix F**.

**Chart 3.1** illustrates that during the months of June and July, water recharges from the lake at a significant flowrate. In this respect, using P Lake as a primary sewage lagoon is not practical unless the recharge water is directed away from the proposed lagoon. The recharge would significantly reduce the retention of sewage in P Lake and decrease treatment; therefore the use of ditching to divert recharge water is carried forward in the conceptual design development.

## 3.5 Proposed Lagoon Configuration

As part of the terms of reference for this project, the use of P Lake itself is to be examined for use as the lagoon. This option has been considered, but is rejected for continued consideration for several reasons:

- Based on 20 year sewage generation values, the estimated 11 667 $m^3$ volume of P Lake is not sufficient to retain and treat a year's volume of sewage;
- Direction from Environment Canada and INAC indicates that exfiltration lagoons (i.e. lagoons that do not retain annual sewage) are not acceptable nor adequate for effective sewage treatment;
- The difficulty associated with constructing berm walls on typically unstable lake bottoms; and
- The difficulties and costs associated with building walls around a lake to increase volume.
- The significant recharge volume as discussed above.

Therefore, to facilitate the best possible sewage treatment for Cape Dorset, a lagoon will be constructed in the area directly east of P Lake to serve as an annual retention lagoon. Upon annual discharge of this primary cell, sewage will flow into P Lake over a period of two (2) weeks. P Lake will discharge by gravity to a small wetlands area and over a waterfall before final discharge into Telik Inlet.

The location of the lagoon treatment system at P Lake and the area east of P Lake meets the following guidelines from the General Sanitation Regulation, Department of Health and Social Services, Government of Nunavut:

- Located more than 450m buffer from the Hamlet
- Located outside of the community watershed
- Enclosed location and prevailing winds at P Lake blow away from town

See **Figure D** for an illustration of the constraint mapping for P Lake.

### 3.6 Groundwater Movement from P Lake

There has been some concern raised with the proposal to use P Lake and the P Lake area as the location for Cape Dorset's new sewage lagoon. The main concern is the notion that sewage may flow from P Lake lagoon to Tee Lake, the Hamlet's source of drinking water. There are several reasons why the risk of sewage contamination to the drinking water source is extremely low. These are discussed below.

#### 3.6.1 Ground Water Movement in Permafrost

There is considerable literature on the issue of groundwater movement within the permafrost region. Much of this literature relates to the movement of contaminations within permafrost, and or the ability of the permafrost to form an impermeable barrier to the movement of the contaminant. The use of frozen core dams at northern mine sites is a common means to contain tailings. Most recently, the Government of Canada (INAC) has approved the use of passive freezing to contain 260,000 tons of arsenic trioxide dust at the Giant Mine Site in Yellowknife.

There is little documentation related to ground water movement and the permafrost in Cape Dorset. However the experiences and research available in other locations where permafrost is present can be applied at the Cape Dorset site. Most of the work associated with ground water movement in permafrost regions in Canada is completed through one of the following means;

- Primary research related to the development of an exploration or development project (mining and oil and gas sites);
- Research completed in conjunction with a University (U of Alberta and Calgary are prominent institutes involved in this area, as is the Ottawa University); or
- The Geological Surveys of Canada.

This body of research indicates that the groundwater movement in the permafrost areas can best be characterized as seasonal flow in the active layer. The active layer in Cape Dorset is expected to be to a depth of 2 to 2.5 meters. Flow within the permafrost (below the active layer) has been identified in some of the documentation. However, the flow measurements suggest that contaminants migrate at a geological pace. In these cases, flow of the contaminants follows the topography of the surface. In summary, the documentation reviewed indicates that ground water flow will be restricted to the upper 2.0 meters of the ground (within the active layer).

### 3.6.2 P Lake and Tee Lake Elevations

P Lake and Tee Lake are located approximately 1 km apart. As per **Drawing E**, the surface of Tee Lake is located at 150.5 metres above sea level (masl), which is significantly higher in elevation than the surface of P Lake (113.0 masl). This variance in elevation suggests that the possibility of sewage running from P Lake to Tee Lake is highly unlikely; sewage would, in essence, have to run uphill in order to reach Tee Lake. In addition, the land mass lying in between P Lake and Tee Lake is significantly higher in elevation than P Lake (183.0 masl, 184.5 masl, 184.5 masl, 193.0 masl) creating a physically impossible path for sewage to flow to Tee Lake from P Lake.

The second flow path extends north east from the P Lake. This flow path will be blocked by the construction of lagoon berms that will contain the volume of sewage discharged into P Lake.

### 3.6.3 P Lake Discharge

As per the pre-design report submitted by Dillon Consulting Limited (July 2005), the P Lake lagoon will be constructed in a rectilinear shape. This particular shape is used to promote plug-flow dynamics during the summer months when the sewage is not frozen. Hence, the lagoon is designed such that sewage will flow as a slug from the truck discharge point to the lagoon discharge point, towards Telik Inlet, and away from Tee Lake.

P Lake is situated approximately 500m from the shore of Tee Lake inlet. There is a steep drop off following the sewage discharge point (**Figure E**), which will promote the plug flow of sewage towards the inlet and away from Tee Lake.

Groundwater migration from the P Lake to T Lake is not supported by the available literature. Documentation reviewed as part of this review indicates that flow of contaminants will follow the topography of the land. With the construction of the berms to contain the sewage, the preferential pathway for the sewage contaminants will be directed to Telik Inlet. **Figure E** shows the topography of the area, and the relative elevations of the two lakes.

# 4 P LAKE FISHERIES

The Community members have communicated to the Hamlet officials that P Lake is not used as a sport or sustenance fishery. It is, however, believed that the lake supports a forage fish base (i.e. Threespine Stickleback *Gasterosteus aculeatus* or the Ninespine Stickleback *Pungitius pungitius).* The steep terrain between the P Lake outlet and the marine environment precludes the movement of fish between these aquatic environs. At this time we are unaware of any information/data on fish species composition or population estimates for the lake.

This section of the report describes the methods and results from the following environmental investigations:

- Fishery inventory and habitat descriptions of 'P' Lake;
- Descriptions of general habitat conditions of the outlet stream between P Lake and the marine environment;
- Collection of baseline information from the marine environment (Telik Inlet) where the outlet of P Lake drains; and
- Photo documentation of all activities

In context of a proposed sewage lagoon for Cape Dorset, the purpose of the investigations was to confirm fish presence/absence in P Lake, and to characterize the receiving marine environment.

The lake is fed primarily through surface runoff and there is no connectivity between P Lake and other fresh water sources on the island. Existing information on inlet surface flow, and habitat in a possible inlet channel, was not found.

The single outlet from P Lake flows via a single-thread channel for approximately 370 m (over a steep cliff and then through a mossy area) and over a waterfall before draining into the marine environment (i.e., Telik Inlet). The steep terrain between the P Lake outlet and the marine environment prevents the movement of fish between these aquatic environments and there is no direct connectivity to the marine environment.

Current information on the fish inventory and habitat of P Lake is lacking. Community members have communicated to the Hamlet officials that P Lake is not used as a sport or sustenance fishery. DFO has confirmed that no sportfish are expected to be present in P Lake (Tania Gordanier, DFO, pers. comm.). It is thought, however, that the lake may support forage fish (i.e., threespine stickleback, *Gasterosteus aculeatus*, and/or the ninespine stickleback, *Pungitius pungitius*).

## 4.1 Methods

### 4.1.1 Fishery Survey of P Lake

A multiple-method sampling protocol was selected to maximize the potential of observing and/or capturing fish that may reside in P Lake. The fishery surveys included: minnow trapping; seine hauls; snorkel surveys; and visual bank observations.

*4.1.1.1 Minnow Traps*

Minnow traps were set overnight on August 11, 2005. Minnow traps, baited with Powerbait Trout Nuggets, were set between 14:00 and 15:15 hrs on August 11 and retrieved between 9:00 and 9:35 hrs on August 12, 2005. Eight traps were set around the shoreline of P Lake, at depths ranging from 0.2-1.0m (see **Figure F** for locations).

*4.1.1.2 Seine Hauls*

Seine hauls were carried out at various locations along the shoreline of P Lake (see **Figure F** for locations). A total of seven hauls were carried out on August 11, 2005. The seine net used was 10 m long and had a mesh size of 1 cm. The distance the seine hauls were pulled ranged from 10 to 20 m.

*4.1.1.3 Snorkel survey*

Snorkel surveys were carried out along six transects over a 1.5 hour period on August 11, 2005. Five transects (ranging in length from 50 to 85 m) were oriented east-west across the lake, while a sixth transect was oriented north-south across the lake (see **Figure F** for locations). Although visibility extended beyond 2 m, the snorkel survey focused on observations within a 1.5 m distance on either side of the snorkeller.

*4.1.1.4 Visual observations*

During all field investigations visual observations were made any time a body of water was sampled or traversed. The field crew was instructed to carefully watch for fish and to record any observations of fish they made.

### 4.1.2 Habitat and Water Quality Survey of P Lake and Outlet

*4.1.2.1 Habitat*

Visual observations of underwater and shoreline substrates were recorded both within P Lake and in the outlet stream entering the small bay in Telik Inlet.

*4.1.2.2 Water quality*

Water quality measurements [dissolved oxygen (DO), pH, conductivity, salinity and water temperature] in P Lake were made with a hand-held pH, conductivity, salinity and temperature monitor (YSI Model 63), and a hand-held dissolved oxygen monitor (YSI Model 55)> Measurements were made once during the sampling period (August 11, 2005).

Water samples collected from the outflow stream from P Lake.

#### *4.1.2.3 Aquatic invertebrates*

Visual observations of aquatic invertebrates were made any time a body of water was sampled or traversed. No samples were collected.

### 4.1.3 Marine Environment

A boat was used to access Telik Inlet where the P Lake outflow stream drains into the marine environment. General habitat conditions of the Inlet were described and efforts to collect sediment sampled were attempted.

### 4.1.4 Photographic Record

During the site visit numerous photographs were collected so that a photographic record of the site could be developed. The locations of selected photographs are illustrated in **Figure G**.

## 4.2 Results

### 4.2.1 Fishery Survey of P Lake

#### *4.2.1.1 Minnow Traps*

**Table 4.1** provides detailed information regarding the minnow trapping survey completed at P Lake. Despite over 152 hours of trapping effort, no fish were collected in any of the traps that were set.

**Table 4.1 Effort and results from minnow trap sets in P Lake**

| Trap Number | Date Set | Time Set | Date Retrieved | Time Retrieved | Duration of set (hrs) | Number of fish captured |
|---|---|---|---|---|---|---|
| MT 1 | Aug 11 | 14:00 | Aug 12 | 09:00 | 19.00 hrs | 0 |
| MT 2 | Aug 11 | 14:00 | Aug 12 | 09:05 | 19.08 hrs | 0 |
| MT 3 | Aug 11 | 14:00 | Aug 12 | 09:10 | 19.17 hrs | 0 |
| MT 4 | Aug 11 | 14:10 | Aug 12 | 09:15 | 19.08 hrs | 0 |
| MT 5 | Aug 11 | 14:15 | Aug 12 | 09:20 | 19.08 hrs | 0 |
| MT 6 | Aug 11 | 14:30 | Aug 12 | 09:25 | 19.92 hrs | 0 |
| MT 7 | Aug 11 | 15:00 | Aug 12 | 09:30 | 18.50 hrs | 0 |
| MT 8 | Aug 11 | 15:15 | Aug 12 | 09:35 | 18.58 hrs | 0 |
| | | | | **Totals** | **152.41 hrs** | **0 fish** |

#### *4.2.1.2 Seine Hauls*

**Table 4.2** provides a summary of the fish catch results from seine netting activities in P Lake. No fish were captured, or observed, during any of the seine net hauls.

**Table 4.2 Effort and results of seine netting efforts in P Lake on August 11, 2005**

| Haul # | Date | Length of haul (m) | Number of fish captured |
|---|---|---|---|
| SH 1 | Aug 11 | 15 | 0 |
| SH 2 | Aug 11 | 15 | 0 |
| SH 3 | Aug 11 | 20 | 0 |
| SH 4 | Aug 11 | 10 | 0 |
| SH 5 | Aug 11 | 10 | 0 |
| SH 6 | Aug 11 | 10 | 0 |
| SH 7 | Aug 11 | 20 | 0 |
| **Total** | | | **0 fish** |

#### *4.2.1.3 Snorkel survey*

**Table 4.3** presents the results of the snorkel surveys conducted in P Lake. An estimated area of 1380 $m^2$, and the complete diversity of habitat types, were examined during the snorkel surveys. This area represented approximately 10.6% of the total area of the lake. It should also be noted that although the snorkel survey concentrated on 1.5 m width on either side of the snorkeller, visibility often extended beyond this width (e.g., 3+ m). No fish were observed during any of the transects completed.

**Table 4.3 Effort and results of snorkel surveys in P Lake during August 11, 2005.**

| Transect # | Date | Length of transect (m) | Width of transect (m) | Area sampled by individual transects ($m^2$) | Number of fish observed |
|---|---|---|---|---|---|
| T1 | Aug 11 | 50 | 3.0 | 150 | 0 |
| T2 | Aug 11 | 70 | 3.0 | 210 | 0 |
| T3 | Aug 11 | 75 | 3.0 | 225 | 0 |
| T4 | Aug 11 | 85 | 3.0 | 255 | 0 |
| T5 | Aug 11 | 60 | 3.0 | 180 | 0 |
| T6 | Aug 11 | 120 | 3.0 | 360 | 0 |
| | | | **Total** | **1380** | **0** |

#### *4.2.1.4 Visual observations*

Although efforts were made to observe and record any fish that may have been made during visual bank observations, no fish were observed during the bank surveys. No attempt was made to document the level of effort expended during the bank surveys.

### 4.2.2 Habitat and Water Quality Survey of P Lake and Outlet

#### *4.2.2.1 Habitat*

<u>P Lake</u>

Substrates in P Lake were composed primarily of boulders and fractured rock (**Figure G**). Any cover which could be utilized by fish would have been provided primarily by depth, large boulders and fractured rock. Substrates at maximum depths were primarily composed of sands and fines. The north shoreline substrate was predominately fractured rock, some greater than 1-2 m diameter, (**Photo 1**), while the south shoreline substrate was a mixture of gravel with areas of sand and fines (**Photo 2**). All other shorelines consisted of rock.

No aquatic vegetation was observed in P Lake and only small amounts of algae were observed on the substrate. Caddisfly (trichopterids) and freshwater crustaceans (amphipods) were also observed in P Lake.

Outlet and Inlet of P Lake

The outlet of P Lake is characterized a small channel that drains into a small wetland area. From the wetland area, it drains through a small channel and over a large cliff forming a waterfall (**Photo 3**). Below the waterfall the outlet stream was intermittent as flow was subsurface and at times lacked a defined channel. Intermittent surface flow also continued downstream and is apparent where the channel passes through grassy/mossy area. Mean width and depth of the reaches where a defined channel occurred were approximately 0.1, and 0.05 m, respectively) (**Photo 4**). Below the grassy/mossy area, the stream again goes sub-surface and lacks a defined channel once the outlet reaches boulder cobble shoreline (**Photo 5**). **Figure G** provides a map of the shoreline and distribution of substrates in P Lake and the outlet into Telik Inlet.
The outlet stream does not provide fish access to P Lake from the ocean due to the large cliff and lack of a defined channel at several locations. Limited summer flows and conditions also suggest that the outlet stream would freeze to the bottom in winter.

The inlet stream into P Lake is best described as having a no or limited definition channel, and if fish were present in the lake, it is highly unlikely the inlet area would provide fish habitat. It would also be expected to freeze to the bottom in winter.

The mean depth and wetted widths for both the inlet and outlet streams where defined channels existed were both approximately 0.1 m, and 0.2 m, respectively.

Marine Environment
Substrates in the small bay in Telik Inlet where the P Lake outlet stream eventually drains were dominated by very clean cobble and boulders. Some algae was observed, but in limited quantities. Benthos were not sampled due to high tide conditions, time limitations, and the coarseness of the substrate.

*4.2.2.2 Water quality*
Water quality measurements collected from P Lake with the hand-held YSI units are provided in **Table 4.4**. Some of the above readings, however, were unexpected (e.g., pH = 10.1 exceeds the CREM guidelines for aquatic life of 9.0), so the units were re-calibrated after being returned to Dillon's Yellowknife office. The results of the recalibrations suggested that the sensor units had been damaged in transport to Cape Dorset, and therefore, equipment malfunction is suspected and the above results collected during the present field trip should not be considered reliable.

**Table 4.4 Water quality measurements collected from P Lake on August 11, 2005**

| Parameter measured | Measurement and units |
|---|---|
| Dissolved oxygen | 3.0 mg/l |
| pH | 10.1 |
| Conductivity | 42 microsiemens |
| Salinity | 0.0 ppt |
| Temperature | 10.2°C |

Other water samples were collected, but were not analyzed because unexpected delays in transit were encountered which exceeded the amount of time which would provide reliable analysis for some parameters (e.g., fecal coliforms).

## 4.3 Conclusions of Fisheries Investigations

Based on the results of the 2005 fisheries investigations, the absence of historical reports documenting fish presence in P Lake, and the presence of impassible barriers that prevent fish movement between P Lake and other fish-bearing waters, it can be concluded that P Lake is barren of fish. The intermittent flow conditions and waterfalls over the cliff indicate that fish passage into P Lake from the marine environment is impossible.

Given that the P Lake system is barren of fish, there is no reason to suggest that converting P Lake into an output lagoon is likely to cause a Harmful Alteration, Disruption or Destruction of fish habitat (HADD). If a HADD is unlikely, a Federal Fisheries Act Authorization for a HADD will not be required.

# 5 LAGOON CONSTRUCTION

The P Lake area provides sufficient land to develop an annual retention lagoon, and also use P Lake as a secondary short retention lagoon. The wetlands down gradient of P Lake, which are indigenous to the area, will provide some nutrient and total suspended solids (TSS) removal as well.

As illustrated by aerial photographs and noted topographic maps, the area east of P Lake is situated in a geographic low point, making the area ideal for construction of a bermed lagoon (**Figures E and H**).

The level of treatment obtained from each stage of the system is discussed in **Section 6**.

## 5.1 Lagoon Configuration

The annual retention lagoon will be constructed using the natural topography of the area. Plug flow conditions will prevail and are important during the time of annual discharge in order to prevent short circuiting, or raw sewage by-passing treatment and directly discharging to P Lake. The lagoon will be constructed to facilitate anaerobic sewage treatment using the following characteristics:

- 3.5 m liquid operating depth
- 0.5 m of allowance on the lagoon bottom for sludge accumulation

The size of the lagoon was determined to accommodate the above design parameters and the predicted volume of sewage generated in 2026 (96 100 $m^3$). The parameters of the lagoon are illustrated in **Drawing 101**.

The development of the earth work quantities was completed based on a site specific survey and using three dimensional modeling of the landforms and final design.

## 5.2 Berm Construction

A site specific geotechnical study was completed, which is submitted in **Appendix G.** Based on the geotechnical report, the lagoon will have;

- 1 m freeboard
- 3.5 meter operating depth
- 0.5 meter dead area (sludge retention) at the base of the lagoon.
- Total berm height will be 5 meters.

The berm construction will include;

- 4 m wide at top to facilitate construction;
- Inside to have a 2.5:1 (H:V) slope;
- Outside to be 2.5:1 (H:V) slope;
- The berms to have riprap protection over the inside slope in areas subject to ice and wave action.
- Where fine grained material is used in the berm construction, the material will be protected against wind erosion with a layer of 50 mm minus gravel;
- Emergency spillways are to be provided to prevent overtopping of the berm. The spill way to be protected from erosion with riprap or a half culvert pipe; and
- An impermeable liner placed vertically on the berm and anchored 2.0 m into the sub-base.
- The berm will be constructed with a Bentomat® liner placed near vertical on the inside of the berm. The liner will be keyed into the base to a depth of 2.0 meters. Bentomat is a high performance environmental liner manufactured with durable high-strength geotextiles and a uniform layer of low-permeability sodium bentonite. Bentomat has a long lasting resistance to physical or chemical break-down in harsh environments. The bentonite's high swelling capacity and low permeability provide an effective hydraulic seal. Because of their unique self-healing sodium bentonite base, liners resist cracking that typically occurs in compacted clay liners subjected to repeated freeze/thaw conditions.
- The liner will be installed vertically in the berm only. No liner will be used in the lagoon base. The field investigation, followed by the thermal analysis complete by AMEC indicates that the lagoon base is competent. Freeze back will occur into the berm, and the base of the lagoon will remain impermeable due to permafrost conditions. Therefore AMEC does not recommend the use of a liner on the base of the lagoon.

The types of material to be used in the berm construction are described in section 4.6.

## 5.3 Truck Pad and Turn-Around

The truck turning access pad will need to be constructed at the top of the lagoon berm to allow for gravity discharge from the truck to the lagoon. The siting of the pad must provide for a cost effective construction, and also provide for a safe operation for the truck drivers in all climatic conditions. The truck pad will have the following elements;

- A minimum turning radius of 15 meters,
- Bollards along the edge of the lagoon to provide for driver safety,
- Stop logs at the discharge location to give the truck driver a physical point to stop the truck,
- Delineators along the edge of the truck pad to indicate the edge of the embankment in winter conditions,
- The side slopes of the truck pad will be protected against erosion with a layer of granular material. The erosion protection will have a minimum gradation of a 50mm minus material. Courser material maybe if economically available.

The truck turn around pad requires a radius of 15 m if a standard sewage truck is to be used. Should the owner feel that the use of larger trucks (B-Trains) are to be used, then a larger turning radius is required. The side slopes of the turn around pad are to be 3:1 (H:V).

## 5.4 Sewage Discharge Flume

Sewage will be disposed from sewage trucks into the lagoon though a free fall discharge pipe. With respect to trucked sewage, free fall discharges are simple in design and operation and easy to access and maintain. The discharge will be constructed with the following specifications:

- 2- 800mm nestable half culverts
- 30% slope
- CSP supported by PTW embedded into the embankment
- Rip rap will be placed on the interior slope of the lagoon berm along the length of the discharge flume, and to the base of the lagoon to prevent erosion.
- Bollards will be in place to prevent the sewage truck from damaging the flume
- Wheel stops will be placed in front of flume.

**Drawing 101** shows a layout of the truck pad and discharge flume area. Details of the design elements of the truck pad and discharge flume are shown in **Drawing 109.**

## 5.5 Lagoon Discharge Structure

The effluent from the lagoon will be discharged to Lake P through discharge system. Several options are possible. Methods used at other locations in Nunavut include;

- A siphon (used in Qikigtarjuaq)
- A gas or diesel fired pump
- A gravity discharge and valve

The goals and objectives of the project are to provide a system with low operating costs and to simplify the operational elements. For these reasons the use of a pumped system is not recommended.

The use of a siphon works well once the lagoon is operating at design capacity. When it is operating in the early years the siphon system has proven problematic. Often the siphon requires priming with a vacuum pump at each discharge event. For these reasons the use of a siphon system is not recommended

The recommended system is the use of a gravity discharge line with a valve located in a manhole within the berm. This is a common system installed throughout Nunavut, most recently in Pond Inlet. Design components of the system include;

- An intake structure to raise the inlet of the pipe above the sludge deposition level. This is a 90 degree bend located at the inlet of the pipe.
- A steel pipe through the lagoon berm
- An access vault located within the berm. The manhole is located in the berm crest to facilitate access to the top of the manhole.
- A valve installed in the Manhole on the discharge pipe.
- A pipe out fall and discharge channel. The outfall area has riprap protection to prevent erosion and to dissipate the energy of the discharge.

**Drawings 111 and 112** illustrate the plan and section of the proposed effluent discharge system.

## 5.6 Berm and Road Material

### 5.6.1 Berm

The design intent for the lagoon is an annual retention cell. The berms are to be constructed to provide low permeability to the sewage. The geotechnical investigation indicted that there is sufficient quantity of material that is suitable for use in the berm construction. Based on the geotechnical report (appended) the following will be used for the construction of the berm walls;

- Construction of the berm walls using a berm core of fine grained (low permeability) material. . The outer faces of the berms would have coarser grained material to prevent erosion on the inside of the walls to protect the berms from wave and ice erosion.
- The berm wall will have a near vertical liner to increase the berms impermeability. The liner will extend from 2.0 m below the base of the lagoon and extend to the top of the berm.

### *5.6.2 Road*

The cost estimate for the road alignment and profile are based on the information provided by a site survey completed by sub Arctic Surveyors in August 2005. In order to access the lagoon location a steep rock face must be traversed. Access would be partially provided along an existing road but a new road 950 m in length and with an elevation change of approximately 56 m would need to be constructed. The plan and profile are shown in **Drawings 102-108**. The profile consists of interpreted data from existing contour mapping, survey data and digital mapping.

The road will be developed based on the following standards;

- The road width will be 8.0 meters. This will allow two trucks to pass safely.
- The maximum grade will be 8%. Where possible the road grade will be maintained below 6%.
- Guard rails will be provided on curves and areas of steep embankment.
- Curves will be a minimum of 25 meters to provide for road safety is adverse climatic conditions.
- Road side delineators will be install to assist in snow clearing
- Side slope of the road will be governed by the stability of the granular material used for the road construction. Geotechnical recommendation will be used to determine the minimum side slope. For safety reasons, a minimum slope of 2:1 will also govern.

The access road to the lagoon will be constructed to the following standards:

- Transportation Association of Canada (TAC): Geometric Design Guide for Canadian Roads, Section 3.1.6: Traffic Barriers (1999)
- Uniform Traffic Control Devices for Canada, Third Edition. Part C, Division 3: Hazard and Delineation Markings (1994)
- AASHTO, Roadside Design Guide, 1989

### *5.6.3 Granular Supply*

Cape Dorset has approximately 30,000 m$^3$ of available granular material. A blast and crush operation will likely be required as part of the road and lagoon construction. We have had several discussions with the community representatives, and with the local contractor Fred Schell. Based on these conversations it is understood that;

- The Hamlet owns a crusher
- The contractor owns an air track drill rig
- The contractor has previously been given a quarry permit for sufficient resources to complete the proposed works. The permit had a 1 year expiry date, and has since expired.
- There are other contractors (Canadrill) who would be willing to provide services to develop a granular resource for this project.

Based on the above discussions, the development of the granular resources to complete the proposed works is possible and there is little risk to the owner associated with the development of the resource. The costs estimates to develop the resource and supply and place the granular material are based on \$100/m$^3$ for rock excavation and \$40/m$^3$ for fill. Since most of the material will be obtained from a blast and crush operation, there is little cost savings when using on site cut (blast) material for fill material.

We have used a 30% expansion factor for on site cut when applied to fill.

The cost estimates for granular supply are summarized below.

**Table 5.1: Cost Estimates**

| Item | Quantity ($m^3$) | Unit Cost | Total Cost |
|---|---|---|---|
| Access Road Cut | 6,200 | $100 | $620,000 |
| Access Road Fill (from cut) | 8,100 | $20 | $16,200 |
| Access Road Fill (borrow) | 21,700 | $40 | $868,000 |
| Lagoon Berms Cut | 0 | $100 | 0 |
| Lagoon Fill (from cut) | 0 | $20 | 0 |
| Lagoon Fill (borrow) | 25,200 | $40 | $1,000,000 |
| **Total** | | | **$2,500,000** |

All estimated costs have an associated accuracy of ± 20.

As part of the geotechnical study, five granular sources were identified. All of these sources are found within the municipal boundary for the community. Granular resources developed within the municipal boundary, and that are used for municipal purposes are exempt from the Nunavut Environmental Impact Review process.

The identified granular sources contain high levels of fines. All sources will require processing (screening) to obtain granular material for the construction of the lagoon berms.

### *5.6.4 Culvert Design*

As illustrated in **Drawings 102-104,** the construction of the road from the Hamlet to the proposed lagoon site will require the construction of several culverts. To determine the design parameters for the construction of the culverts, the peak water flow through the culvert was determined.

#### *5.6.4.1 Method of Flood Estimation based on Rainfall Data*

The rational method was used to estimate the peak flow for the culvert design. This method generally produces reliable results for small watersheds where the input parameters can be properly quantified. The equation used is:

$$Q = \frac{RIA}{360} \qquad [1]$$

Where,

Q = the design flow in $m^3/s$

R = a co-efficient that estimates the fraction of rainfall that runs off (the rest is assumed to sink into the ground or get stored in depressions and not appear at the point of concentration (POC) until after the peak flow has passed)

I = the average rainfall intensity (derived from a regional IDF curve for a 10 year return period) during the time of concentration ($T_C$) (**Appendix H**)

$T_c$ = the time that it takes water to flow from the highest point in the watershed to the point of interest. $T_c$ is also knows as the "response time" of the basin (**Appendix H**)

A = watershed area in hectares (Determined by Catchment Area Drawing in **Appendix H**).

For the Cape Dorset region, a set of Intensity-Duration Frequency (IDF) curves was available from Environment Canada (**Appendix H**). The data used to create the IDF curves was collected at the Cape Dorset Airport.

Practical difficulties are inherent when estimating design floods based on rainfall data. It is difficult to estimate $T_c$, the time of concentration, R, the fraction of the rainfall that runs off (rather than sinking into the ground) and I, the "design" rainfall intensity. For this reason, a factor of safety of 10% has been added to the design flow in addition to the following values to account for inaccuracies in the inputs.

Area inaccuracy 5% or 0.05 = 105% of calculated value
R inaccuracy 20% or 0.20 = 120% of estimated value
I inaccuracy 5% or 0.05 = 105% of value taken from IDF curve

With a design peak flow ($Q_d$) based on an estimated 10 year return peak flow ($Q_{10}$) established, the Manning's formula (**Equation 2**) was used to size the culvert diameter based on a velocity of water flow in the pipe of approximately 1.5 m/s:

$$Q = \frac{A\left(kr^{\frac{2}{3}}s^{\frac{1}{2}}\right)}{n} \qquad [2]$$

Where,

Q = Flow in $m^3$/s or $ft^3$/sec
k = units factor (1.0 metric) or (1.486 Imperial)
r = the hydraulic radius of the channel section
s = slope of channel in m/m or ft/ft
n = Mannings coefficient (equal to 0.013 for typical culvert material)

As show in **Appendix F**, the peak flow through the culvert was conservatively calculated to be **1.72 $m^3$/s (60.7 $ft^3$/sec)**. Using a design flow of **1.72 $m^3$/s** and a slope of 0.18, a typical 1,200 mm (48") circular steel culvert will give a velocity of approximately 1.5 m/s.

## 5.7 P Lake Dimensions

P Lake will serve as a short retention lagoon. As per **Section 3** and **Drawing B** the volume of the Lake is approximately 11 667 $m^3$. The P Lake lagoon will offer treatment during a 2 week period in the fall, as the primary lagoon is discharged.

**Table 5.2** shows the sewage retention time in P Lake for each volume of sewage produced by the community over the 20 year lifespan of the system.

**Table 5.2: Sewage Retention Time in P Lake**

| Year | Annual Sewage Volume ($m^3$) | Discharge Time (days) | Retention time (days) |
|---|---|---|---|
| 2006 | 59829 | 14 | 2.7 |
| 2007 | 61448 | 14 | 2.7 |
| 2008 | 63026 | 14 | 2.6 |
| 2009 | 64671 | 14 | 2.5 |
| 2010 | 66330 | 14 | 2.5 |
| 2011 | 68283 | 14 | 2.4 |
| 2012 | 70198 | 14 | 2.3 |
| 2013 | 71902 | 14 | 2.3 |
| 2014 | 73735 | 14 | 2.2 |
| 2015 | 75467 | 14 | 2.2 |
| 2016 | 77213 | 14 | 2.1 |
| 2017 | 79208 | 14 | 2.1 |
| 2018 | 81042 | 14 | 2.0 |
| 2019 | 83190 | 14 | 2.0 |
| 2020 | 85358 | 14 | 1.9 |
| 2021 | 86530 | 14 | 1.9 |
| 2022 | 88405 | 14 | 1.9 |
| 2023 | 90294 | 14 | 1.8 |
| 2024 | 92197 | 14 | 1.8 |
| 2025 | 94115 | 14 | 1.7 |
| 2026 | 96047 | 14 | 1.7 |

## 6 TREATMENT QUALITY

The lagoon treatment system will be designed to meet the following effluent criteria at the discharge point to Telik Inlet:

- 45 mg/L $BOD_5$
- 45 mg/L SS
- $10^4$ Fecal Coliform / 100mL

Dillon has taken several measures to predict treatment quality and ensure that the lagoon treatment systems effluent discharged to Telik Inlet will meet the above criteria.

### 6.1 Annual Lagoon Kinetics

The level of treatment achieved by a lagoon system can be predicted using the following kinetic formula[1]:

$$\frac{C_e}{C_i} = e^{-Kt} \qquad [2]$$

Where,
$C_e$ = Concentration of substrate ($BOD_5$) in lagoon effluent (mg/L)
$C_i$ = Concentration of substrate ($BOD_5$) in lagoon influent (mg/L)
t = Residence time of sewage in lagoon (days)
K = kinetic rate constant for ($days^{-1}$)

The kinetic rate constant, K, varies according to temperature:

$$K = K_{20}\theta^{T-\theta} \qquad [3]$$

Where,
K = $BOD_5$ kinetic rate constant ($days^{-1}$)
$K_{20}$ = $BOD_5$ kinetic rate constant ($days^{-1}$) for $20^0$C
θ = temperature coefficient
T = temperature of lagoon contents in the critical or coldest winter months in degrees Celsius ($^0$C)

A typical value for θ is 1.06[2]. Although typical values for $K_{20}$ range from 0.25 – 0.50 $days^{-1}$, a significantly lower value for K (0.10 $days^{-1}$) was assumed in this case, to be conservative and to account for the cold climate conditions. Using these assumed values the effluent quality from the constructed

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[1] Environment Canada Report EPS 3 NR 1. (1987) Cold Climate Sewage Lagoons. *Proceedings of the June 1985 Workshop, Winnipeg, Manitoba.* Appendix D-3.

[2] Metcalf and Eddy, Inc. (1991). *Wastewater Engineering: Treatment, Disposal and Reuse, 3rd Edition.* Toronto : McGraw-Hill Inc.

primary lagoon was predicted for a variety of conservative temperatures and retention times (Error! Reference source not found.). Although the lagoon will hold sewage for a year's time, the effective treatment time used in Error! Reference source not found. only accounts for the length of time sewage is completely thawed for treatment during the summer months. Since freeze-up can vary and occur anytime from September – November, a range of 70-90 days of treatment were analyzed. Winter treatment was assumed to be negligible in **Table 6.1**.

**Table 6.1: Prediction of Effluent BOD using Lagoon Kinetics (Annual Retention Lagoon)**

| t (days) | $K_{20}$ (days$^{-1}$) | θ | T (°C) | K (days$^{-1}$) | $C_e/C_i$ | $C_i$ (mg/L) | $C_e$ (mg/L) |
|---|---|---|---|---|---|---|---|
| 90 | 0.1 | 1.06 | 3 | 0.037 | 0.0354 | 625 | 22 |
| 90 | 0.1 | 1.06 | 4 | 0.039 | 0.0289 | 625 | 18 |
| 90 | 0.1 | 1.06 | 5 | 0.042 | 0.0234 | 625 | 15 |
| 90 | 0.1 | 1.06 | 6 | 0.044 | 0.0187 | 625 | 12 |
| 90 | 0.1 | 1.06 | 7 | 0.047 | 0.0147 | 625 | 9 |
| 80 | 0.1 | 1.06 | 3 | 0.037 | 0.0513 | 625 | 32 |
| 80 | 0.1 | 1.06 | 4 | 0.039 | 0.0429 | 625 | 27 |
| 80 | 0.1 | 1.06 | 5 | 0.042 | 0.0355 | 625 | 22 |
| 80 | 0.1 | 1.06 | 6 | 0.044 | 0.0291 | 625 | 18 |
| 80 | 0.1 | 1.06 | 7 | 0.047 | 0.0235 | 625 | 15 |
| 70 | 0.1 | 1.06 | 3 | 0.037 | 0.0743 | 625 | 46 |
| 70 | 0.1 | 1.06 | 4 | 0.039 | 0.0636 | 625 | 40 |
| 70 | 0.1 | 1.06 | 5 | 0.042 | 0.0539 | 625 | 34 |
| 70 | 0.1 | 1.06 | 6 | 0.044 | 0.0452 | 625 | 28 |
| 70 | 0.1 | 1.06 | 7 | 0.047 | 0.0376 | 625 | 23 |

Based on the above data, the $BOD_5$ of the effluent discharged from the primary lagoon will range from 9 mg/L (90 day treatment period, 7°C) to 46 mg/L (70 day treatment period, 3°C). The short detention lagoon (P Lake), wetlands area and outfall to Telik Inlet will reduce this value even further to meet the effluent discharge criteria.

## 6.2 P Lake Lagoon Kinetics

The same kinetics used in **Section 5.1** can determine the amount of treatment that the P Lake lagoon will offer during the 14 day annual discharge of the primary lagoon. **Table 6.2** illustrates the effluent $BOD_5$ values determined for P Lake. These values were determined using equations **[2]** and **[3]** and the following parameters:

- The range of retention times determined in

**Table 5.2**

- The range of $BOD_5$ influent values ($BOD_5$ effluent values from primary lagoon) determined in **Table 6.1**
- $\theta = 1.06$
- $K = 0.1$ days$^{-1}$

**Table 6.2: Prediction of Effluent BOD using Lagoon Kinetics (P Lake Lagoon)**

| t (days) | $K_{20}$ (days$^{-1}$) | θ | T (°C) | K (days$^{-1}$) | $C_e/C_i$ | $C_i$ (mg/L) | $C_e$ (mg/L) |
|---|---|---|---|---|---|---|---|
| 3.5 | 0.1 | 1.06 | 5 | 0.042 | 0.8641 | 50 | 43 |
| 3.5 | 0.1 | 1.06 | 5 | 0.042 | 0.8641 | 40 | 35 |
| 3.5 | 0.1 | 1.06 | 5 | 0.042 | 0.8641 | 30 | 26 |
| 3.5 | 0.1 | 1.06 | 5 | 0.042 | 0.8641 | 20 | 17 |
| 3.5 | 0.1 | 1.06 | 5 | 0.042 | 0.8641 | 10 | 9 |
| 2.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9009 | 50 | 45 |
| 2.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9009 | 40 | 36 |
| 2.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9009 | 30 | 27 |
| 2.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9009 | 20 | 18 |
| 2.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9009 | 10 | 9 |
| 1.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9393 | 50 | 47 |
| 1.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9393 | 40 | 38 |
| 1.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9393 | 30 | 28 |
| 1.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9393 | 20 | 19 |
| 1.5 | 0.1 | 1.06 | 5 | 0.042 | 0.9393 | 10 | 9 |

Although equation **[2]** is useful for a first look at the potential performance of the annual retention lagoon and P Lake lagoon, the equation has not been tested for it's effectiveness in modeling Northern lagoon systems. Heinke *et al*[3] studied the effectiveness of lagoon sewage treatment in the North, and tabulated predicted lagoon treatment for Northern lagoon systems (**Table 6.3**).

**Table 6.3: Expected Performance of Lagoon Treatment of Municipal Type Wastewaters for Lagoon Systems**

| Parameter | Short Detention (% Reduction) | Long Detention (% Reduction) |
|---|---|---|
| *Summer* | | |
| $BOD_5$ | 40 | 80 |
| Suspended Solids | 50 | 80 |
| Fecal Coliform | 60 | 99.9 |
| *Winter* | | |
| $BOD_5$ | 40 | 50 |
| Suspended Solids | 60 | 50 |
| Fecal Coliform | 70 | 80 |

[3] Heinke, G.W., Smith, D. W., Finch, G.R. (1991) Guidelines for the planning and design of wastewater lagoon systems in cold climates. *Canadian Journal of Civil Engineering*, 18(4) 556-567.

Based on this data, the primary annual detention lagoon will reduce the influent 625 mg/L $BOD_5$ to 86 mg/L from both winter and summer treatment. Following this treatment, the secondary short detention lagoon (P Lake) will reduce the influent 86 mg/L to 51 mg/L. The wetland treatment and outfall for Telik Inlet will offer additional treatment to meet the effluent discharge criteria.

### 6.3 Fecal Coliform Reduction

The reduction of fecal coliforms (FC) can also be predicted using **Table 6.3**. The average generation of FC in domestic sewage is $2x10^9$ FC per person per day[4]. Using this value and the predicted sewage volume generation from **Table 2.1**, the average fecal coliform concentration in the P Lake Lagoon system was determined in **Table 6.4.**

**Table 6.4: Reduction of Fecal Coliform from Lagoon Treatment System**

| Year | Population | Fecal Coliorm | | Sewage Volume | Fecal Coliform | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Raw Influent | Annual Lagoon Effluent (99.9% Reduction) | P Lake Lagoon Effluent (40% Reduction) | P Lake Lagoon Effluent |
| | | (FC/p/d) | (FC/d) | (L/d) | (FC/L) | (FC/L) | (FC/L) | (FC/100mL) |
| 2006 | 1382 | 2.0E+09 | 2.8E+12 | 1.6E+05 | 1.7E+07 | 1.7E+04 | 3.4E+03 | 3.4E+02 |
| 2007 | 1412 | 2.0E+09 | 2.8E+12 | 1.7E+05 | 1.7E+07 | 1.7E+04 | 3.4E+03 | 3.4E+02 |
| 2008 | 1441 | 2.0E+09 | 2.9E+12 | 1.7E+05 | 1.7E+07 | 1.7E+04 | 3.3E+03 | 3.3E+02 |
| 2009 | 1471 | 2.0E+09 | 2.9E+12 | 1.8E+05 | 1.7E+07 | 1.7E+04 | 3.3E+03 | 3.3E+02 |
| 2010 | 1501 | 2.0E+09 | 3.0E+12 | 1.8E+05 | 1.7E+07 | 1.7E+04 | 3.3E+03 | 3.3E+02 |
| 2011 | 1536 | 2.0E+09 | 3.1E+12 | 1.9E+05 | 1.6E+07 | 1.6E+04 | 3.3E+03 | 3.3E+02 |
| 2012 | 1570 | 2.0E+09 | 3.1E+12 | 1.9E+05 | 1.6E+07 | 1.6E+04 | 3.3E+03 | 3.3E+02 |
| 2013 | 1600 | 2.0E+09 | 3.2E+12 | 2.0E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2014 | 1632 | 2.0E+09 | 3.3E+12 | 2.0E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2015 | 1662 | 2.0E+09 | 3.3E+12 | 2.1E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2016 | 1692 | 2.0E+09 | 3.4E+12 | 2.1E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2017 | 1726 | 2.0E+09 | 3.5E+12 | 2.2E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2018 | 1757 | 2.0E+09 | 3.5E+12 | 2.2E+05 | 1.6E+07 | 1.6E+04 | 3.2E+03 | 3.2E+02 |
| 2019 | 1793 | 2.0E+09 | 3.6E+12 | 2.3E+05 | 1.6E+07 | 1.6E+04 | 3.1E+03 | 3.1E+02 |
| 2020 | 1829 | 2.0E+09 | 3.7E+12 | 2.3E+05 | 1.6E+07 | 1.6E+04 | 3.1E+03 | 3.1E+02 |
| 2021 | 1848 | 2.0E+09 | 3.7E+12 | 2.4E+05 | 1.6E+07 | 1.6E+04 | 3.1E+03 | 3.1E+02 |
| 2022 | 1879 | 2.0E+09 | 3.8E+12 | 2.4E+05 | 1.6E+07 | 1.6E+04 | 3.1E+03 | 3.1E+02 |
| 2023 | 1910 | 2.0E+09 | 3.8E+12 | 2.5E+05 | 1.5E+07 | 1.5E+04 | 3.1E+03 | 3.1E+02 |
| 2024 | 1941 | 2.0E+09 | 3.9E+12 | 2.5E+05 | 1.5E+07 | 1.5E+04 | 3.1E+03 | 3.1E+02 |
| 2025 | 1971 | 2.0E+09 | 3.9E+12 | 2.6E+05 | 1.5E+07 | 1.5E+04 | 3.1E+03 | 3.1E+02 |
| 2026 | 2002 | 2.0E+09 | 4.0E+12 | 2.6E+05 | 1.5E+07 | 1.5E+04 | 3.0E+03 | 3.0E+02 |

The predicted concentration of FC/100mL of P Lake Lagoon effluent is far beneath the design criteria of $10^4$ FC/100mL.

[4] Metcalf and Eddy, Inc. (1991). *Wastewater Engineering: Treatment, Disposal and Reuse, 3rd Edition.* Toronto : McGraw-Hill Inc.

## 6.4 Wetland Sewage Treatment - Nutrient Removal

Lagoon treatment systems often have difficultly reducing nutrients (nitrogen and phosphorus) to regulated levels. The effluent from the P Lake lagoon will be discharged to a wetlands area. Northern lagoon systems that run into wetlands areas can generally meet nutrient levels. Wetlands remove nutrients by a variety of natural processes: plant uptake, filtration, sorption, flocculation, sedimentation and biological degradation.

## 6.5 Suggested Design Criteria

Design criteria have been developed to ensure that conditions in a lagoon treatment system are sufficient for proper sewage treatment. These design criteria take the following details into consideration:

- Sunlight for disinfection of microorganisms
- Wind for sewage aeration
- Odour control
- Sufficient Treatment of $BOD_5$

For sewage lagoons, the province of Manitoba[5] recommends not exceeding an organic loading of 56 kg/ha/d. Based on equation **[1]** and a $BOD_5$ of 625 mg/L, the maximum organic loading (in year 20) will be 53 kg/ha/d (**Appendix I**).

## 6.6 Functional Lagoon Systems in the North

To support the proposed lagoon treatment system design, Dillon will draw design parameters from existing sewage treatment lagoon that are functional and achieving the proposed effluent criteria for Cape Dorset, NU.

### 6.6.1 Nunavut

Dillon consulted with Mr. Constantine Bodykevich, Water Resources Officer, Indian and Northern Affairs Canada, Nunavut District Office. Based on his annual inspections of existing lagoons systems in Nunavut, Mr. Bodykevich offered the following advice for constructing a functional sewage lagoon system in Cape Dorset:

- Construct an annual retention lagoon as opposed to a seepage lagoon
- Construct lagoon berms with fine grade material that won't allow for the seepage of small particulate matter, i.e. shale, not course gravel
- Construct berms will a 3 m width at the top and a side slope with less than 50% grade

Dillon's preliminary design meets and/or exceeds these recommendations.

[5] Province of Manitoba. (1985) Design Objectives for Standard Sewage Lagoons.

### 6.6.2 Fort Liard

Dillon has been involved with various stages of the design of the sewage lagoon system in Fort Liard, NWT. Although the system in Fort Liard consists of 3 cells in sequence, the first 2 cells have a retention time of approximately 1 year and are comparable to a single cell with annual retention, proposed for Cape Dorset. A sample taken from the second cell on July 16, 2002 showed the following concentrations:

- $BOD_5$: 16 mg/L
- FC: 8 CFU/100 mL
- TSS: 41 mg/L

Although the climate in Fort Liard is warmer than in Cape Dorset, this sample was taken mid-way through the treatment season, after approximately 2.5 months of treatment. This is approximately the length of the treatment season in Cape Dorset. The results indicate that an annual retention lagoon is capable of treating sewage to the required guidelines.

## 6.7 Additional Sewage Treatment

Looking beyond the 20 year design horizon, there are opportunities to expand the lagoon system on the site, or to enhance the treatment system to provide additional future capacity. The proposed lagoon treatment system may be upgraded to enhance treatment and prolong the life of the system using a number of technological means. A long tem monitoring program is recommended to determine what maybe undertaken in the future to extend the 20 year design life of the facility. These are discussed below.

### 6.7.1 Aeration

Should additional treatment be required by the lagoon treatment system, the annual retention lagoon can be retro-fitted with aerators during the summer months. Aeration enhances the level of treatment in several ways:

- Completely mixes the system
- Increases temperature
- Addition of dissolved oxygen

All of the above factors lead to an increased rate of $BOD_5$ degradation. Depending on the detention time of the lagoon, the effluent from an aerated lagoon contains about one-third to one-half the value of $BOD_5$ from that of a non-aerated system.

Aeration is best practiced in an on/off operation. Approximately one-month prior to annual discharged the sewage can be aerated to advance treatment of the system. Two weeks prior to annual discharge, the aerators can be turned off, allowing settling of solids and removal of microorganisms.

### 6.7.2 Solar Aerators

The client has expressed interest in using a solar aerator in the sewage lagoon, to increase the rate of treatment. However, the effectiveness of this is uncertain. Cooler water temperatures hold more dissolved oxygen, and decrease the metabolic rate of microorganisms. Thus, the rate of $BOD_5$ degradation may be temperature-limiting, rather than oxygen-limiting.

The rate of BOD degradation in a lagoon system assumes that there is sufficient oxygen in the system. Adding aerators would not substantially increase the treatment rate above what is given by this equation. In the feasibility report, values of k were estimated to be between 0.037 – 0.047 $d^{-1}$. Using an influent concentration of 625 mg/L and an effluent concentration of 45 mg/L (as required by the Water Board), the treatment time would range between 56 and 71 days. To increase this rate, the water temperature would need to be increased.

#### *6.7.2.1 Feasibility of Aerators in Cape Dorset*

SolarBee® aerators have 3-80 watt solar panels, each producing 68 watts of usable output, for a total of 102 usable watts. Low speed, surface aerators typically have an oxygen transfer rate of 0.7 – 1.5 $kgO_2$/KWh.

The oxygen demand of 7 months of sewage (November – May), with an influent $BOD_5$ concentration of 625 mg/L, would range between 32719 kg in 2006 to 52525 kg is 2026. This is the total oxygen demand, assuming a ratio of $BOD_u$ : $BOD_5$ of 1.5, where $BOD_u$ is the ultimate oxygen demand. Over a 60 day period, the daily oxygen demand would be 875 kg $O_2$/d.

According to H2O Logics Inc., a SolarBee® distributor, the oxygen transfer rate for one of their machines is 300 lbs $O_2$/acre/day (or 336 kg $O_2$/ha/d). Also according to H2O Logic, the natural reaeration rate of lakes is 50 lbs $O_2$/acre/day (or 56 kg $O_2$/ha/d). With a lagoon size of 2.4 ha (185 m x 132 m), the natural surface reaeration is 134 kg $O_2$/d, considerably less than the 875 kg $O_2$/d predicted above.

### 6.7.3 Treatment Beyond 20 years

The proposed 2-celled lagoon treatment system is designed for a 20 year use; however, to maximize the utilization of the system, the treatment area may be expanded to accommodate sewage beyond 2026. **Table 6.5** lists the predicted yearly volume of sewage for years 20-40 of the systems use.

**Table 6.5: Predicted Sewage Generation Beyond Year 2026**

| Year | Population | MACA Predicted Sewage Production (L) | MACA Predicted Sewage Production ($m^3$) |
|---|---|---|---|
| 2027 | 2072 | 100520230 | 100520 |
| 2028 | 2110 | 102924133 | 102924 |
| 2029 | 2148 | 105392901 | 105393 |
| 2030 | 2186 | 107928488 | 107928 |
| 2031 | 2226 | 110532909 | 110533 |
| 2032 | 2266 | 113208245 | 113208 |
| 2033 | 2306 | 115956647 | 115957 |
| 2034 | 2348 | 118780333 | 118780 |
| 2035 | 2390 | 121681597 | 121682 |
| 2036 | 2433 | 124662807 | 124663 |
| 2037 | 2477 | 127726409 | 127726 |
| 2038 | 2522 | 130874930 | 130875 |
| 2039 | 2567 | 134110979 | 134111 |
| 2040 | 2613 | 137437253 | 137437 |
| 2041 | 2660 | 140856538 | 140857 |
| 2042 | 2708 | 144371710 | 144372 |
| 2043 | 2757 | 147985745 | 147986 |
| 2044 | 2806 | 151701714 | 151702 |
| 2045 | 2857 | 155522791 | 155523 |
| 2046 | 2908 | 159452257 | 159452 |

In order to treat sewage up to year 2046 (year 40 of system operation) the P Lake lagoon must be built up to accommodate 63 900 $m^3$ of sewage (160 000$m^3$ generated in 2046 – 96 100 $m^3$ capacity of primary lagoon). This may be accomplished by building up berms surrounding P Lake similar to those described in **Section 5.1**.

After this expansion, the system would operate in a slightly different manner. The primary lagoon would no longer act as an annual retention lagoon since it would no longer accommodate a year's volume of sewage. Once full, the primary lagoon would be discharged to the newly expanded P Lake lagoon. The P Lake lagoon would then act as an additional long retention plug flow lagoon. After making its way to the plug flow lagoon, effluent would flow by gravity to the wetlands area before final discharge to Telik Inlet.

# 7 SAMPLING PROGRAM

A key component to the operations and maintenance of the proposed sewage treatment system is a sampling program. Dillon has developed the following sampling program to:

- Monitor treatment and verify compliance to regulations; and
- Model and understand the treatment process to aid with future expansions of the system.

The proposed sampling program will address the water quality on a temporal basis, the cumulative impacts to the plants and soil, and allow for trending of the data to see if we reach a stasis point after several years of treatment. The sampling program should be undertaken by the community as part of the annual operations.

## 7.1 Sampling Protocol

It is estimated that 8 sample locations will be required to document conditions along the effluent path:

- Control;
- Primary Lagoon inflow;
- Primary Lagoon effluent;
- P Lake (Secondary) Lagoon effluent;
- Wetlands effluent; and
- 3 taken along wetlands (between P Lake discharge and outlet).

Water samples would be taken weekly, during periods of open water. With these sample locations, each stage of the treatment process would be noted, with emphasis on the wetlands area. This sampling protocol would need to be conducted over several years, to obtain data for trend analysis. It could be scaled down after the first year, to remove sample locations that are not considered essential (i.e. lagoon inflow, along wetlands flow path).

As recommended in Dillon's "Sewage Treatment Using Tundra Wetlands" report (1997), a site specific ecological study of the wetland system should be undertaken, to identify and characterize the plant species in the wetland system. If this is conducted before discharging sewage to the wetland and for a few subsequent years, it could be used to monitor changes in the plant species with time. A minimum of two plots is recommended, located along the wetlands channel, and one control plot. Data would be collected twice during the growing season, late June (early stages of growth) and early-August (peak growth). This should be conducted by trained biologists, made up of the same team each season, to ensure consistency. No sample analysis is required, as data collection and logging is done in the field, by trained personnel. Costs would include the time and disbursements to send biologist(s) to site to conduct survey, twice/year.

Cumulative impacts to the soil have not been addressed in the above program. Sediment sampling could occur, if desired, at various locations along the wetlands. Deposition rate could be measured, or sediment samples could be analyzed themselves, for various parameters. These options could be explored further, if desired.

**Table 7.1: Analytical Parameters and Costs for Water Sampling**

| Parameter | Analytical Cost* |
|---|---|
| $BOD_5$ | $21.60 |
| Fecal coliforms | $11.20 |
| Total suspended solids | $8.80 |
| Ammonia nitrogen | $12.80 |
| Total phosphorus | $14.40 |
| Total (per sample) | $68.80 |

*Based on prices from Accutest Laboratories in Ottawa

For 8 samples, the total cost would be: $550.40 + GST

For weekly samples, over 10 weeks, the total cost would be: $5504.00 + GST

## 7.2 Sample Shipment

If samples are taken early Tuesday or Thursday mornings, they can be shipped on the 11 am First Air flight to Iqaluit. There is a 6 pm freighter from Iqaluit to Ottawa on Tues/Thurs. Coolers can be delivered/picked-up first thing Wednesday or Friday morning to/by Accutest.

According to Accutest, FC samples need to be analyzed within 48 hours, and $BOD_5$ samples need to be analyzed within 7 days of sampling. For both parameters, 24 hours is preferred between sampling and analysis, but not required.

Shipping costs are approximately $140 (general) and $180 (priority). Regular shipping should be sufficient to make the Iqaluit connection, but it could be sent priority just in case.

## 7.3 Sampling Equipment

Sample bottles and coolers will be sent to the community by Accutest. Latex gloves will be required for each sample. If a boat was available, samples could be taken from the middle of the wetlands.

Cost of latex gloves for the summer: $80

# 8 CONSTRUCTION STRATEGY

The GN's intent is to complete this project over the fiscal years 2005/06 and 2006/07. The work is to proceed with the supply of as much of the materials on the 2005 sea lift. Some earth works may proceed in 2005. The majority of the works will be completed in 2006. The tender of the major works will occur in 2005. The entire project is to be commissioned in September/October 2006.

A schedule outlining this construction strategy is shown in **Table 8.1**.

**Table 8.1: Project Schedule**

| Task | Milestone Date |
|---|---|
| | |
| Acceptance of the Pre-Design Document | October, 2005 |
| Site Survey, geotechnical investigation & Community Consultation | August 2005 |
| Fisheries study Field Work | August 2005 |
| 50% submission Detailed Design | August 2005 |
| | |
| **Application for Water License** | **July 6th, 2005** |
| Completion of Fisheries Study | August 2005 |
| 100% Submission of Detailed Design | October 2005 |
| **Comments Received From DFO & EC** | November 2005 |
| Comments Received From Water Board | December 2005 |
| Comments Received From Client | September 2005 |
| Authorization From Water Board received | December 2005 |
| Tender Period | January 2005 |
| | |
| **Construction FY 2006** | |
| Contract Award | January, 2006 |
| Quarrying | January to March, 2006 |
| | |
| **Construction FY 2007** | |
| Quarrying and material mobilization | April to June 2006 |
| Road Construction | July 2006 |
| Lagoon works | July to September 2006 |
| Sea lift of materials | September 2006 |
| Commissioning | October 2006 |

# 9 APPROVALS

## 9.1 Regulatory Agencies

To complete this project there are several approval agencies that need to be made aware of the intended works. Not all of the agencies provide authorization, however, they all can be involved through the required licensing and authorization processes required of the project owner. **Table 9.1** outlines the agencies that need to be involved in the approval process.

**Table 9.1: Approval Agencies**

| Agency | Regulations |
|---|---|
| Indian and Northern Affairs Canada (INAC) | Inland Waters Act<br>Marine Waters Act<br>Monitoring of Water Licenses |
| Department of Health | Health Act<br>General Sanitation Act |
| Department of Fisheries and Oceans (DFO) | Fisheries Act (Section 35) related to fish habitat |
| Environment Canada (EC) | Fisheries Act (Section 36) related to the discharge of deleterious substances |
| Nunavut Water Board | Nunavut Land Claims agreement |

Each of the above agencies has been contacted to discuss their requirements for the proposed works. While the project proposal must meet the requirements of all the agencies of particular note are the Nunavut Water Board, the Department of Fisheries and Oceans, and Environment Canada. The project can not proceed without specific authorization from each of these three bodies.

The Water Board issues a Water License to the community for the withdrawal of water (over 50,000 L) and the subsequent deposit of the waste water. There is a formalized licensing process and application form to be completed and submitted to the Water Board for review and approval. This can only proceed once the detailed design is at the point to show sufficient information for the Board's review.

## 9.2 DFO Approvals

In September 2005 Dillon Consulting Limited (Dillon), on behalf of the Government of Nunavut (GN) submitted a report to the Department of Fisheries and Oceans (DFO) concerning the fisheries at P Lake. A description of the work plan and results is described in Section 4.0 of this report.

### *9.2.1 Access to "P" Lake, and Impacts to Fish or Fish Habitat*

A new road has been planned to access "P" Lake. Based on the information we have, there is no indication that the road will have any impact on fish or fish habitat. The current road design does not include any stream crossings, nor does the route encroach on any permanent water bodies. All construction work will likely be carried out in isolation of flow or in the dry. The culvert being installed is intended to handle natural runoff that intersects the road at the point indicated on figure 2.

Additional sediment resulting from the construction works will not enter any fish habitat. During construction, sediment controls will be in place to ensure sediment-laden water is not released to areas downstream of the work site. All disturbed areas will be isolated from fisheries habitat, and there will be no permanent disruption of native plants or grasses.

### 9.3 Water License Application Requirements

As part of the regulatory review process completed by Dillon, the technical advisor for the Nunavut Water Board was contacted to discuss the requirements for the Water License application. With the license application, or shortly after the application, the Water Board will likely require the submission of the following documents;

- Operations and Maintenance Plan for the Proposed System
- Abandonment and restoration plan for the Existing 3 Cell Sewage Lagoon System
- Abandonment and Restoration Plan for the new P Lake lagoon system
- An Emergency or Contingency Plan to address the potential for sewage discharge in the event that the new system (P Lake Lagoon) is not accessible. An example would be in blizzard conditions when the access road maybe blocked with snow.

The GN has identified the use of the existing Cell 1 of the 3 cell system as a potential resolution to the contingency plan at times that the proposed access road is inaccessible. This will be carried forward through the design.

# 10 SUMMARY AND CONCLUSIONS

The new sewage treatment system will be designed for a 20-year life span (2006-2026). Predicted population values until the year 2020 were provided by Nunavut Bureau of Statistics (**Appendix D**). The population for 2026 was predicted to be 2002 persons. Based on this information, the lagoon will be designed to treat 96 100 $m^3$, the annual sewage volume for a population of 2002 persons.

Cape Dorset trucked sewage is assumed to have the following characteristics:

- Average raw Biochemical Oxygen Demand ($BOD_5$) concentration of 625 mg/L
- Average raw suspended solids (SS) concentration of 900 mg/L

The lagoon treatment system will be designed to meet the following effluent criteria:

- 45 mg/L $BOD_5$
- 45 mg/L SS
- $10^4$ Fecal Coliform / 100mL

Dillon has taken several measures to predict treatment quality and ensure that the lagoon treatment systems effluent discharged to Telik Inlet will meet the above criteria. Each method indicates that the use of an annual storage lagoon will meet the discharge criteria.

The annual retention lagoon will be constructed with (near) rectilinear dimensions to promote plug flow conditions. Plug flow conditions are important during the time of annual discharge in order to prevent short circuiting, or raw sewage by-passing treatment and directly discharging to P Lake. The lagoon will be constructed to facilitate anaerobic sewage treatment (at full capacity) using the following characteristics:

- 3.5 m liquid operating depth
- 0.5 m of allowance on the lagoon bottom for sludge accumulation

The size of the lagoon was determined to accommodate the above design parameters and the predicted volume of sewage generated in 2026 (96 100 $m^3$). The parameters of the lagoon are:

- 185 m x 132 x to the lagoon liquid surface at full capacity in year 2026 (3.1 ha)
- 179 m x 129 m to the inside toe of the berms (2.4 ha)

The above dimensions can be accommodated by the proposed area preceding P Lake.

**Drawings 100-112** show the proposed detail to be carried forward to the detailed design phase. This includes;

- Approximately 950 meters of new road construction. The road will have a maximum grade of 6%. Guardrails will be installed on all down gradient edges. The road width will be 8.0 meters.
- A truck turn around pad.
- A gravity truck discharge flume.
- A gravity discharge pipe complete with an access vault and valve to control the lagoon discharge
- Ditching and culverts to direct runoff away from the lagoon.
- The lagoon walls will be constructed partially from fill, and partially from cut into the rock. The rock removed will be use for fill sections. The inside of the lagoon walls will be riprap protected in the fill sections.

The estimated cost of construction for the proposed system is shown in **Table 10.1**. Life cycle costing is shown in **Table 10.2.**

**Table 10.1 Cost Estimates**

| Item | Units | Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|
| | | | | |
| **Access Road & Truck Pad** | | | | |
| Cut (rock blasting) | M3 | 3,921 | $100 | $392,100 |
| Fill (borrow) | M3 | 22,405 | $35 | $784,175 |
| Granular 19 mm Minus | M3 | 901 | $50 | $45,050 |
| Culvert (1,200 mm) | LM | 78 | $50 | $3,900 |
| Guard Rail | LM | 276 | $200 | $55,200 |
| Road Delineators | each | 160 | $50 | $8,000 |
| | | | | |
| **Lagoon Construction** | | | | |
| Cut (rock blasting) | M3 | 0 | $100 | $0 |
| Fill (borrow) | M3 | 21,942 | $35 | $767,970 |
| Rip Rap | M2 | 686 | $35 | $24,010 |
| Discharge Flume | Each | 1 | $10,000 | $10,000 |
| Effluent Discharge Structure | Each | 1 | $80,000 | $80,000 |
| Bollard | Each | 30 | $500 | $15,000 |
| Ditching | LM | 350 | $10 | $3,500 |
| Liner | M2 | 3,200 | $40 | $128,000 |
| | | | | |
| | | | | |
| | | | | |
| Subtotal | | | | 2,316,900 |
| Engineering | 10% | | | 230,000 |
| Contingency | 20% | | | 460,000 |
| GST | 7% | | | 210,000 |
| **Total** | | | | **$3,217,000** |

The above costs include the cost of mobilization for equipment, manpower and material (other than granular) to the community. It has been assumed that part of the equipment and labour will be provided from the local contractors and labour forces in accordance with the Inuit Content requirements for the contract.

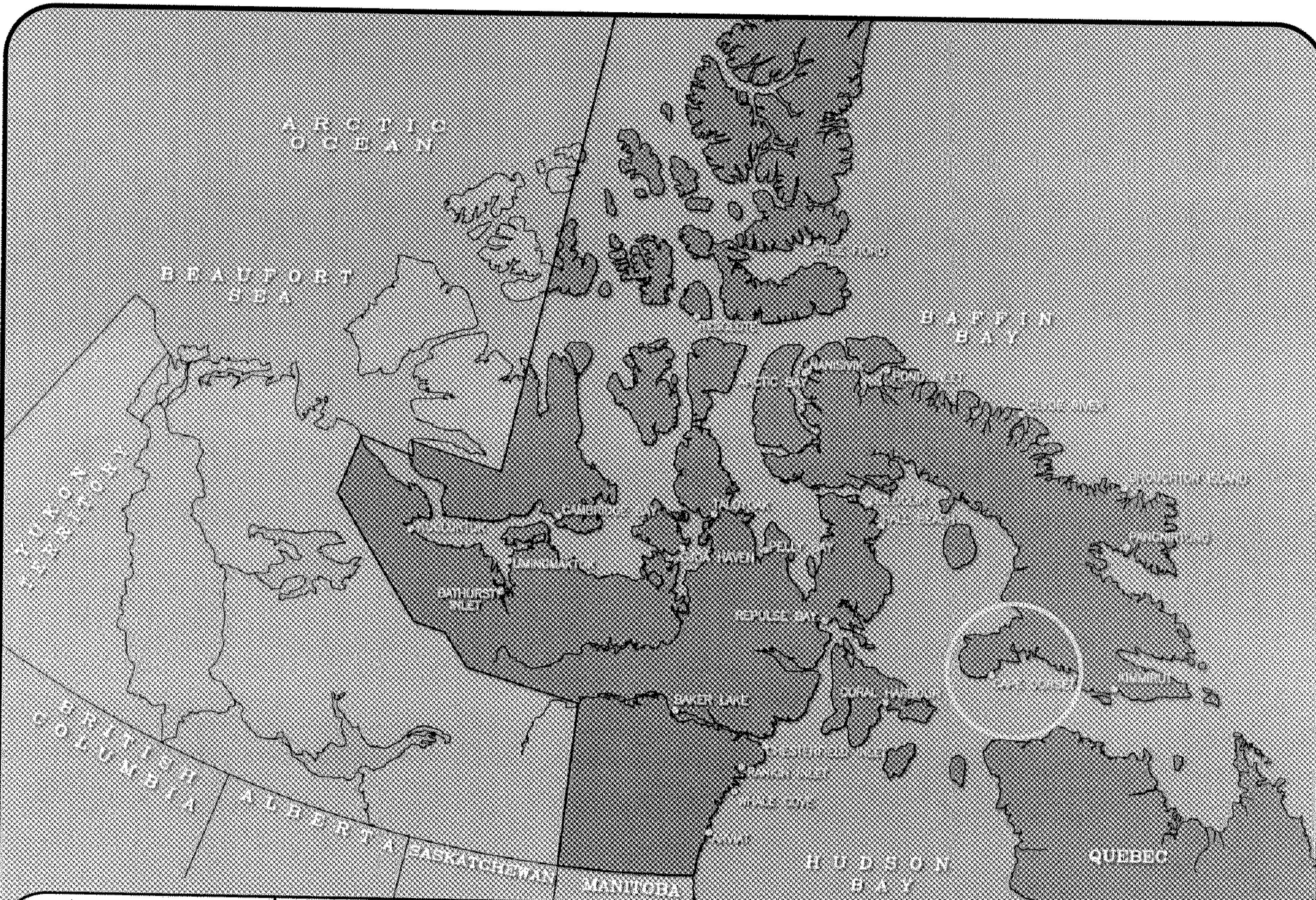
**Table 10.2 Life Cycle Costing**

| Item | Total Cost |
|---|---|
| | |
| **Total Lagoon Capital** | **$3,047,000** |
| **Total Sewage Hauling Life Cycle Costing[1, 2]** | **$14,827,000** |
| | |
| **Total Life Cycle Costing[1]** | **$17,874,000** |

[1]Life Cycle Costing is determined for a 20 year life, using an 8% discount rate. [2] Sewage hauling Life Cycle Costing is determined from a template provided by the Department of Municipal and Community Affairs, Government of the Northwest Territories.

# APPENDIX A

# FIGURES



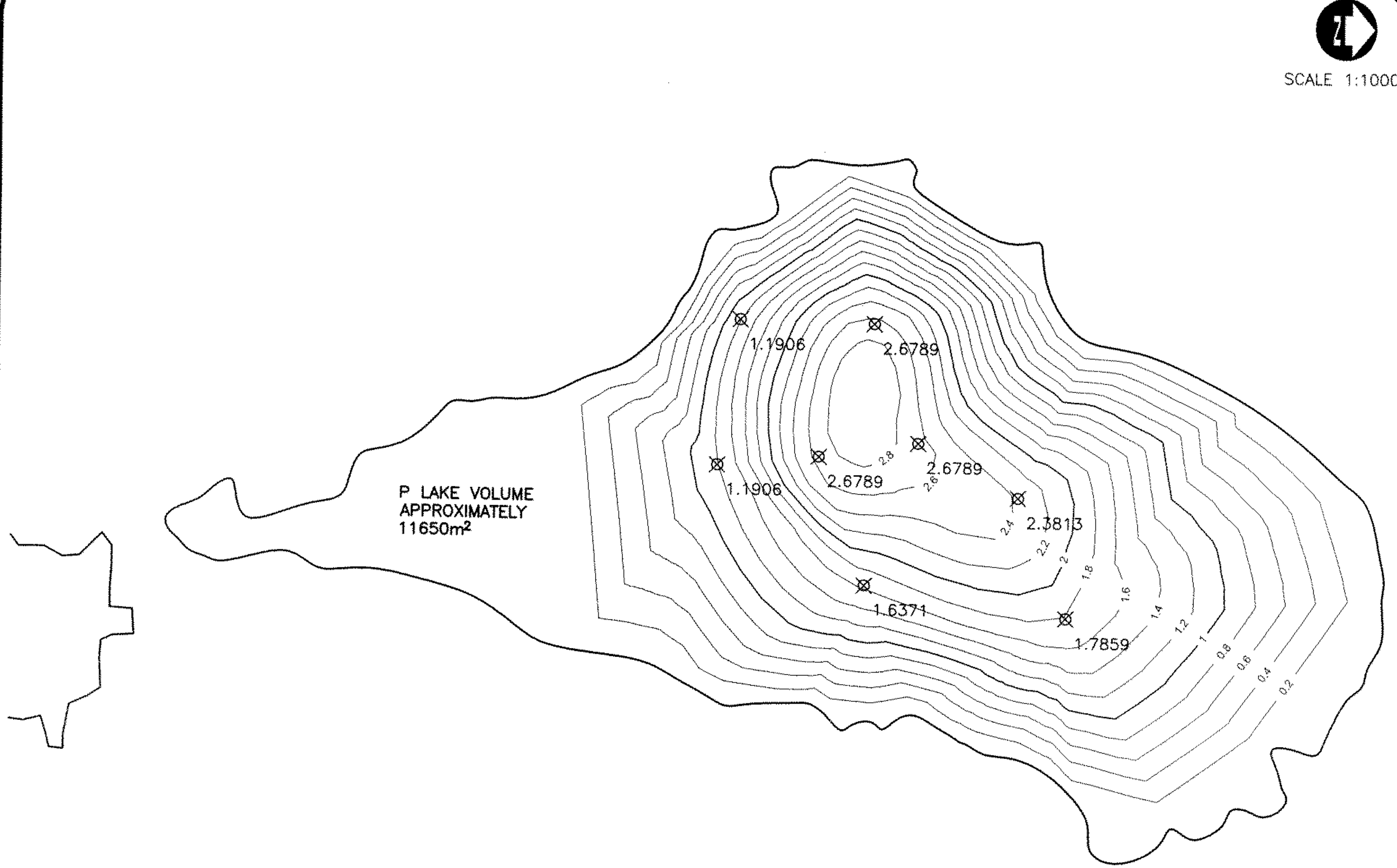

DILLON CONSULTING

| PROJECT | Cape Dorset Sewage Treatment System | PROJECT NUMBER | 05-4319-2000 |
|---|---|---|---|
| TITLE | Cape Doset Location Plan | DATE | May 05 |
| | | FIGURE NUMBER | A |

EDIT DATE: 30.05.2005 ACAD FILE:


| | | |
|---|---|---|
| DILLON CONSULTING | PROJECT: Cape Dorset Sewage Treatment System | PROJECT NUMBER: 05-4319-2000 |
| | | DATE: May 05 |
| | TITLE: Community Layout and Alternative Sites | FIGURE NUMBER: B |

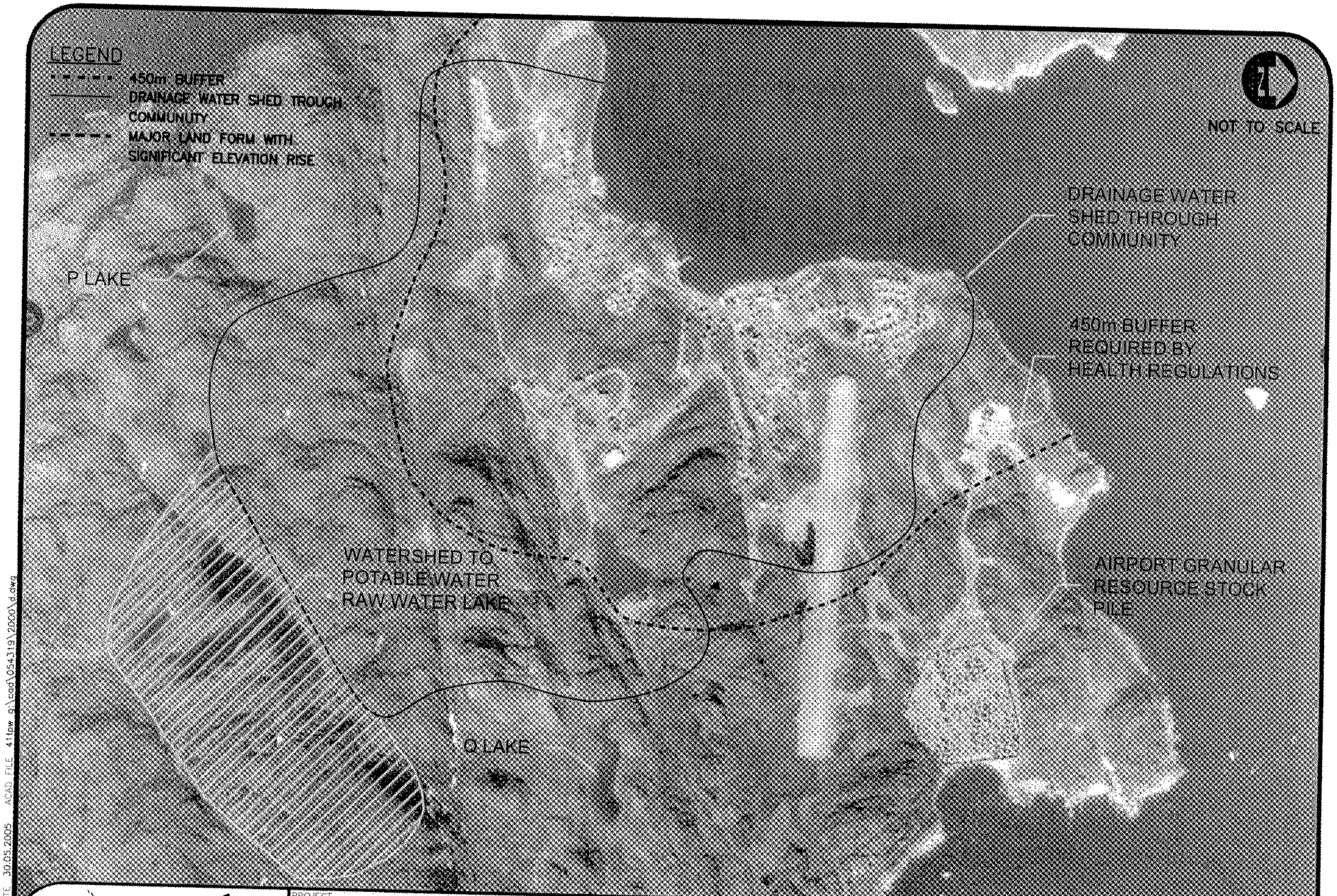
EDIT DATE: 30.05.2005 ACAD FILE: 41lpw g:\cad\054319\2000\b.dwg




NOTE: ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.

| | | |
|---|---|---|
| DILLON CONSULTING | PROJECT<br>Cape Dorset<br>Sewage Treatment System | PROJECT NUMBER<br>05-4319-2000 |
| | | DATE<br>June 05 |
| | TITLE<br>Bathymetry of Lake – P | FIGURE NUMBER<br>C |

EDIT DATE: 16.06.2005 ACAD FILE: 41tpw g:\cad\054319\2000\c.dwg




EDIT DATE 30.05.2005 ACAD FILE 41low g:\cad\054319\2000\d.dwg

DILLON CONSULTING

| | |
|---|---|
| PROJECT: Cape Dorset Sewage Treatment System | PROJECT NUMBER: 05-4319-2000 |
| | DATE: June 05 |
| TITLE: Constraint Map – Community Water Shed and 450m Setback | FIGURE NUMBER: D |

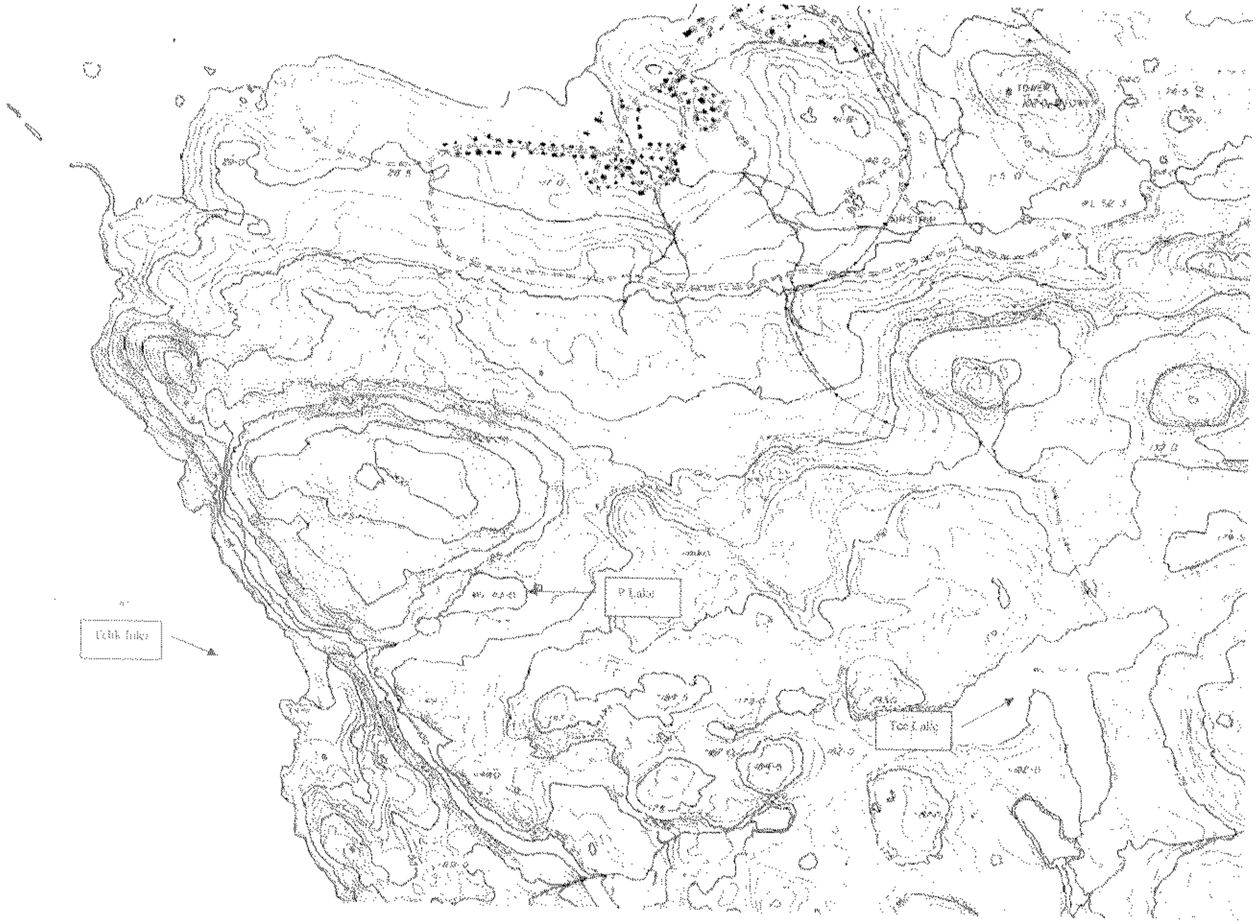



**Figure E Topographic Map**

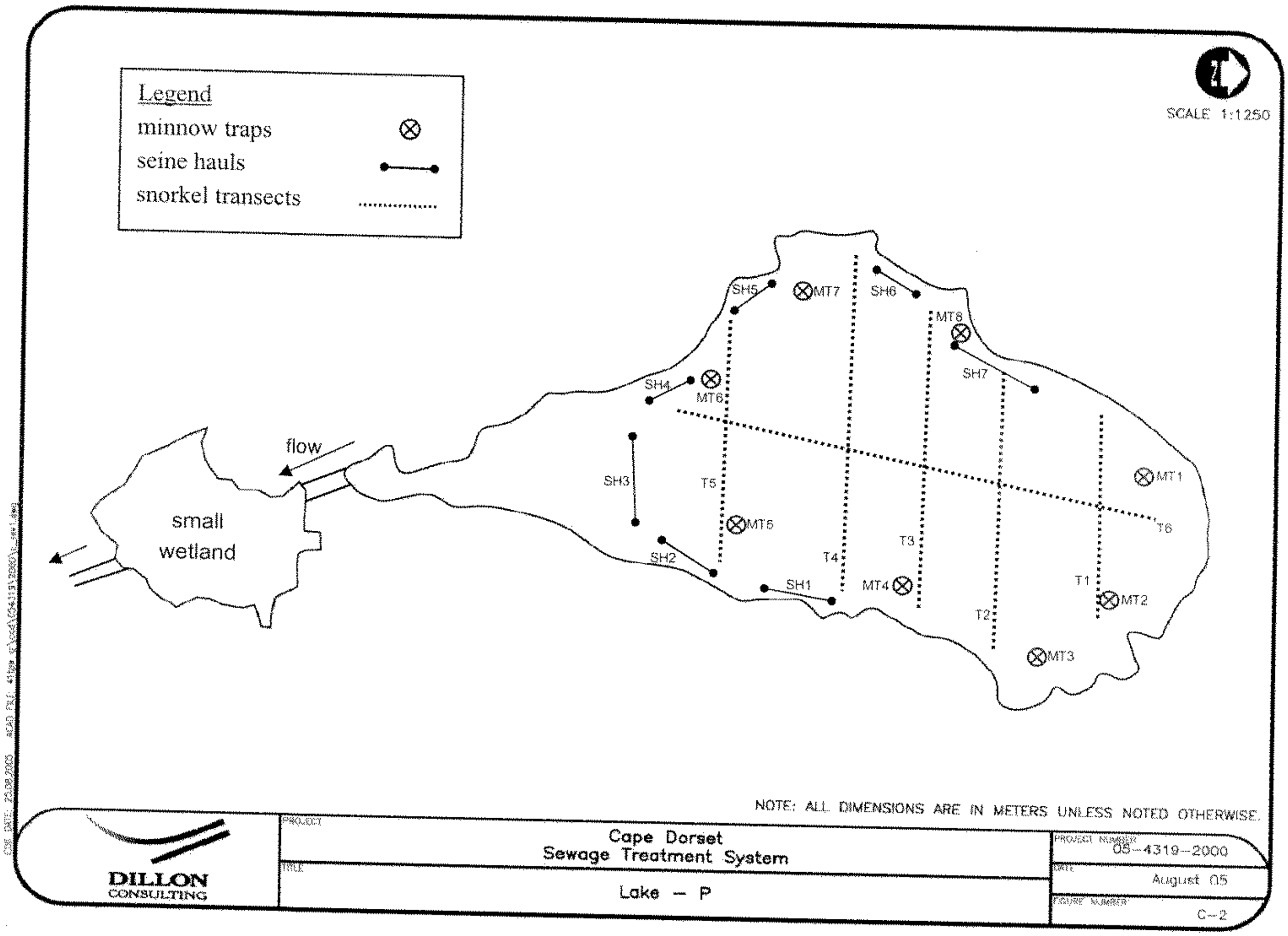



**Figure F. Map showing locations of minnow trap sets, seine hauls and snorkel survey transects in P Lake.**

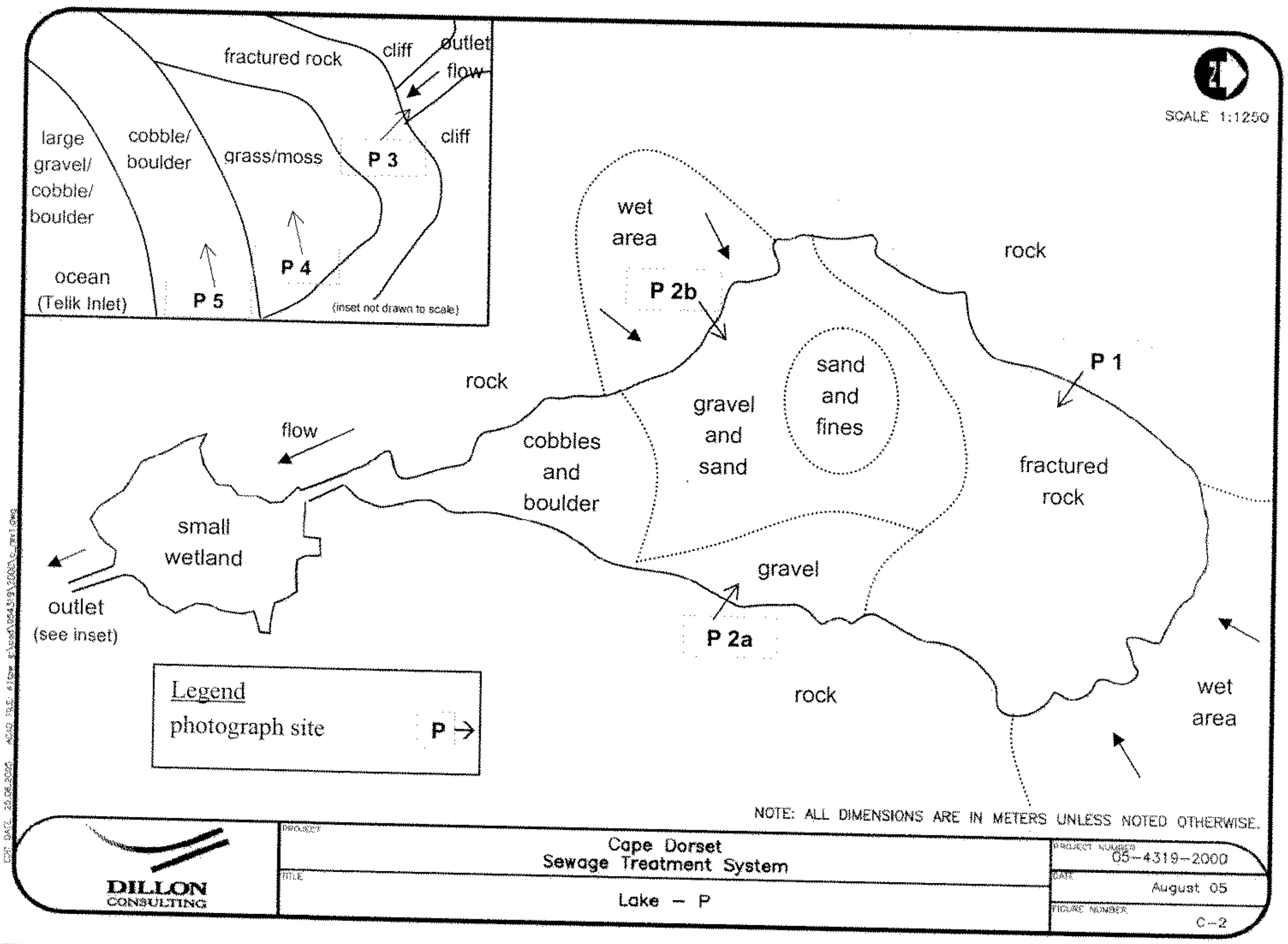
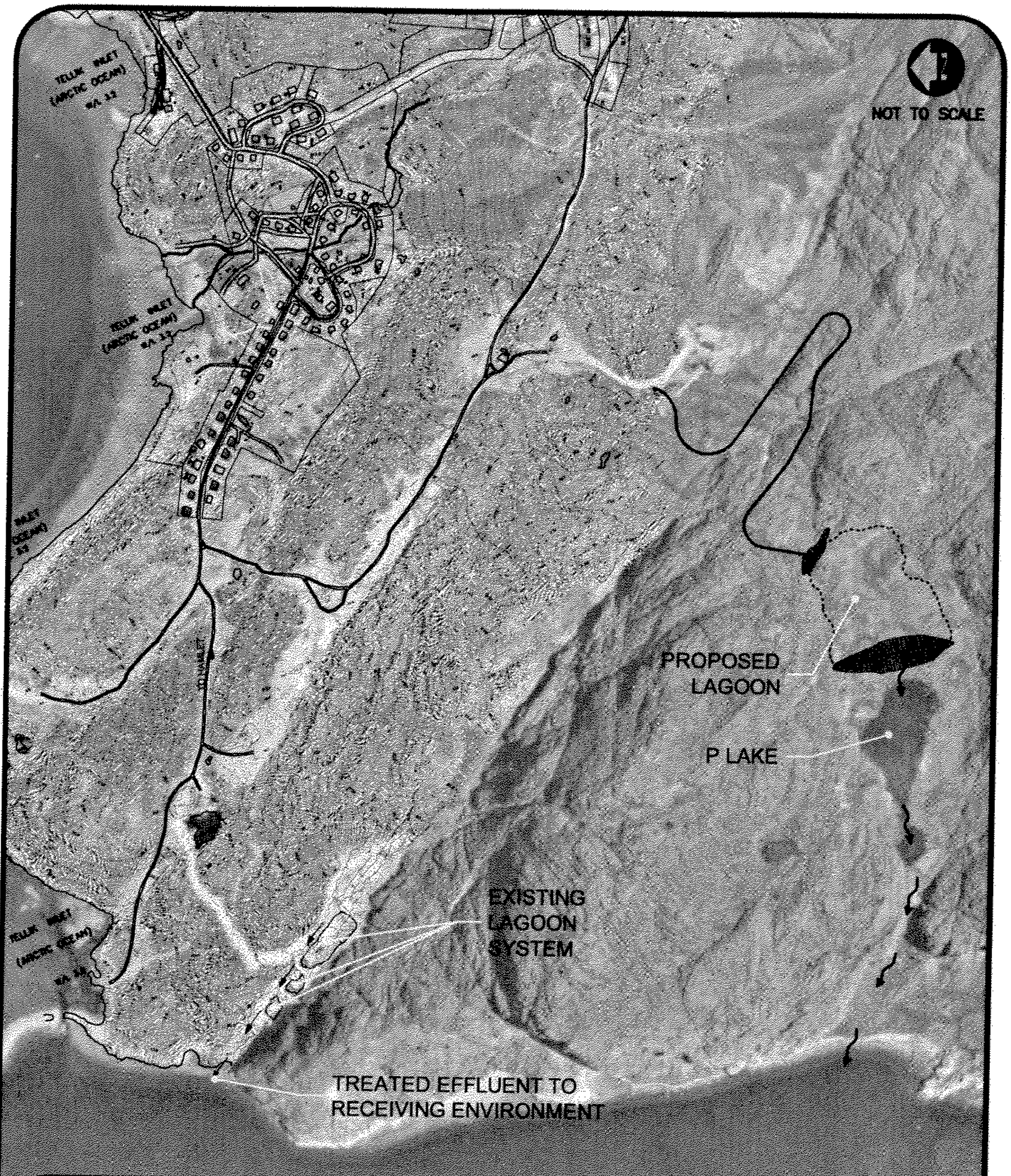



**Figure G. Map showing shoreline and underwater substrate conditions in P Lake and the outlet into Telik Inlet (inset).**




EDIT DATE: 30.06.2005

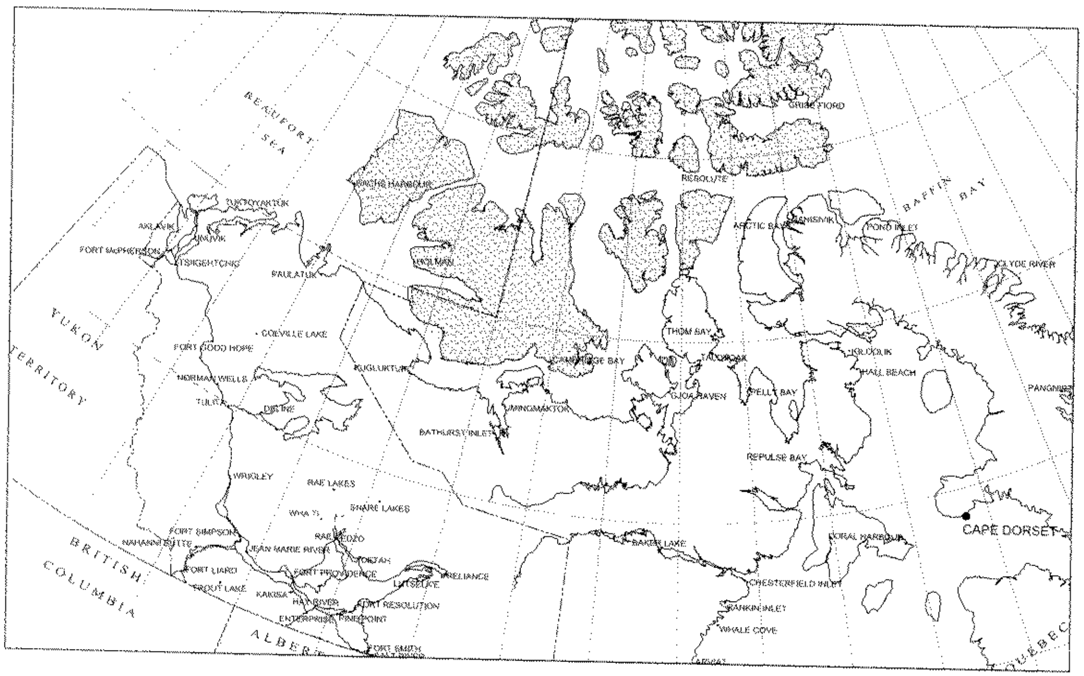
DILLON CONSULTING

| PROJECT | PROJECT NUMBER |
|---|---|
| Cape Dorset<br>Sewage Treatment System | 05-4319-2000 |
| TITLE | DATE |
| Proposed Lagoon and Road | June 05 |
| | FIGURE NUMBER |

Nunavut

# THE GOVERNMENT OF NUNAVUT
# COMMUNITY AND GOVERNMENT SERVICES

PROJECT: P LAKE AREA - SEWAGE LAGOON SYSTEM 95% REVIEW DRAWINGS
LOCATION: CAPE DORSET, N.U.
PROJECT NO: 3439
DATE: DECEMBER 2006




LOCATION PLAN

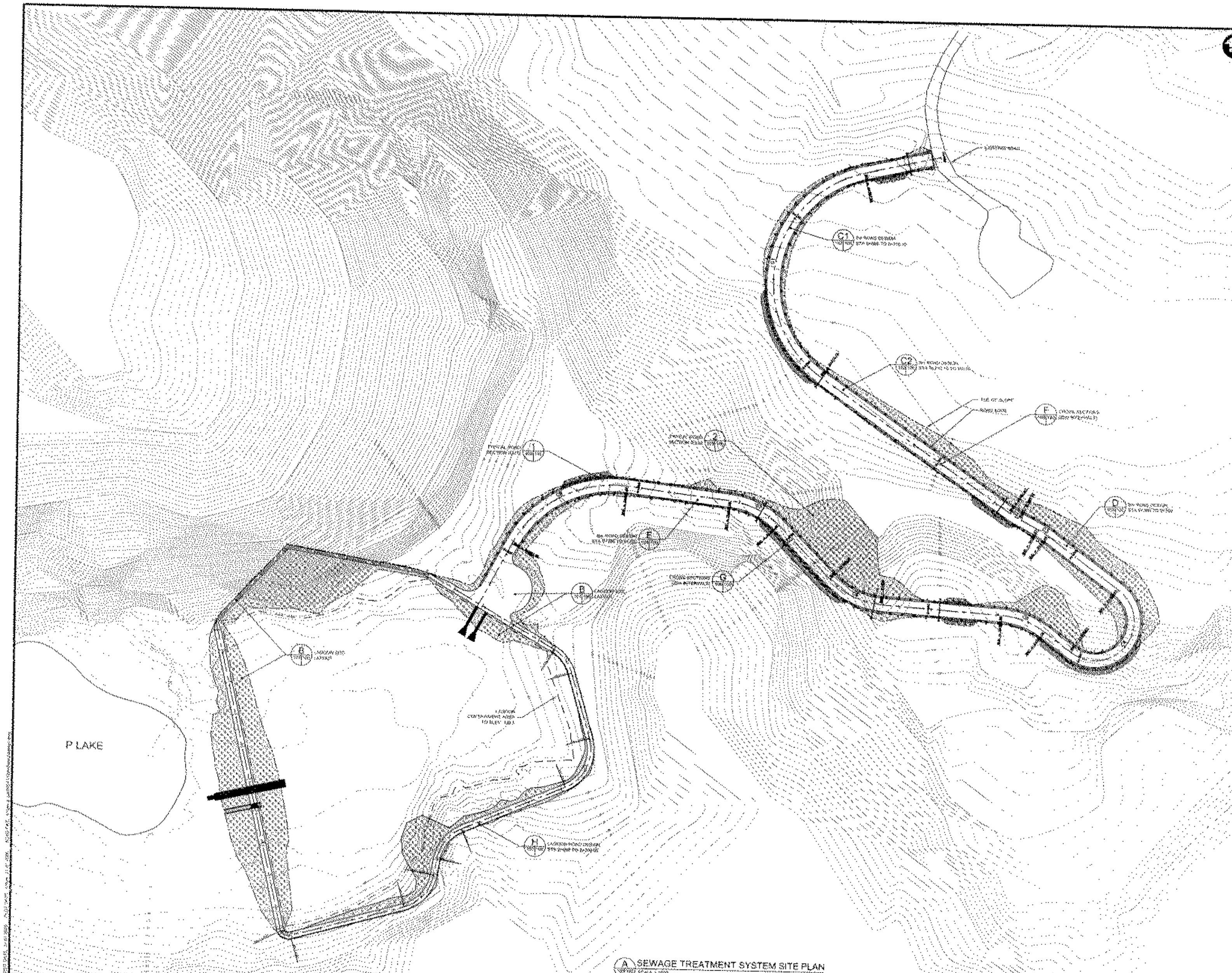
LIST OF DRAWINGS

| Sheet Number | Sheet Title |
|---|---|
| 000 | Cover |
| 100 | Site Plan |
| 101 | Lagoon [illegible] |
| [illegible] | Road Plan and Profile Station [illegible] |
| [illegible] | Road Plan and Profile Station [illegible] |
| [illegible] | Road Plan and Profile Station [illegible] |
| [illegible] | [illegible] Cross Sections Station [illegible] |
| [illegible] | [illegible] Cross Sections Station [illegible] |
| [illegible] | Lagoon Road Plan and Profile Station [illegible] |
| [illegible] | Lagoon Road Cross Sections Station [illegible] |
| [illegible] | [illegible] & Sewage Discharge Details and Sections |
| [illegible] | [illegible] - Gate Details and Sections |
| [illegible] | Lagoon [illegible] Sections and Details |
| [illegible] | [illegible] |

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

DILLON
CONSULTING

DRAWING NUMBER 000




A SEWAGE TREATMENT SYSTEM SITE PLAN

LEGEND

PLAN:

EXISTING
MINOR CONTOUR (1m)
MAJOR CONTOUR (5m)

DESIGN
ROAD CENTERLINE
ROAD EDGE
TOE OF SLOPE
CUT LIMITS
GUARDRAIL
DELINEATOR
LAGOON CONTAINMENT LIMIT
BOLLARD
FLOW DIRECTION

FILL AREA
CUT AREA

NOTES

DIMENSIONS ARE IN MILLIMETRES UNLESS SPECIFIED OTHERWISE

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| | | | |
|---|---|---|---|
| 3 | 01/20/09 | 95% SUBMISSION | GS |
| 2 | 10/28/08 | 70% SUBMISSION | GS |
| 1 | 06/11/08 | ISSUED FOR CLIENT REVIEW | GS |
| CHANGE | DATE | DESCRIPTION | CHECK |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | GS | DEC 08 |

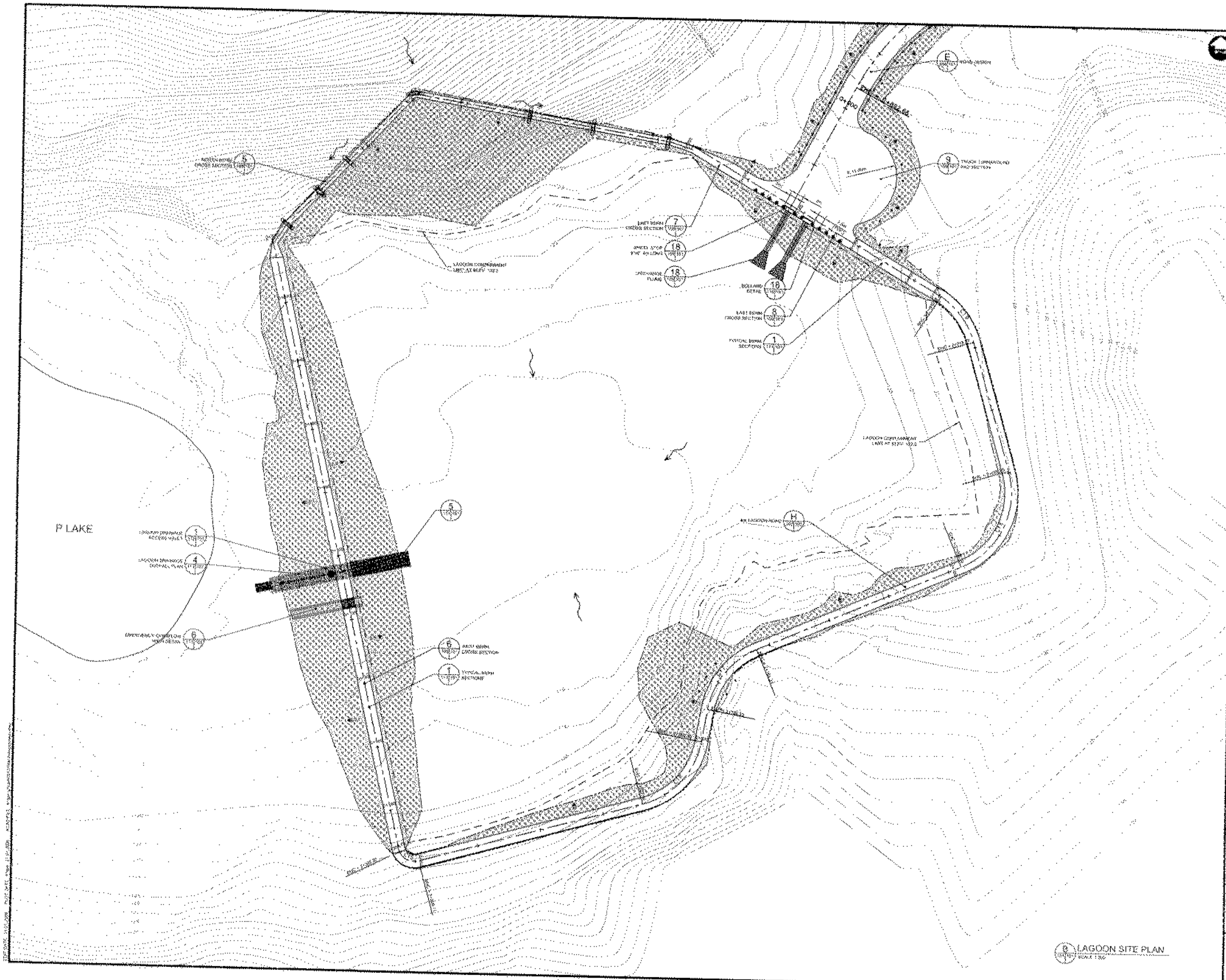
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
SITE PLAN

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 08-4319-2000
CLIENT PROJECT NUMBER: 3439
DRAWING NUMBER: 100




## LEGEND

PLAN

EXISTING
MINOR CONTOUR (1m)
MAJOR CONTOUR (5m)

DESIGN
ROAD CENTERLINE
ROAD EDGE
TOE OF SLOPE
CUT LIMITS
GUARDRAIL
DELINEATOR
LAGOON CONTAINMENT LIMIT
BOLLARD
FLOW DIRECTION

FILL AREA

CUT AREA

## NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE.

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| CHANGE | DATE | DESCRIPTION | CHECK |
|---|---|---|---|
| 3 | 01/20/08 | 95% SUBMISSION | GS |
| 2 | 12/20/06 | 75% SUBMISSION | GS |
| 1 | 06/11/06 | ISSUED FOR CLIENT REVIEW | GS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | GS | DEC 06 |

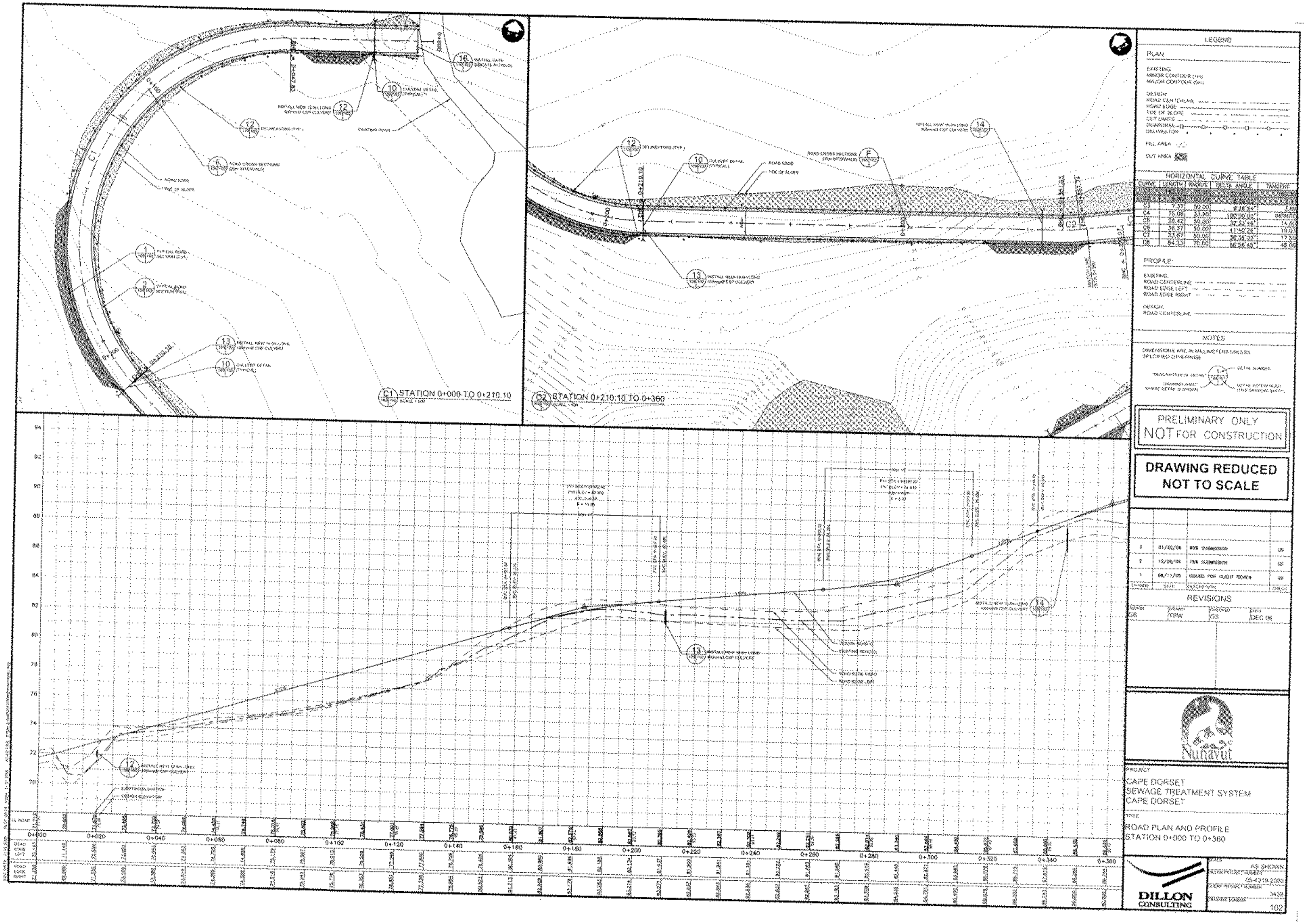
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

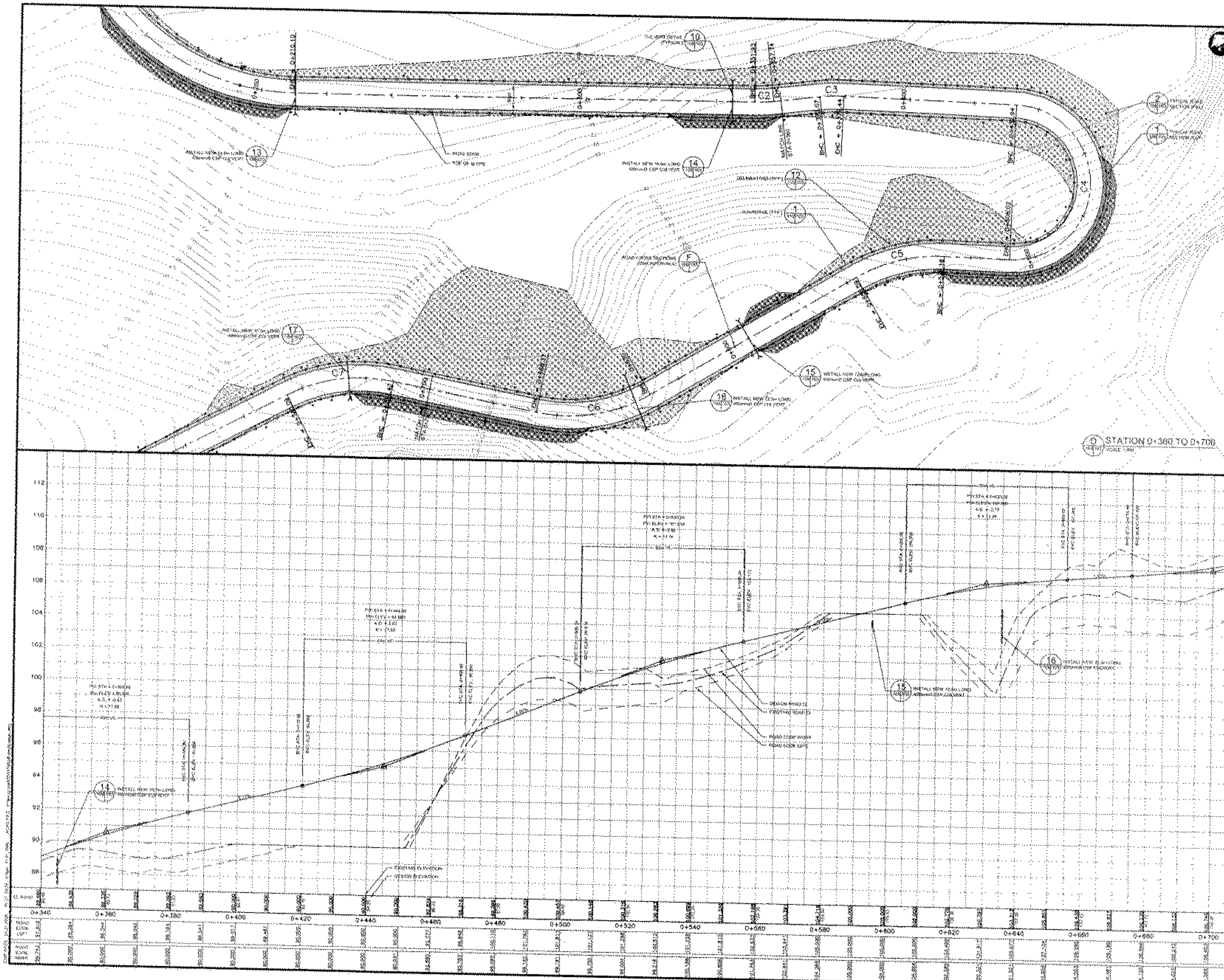
TITLE
LAGOON CONTAINMENT BERMS
AND TRUCK TURNAROUND PAD

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 06-4319-2000
DRAWING NUMBER: 101



C1 STATION 0+000 TO 0+210.10
C2 STATION 0+210.10 TO 0+360
LEGEND
PLAN
HORIZONTAL CURVE TABLE
PROFILE
NOTES
PRELIMINARY ONLY
NOT FOR CONSTRUCTION
DRAWING REDUCED
NOT TO SCALE
REVISIONS
Nunavut
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET
ROAD PLAN AND PROFILE
STATION 0+000 TO 0+360
AS SHOWN
DILLON
CONSULTING
102




LEGEND

PLAN:

EXISTING
MINOR CONTOUR (1m)
MAJOR CONTOUR (5m)

DESIGN
ROAD CENTERLINE
ROAD EDGE
TOE OF SLOPE
CUT LIMITS
GUARDRAIL
DELINEATOR

FILL AREA
CUT AREA

HORIZONTAL CURVE TABLE

PROFILE

EXISTING
ROAD CENTERLINE
ROAD EDGE LEFT
ROAD EDGE RIGHT

DESIGN
ROAD CENTERLINE

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| No. | DATE | DESCRIPTION | CHECK |
|---|---|---|---|
| 3 | 01/26/06 | 95% SUBMISSION | OS |
| 2 | 10/28/05 | 75% SUBMISSION | OS |
| 1 | 08/17/05 | ISSUED FOR CLIENT REVIEW | OS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | OS | DEC. 06 |

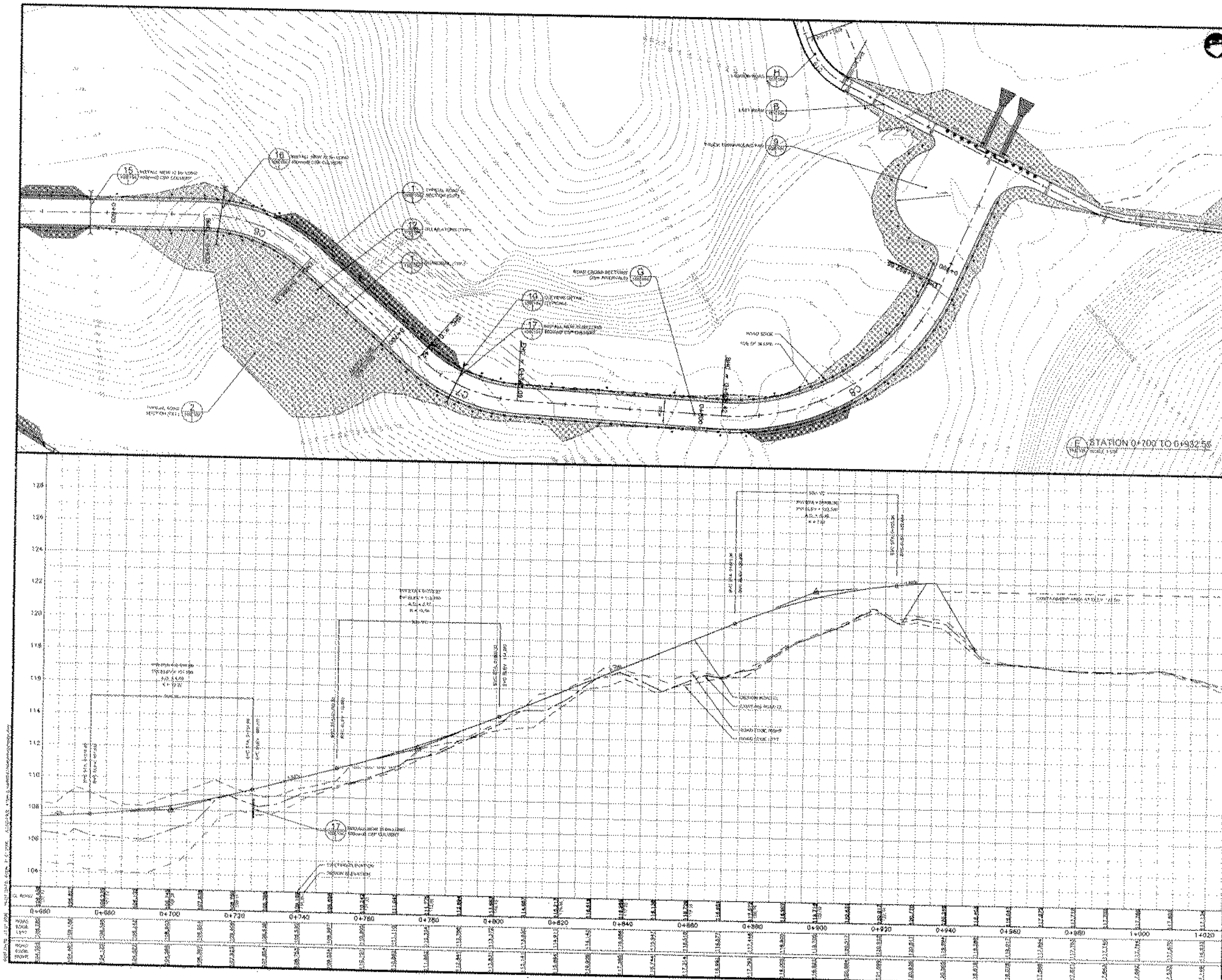
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
ROAD PLAN AND PROFILE
STATION 0+360 TO 0+700

DILLON CONSULTING

SCALE: AS SHOWN
05-4318-2000
3439
103




LEGEND

PLAN:

EXISTING
MINOR CONTOUR
MAJOR CONTOUR

DESIGN
ROAD CENTERLINE
ROAD EDGE
TOE OF SLOPE
CUT LIMITS
GUARDRAIL
DELINEATOR

FILL AREA

CUT AREA

HORIZONTAL CURVE TABLE

| CURVE | LENGTH | RADIUS | DELTA ANGLE | TANGENT |
|---|---|---|---|---|
| C1 | 162.27 | 70.00 | 132°49'16" | 160.30 |
| C2 | 2.89 | 50.00 | [illegible] | 7.01 |
| C3 | 2.37 | 50.00 | [illegible] | [illegible] |

PROFILE:

EXISTING
ROAD CENTERLINE
ROAD EDGE LEFT
ROAD EDGE RIGHT

DESIGN
ROAD CENTERLINE

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

DRAWING REDUCED
NOT TO SCALE

REVISIONS

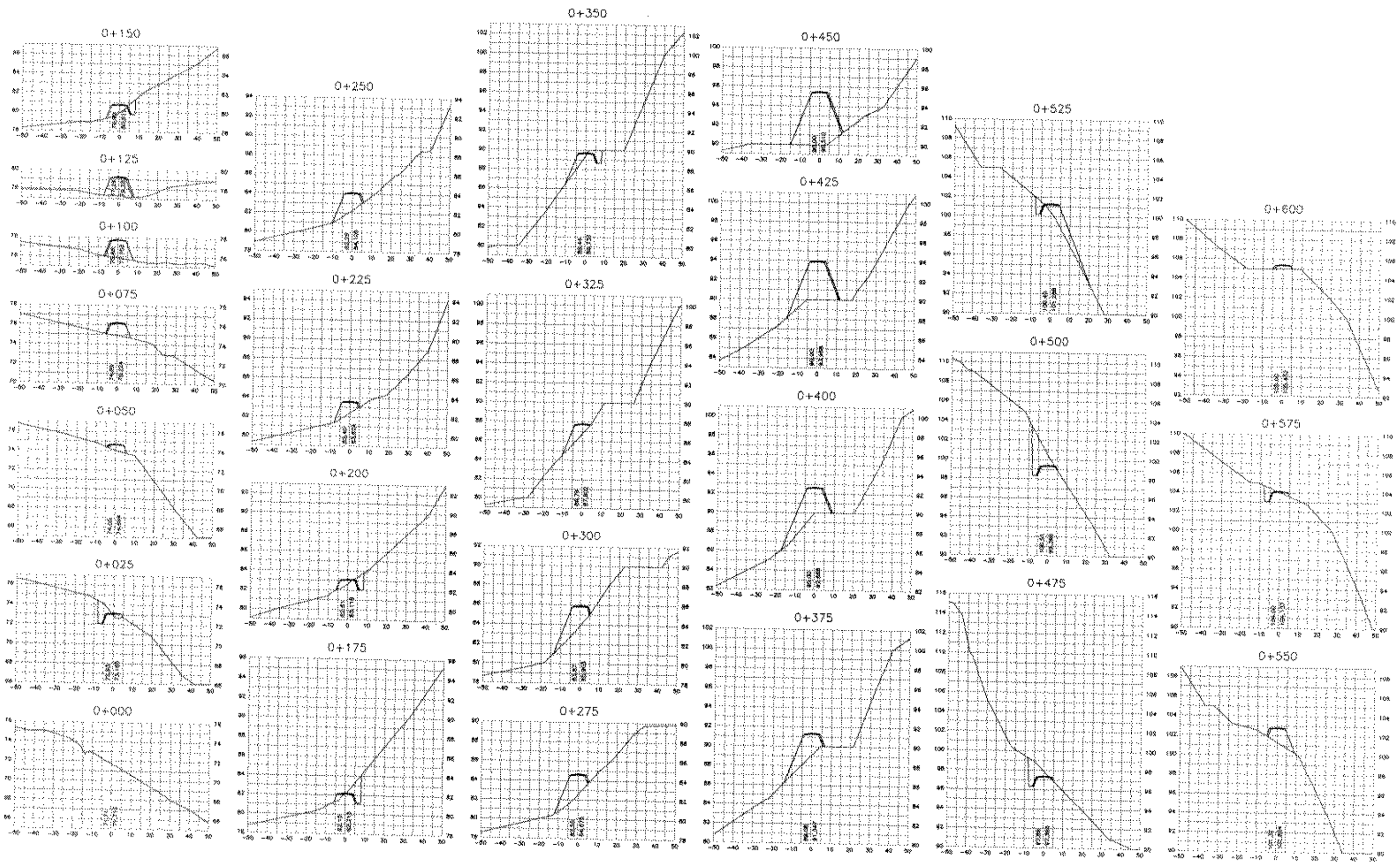
| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | GS | DEC 08 |

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
ROAD PLAN AND PROFILE
STATION 0+700 TO 0+932.55

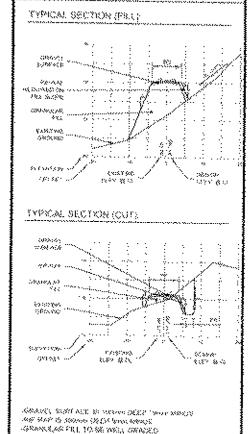
DILLON CONSULTING

SCALE: AS SHOWN
05-4319-2000
3439
104




ROAD CROSS SECTIONS 0+000 TO 0+600

LEGEND




NOTES

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | GS | DEC 06 |

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
DESIGN CROSS SECTIONS
STATION 0+000 TO 0+600

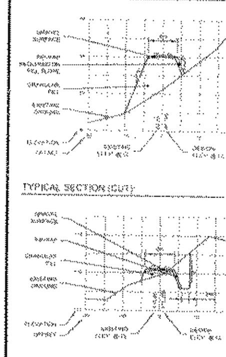
DILLON CONSULTING

| | |
|---|---|
| SCALE | AS SHOWN |
| DILLON PROJECT NUMBER | 06-4319-2000 |
| | 3439 |
| DRAWING NUMBER | 105 |

LEGEND

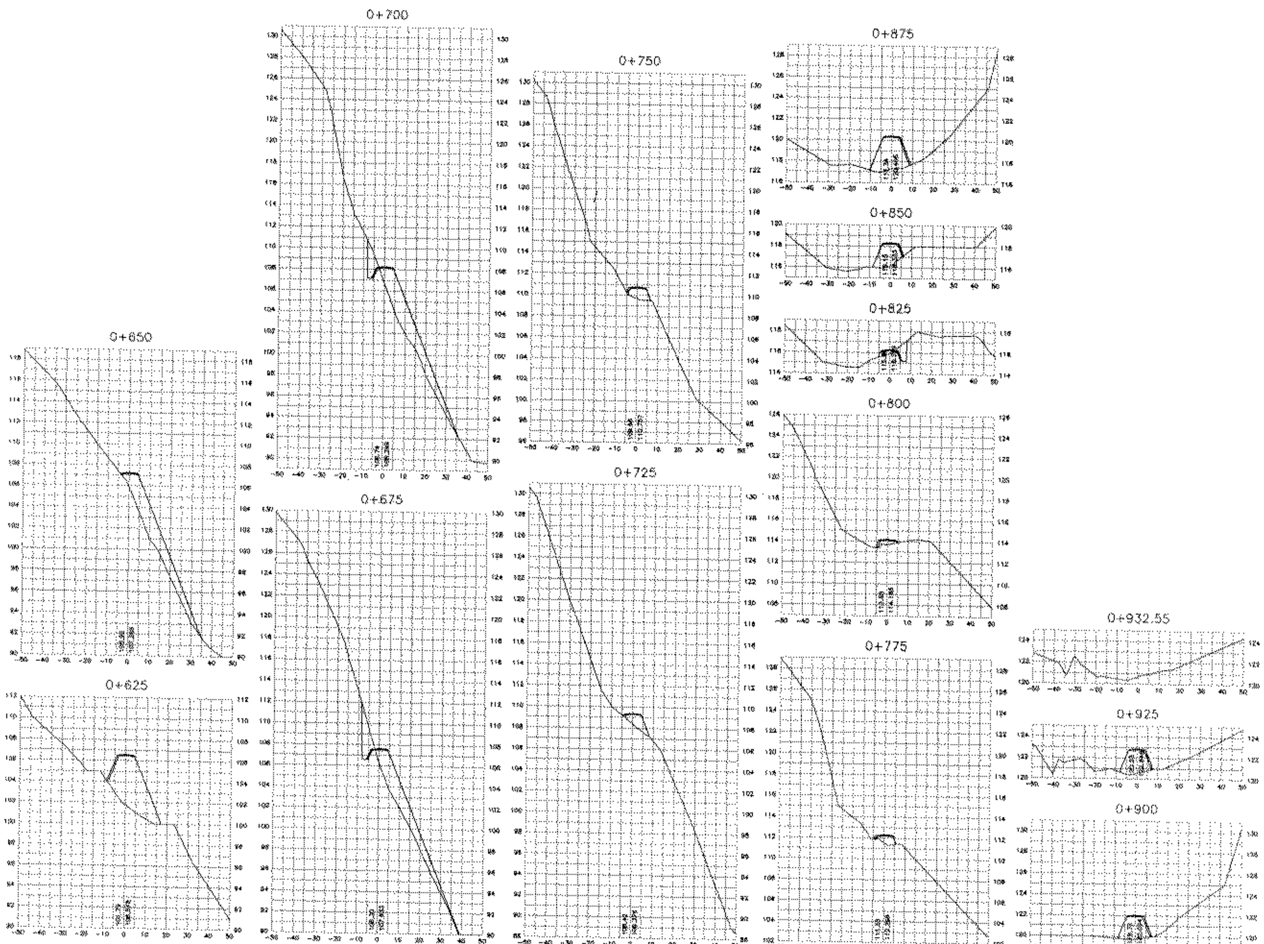
TYPICAL SECTION (FILL)

TYPICAL SECTION (CUT)



GRAVEL SURFACE IS 100mm DEEP 19mm MINUS
RIP RAP IS 300mm DEEP 5mm MINUS
GRANULAR FILL TO BE WELL GRADED

NOTES




ROAD CROSS SECTIONS 0+625 TO 0+932.55

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| REVISION | DATE | ISSUED FOR | CHECK |
|---|---|---|---|
| | | | |
| | | | |
| 3 | [illegible] | 90% SUBMISSION | OS |
| 2 | [illegible] | 75% SUBMISSION | OS |
| 1 | [illegible] | ISSUED FOR CLIENT REVIEW | OS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | OS | DEC 06 |

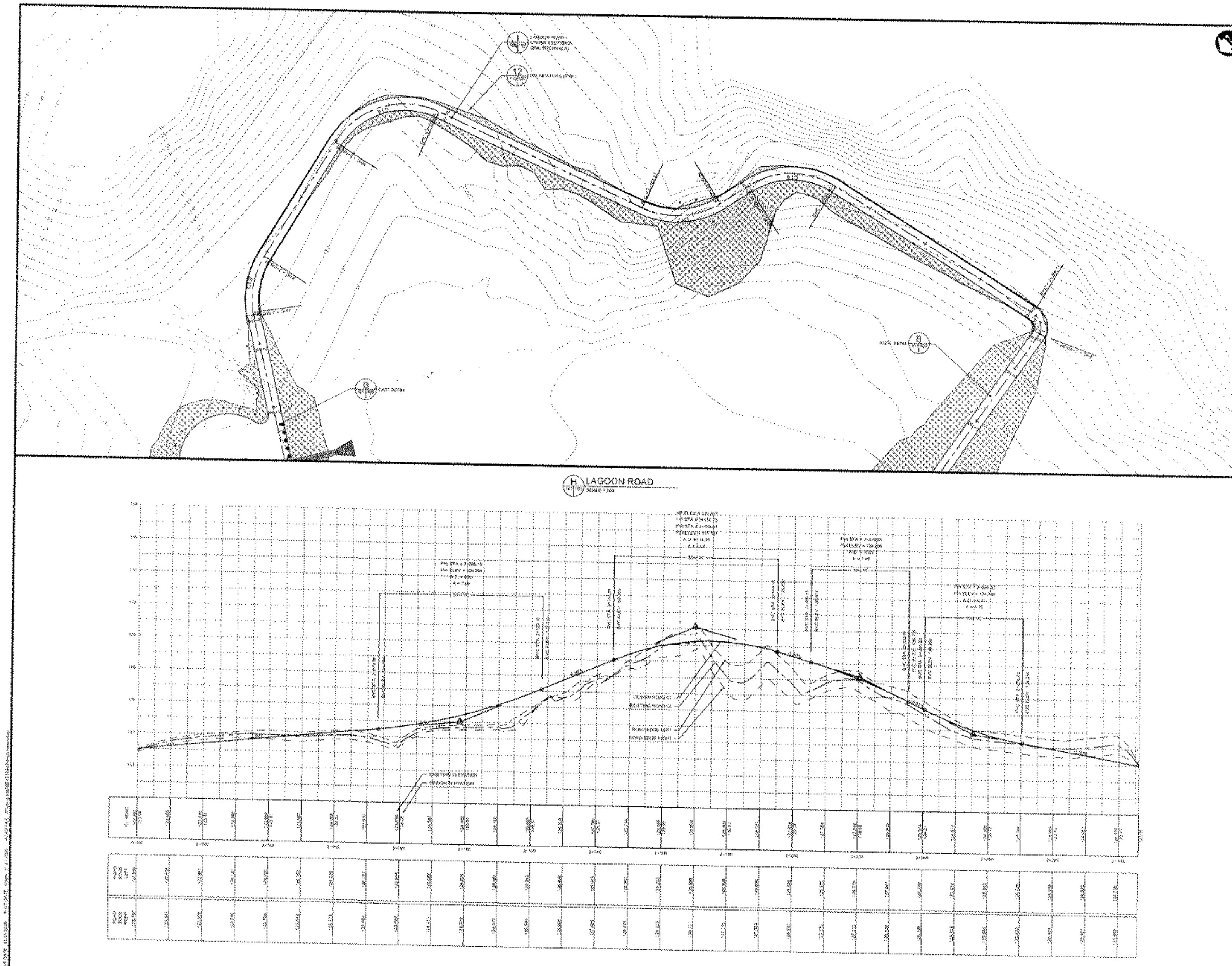
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
DESIGN CROSS SECTIONS
STATION 0+625 TO 0+932.55

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4319-2000
CLIENT PROJECT NUMBER: 3439
DRAWING NUMBER: 106




LEGEND

PLAN:

EXISTING
MINOR CONTOUR (1m)
MAJOR CONTOUR (5m)

DESIGN
ROAD CENTERLINE
ROAD EDGE
TOE OF SLOPE
CUT LINES
GUARDRAIL
DELINEATOR

FILL AREA

CUT AREA

HORIZONTAL CURVE TABLE

| CURVE | LENGTH | RADIUS | DELTA ANGLE | TANGENT |
| --- | --- | --- | --- | --- |

PROFILE:

EXISTING
ROAD CENTERLINE
ROAD EDGE LEFT
ROAD EDGE RIGHT

DESIGN
ROAD CENTERLINE

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| CHANGE | DATE | DESCRIPTION | CHECK |
| --- | --- | --- | --- |
| 3 | [illegible] | 99% SUBMISSION | GS |
| 2 | [illegible] | 75% SUBMISSION | GS |
| 1 | [illegible] | ISSUED FOR CLIENT REVIEW | GS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
| --- | --- | --- | --- |
| GS | TPW | GS | DEC 06 |

Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

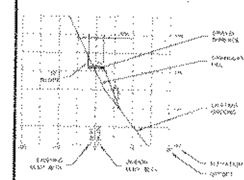
TITLE
LAGOON ROAD PLAN AND PROFILE
STATION 2+000 TO 2+306.05

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4319-2000
DRAWING NUMBER: 107

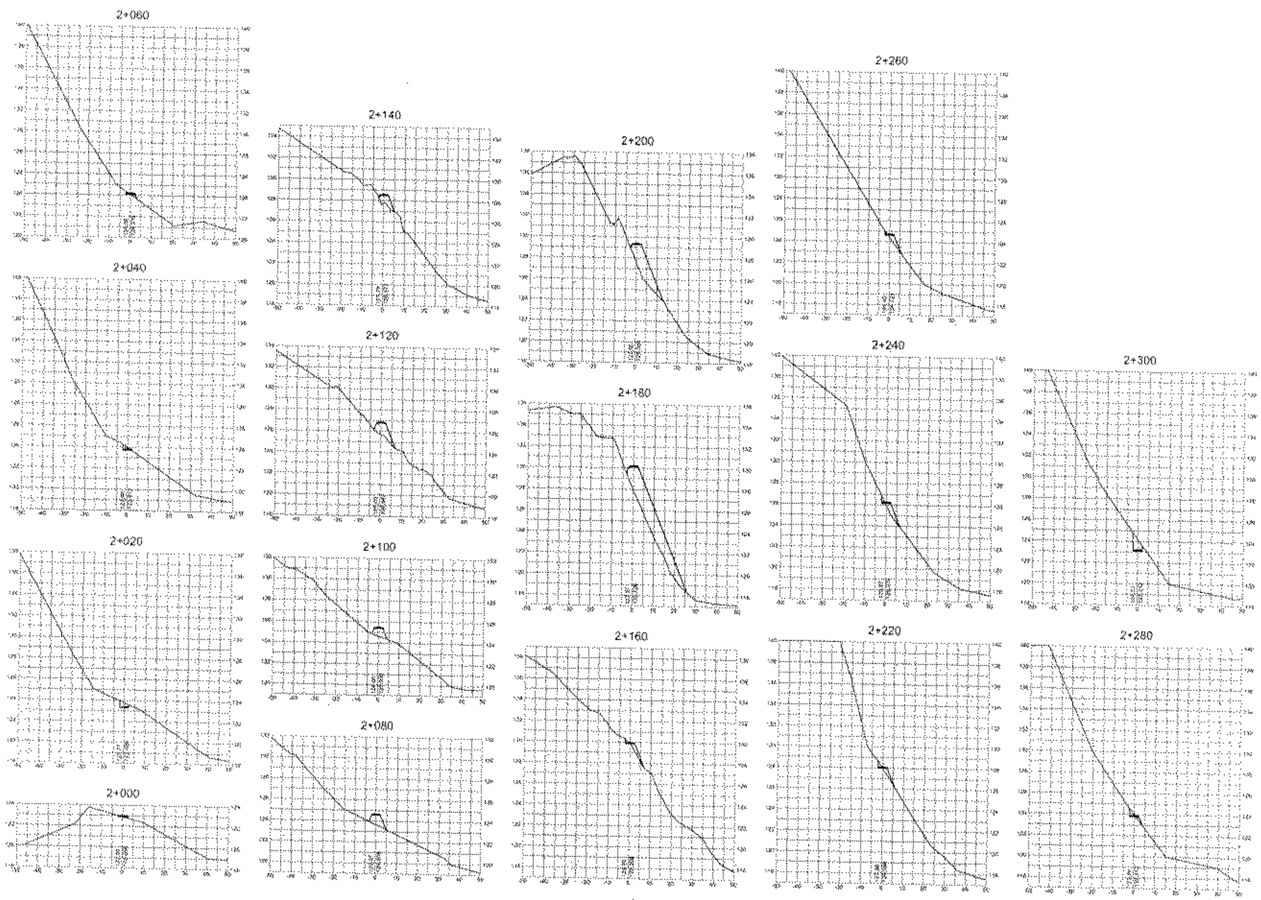
LEGEND

TYPICAL SECTION (CUT/FILL)



-GRAVEL SURFACE IS 100mm DEEP
-GRANULAR FILL TO BE WELL GRADED

NOTES




LAGOON ROAD CROSS SECTIONS 2+000 TO 2+300

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED**
**NOT TO SCALE**

| CHANGE | DATE | DESCRIPTION | CHECK |
|---|---|---|---|
| 3 | 01/30/06 | SSR SUBMISSION | GS |
| 2 | 10/19/05 | PSR SUBMISSION | GS |
| 1 | 06/11/05 | ISSUED FOR CLIENT REVIEW | GS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | TPW | GS | DEC 06 |

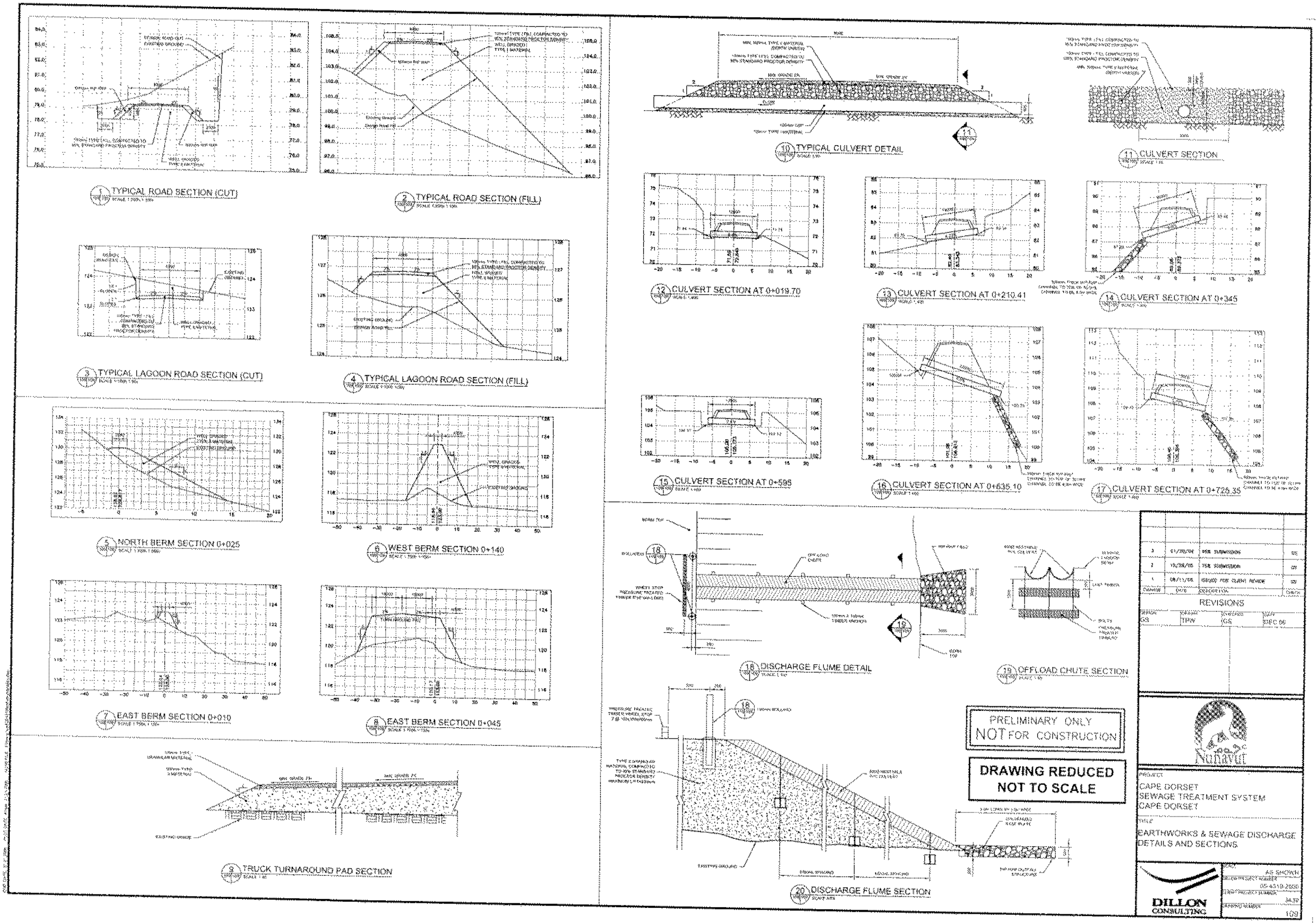
Nunavut

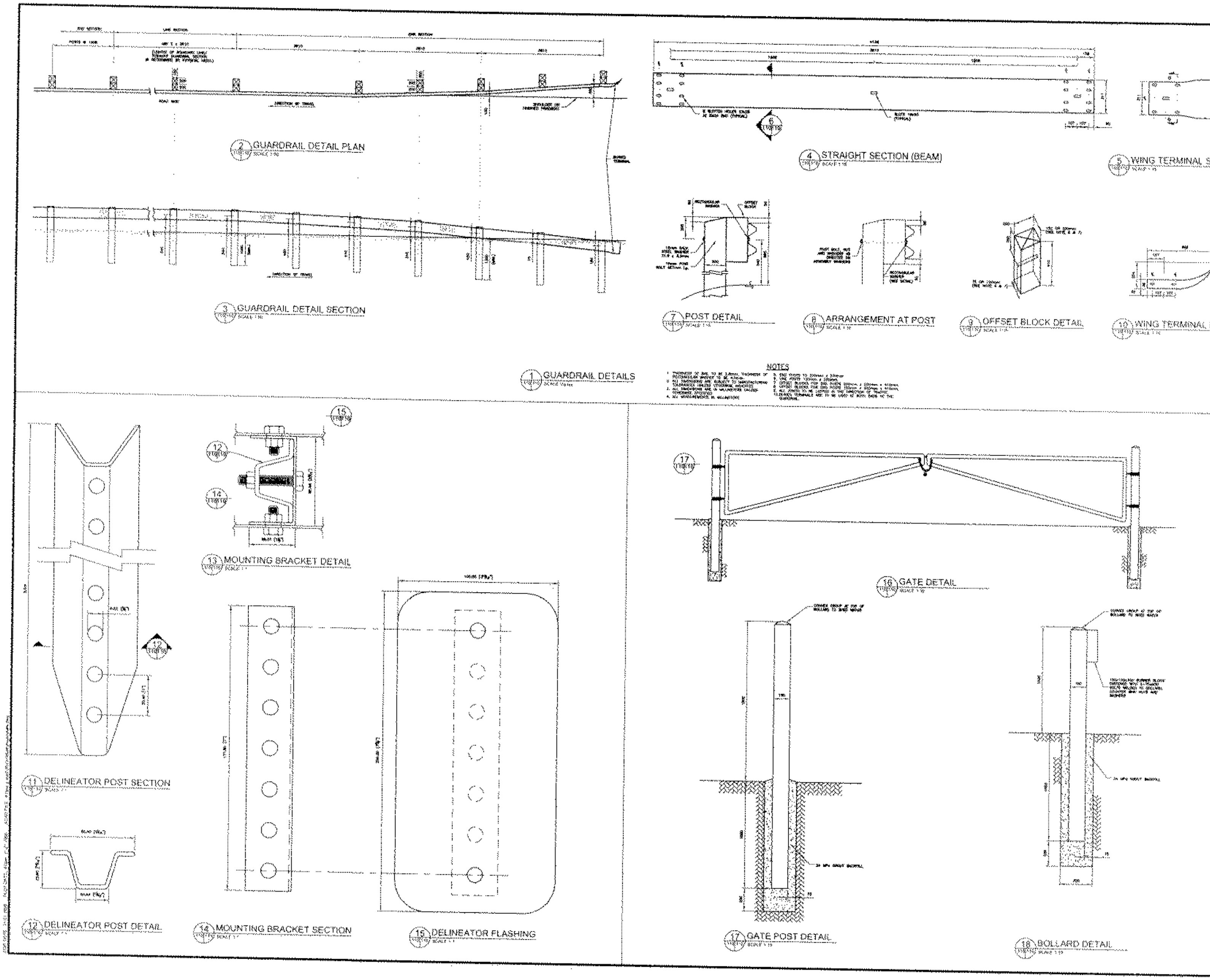
PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
LAGOON ROAD CROSS SECTIONS
STATION 2+000 TO 2+300

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4319-2000
CLIENT PROJECT NUMBER: 3432
DRAWING NUMBER: 105

DILLON CONSULTING


1 TYPICAL ROAD SECTION (CUT)
2 TYPICAL ROAD SECTION (FILL)
3 TYPICAL LAGOON ROAD SECTION (CUT)
4 TYPICAL LAGOON ROAD SECTION (FILL)
5 NORTH BERM SECTION 0+025
6 WEST BERM SECTION 0+140
7 EAST BERM SECTION 0+010
8 EAST BERM SECTION 0+045
9 TRUCK TURNAROUND PAD SECTION
10 TYPICAL CULVERT DETAIL
11 CULVERT SECTION
12 CULVERT SECTION AT 0+019.70
13 CULVERT SECTION AT 0+210.41
14 CULVERT SECTION AT 0+345
15 CULVERT SECTION AT 0+595
16 CULVERT SECTION AT 0+635.10
17 CULVERT SECTION AT 0+726.35
18 DISCHARGE FLUME DETAIL
19 OFFLOAD CHUTE SECTION
20 DISCHARGE FLUME SECTION
PRELIMINARY ONLY
NOT FOR CONSTRUCTION
DRAWING REDUCED
NOT TO SCALE
REVISIONS
GS
TPW
GS
Nunavut
PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET
TITLE
EARTHWORKS & SEWAGE DISCHARGE
DETAILS AND SECTIONS
DILLON
CONSULTING
AS SHOWN
3439
109




PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

REVISIONS

| | | | |
|---|---|---|---|
| DRAWN | DESIGN | CHECKED | DATE |
| GS | TPW | GS | DEC 06 |

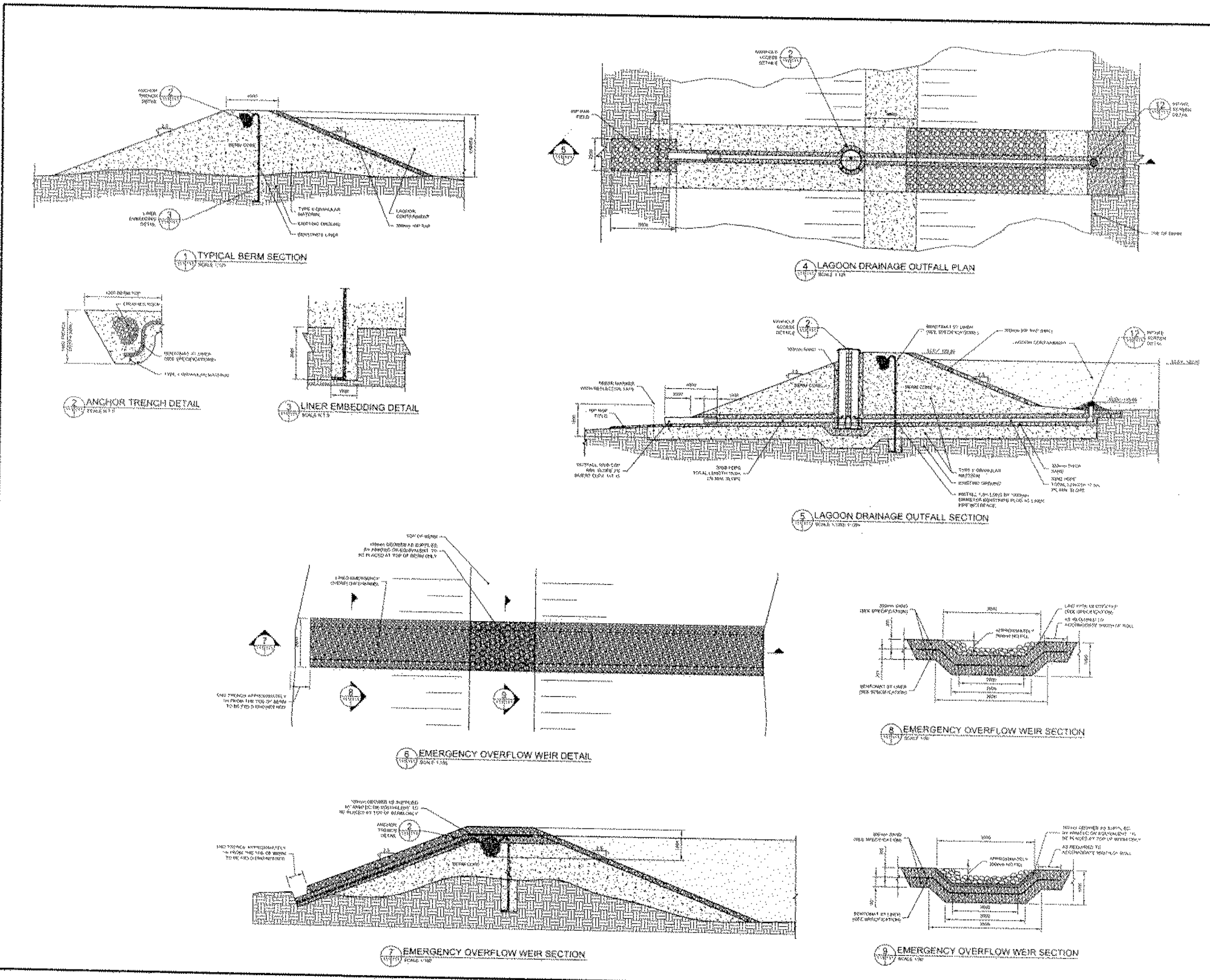
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
GUARDRAIL - DELINEATOR - GATE
DETAILS AND SECTIONS

DILLON CONSULTING

AS SHOWN
05-4319-2000
3430
110




LEGEND

NOTES

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| | | | |
|---|---|---|---|
| 3 | 01/20/06 | 95% SUBMISSION | DS |
| 2 | 10/28/05 | 75% SUBMISSION | DS |
| 1 | 06/1/05 | ISSUED FOR CLIENT REVIEW | DS |
| CHANGE | DATE | DESCRIPTION | CHECK |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| DS | TPW | DS | DEC 06 |

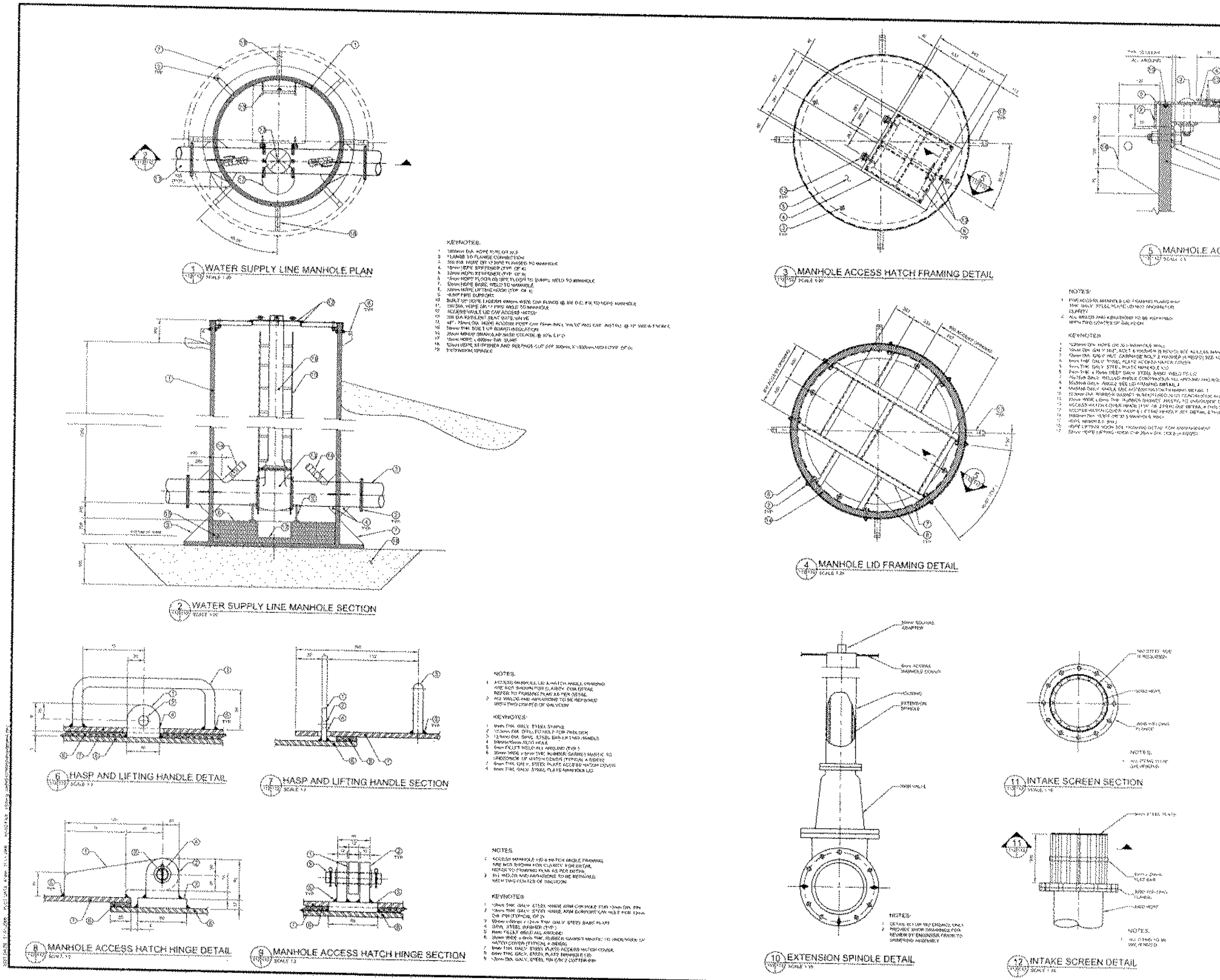
Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
LAGOON BERM SECTIONS AND DETAILS

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4319-2000
CLIENT PROJECT NUMBER: 3433
DRAWING NUMBER: 111

DILLON CONSULTING




PRELIMINARY ONLY
NOT FOR CONSTRUCTION

**DRAWING REDUCED NOT TO SCALE**

| CHANGE | DATE | DESCRIPTION | CHECK |
|---|---|---|---|
| 3 | 21/20/06 | 95% SUBMISSION | GS |
| 2 | 15/28/06 | 75% SUBMISSION | GS |
| 1 | 08/11/06 | ISSUED FOR CLIENT REVIEW | GS |

REVISIONS

| DESIGN | DRAWN | CHECKED | DATE |
|---|---|---|---|
| GS | NPW | GS | DEC 06 |

Nunavut

PROJECT
CAPE DORSET
SEWAGE TREATMENT SYSTEM
CAPE DORSET

TITLE
ACCESS MANHOLE DETAILS

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4319-2000
DRAWING NUMBER: 112

# APPENDIX B

# PHOTOS

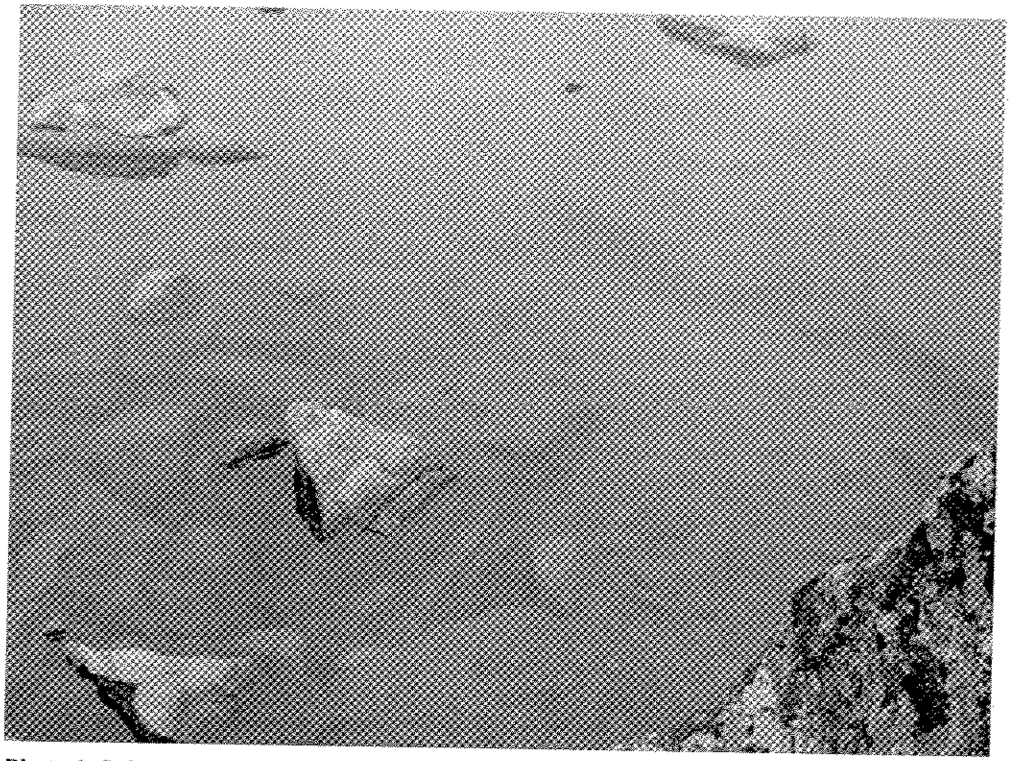


**Photo 1. Substrate of north shoreline.**

**Photo 2a and 2b. Substrate of south shoreline.**

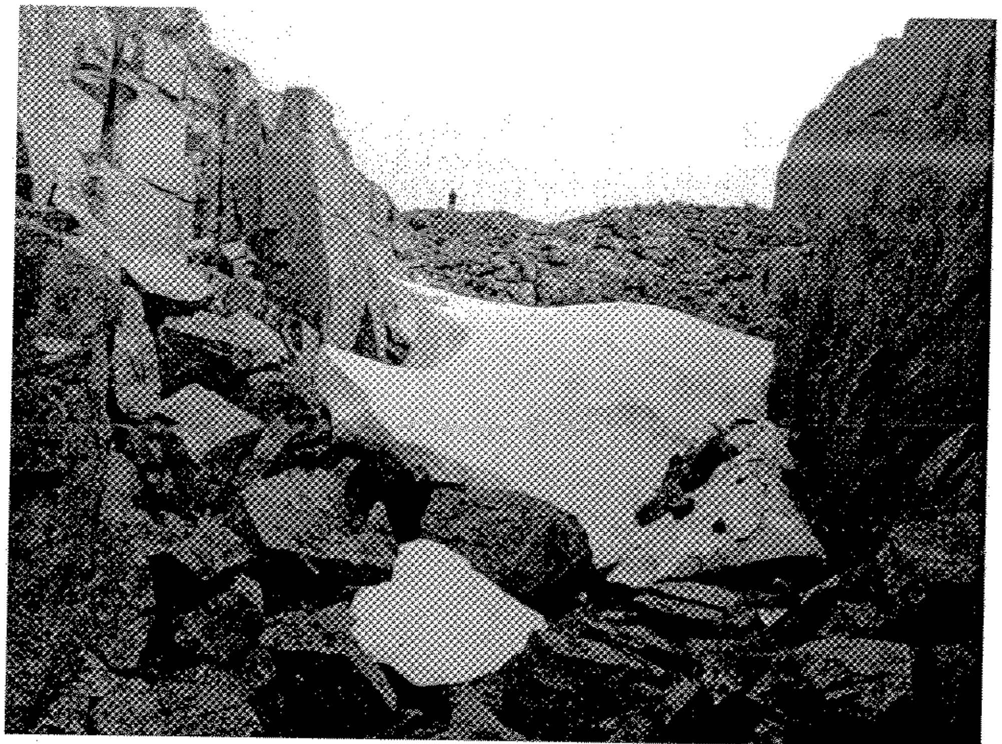


**Photo 3. Path of outlet stream over large cliff. Photo taken from base of cliff.**

**Photo 4. Path of outlet stream through mossy area at base of large cliff. Photo taken from bay.**

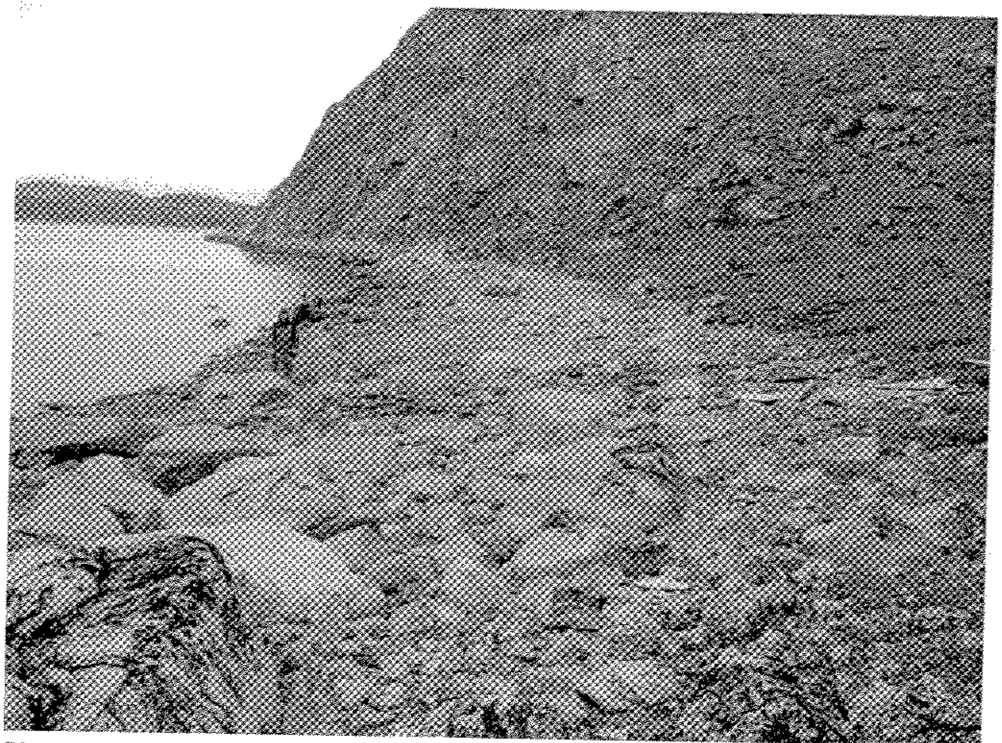


**Photo 5. Cobble/boulder substrate at shoreline of Telik Inlet.**

# APPENDIX C

# STAKEHOLDER CONSULTATION

**Cape Dorset Sewage Treatment System – Agencies Contacted With Regard to Feasibility of Using P Lake Lagoon System**

| Regulatory Agency | Date | Phone Number | Contact | Comment |
|---|---|---|---|---|
| **Department of Fisheries and Oceans (DFO)** | March 17, 2005 | Ph. 867-979-8007<br>Fx. 867-979-8039<br><br>GordanierT@DFO-MPO.GC.CA | **Tania Gordanier**<br>*Habitat Biologist* | - Authorization under section 35 (2) of the Fisheries Act<br>- Policy of Net Gain, compensate for lost habitat. Must include a work plan describing area to be enhanced and monitoring program.<br>- Engineering drawings should be included with position letter. Traditional knowledge is always beneficial as well.<br>- DFO will need to assess any stream crossings that might occur during construction of road to P Lake<br>- Once application is made to DFO they will initiate the CEA screening process under the Canadian Environmental Assessment Act. |
| **Department of Health and Social Services** | March 17, 2005 | Ph. 867-975-4817<br>Fx. 867-975-4830 | **Wanda Joy**<br>*Public Health Officer* | - There is no application required, but the construction must meet the guidelines set out under the Public Health Act: *Public Sewage Systems Regulations*<br>- They require that a copy of the work plan and associated drawings be sent to them |
| **Environment Canada (EC)** | March 18, 2005 | Ph. 867-6694730 | **Craig Broome**<br>*Head Enforcement* | - There are no requirements from the enforcement division right now.<br>- Should contact Colette Meloche in Iqaluit |

| Agency | Date | Phone Number | Contact | Comment |
|---|---|---|---|---|
| **Environment Canada (EC)** | March 21, 2005 | Ph. 867-975-4639<br>Fx. 867-975-4645 | **Colette Meloche**<br>*Environmental Assessment Specialist* | - EC will get involved once the application to DFO and the NWB has been submitted.<br>- Enforcement officers will be notified of the situation and will complete inspections once work is initiated<br>- There are no permits or approvals required from EC at this time |
| **Department of Indian and Northern Affairs (DIAND)** | March 21, 2005 | Ph. 867-975-4298<br>Fx. 867-975-6445 | **Constantine Bodykevich**<br>*Water Resources Officer* | - Requirement to meet CCME guidelines re: Discharge into Salt Water<br>- DIAND will review work plan once application to NWB has been submitted |

# APPENDIX D

# POPULATION STATISTICS

# Nunavut: Community Population Projections

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nunavut | 27,688 | 28,410 | 29,154 | 29,885 | 30,601 | 31,317 | 32,036 | 32,774 | 33,530 | 34,311 | 35,114 |
| Arctic Bay | 730 | 747 | 763 | 782 | 801 | 819 | 837 | 855 | 876 | 894 | 916 |
| Arviat | 1,690 | 1,736 | 1,784 | 1,833 | 1,883 | 1,929 | 1,982 | 2,033 | 2,088 | 2,142 | 2,198 |
| Baker Lake | 1,470 | 1,501 | 1,534 | 1,563 | 1,594 | 1,624 | 1,655 | 1,683 | 1,712 | 1,745 | 1,777 |
| Bathurst Inlet | X | X | X | X | X | X | X | X | X | X | X |
| Bay Chimo | X | X | X | X | X | X | X | X | X | X | X |
| Cambridge Bay | 1,418 | 1,449 | 1,484 | 1,517 | 1,550 | 1,581 | 1,609 | 1,642 | 1,679 | 1,715 | 1,752 |
| Cape Dorset | 1,213 | 1,240 | 1,268 | 1,298 | 1,327 | 1,354 | 1,382 | 1,412 | 1,441 | 1,471 | 1,501 |
| Chesterfield Inlet | 372 | 382 | 391 | 401 | 409 | 420 | 431 | 443 | 452 | 465 | 476 |
| Clyde River | 771 | 789 | 812 | 830 | 848 | 867 | 890 | 913 | 937 | 959 | 982 |
| Coral Harbour | 845 | 865 | 888 | 911 | 933 | 955 | 978 | 1,003 | 1,024 | 1,049 | 1,078 |
| Gjoa Haven | 984 | 1,005 | 1,023 | 1,045 | 1,063 | 1,084 | 1,102 | 1,117 | 1,136 | 1,154 | 1,173 |
| Grise Ford | 145 | 146 | 147 | 146 | 146 | 147 | 149 | 151 | 151 | 153 | 155 |
| Hall Beach | 635 | 656 | 677 | 696 | 714 | 734 | 754 | 771 | 790 | 810 | 829 |
| Igloolik | 1,379 | 1,417 | 1,456 | 1,495 | 1,529 | 1,562 | 1,594 | 1,627 | 1,660 | 1,701 | 1,736 |
| Iqaluit | 4,762 | 4,930 | 5,108 | 5,278 | 5,438 | 5,606 | 5,768 | 5,936 | 6,108 | 6,289 | 6,477 |
| Kimmirut | 450 | 461 | 474 | 485 | 496 | 506 | 519 | 530 | 546 | 560 | 573 |
| Kugaaruk | 582 | 601 | 616 | 631 | 648 | 664 | 682 | 701 | 719 | 737 | 756 |
| Kugluktuk | 1,389 | 1,422 | 1,456 | 1,490 | 1,522 | 1,556 | 1,585 | 1,618 | 1,653 | 1,686 | 1,720 |
| Nanisivik | 230 | 225 | 224 | 226 | 225 | 223 | 222 | 220 | 221 | 221 | 220 |
| Pangnirtung | 1,506 | 1,539 | 1,575 | 1,613 | 1,651 | 1,687 | 1,722 | 1,756 | 1,792 | 1,831 | 1,870 |
| Pond Inlet | 1,314 | 1,361 | 1,405 | 1,443 | 1,489 | 1,532 | 1,574 | 1,624 | 1,668 | 1,714 | 1,761 |
| Qikiqtarjuaq | 522 | 537 | 551 | 566 | 582 | 599 | 614 | 629 | 641 | 654 | 668 |
| Rankin Inlet | 2,277 | 2,327 | 2,376 | 2,432 | 2,483 | 2,527 | 2,576 | 2,629 | 2,683 | 2,734 | 2,791 |
| Repulse Bay | 615 | 630 | 648 | 664 | 682 | 702 | 720 | 738 | 757 | 777 | 797 |
| Resolute Bay | 243 | 246 | 247 | 249 | 251 | 253 | 252 | 255 | 257 | 260 | 263 |
| Sanikiluaq | 702 | 722 | 740 | 758 | 776 | 796 | 816 | 834 | 853 | 873 | 896 |
| Taloyoak | 804 | 825 | 847 | 866 | 886 | 904 | 925 | 947 | 968 | 992 | 1,016 |
| Whale Cove | 312 | 321 | 328 | 336 | 344 | 351 | 358 | 367 | 378 | 388 | 397 |

**Notes:** Population projections produced by Statistics Canada and the Nunavut Bureau of Statistics include people in the population who are residents of Nunavut and do NOT have a home elsewhere in Canada from which they are temporarily absent. Therefore, temporary residents such as construction crews, residents in mining camps, etc. are not included in the population projections.

Data are suppressed for (a) communities with a population of 50 or less and (b) 'unorganized areas' -- but they are included in the Nunavut total.

# Nunavut: Community Population Projections

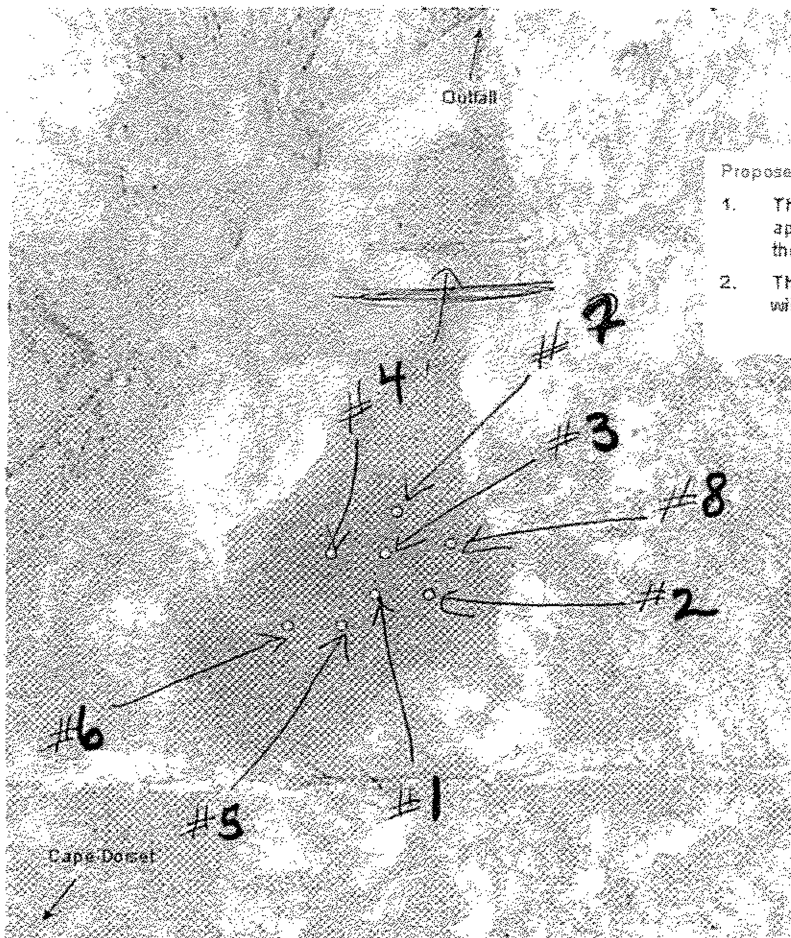
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nunavut | 35,114 | 35,937 | 36,773 | 37,619 | 38,471 | 39,335 | 40,217 | 41,106 | 42,001 | 42,904 | 43,824 |
| Arctic Bay | 916 | 939 | 960 | 980 | 1,003 | 1,019 | 1,033 | 1,049 | 1,065 | 1,078 | 1,094 |
| Arviat | 2,198 | 2,256 | 2,320 | 2,381 | 2,449 | 2,517 | 2,584 | 2,658 | 2,721 | 2,791 | 2,855 |
| Baker Lake | 1,777 | 1,808 | 1,843 | 1,882 | 1,918 | 1,957 | 1,996 | 2,036 | 2,072 | 2,108 | 2,148 |
| Bathurst Inlet | X | X | X | X | X | X | X | X | X | X | X |
| Bay Chimo | X | X | X | X | X | X | X | X | X | X | X |
| Cambridge Bay | 1,752 | 1,790 | 1,828 | 1,865 | 1,900 | 1,939 | 1,979 | 2,018 | 2,057 | 2,095 | 2,137 |
| Cape Dorset | 1,501 | 1,536 | 1,570 | 1,600 | 1,632 | 1,662 | 1,692 | 1,726 | 1,757 | 1,793 | 1,829 |
| Chesterfield Inlet | 476 | 486 | 498 | 509 | 519 | 528 | 539 | 549 | 563 | 572 | 583 |
| Clyde River | 982 | 1,007 | 1,028 | 1,050 | 1,072 | 1,095 | 1,121 | 1,144 | 1,167 | 1,190 | 1,214 |
| Coral Harbour | 1,078 | 1,101 | 1,128 | 1,158 | 1,187 | 1,219 | 1,250 | 1,281 | 1,312 | 1,345 | 1,376 |
| Gjoa Haven | 1,173 | 1,194 | 1,217 | 1,242 | 1,266 | 1,290 | 1,317 | 1,345 | 1,375 | 1,405 | 1,435 |
| Grise Ford | 155 | 157 | 160 | 160 | 163 | 165 | 166 | 168 | 169 | 172 | 173 |
| Hall Beach | 829 | 850 | 870 | 890 | 912 | 934 | 957 | 982 | 1,008 | 1,029 | 1,052 |
| Igloolik | 1,736 | 1,773 | 1,807 | 1,842 | 1,883 | 1,922 | 1,960 | 2,001 | 2,043 | 2,086 | 2,131 |
| Iqaluit | 6,477 | 6,669 | 6,866 | 7,064 | 7,276 | 7,456 | 7,637 | 7,814 | 7,997 | 8,178 | 8,391 |
| Kimmirut | 573 | 589 | 601 | 612 | 624 | 636 | 649 | 662 | 675 | 688 | 706 |
| Kugaaruk | 756 | 779 | 802 | 823 | 844 | 867 | 889 | 911 | 934 | 957 | 979 |
| Kugluktuk | 1,720 | 1,760 | 1,793 | 1,827 | 1,859 | 1,893 | 1,928 | 1,965 | 2,000 | 2,041 | 2,076 |
| Nanisivik | 220 | 218 | 215 | 215 | 209 | 205 | 202 | 200 | 196 | 195 | 191 |
| Pangnirtung | 1,870 | 1,905 | 1,955 | 1,995 | 2,032 | 2,074 | 2,117 | 2,160 | 2,202 | 2,243 | 2,280 |
| Pond Inlet | 1,761 | 1,808 | 1,851 | 1,904 | 1,951 | 1,999 | 2,047 | 2,093 | 2,137 | 2,184 | 2,233 |
| Qikiqtarjuaq | 668 | 683 | 697 | 711 | 724 | 737 | 752 | 765 | 780 | 795 | 811 |
| Rankin Inlet | 2,791 | 2,848 | 2,907 | 2,970 | 3,030 | 3,120 | 3,213 | 3,314 | 3,429 | 3,537 | 3,633 |
| Repulse Bay | 797 | 818 | 838 | 858 | 881 | 903 | 928 | 949 | 970 | 990 | 1,012 |
| Resolute Bay | 263 | 266 | 269 | 270 | 272 | 275 | 279 | 281 | 283 | 287 | 288 |
| Sanikiluaq | 896 | 918 | 939 | 963 | 987 | 1,008 | 1,029 | 1,050 | 1,069 | 1,090 | 1,108 |
| Taloyoak | 1,016 | 1,039 | 1,065 | 1,094 | 1,119 | 1,147 | 1,179 | 1,209 | 1,236 | 1,265 | 1,294 |
| Whale Cove | 397 | 405 | 412 | 422 | 432 | 442 | 450 | 458 | 469 | 481 | 491 |

**Notes:** Population projections produced by Statistics Canada and the Nunavut Bureau of Statistics include people in the population who are residents of Nunavut and do NOT have a home elsewhere in Canada from which they are temporarily absent. Therefore, temporary residents such as construction crews, residents in mining camps, etc. are not included in the population projections.

Data are suppressed for (a) communities with a population of 50 or less and (b) 'unorganized areas' -- but they are included in the Nunavut total.

# APPENDIX E

# P LAKE BATHYMETRY AND VOLUME




Proposed Drill Points:

1. The yellow spots indicate the approximate locations for drilling through the ice
2. The depth of the ice and water will be required.

P Lake

| | Depth of Ice | Depth of water | Total Depth from Top to Bottom |
|---|---|---|---|
| 1 | 4' | 5' | 9' |
| 2 | 4' | 5' | 9' |
| 3 | 4' | 5' | 9' |
| 4 | 4' | 1.5' | 5.5' |
| 5 | 4' | 4' | 8' |
| 6 | 4' | 2' | 6' |
| 7 | 4' | Ø | 4' |
| 8 | 4' | Ø | 4' |

# APPENDIX F

# DETERMINATION OF P LAKE WATER RECHARGE RATES

# Tributary Area & Runoff Calculations

**Condition:** 10 Year Return Period — **Date:** 14-Apr-05
**Location:** "P" Lake Catchment area (Cape Dorset) — **P.O.C.** P Lake

| Area No. | Cover or Dev. State | Approx. Grade (%) | Area ($m^2$) | Area (ha) | R* | A X R | Comments: |
|---|---|---|---|---|---|---|---|
| 1 | Undeveloped | 34 | 118507 | 11.85 | 0.85 | 10.0731 | Steep, solid rock |
| 2 | Undeveloped | 4 | 108010 | 10.80 | 0.50 | 5.4005 | Flat. Silt-soil. Storage |
| 3 | Undeveloped | 30 | 67303 | 6.73 | 0.80 | 5.3842 | Steep. Channeled rock |
| 4 | Undeveloped | 10 | 58242 | 5.82 | 0.70 | 4.0770 | Moderate, small storage |
| | | ∑Areas= | 352063 | 35.21 | Total ∑AXR= | 24.9348 | |

* R values were estimated using Table 2-26 "Watershed Characteristics for Determining Runoff Coefficinent..." (U.S. Soil Conservation Service)

Tc=Ts + Tr where,
Ts=Saturation Time (Inlet Time)
Tr=Running or system flow time

NOTE: For frozen or highly impervious surfaces, the value for Ts is near zero (0).

Method of Tr determination: Overland Flow Nomograph
Drop from Remote Point to Outlet: **25** m (From Topographic Map) — Average Slope (%) = 5.2
Length of Overland Travel: **480** m (AutoCAD drawing - Figure 6)
Time Correction Factor: **1** (For Bare Earth)

**Tr =** **13** minutes (Overland Flow Nomograph)

Preliminary check: Velocity (average) = L/t 0.615 m/s

CALCULATED FLOW (Qc):

Qc = (A · R · I) / 360 = (Total AR · I) / 360

| | | |
|---|---|---|
| Return Period: | **10 years** | |
| Drainage Area: | **35.2** | (AutoCAD drawing - Figure 6) |
| Total AR: | **24.9** | (See above) |
| Running Time (Tr): | **7** | (Overland Flow Nomograph - attached) |
| Saturation time (Ts): | **3** | (near 0 for frozen/impervious surfaces) |
| Concentration Time (Tc): | **10** | (minutes) |
| Intensity: | **18** | (mm/hr) - IDF curves for Cape Dorset |

$$Q_{10} = \frac{24.9 \quad X \quad 18}{360} \qquad Q_{10} = 1.2467\ m^3/s$$

DESIGN FLOW:

Qd = $Q_{10}$ · (1+A%)(1+R%)(1+I%)(FOS)

Where:

| | |
|---|---|
| FOS | 0.10 |
| A%= | 0.05 |
| R%= | 0.20 |
| I%= | 0.05 |

$Q_d$= 1.81 $m^3/s$

**Cape Dorset A, NU** WATER BUDGET MEANS FOR THE PERIOD 1980-1993

P' LAKE CATCHMENT AREA CALCULATIONS

LAT.... 64.23 WATER HOLDING CAPACITY... 5 MM HEAT INDEX... 3.42
LONG... 76.53 LOWER ZONE............ 3 MM A............ .553

| MONTH | TEMP °C | PCPN | RAIN | MELT | PE | AE | DEF | SURP | SNOW | SOIL | ACC P | AREA (m3) | AREA (ha) | AVRG Q (m³/week) | AVRG Q (m³/day) | AVRG Q (m³/hr) | AVRG Q (m³/sec) | AVRG Q (L/min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-Jan | -24 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 94 | 5 | 113 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Jan | -24.9 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 5 | 117 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Jan | -24.3 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 105 | 5 | 123 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Jan | -25.4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 109 | 5 | 127 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-Feb | -27.3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 112 | 5 | 131 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Feb | -26 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 114 | 5 | 133 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Feb | -25.5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 120 | 5 | 139 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Feb | -24.5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 125 | 5 | 144 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-Mar | -25.4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 128 | 5 | 146 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Mar | -23.6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 134 | 5 | 153 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Mar | -22.9 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 138 | 5 | 157 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Mar | -20.4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 143 | 5 | 161 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-Apr | -18.5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 148 | 5 | 166 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Apr | -18.4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 153 | 5 | 171 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Apr | -16.7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 160 | 5 | 177 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Apr | -13.9 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 168 | 5 | 184 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 05-Apr | -10.6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 173 | 5 | 189 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-May | -8.9 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 182 | 5 | 197 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-May | -7.7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 188 | 5 | 204 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-May | -5.6 | 4 | 0 | 4 | 1 | 1 | 0 | 3 | 188 | 5 | 209 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 04-May | -3.7 | 8 | 1 | 6 | 2 | 2 | 0 | 5 | 189 | 5 | 217 | 352063 | 35.21 | 1760.31 | 251.47 | 10.48 | 0.0029 | 174.63 |
| 01-Jun | -1.3 | 8 | 2 | 18 | 4 | 4 | 0 | 15 | 177 | 5 | 224 | 352063 | 35.21 | 5280.94 | 754.42 | 31.43 | 0.0087 | 523.90 |
| 02-Jun | -0.1 | 7 | 5 | 14 | 5 | 5 | 0 | 15 | 164 | 5 | 231 | 352063 | 35.21 | 5280.94 | 754.42 | 31.43 | 0.0087 | 523.90 |
| 03-Jun | 1.6 | 5 | 5 | 32 | 13 | 12 | 0 | 25 | 133 | 4 | 236 | 352063 | 35.21 | 8801.57 | 1257.37 | 52.39 | 0.0146 | 873.17 |
| 04-Jun | 3.3 | 6 | 4 | 59 | 21 | 18 | -4 | 46 | 75 | 4 | 242 | 352063 | 35.21 | 16194.89 | 2313.56 | 96.40 | 0.0268 | 1606.64 |
| 01-Jul | 5.7 | 3 | 3 | 59 | 29 | 18 | -11 | 45 | 16 | 3 | 245 | 352063 | 35.21 | 15842.82 | 2263.26 | 94.30 | 0.0262 | 1571.71 |
| 02-Jul | 6.3 | 6 | 6 | 10 | 31 | 12 | -19 | 6 | 6 | 1 | 251 | 352063 | 35.21 | 2112.38 | 301.77 | 12.57 | 0.0035 | 209.56 |
| 03-Jul | 8.4 | 5 | 5 | 6 | 35 | 7 | -28 | 5 | 0 | 0 | 257 | 352063 | 35.21 | 1760.31 | 251.47 | 10.48 | 0.0029 | 174.63 |
| 04-Jul | 7.6 | 8 | 8 | 0 | 32 | 8 | -25 | 0 | 0 | 0 | 265 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 05-Jul | 7.8 | 11 | 11 | 0 | 32 | 11 | -20 | 0 | 0 | 0 | 275 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-Aug | 6.3 | 8 | 8 | 0 | 27 | 8 | -19 | 0 | 0 | 0 | 283 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Aug | 6.3 | 14 | 14 | 0 | 26 | 13 | -13 | 1 | 0 | 1 | 297 | 352063 | 35.21 | 352.06 | 50.29 | 2.10 | 0.0006 | 34.93 |
| 03-Aug | 8 | 16 | 16 | 0 | 24 | 13 | -11 | 3 | 0 | 1 | 314 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 04-Aug | 6.3 | 17 | 17 | 0 | 21 | 11 | -10 | 6 | 0 | 2 | 331 | 352063 | 35.21 | 2112.38 | 301.77 | 12.57 | 0.0035 | 209.56 |
| 01-Sep | 3.7 | 15 | 15 | 0 | 16 | 9 | -7 | 6 | 0 | 2 | 347 | 352063 | 35.21 | 2112.38 | 301.77 | 12.57 | 0.0035 | 209.56 |
| 02-Sep | 3.3 | 11 | 11 | 0 | 14 | 8 | -7 | 3 | 0 | 2 | 358 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 03-Sep | 1.9 | 6 | 6 | 1 | 10 | 4 | -5 | 2 | 0 | 2 | 365 | 352063 | 35.21 | 704.13 | 100.59 | 4.19 | 0.0012 | 69.85 |
| 04-Sep | 0.7 | 17 | 16 | 0 | 6 | 5 | -1 | 9 | 1 | 4 | 382 | 352063 | 35.21 | 3168.56 | 452.65 | 18.86 | 0.0052 | 314.34 |
| 05-Sep | -1.4 | 7 | 5 | 0 | 2 | 2 | 0 | 3 | 3 | 4 | 390 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 01-Oct | -2.3 | 9 | 4 | 1 | 1 | 1 | 0 | 3 | 8 | 5 | 10 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 02-Oct | -2.9 | 8 | 2 | 2 | 0 | 0 | 0 | 3 | 12 | 5 | 18 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 03-Oct | -4.6 | 10 | 1 | 1 | 0 | 0 | 0 | 2 | 19 | 5 | 28 | 352063 | 35.21 | 704.13 | 100.59 | 4.19 | 0.0012 | 69.85 |
| 04-Oct | -5.8 | 10 | 2 | 2 | 0 | 0 | 0 | 3 | 26 | 5 | 39 | 352063 | 35.21 | 1056.19 | 150.88 | 6.29 | 0.0017 | 104.78 |
| 01-Nov | -8.4 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 33 | 5 | 46 | 352063 | 35.21 | 352.06 | 50.29 | 2.10 | 0.0006 | 34.93 |
| 02-Nov | -9.5 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 5 | 58 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Nov | -13.7 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 5 | 68 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Nov | -13.7 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 5 | 80 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 01-Dec | -14.8 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 5 | 87 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 02-Dec | -18.3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 5 | 92 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 03-Dec | -20.2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 86 | 5 | 99 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 04-Dec | -22.4 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 5 | 106 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |
| 05-Dec | -24.2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 99 | 5 | 112 | 352063 | 35.21 | 0.00 | 0.00 | 0.00 | 0.0000 | 0.00 |

Cape Dorset

STANDARD DEVIATIONS FOR THE PERIOD 1960 - 1993

| MONTH | TEMP °C | PCPN | RAIN | MELT | PE | AE | DEF | SURP | SNOW | SOIL | ACC P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-Jan | 4.3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 1 | 26 |
| 02-Jan | 3.8 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 1 | 27 |
| 03-Jan | 4.3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 1 | 28 |
| 04-Jan | 5.9 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 1 | 28 |
| 01-Feb | 3.5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 29 |
| 02-Feb | 5.5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 29 |
| 03-Feb | 4.3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 30 |
| 04-Feb | 4.7 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 30 |
| 01-Mar | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 1 | 31 |
| 02-Mar | 5.2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1 | 33 |
| 03-Mar | 4.3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 1 | 34 |
| 04-Mar | 5.5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1 | 34 |
| 01-Apr | 4.6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 1 | 35 |
| 02-Apr | 2.4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 1 | 36 |
| 03-Apr | 3.7 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 1 | 37 |
| 04-Apr | 3.9 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 1 | 40 |
| 05-Apr | 3.8 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 1 | 40 |
| 01-May | 2.2 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 1 | 46 |
| 02-May | 2.9 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 53 | 1 | 49 |
| 03-May | 3.4 | 3 | 1 | 11 | 3 | 3 | 0 | 9 | 58 | 1 | 51 |
| 04-May | 2.8 | 8 | 2 | 11 | 3 | 3 | 0 | 9 | 60 | 1 | 48 |
| 01-Jun | 2.1 | 6 | 3 | 28 | 7 | 7 | 0 | 23 | 82 | 0 | 51 |
| 02-Jun | 1.1 | 7 | 7 | 17 | 5 | 5 | 0 | 15 | 87 | 0 | 48 |
| 03-Jun | 2.2 | 8 | 8 | 23 | 9 | 8 | 1 | 17 | 94 | 2 | 52 |
| 04-Jun | 1.6 | 6 | 5 | 39 | 7 | 8 | 8 | 31 | 86 | 2 | 51 |
| 01-Jul | 1.9 | 4 | 4 | 67 | 6 | 13 | 14 | 55 | 50 | 3 | 51 |
| 02-Jul | 1.4 | 9 | 9 | 26 | 4 | 10 | 11 | 23 | 24 | 2 | 51 |
| 03-Jul | 2.9 | 5 | 5 | 24 | 7 | 8 | 13 | 19 | 0 | 1 | 51 |
| 04-Jul | 2.4 | 8 | 8 | 0 | 6 | 6 | 11 | 1 | 0 | 1 | 50 |
| 05-Jul | 2 | 9 | 9 | 0 | 5 | 8 | 11 | 0 | 0 | 0 | 53 |
| 01-Aug | 1.5 | 7 | 7 | 0 | 4 | 7 | 9 | 0 | 0 | 0 | 52 |
| 02-Aug | 2 | 10 | 10 | 0 | 4 | 8 | 11 | 2 | 0 | 2 | 55 |
| 03-Aug | 1.8 | 14 | 14 | 0 | 4 | 8 | 11 | 7 | 0 | 2 | 53 |
| 04-Aug | 1.9 | 19 | 19 | 0 | 4 | 8 | 10 | 14 | 0 | 2 | 61 |
| 01-Sep | 1.7 | 15 | 15 | 0 | 4 | 6 | 9 | 10 | 0 | 2 | 63 |
| 02-Sep | 1.4 | 11 | 11 | 0 | 4 | 6 | 8 | 6 | 0 | 2 | 65 |
| 03-Sep | 1.8 | 7 | 7 | 2 | 5 | 3 | 6 | 4 | 0 | 2 | 63 |
| 04-Sep | 1.5 | 12 | 10 | 0 | 4 | 4 | 2 | 8 | 4 | 2 | 66 |
| 05-Sep | 1.9 | 6 | 6 | 1 | 3 | 3 | 1 | 5 | 4 | 2 | 64 |
| 01-Oct | 1.6 | 7 | 5 | 2 | 2 | 2 | 0 | 4 | 7 | 1 | 7 |
| 02-Oct | 1.5 | 5 | 2 | 2 | 1 | 1 | 0 | 4 | 11 | 1 | 7 |
| 03-Oct | 2.1 | 7 | 3 | 4 | 1 | 1 | 0 | 4 | 11 | 1 | 10 |
| 04-Oct | 3.1 | 6 | 4 | 5 | 1 | 1 | 0 | 9 | 16 | 1 | 11 |
| 01-Nov | 4 | 4 | 1 | 1 | 0 | 0 | 0 | 1 | 18 | 1 | 12 |
| 02-Nov | 3.1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 1 | 11 |
| 03-Nov | 3.8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 1 | 17 |
| 04-Nov | 3.2 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 1 | 21 |
| 01-Dec | 4.5 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 1 | 22 |
| 02-Dec | 5.1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 1 | 21 |
| 03-Dec | 5.4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 1 | 22 |
| 04-Dec | 4.4 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 1 | 24 |
| 05-Dec | 4.4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 1 | 26 |

# APPENDIX G

# GEOTECHNICAL INVESTIGATION

# APPENDIX H

# DETERMINATION OF CULVERT PEAK DESIGN FLOW

# Tributary Area & Runoff Calculations

**Condition:** 10 Year Return Period **(using HIGHER "R" values)** **Date:** 14-Apr-05
**Location:** Catchment area affecting new sewage lagoon access Rd **P.O.C.** New Culvert

| Area No. | Cover or Dev. State | Approx. Grade (%) | Area ($m^2$) | Area (ha) | R* | A X R | Comments: |
|---|---|---|---|---|---|---|---|
| 5 | Undeveloped | 8 | 19838 | 1.98 | 0.50 | 0.9919 | Relatively flat. Silt-like soil |
| 6 | Undeveloped | 25 | 38582 | 3.86 | 0.85 | 3.2794 | Fairly Steep, No storage |
| 7 | Undeveloped | 30 | 79812 | 7.98 | 0.70 | 5.5869 | Moderate slope, with storage |
| 8 | Undeveloped | 9 | 52582 | 5.26 | 0.60 | 3.1549 | Moderate slope, with storage |
| 9 | Undeveloped | 6 | 73192 | 7.32 | 0.60 | 4.3915 | Moderate slope, with storage |
| 10 | Undeveloped | 7 | 153084 | 15.31 | 0.60 | 9.1850 | Moderate slope, with storage |
| | | | | | | | |
| | | ∑Areas= | 417089 | 41.71 | Total ∑AXR= | 26.5896 | |

* R values were estimated using Table 2-26 "Watershed Characteristics for Determining Runoff Coefficinent..." (U.S. Soil Conservation Service)

Tc=Ts + Tr where,

Ts=Saturation Time (Inlet Time)
Tr=Running or system flow time

NOTE: For frozen or highly impervious surfaces, the value for Ts is near zero (0).

Method of Tr determination: Overland Flow Nomograph
Drop from Remote Point to Outlet: **85** m (From Topographic Map) Average Slope (%) = 6.7
Length of Overland Travel: **1270** m (AutoCAD drawing - Figure 6)
Time Correction Factor: **1** (For Bare Earth)

**Tr =** **13** minutes (Overland Flow Nomograph)

Preliminary check: Velocity (average) = L/t 1.628 m/s

CALCULATED FLOW (Qc):

Qc = (A · R · I) / 360 = (Total AR · I) / 360

| | | |
|---|---|---|
| Return Period: | **10 years** | |
| Drainage Area: | **41.7** | (AutoCAD drawing - Figure 6) |
| Total AR: | **26.6** | (See above) |
| Running Time (Tr): | **13** | (Overland Flow Nomograph - attached) |
| Saturation time (Ts): | **2** | (near 0 for frozen/impervious surfaces) |
| Concentration Time (Tc): | **15** | (minutes) |
| Intensity: | **16** | (mm/hr) - IDF curves for Cape Dorset |

$$Q_{10} = \frac{26.6 \quad X \quad 16}{360} \qquad Q_{10} = 1.1818\ m^3/s$$

DESIGN FLOW:

$Qd = Q_{10} \cdot (1+A\%)(1+R\%)(1+I\%)(FOS)$ Where:

| | |
|---|---|
| FOS | 0.10 |
| A%= | 0.05 |
| R%= | 0.20 |
| I%= | 0.05 |

$Q_d$= 1.72 $m^3/s$

Catchment Area for culvert Calcs (Total: 41.7 ha)
Watershed Characteristics

**TABLE 2-26. WATERSHED CHARACTERISTICS FOR DETERMINING RUNOFF COEFFICIENT IN THE RATIONAL FORMULA**

*(Source: U.S. Soil Conservation Service)*

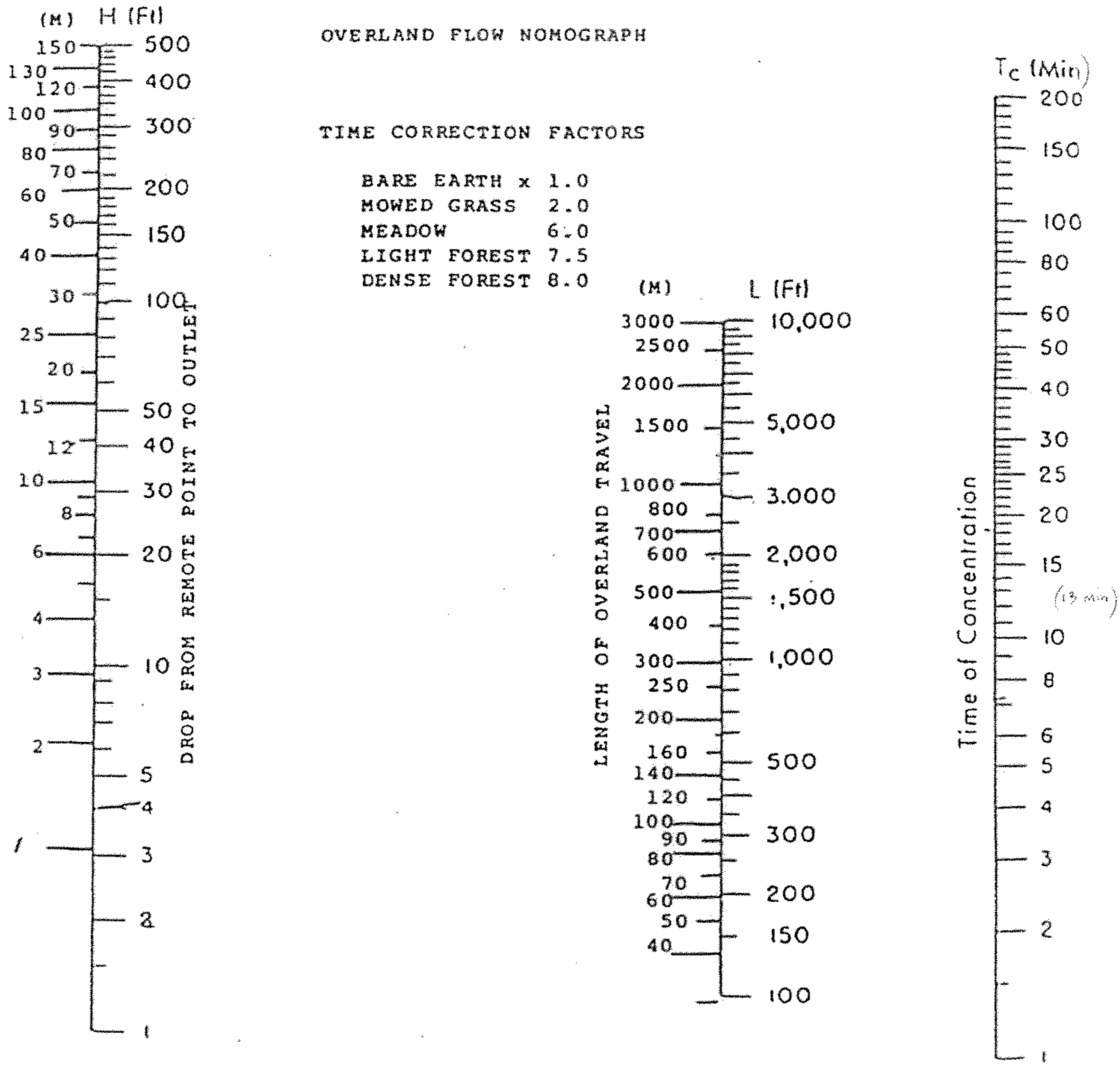
[For each watershed characteristic in left column select appropriate descriptive box; add four numerical values given in parentheses to obtain runoff coefficient as a percentage.]

| | Designation of watershed characteristics | Runoff-producing characteristics | | | |
|---|---|---|---|---|---|
| | | 100 extreme | 75 high | 50 normal | 25 low |
| (A) | Relief | (40) Steep, rugged terrain, with average slopes generally above 30% | (30) Hilly, with average slopes of 10 to 30% | (20) Rolling, with average slopes of 5 to 10% | (10) Relatively flat land, with average slopes of 0 to 5% |
| (B) | Soil infiltration | (20) No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity | (15) Slow to take up water; clay or other soil of low infiltration capacity, such as heavy gumbo | (10) Normal; deep loam with infiltration about equal to that of typical prairie soil | (5) High; deep sand or other soil that takes up water readily and rapidly |
| (C) | Vegetal cover | (20) No effective plant cover; bare or very sparse cover | (15) Poor to fair; clean-cultivated crops or poor natural cover; less than 10% of drainage area under good cover | (10) Fair to good; about 50% of drainage area in good grassland, woodland, or equivalent cover; not more than 50% of area in clean-cultivated crops | (5) Good to excellent; about 90% of drainage area in good grassland, woodland, or equivalent cover |
| (D) | Surface storage | (20) Negligible; surface depressions few and shallow; drainage-ways steep and small; no ponds or marshes | (15) Low; well-defined system of small drainage-ways; no ponds or marshes | (10) Normal; considerable surface-depression storage; drainage system similar to that of typical prairie lands; lakes, ponds and marshes less than 2% of drainage area | (5) High; surface-depression storage high; drainage system not sharply defined; large flood-plain storage or a large number of lakes, ponds or marshes |

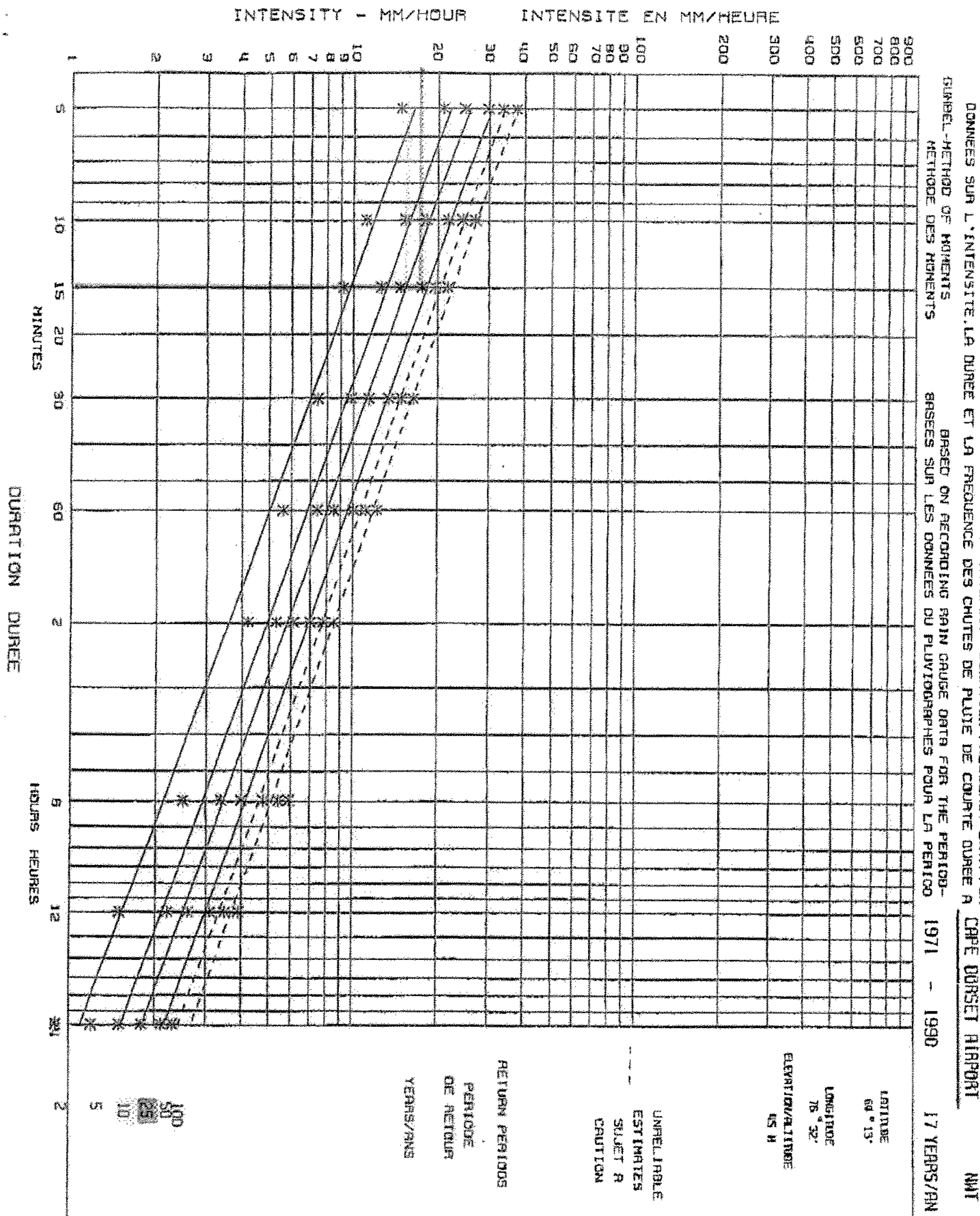
* Note: Areas are defined on Figure 6

| | Area # 5 | Area # 6 | Area # 7 | Area # 8 | Area # 9 | Area # 10 |
|---|---|---|---|---|---|---|
| (A) | 20 | 30 | 30 | 20 | 20 | 20 |
| (B) | 5 | 20 | 10 | 10 | 10 | 10 |
| (C) | 20 | 20 | 20 | 20 | 20 | 20 |
| (D) | 5 | 20 | 10 | 10 | 10 | 10 |
| Total | 50 | 90 | 70 | 60 | 60 | 60. |

Cape Dorset (05-4319-2000)
New sewage treatment lagoon Road - Culvert Design.




OVERLAND FLOW CORRECTION FACTOR NOMOGRAPH

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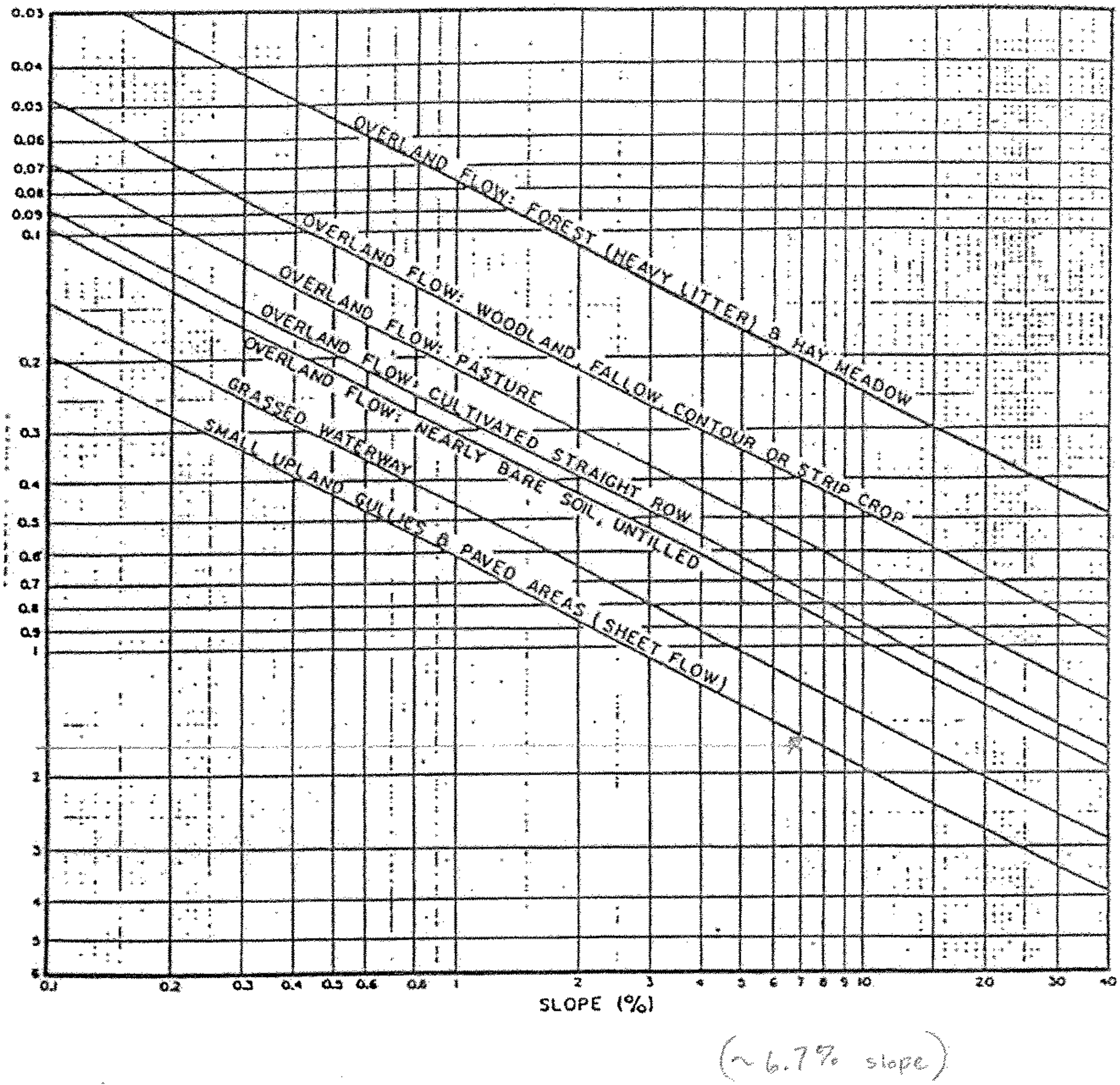


OVERLAND FLOW SURFACE VELOCITY NOMOPGRAPH


DILLON CONSULTING

PROJECT: Cape Dorset Sewage Treatment System

TITLE: Lake - P and Lagoon Site Catchment Areas

PROJECT NUMBER: 05-4319-2000

DATE: May 05

FIGURE NUMBER: K

# APPENDIX I

# ORGANIC LOADING CALCULATIONS

| Year | Population | MACA Predicted Sewage Production (L/d) | BOD (mg/L) | Organic Loading (Kg/d) | Lagoon Area (ha) | Areal Organic Loading (Kg/ha/d) |
|---|---|---|---|---|---|---|
| 2000 | 1213 | 1.40E+05 | 625 | 87 | 3.1 | 28 |
| 2001 | 1240 | 1.43E+05 | 625 | 90 | 3.1 | 29 |
| 2002 | 1268 | 1.47E+05 | 625 | 92 | 3.1 | 30 |
| 2003 | 1298 | 1.52E+05 | 625 | 95 | 3.1 | 31 |
| 2004 | 1327 | 1.56E+05 | 625 | 97 | 3.1 | 31 |
| 2005 | 1354 | 1.60E+05 | 625 | 100 | 3.1 | 32 |
| 2006 | 1382 | 1.64E+05 | 625 | 102 | 3.1 | 33 |
| 2007 | 1412 | 1.68E+05 | 625 | 105 | 3.1 | 34 |
| 2008 | 1441 | 1.73E+05 | 625 | 108 | 3.1 | 35 |
| 2009 | 1471 | 1.77E+05 | 625 | 111 | 3.1 | 36 |
| 2010 | 1501 | 1.82E+05 | 625 | 114 | 3.1 | 37 |
| 2011 | 1536 | 1.87E+05 | 625 | 117 | 3.1 | 38 |
| 2012 | 1570 | 1.92E+05 | 625 | 120 | 3.1 | 39 |
| 2013 | 1600 | 1.97E+05 | 625 | 123 | 3.1 | 40 |
| 2014 | 1632 | 2.02E+05 | 625 | 126 | 3.1 | 41 |
| 2015 | 1662 | 2.07E+05 | 625 | 129 | 3.1 | 42 |
| 2016 | 1692 | 2.12E+05 | 625 | 132 | 3.1 | 43 |
| 2017 | 1726 | 2.17E+05 | 625 | 136 | 3.1 | 44 |
| 2018 | 1757 | 2.22E+05 | 625 | 139 | 3.1 | 45 |
| 2019 | 1793 | 2.28E+05 | 625 | 142 | 3.1 | 46 |
| 2020 | 1829 | 2.34E+05 | 625 | 146 | 3.1 | 47 |
| 2021 | 1848 | 2.37E+05 | 625 | 148 | 3.1 | 48 |
| 2022 | 1879 | 2.42E+05 | 625 | 151 | 3.1 | 49 |
| 2023 | 1910 | 2.47E+05 | 625 | 155 | 3.1 | 50 |
| 2024 | 1941 | 2.53E+05 | 625 | 158 | 3.1 | 51 |
| 2025 | 1971 | 2.58E+05 | 625 | 161 | 3.1 | 52 |
| 2026 | 2002 | 2.63E+05 | 625 | 164 | 3.1 | 53 |

# APPENDIX J

# LETTER TO HUNTERS AND TRAPPERS ASSOCIATION

April 14, 2005

Qavaroak Qatsiya
Chairperson
Aiviq HTA
P.O. Box 300
Cape Dorset, Nunavut
X0A 0C0

Dear Qavaroak,

At our recent meeting, the Nunavut Wildlife Management Board (NWMB or Board) reviewed your application for funding for *Fish lakes and Rivers Restoration* project. The project was approved for funding in the amount of $29,216, subject to the following conditions:

1. The proponent should be encouraged to seek other sources of funding. This should be confirmed in writing.

2. Funding should be conditional on clarification of the budget line items A- $9,000 for 2 hunters/boat owners for 6 trips
   B- Specify what is included in the 5K in-kind from the HTO

3. Funding should be conditional on the Aiviq HTO being up to date and in satisfactory standing with NWMB for receiving regular funding from NWMB.

Conditions must be met before a contribution agreement will be established. The deadline for meeting these conditions is **30 June, 2005**. If you do not fulfil these conditions by that date, funding will not be provided for this year and a new application must be submitted for next year. Please let us know if you anticipate any problems in meeting this deadline.

Once you have met these conditions, a contribution agreement will be forwarded to the HTA for your review and signature.

I wish you success with this project.

Yours sincerely,

Josée Galipeau
A/Director Wildlife Management

cc. QWB
DFO Iqaluit