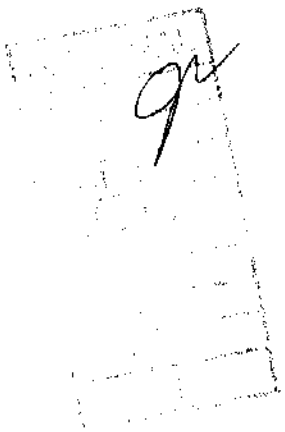

Cape Dorset Sewage Facility Study

Government of Nunavut
Department of Community Government and Transportation

01-8742-1000

Submitted by

Dillon Consulting Limited

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Revision 0 Report

March, 2001

EXECUTIVE SUMMARY

The Department of Community Government and Transportation, Government of Nunavut, retained Dillon Consulting Limited (Dillon) to produce a sewage facility planning study for Cape Dorset, Nunavut. The purpose of this study is to identify and analyse problems with the existing sewage disposal facility and to outline the options available in the community**.** The scope of this study was set out in the terms of the contract CT500161 issued by the Government of Nunavut, Department of Community Government and Transportation. The scope of work includes the following items.

1. "Complete in depth interview with the director of Municipal Works covering all aspects of the existing sewage lagoon, it's operating history, all seasonal operating difficulties, any records of system failures, probable causes, what remedial measures were carried out, cost of repairs, the effectiveness of the repairs.
2. Obtain any copies of regulatory inspections reports and recommendations that the Hamlet has on file since the lagoon went into service.
3. Interview all other Hamlet Staff that the Director can recommend, who has any experience or knowledge concerning operations or construction of the lagoon.
4. Conduct a detailed in-depth tour of the lagoon and entire site, documenting all areas with a careful photo record.
5. Tour the entire site adjacent area of the community seeking out any potential alternative lagoon sites.
6. Gather topographic and photographic mapping of the community and study to locate all possible alternative lagoon sites.
7. From the study and all information that was gathered, compose a report covering the following alternatives;
    1. Analysis of the problems with the existing lagoon and a proposed method to repair and restore the lagoon to full capacity such that it will operate in a manner satisfactory to meet the guidelines and requirements for the regulatory agencies for the ten and twenty year horizons.
    2. Schematic design sketches indicating proposed modifications and Class B cost estimates.
    3. For each lagoon site, provide schematic design sketches showing lagoon configuration, capacity, berm heights, access roads required etc and Class B cost estimates
    4. Proposed location for a mechanical treatment plant system showing siting, components required, electrical source, a rough description of the operating characteristics of the system or proposed systems, and class B estimates
    5. A recommendation for the most cost effective and long term solution for treating the sewage generated by the community.

The projected sewage generation at the end of 10 years (2011) is 66,330$m^{3,}$ and at the 20 year (2021) horizon was found to be 87,545m^3. The discharge criteria for the lagoon system would be expected to meet the requirements outlined in ***Table 4.1 - Municipal Waste water Effluent Quality Guidelines*** from the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories* (See ***Appendix J***). The discharge environment is a marine bay. Based on this table the required effluent criteria for Biochemical Oxygen demand (BOD), Suspended Solids (TSS), and Faecal Coliforms (F. Coli) can be suggested. These values, and the results rom the September 5, 200 testing completed by DIAND are shown in ***Table i.4***.

Table i.1
Effluent Criteria

Parameter	Suggested Criteria	September 5, 2000 Results
BOD (mg/l)	100	34
TSS (mg/l)	120	15
Faecal Coliforms (CFU/dl)	No guideline	90000
pH	6 to 9	8

The Cape Dorset Sewage Treatment Facility was inspected on February 20 & 21, 2001. The existing system was designed to have 3 lagoon cells constructed in a series. The cells are located in a valley and are placed in a terraced formation. The lower two cells have failed due to a breach in the down gradient walls. The wall breach is the result of spring melt water entering the cells, and then over topping the down gradient walls. The granular material used for the construction of the cells is fine grained and subject to mass wastage (erosion).

The assessment of the existing lagoons also indicates that the cells are under sized for the community sewage generation, assuming that the original intent is an annual storage lagoon. There is insufficient space within the valley to construct a lagoon system with the required hydraulic capacity for an annual storage lagoon system. Expansion of the lagoon system in the existing location will require extensive rock removal to provide for the required hydraulic capacity.

An alternative lagoon site is identified to the north of the community in an area that has been used for granular resource extraction by the Airports Division. To construct a lagoon system in this area, a two celled system is recommended. The site has approximately 8 metres of grade across the site, and the use of two cells reduces the amount of earth work required at the site.

Two mechanical plants were identified for assessment. The use of primary sewage treatment with the effluent discharged at shoreline provides for similar treatment to a facultative lagoon. This system can be installed at the location of the exiting lagoon site. The discharge for this plant would be in the same location as the existing lagoon system.

The alternative to the primary treatment plant, is the use of a macerator and deep water discharge. The use of this approach meets the guidelines for treatment as set out by the previous Water Board. A site specific study would be required to determine the impact of the sewage discharge on the marine environment.

The estimated capital and operational costs for the options are shown in the table below.

Table i.2
Summary of Costs

Option	**Capital Cost**	**Annual Operation and Maintenance Cost**	**20 Year Life Cycle Cost 8% discount**	**20 Year Life Cycle Cost 4% discount**
1- Upgrade of the existing	$4,250,000	2% of Capital	$5,080,000	$5,405,000
2- Alternative Lagoon Site	$1,600,000	2% of Capital	$1,910,000	$2,030,000
3- Macerator and Deep Water Discharge	$1,300,000	5% of capital	$1,937,000	$2,180,000
4 - Primary Treatment and Shore Discharge	$2,420,000	7.5 % Capital	$4,200,000	$4,890,000

The above table does not include the cost of sewage collection or trucking. The estimates include a 10% contingency allowance and a 8% engineering allowance on the capital costs. GST is not included in the above amounts.

The most cost effective alternative to the near and long term sewage treatment and disposal for the community of Cape Dorset is the construction of a new sewage lagoon at the alternative site as shown in ***Figure 2, Appendix A***. The terms of reference for this study indicated that the option selection for the sewage disposal was to be based solely on a cost analysis. The cost difference between the alternative lagoon site and the deep water discharge is marginal, and at the level of class B estimates can be considered to be identical. Other issues that may need to be addressed in the final selection of the sewage treatment and disposal option are;

- Impact of effluent discharge point.

- Impact of the alternative site on the granular resource.
- Impact of the site on tourism
- Acceptance of the deep water discharge to the regulators

Additional information required prior to proceeding with the acceptance of this recommendation includes;

- Conduct site specific geotechnical studies.
- Submit the conceptual plans to the various regulatory agencies for review and comment.
- Conduct a site specific topographic survey and Bathymetric survey to allow for tender quantity estimates
- Complete a Water Licence application to the Nunavut Water Board.
- Review the granular resources in the community area to determine the long term impact to the community granular supply created by the use of the proposed site.
- Discuss with the community government the acceptability of the proposed site to the residents and representatives of the community.

1.0 INTRODUCTION

1.1 Purpose

The Department of Community Government and Transportation (CG&T), Government of Nunavut, retained Dillon Consulting Limited (Dillon) in February 2001 to complete a sewage disposal planning study for the community of Cape Dorset, Nunavut. The planning study was produced to assist CG&T and the community government of the Hamlet of Cape Dorset in selecting the best option to meet the current and future sewage disposal needs of the community. The need to address the sewage disposal facility was prompted by health, safety and aesthetic concerns expresses by the community government and regulatory agencies (Environment Canada, Department of Indian And Northern Development (DIAND) and Department of Health).

The scope of this study was set out in the terms of the contract CT500161 issued by the Government of Nunavut, Department of Community Government and Transportation. The scope of work includes the following items.

8. "Complete in depth interview with the director of Municipal Works covering all aspects of the existing sewage lagoon, it's operating history, all seasonal operating difficulties, any records of system failures, probable causes, what remedial measures were carried out, cost of repais, the effectiveness of the repairs.
9. Obtain any copies of regulatory inspections reports and recommendations that the Hamlet has on file since the lagoon went into service.
10. Interview all other Hamlet Staff that the Director can recommend, who has any experience or knowledge concerning operations or construction of the lagoon.
11. Conduct a detailed in-depth tour of the lagoon and entire site, documenting all areas with a careful photo record.
12. Tour the entire site adjacent area of the community seeking out any potenial alternative lagoon sites.
13. Gather topographic and photographic mapping of the community and study to locate all possible alternative lagoon sites.
14. From the study and all information that was gathered, compose a report covering the following alternatives;
    6. Analysis of the problems with the existing lagoon and a proposed method to repair and restore the lagoon to full capacity such that it will operate in a manner satisfactory to meet the guidelines and requirements for the regulatory agencies for the ten and twenty year horizons.
    7. Schematic design sketches indicating proposed modifications and Class B cost estimates.
    8. For each lagoon site, provide schematic design sketches showing lagoon

configuration, capacity, berm heights, access roads required etc and Class B cost estimates

9. Proposed location for a mechanical treatment plant system showing siting, components required, electrical source, a rough description of the operating characteristics of the system or proposed systems, and class B estimates
10. A recommendation for the most cost effective and long term solution for treating the sewage generated by the community.

1.2 Site Setting

Cape Dorset is situated on the Foxe Peninsula on the west side of Baffin Island at 64^{o}N 76^{o}W. See ***Figure 1 Appendix A***. The community has the following services: health centre, diesel power generation, bulk fuel storage facility, airport, Co-op and Northern stores, government offices, and annual resupply sealift.

1.3 Geology and Terrain

Local geology consists of mostly exposed bedrock. The soil consists of granular matter ranging from fine sand to gravel and rock fragments. The community occupies two minor coastal valleys. At each valley mouth extensive mud flats are found.

Cape Dorset is located within the continuous permafrost zone. The active layer ranges from 0.6 to 0.75m below the surface.

1.4 Vegetation and Climate

Vegetation and climate are typical of far northern regions. The limited soils support a variety of tundra vegetation, grasses, mosses, flowers and lichens in a thin organic layer. The mean annual precipitation is listed as 26.7 cm. Mean July highs and lows are 7.2^{o}C and 3.3^{o}C respectively, while mean January highs and lows are -23.3^{o}C and -28.9^{o}C. The winds are generally west and annually average 18.5 km/h. (www.infonorth.org)

2.0 COMMUNITY SITE VISIT

2.1 General

The site visit was completed by Mr. David Parker , Community Government and Transportation, GN and Mr. Gary Strong of Dillon. The visit was completed on February 20 and 21, 2001. The intent of the site visit was to address the first 5 requirements of the terms of reference, these are briefly,

- Interview the Director of Municipal Works
- Obtain copies of all available information from the community
- Interview other Hamlet staff as appropriate
- Tour the existing site and photograph the existing condition
- Investigate alternative sites.

The following sections outlines the work completed under each of these tasks.

2.2 Interview the Director of Municipal Works

The Director of Municipal Works is Mr. Don Holmes. The following list of information is based on the discussions held with Mr Holmes at site and subsequently in his office over the two day period. Mr Holmes provided full access to the site and made himself available when required to discuss the concerns with the lagoon operation. The author would like to recognize the efforts made by Mr. Holmes and his staff in the completion of this report.

- The new lagoons have never operated per the original intent. There have always been problems with sewage overflows, seepage, and lagoon wall breaches.
- The new lagoons are only used in the summer. In the winter the sewage is discharged in an alternative site, as shown in ***Figure 1, Appendix A***.
- In the winter the lagoon would fill up, and then start to overflow the front of the lagoon. The lagoon walls are constructed from fine particles and the overflowing sewage would erode the wall.
- The lagoon is designed to have 3 cells. The top cell is not operational in the winter. The bottom two cells have experienced wall breaches. The bottom two cells are currently inoperable. In the summer the sewage discharged from the top cell flows through the breached lower cells.
- The lagoons discharge to the ocean in an area that flows away from the community. The discharge location has a tidal land bridge between the discharge point and the community. This discharge location is preferred to any one that is on the community side of the tidal land bridge. The land bridge location is shown in ***Figure 1***.
- Mr. Holmes provided two reports on the work completed to construct and repair the lagoon and solid waste facility. From these records the following can be determined

- The lagoon system was originally built in 1994 to 1996. The design was for a three tiered lagoon system, with sewage overflowing from one lagoon to the next. The lagoons were constructed in a terraced manner down a natural valley.
- In the year of construction it was noted that the upper lagoon was ex-filtrating rapidly. The report indicates that this was because the lagoon was constructed on bedrock, and granular wall construction did not provide a seal to the bedrock. The report suggests that the addition of a clay layer to the base of the lagoon would remedy the problem. This work was not carried out due to funding limitations.
- The report shows the cost to construct the lagoon, and the subsequent costs in the attempted repairs. The costs include the cost to construct the lagoon and also the landfill site located up gradient of the lagoon site. (See ***Figure 3***)

- Mr. Holmes' opinion is that the lagoons are failing because of natural spring runoff draining through the valley where the lagoons are located. The run off does not enter into the upper lagoon, but does traverse through the lower lagoons. The drainage creates erosion and the resultant breaches in the lagoon walls.

The reports provided by Mr. Holmes are included in ***Appendix C***. A summary of the costs associated with the construction and repairs are shown below.

Fiscal Year	**Budgeted Costs**	**Actual Costs**
1994/1995	$78,784.00	$51,888.35
1995/1996	$101,000.00	$182,740.24
Totals	$179,784.00	$234,628.59

2.3 Copies of Available Information From the Community

In addition to the above report, we requested that the community government provide us with any additional information. A copy of the request for information is included in ***Appendix B***. We received the original site sketch for the construction of the lagoon, the preliminary drawings for the construction of the lagoon and landfill system by FSC Group, and a list of equipment and equipment rates. This information, excluding the preliminary drawings is also included in ***Appendix C***. Other information was also provided, but though somewhat related, was not found to be useful to this assignment. This included the Cape Dorset Waste Disposal Project Engineering report, July 1991, by Reinders Northern Limited.

The use of water and the disposal of waste is regulated under the Northern Inlands Water Act as regulated by DIAND and the Nunavut Land Claims Settlement Act as regulated by the Nunavut

Water Board (NWB). Through these acts, the Hamlet is required to have a permit for the with drawl of water for potable use. The NWB also requires the provision of a water licence for the disposal of liquid or solid waste. The Hamlet of Cape Dorset does not currently have a water licence for the operation of the sewage lagoon. The Hamlet is operating in contravention of the governing legislation. We understand that the Hamlet is currently applying for their Water Licence through the NWB.

Without a Water Licence in place, there is no requirement for annual reporting to the Water Board by the community government. Further there is no requirement for DIAND to provide any reports to the community.

DIAND, Environment Canada and the Department of Health were contacted to determine if they had any inspection reports on file that could be released. The following information was gathered.

- Included in ***Appendix K*** is a copy of a letter of inspection from DIAND related to the Sewage and Solid Waste Facility is Cape Dorset. This inspection included the collection and analysis of effluent from the lagoon in September, 2000.
- Included in ***Appendix K*** is a letter from the Department of Health & Social Services outlining concerns that the department has with the operation of the lagoon system.

Environment Canada indicated that they do not have any records of inspections completed by their staff related to the sewage lagoon.

2.4 Interview other Hamlet staff

Mr Holmes identified that the Assistant Director, Municipal Works, Mr Adamie Curley would be a good contact. The following is a list of his comments;

- The material used to construct the lagoon wall berms is too fine and erodes easily. The hamlet has access to better (coarser material). Mr Curley felt that the berms should be lined with coarse material, or reconstructed using a blend of the coarse and fine material to reduce the erosion of the material.
- The lower lagoons could be used as a wetland area to help treat the sewage.
- The area above the upper lagoon is a clay material. This area could be used for a lagoon cell.
- A list of local contractors and the equipment available through these contractors were provided. (See ***Appendix D***)

2.5 Existing Site Investigation

The site was visited on both February 20th and 21st, 2001. Photographs of the site were taken and are shown in ***Appendix B***. The site was snow covered at the time of the inspection, as can be seen in the photographs. Some points of interest about the site are;

- The site access is a road that leads to both the solid waste site and the sewage lagoon.
- The lagoon system is comprised of three cells. The lower two cells have been breached. A large breach exists in the west wall of the lower two cells.
- The upper cell is constructed on a slope. The wall crests are sloped down gradient to the west.
- The front wall of the upper cell is substantially higher than the side walls.
- The site is bounded to the south by a rock face that is approximately 50 metres in height.
- The lagoon system discharges to the ocean to the west of the tidal land bridge. This area of the ocean drains away from the community site.
- The truck discharge area does no have bollards or other devises to demark the truck discharge point.
- The site is not fenced
- The site does not have signs or other structures to indicate the site use.

2.6 Alternative Sites Investigation

At a preliminary level, the following criteria were used to develop potential areas for the alternative sites.

- The lagoon discharge can not be to the water shed of the potable water supply,
- The lagoon discharge can not be to a water shed that flows through the community.
- The site must be accessible
- The site must be outside the 450m buffer zone required in the Sanitation Regulations under the Health Act of the Government of Nunavut.

The general terrain around Cape Dorset is hilly, with prominent bedrock outcrops. There ae several main drainage paths that traverse through the hamlet proper. These drains originate in the hills located south and west of the hamlet. ***Figure 2, Appendix A***, shows the drainage area the flows through the community site and the water shed to the potable water lake.

The land south west of the community proper is bounded by a major land form where there is a significant rise in elevation (approximately a 100 metre rise). Access to the uplands area is not feasible as the majority of the land form rises the 100 metres over a distance of 10 to 20 metres. The only access up this land form is along the raw water pipeline. This access has an average slope of over 12%, with some sections in excess of 20%. This land form is shown on ***Figure 2***.

The 450 m buffer zone requirement of the health act is shown on ***Figure 2***.

Based on this set of initial criteria, two areas were identified for a lagoon site. The first is the existing lagoon site, the second is an area located to the east of the runway. These areas are shown on ***Figure 2.***

The alternative site is located near the granular resource or the airport. The site is located in a saddle between two bedrock outcrops. There is an access road to the site that is used in the summer. The access road is not maintained in the winter, as the granular resource is not used in the winter months. There is a building in the site area, that is understood to be the property of CG&T, Airports division. ***Appendix B*** shows photographs of the access to the site and the general terrain of the site.

2.7 Other Data Sources

CG&T's regional office is located in the community of Cape Dorset. The files of CG&T were searched for existing information. The following data was collected from this source;

- Air photographs of the community, the existing site and the alternative site.
- Topographic mapping of the community and surrounding area,

This information has been used in the development of the figures, and the criteria for the site selection as described above. Based on the information gathered to date, the size of the existing lagoons are shown in the follow table.

Lagoon Cell	**Width (m)**	**Length (m)**	**Volume Estimate (m^3)**
Cell1 - Upper Cell	30	120	8,208
Cell 2	30	30	1,728
Cell 3	60	80	12,000
Total			21,936

3.0 SYSTEM UPGRADE REQUIREMENTS

3.1 General

One requirement of the project is to analyse the problems with the existing lagoon and a proposed method to repair and restore the lagoon to full capacity such that it will operate in a manner satisfactory to meet the guidelines and requirements for the regulatory agencies for ten and twenty year horizons. The projected sewage waste volumes are developed in order to design the appropriate size for the facility. This section develops the expected sewage waste volumes that will be trucked to the facility over the planning horizon, which are 10 and 20 years as set out in the terms of reference. This report uses the methods described in "The General Terms of Reference for Sanitation Planning Studies, MACA" to develop the 10 and 20 year sewage generation values.

3.2 Population

The Government of Nunavut Bureau of Statistics has developed population projections for Cape Dorset until the year 2020. These projections were used to calculate the sewage waste generation for this study. The projected population at the end of 20 years was extrapolated to be 1865 residents in 2021. See ***Table 3.1***.

Table 3.1
Cape Dorset Population and Projections, 2000-2021

Year	Population	Year	Population
2000	1213	2011	1536
2001	1240	2012	1570
2002	1268	2013	1600
2003	1298	2014	1632
2004	1327	2015	1662
2005	1354	2016	1692
2006	1382	2017	1726
2007	1412	2018	1757
2008	1441	2019	1793

Year	Population	Year	Population
2009	1471	2020	1829
2010	1501	2021[1]	1865

2000-2020 Projections: Government of Nunavut, Bureau of Statistics.
1 Extrapolated

3.3 Sewage Generation

In trucked service communities, it can be assumed that the sewage generated is equal to the water consumption. Therefore, the daily and annual sewage generation rates for Cape Dorset are equal to water consumption rates.

The MACA general Terms of Reference include a standard for water consumption in communities of less than 2000 residents with trucked water can be estimated with the following formula:

Water Use (l/cd) = 90 l/cd x (1.0 + 0.00023 x population)

The factors of 0.00023 x population represents the commercial and industrial water use.

The projected sewage generation at the end of 10 years (2011) is 66,330$m^{3,}$ and at the 20 year (2021) horizon was found to be 87,545m^3. ***Table 3.2*** shows the daily and annual sewage generation for the planning horizon.

Table 3.2
Annual Sewage Generation, Cape Dorset

Year	Population	Daily (M^3)	Annual (M^3)	Year	Population	Daily (M^3)	Annual (M^3)
2000	1213	140	50964	2011	1536	187	68283
2001	1240	143	52351	2012	1570	192	70198

Year	Population	Daily (M^3)	Annual (M^3)	Year	Population	Daily (M^3)	Annual (M^3)
2002	1268	147	53802	2013	1600	197	71902
2003	1298	152	55369	2014	1632	202	73735
2004	1327	156	56897	2015	1662	207	75467
2005	1354	160	58331	2016	1692	212	77213
2006	1382	164	59829	2017	1726	217	79208
2007	1412	168	61448	2018	1757	222	81042
2008	1441	173	63026	2019	1793	228	83190
2009	1471	177	64671	2020	1829	234	85358
2010	**1501**	**182**	**66330**	**2020**	**1865**	**240**	**87545**

3.4 Lagoon Requirements

The requirements for the design and operation of lagoons in Nunavut can be found in the following documents;

Guidelines for disposal of wastewater in Coastal communities of the NWT, G.W. Heinke, D. W. Smith and R. Gerard, March 1990

Guidelines for the Planning, Design and Operation and Maintenance of Wastewater Lagoon Systems in the NWT G.W. Heinke, D. W. Smith and R. Finch, November 1988,

Guidelines for the discharge of Treated Municipal Waste Water in the NWT, Northwest Territories Water Board, 1992.

Cold Regions Monograph, third edition, 1996

These documents were developed prior to the division of Nunavut from the NWT. Whereas these are NWT based documents, the principals contained within these documents have been generally accepted by the regulatory agencies in the Nunavut Territory.

As stated previously, the community government of the Hamlet of Cape Dorset does not currently have Water Licence, and as such there is no prescribed discharge criteria for the

sewage lagoon system. The following analysis is based on the current standards of practice for licenced facilities of communities similar in size to Cape Dorset. These communities typically use a lagoon sized to store the sewage generated in the community for one year. The treatment method for the annual storage lagoon is a facultative lagoon. Normally these lagoons have a liquid depth of approximately 3.0 metres, and a free board height above the maximum liquid height of 0.3 metres. Therefore the height of the berm walls is 3.3 metres.

The soil matrix in Cape Dorset used for the construction of the lagoon is a sandy material. The design information obtained from the community did not show the design side slope. Due to snow cover, it was not possible to obtain meaningful measurements to determine the field side slopes. For this analysis, a 2:1 horizontal to vertical slope is assumed. To size the lagoon the following formula is used;

$$\text{Volume} = V = d\{(a+Sd)(b+Sd)\}$$

Where d = depth
a = width measured at the toe of slope on the inside of the lagoon
b = length measured at the toe of slope on the inside of the lagoon
S = side slope

Once the required volume for the sewage treatment is calculated, the size needs to be adjusted to account for the freeboard, lagoon wall crest width, and lagoon wall back slope. ***Appendix M*** illustrates some tentative sizes based on the above formula and the use of 1, 2 and 3 cell lagoon system configurations. It is apparent that the existing system does not have sufficient volume to provide for an annual storage lagoon system even if all three cell were functioning.

The discharge criteria for the lagoon system would be expected to meet the requirements outlined in ***Table 4.1 - Municipal Waste water Effluent Quality Guidelines*** from the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories* (See ***Appendix J***). The discharge environment is a marine bay. Based on this table the required effluent criteria for Biochemical Oxygen demand (BOD), Suspended Solids (TSS), and Faecal Coliforms (F. Coli) can be suggested. These values, and the results rom the September 5, 200 testing completed by DIAND are shown in ***Table 3.3***

Table 3.3
Effluent Criteria

Parameter	Suggested Criteria	September 5, 2000 Results
BOD (mg/l)	100	34
TSS (mg/l)	120	15
Faecal Coliforms (CFU/dl)	No guideline	90000
pH	6 to 9	8

The above guidelines also indicate the following;

> *Marine outfalls are to meet the design specifications in Appendix A (see appendix E). Where treatment is not practical, discharge of untreated wastewater to the open sea is permitted if, as a minimum, floatable materials are removed and the waste water is comminuted or macerated. The requirements for discharges to bays or fiords may be relaxed, depending on the findings of site-specific studies. Similarly, the minimum distance offshore may be relaxed, depending on effluent quality and on the findings of site-specific studies.*
>
> *In the case of an open, well flushed marine bay or fiord, bacteriological standards will be of concern only where discharge might affect fishery (including shellfish harvesting) or water contact recreation*

There are no records of site specific studies related to the bay receiving the sewage effluent discharge. For the purpose of this document it is assumed that the values given in ***Table 3.4*** are the acceptable discharge criteria.

3.5 Problem Analysis

This section covers an analysis of the problems with the existing lagoon and a proposed method to repair and restore the lagoon to full capacity such that it will operate in a manner satisfactory to meet the guidelines and requirements for the regulatory agencies for ten and twenty year horizons. The regulatory guidelines are as set out in the previous section.

Hydraulic Capacity

The existing lagoon system does not meet the required hydraulic capacity requirements. To meet the requirements of an annual storage lagoon, the system would need to be expanded by nearly

three times, assuming that all cells were operating. As such, an expansion to the size of the existing system is required.

Currently spring melt water is permitted to enter into the lower two cells. To meet the hydraulic capacity requirements for storage of spring melt water, the lower cells would need additional space. It is recommended that the cells be designed to prevent melt water from entering into the cells.

Wall Design

Based on the review of the site, and the discussions with the site personnel, we agree with opinion of the community government's staff that the material used in the construction of the berms will be subject to erosion. Where spring melt water, or sewage effluent discharge is to be in contact with the walls, it is recommended that armour rock be placed to prevent erosion. In the case of sewage discharge, the use of a pipe culvert is also practical.

The lagoon walls for Cell 1 (Upper Cell) have been constructed with the top of the south and north walls sloped. This results in a lagoon cell that will "fill up" on the down stream end, and be under utilized on the upstream end. Additional material placed on the down stream and side walls, to bring the lagoon walls up to a level grade, is required. This will result in the need to raise the floor of the lagoon, so that the operating depth of the lagoon is maintained at approximately 3.0 metres plus 0.3 meters of freeboard.

Access Road and Truck Discharge Point

These components were found to be in reasonable order. The use of bollards on the truck pad to both demark the edge of the pad and to provide additional vehicle safety is recommended.

3.6 Lagoon Repairs

To meet the requirements of the regulatory agencies, the following repair/upgrade was reviewed for the existing site;

- Expand Cell 1 (upper cell) to the north. This will require the relocation of the existing access road. The road will be reconstructed onto a be rock outcrop next to the expanded cell.
- Construct two new cells up gradient of Cell 1. New Cells denoted as Cell A and B. These Cells will be directly down gradient of the land fill site.
- Reconstruct the south walls of the lower cells (cell 2 and 3). These cells should be moved north away from the land form to the south, and armoured to protect the walls from erosion. The

relocation of the walls will allow spring melt water to by pass the lagoon cells in a constructed and armoured ditch.

- Install overflow culverts in all cells, complete with riprap channels that will take sewage effluent from one cell to the next without causing erosion to the cell walls.
- Raise the floor of Cell 1, and increase the down gradient and side walls to provide for full use of Cell 1.

These modifications are shown in ***Figure 3***. The result is a lagoon system with a estimated hydraulic capacity as outlined in ***Table 3.4***.

Table 3.4
Modified Lagoon System Capacity

Cell	Length (m)	Width (m)	Depth (m)	Volume (m^3)
New Upper Cell A	40	50	3	4,000
New Upper Cell B	55	40	3	5,000
Cell 1	38	120	3	10,950
Cell 2	30	20	3	1,200
Cell 3	40	80	3	7,550
Total				25,950

As shown in the above table, even with the recommended changes to the system, the site can not meet the storage requirements for an annual storage lagoon system.

To meet the requirements of the regulatory agencies, there will be a need to complete extensive rock removal to expand the lagoon system. ***Appendix F*** shows the required expansion at the existing site for a one cell annual storage lagoon system.

4.0 ALTERNATIVE LAGOON SITE

The alternative site is located east of the community near the existing granular stock pile for the airport division of CG&T. This site is bounded on the east by the ocean and on the north by a rock out crop. The site is relatively flat in comparison to the general terrain around the community site. Topographic mapping indicates that there is an intermittent stream that runs through the south side of the site. Due to the time of year of the inspection, the location and presence of this stream could not be confirmed. Based on the air photographs of the area, it would appear that the site has been used for a granular resource site for several years. The future use of the site, and the remaining granular resources located at the site were undetermined at the time of reporting. Since no other site was identified for assessment, further work on this site alternative site was deemed necessary.

The system components would be as follows;

- Access road to the site area. An access road currently exists and the road is currently used by gravel haul trucks. No upgrading of the road is deemed necessary.

- Lagoon access and truck turn around pad. This will be a short length of road, approximately 100 metres, and a granular pad, approximately 15 metres in radius.

- Truck discharge flume. Standard details are shown in ***Appendix L***. Appendix L contains standard detail for several aspects of a lagoon construction.

- Lagoon Cells. A two cell lagoon is suggested for this alternative. There is approximately 8 metres of elevation difference across the site. It is assumed that the area does not has excessive rock out crops or near surface rock that would require rock removal. This assumption needs to be checked through a geo-technical investigation which is beyond the current scope of work. The use of two cells allows for the best use of the elevation difference, and will reduce the amount of cut and fill required on the site.

- Lagoon discharge system. The construction of the lagoon walls can be completed using granular material. This would provide the system with a natural ex-filtration through the walls. In addition to this system, it is recommended that an overflow culvert be installed complete with a rip rap channel.

Appendix L shows the lagoon system drawings and details for this option.

5.0 MECHANICAL SEWAGE FACILITY OPTIONS

5.1 Methods of Treatment

The two methods of treatment identified a mechanical plant.

Macerator/Grinder and Deep Water Discharge- one option for the mechanical plant is the use of a macerator and deep water discharge. This approach reduces the particle size of the sewage to remove floating material. The deep water discharge is used to take the sewage away from the shore line. Site specific bathymetry will be required to determine the length and depth requirements for the discharge line. This is a similar approach to that used in Rankin Inlet, except that there is not the requirement for a fine screen in the treatment system which is in place in Rankin Inlet. The removal of the fine

screen from the treatment train, reduces the cost of operation and maintenance of the system.

Primary Sewage Plant, and Shoreline Discharge - a mechanical plant can be constructed to provide sewage treatment equal to the annual lagoon system. This system would discharge effluent on a daily basis at a location similar to the lagoon discharge location. A plant similar to this has been installed in Fort Simpson, NWT, and is currently being commissioned.

5.2 System Components

The mechanical systems can be installed at either of the two sites identified for the lagoons. It is also possible to install the macerator/grinder and deep water discharge option closer to the community, as the 450 metre setback required for the department of health does not apply to deep water discharge systems. However, it is favourable to have the deep water discharge located in an area away from recreational, and harvesting activities of the community. Both of the lagoon sites provide for this requirement. The system components for each site and each mechanical plant have many similarities. These would include;

- Access road to the Plant. The existing site has an access road. As discussed above, the alternative site also has an existing road.
- Lot grading. For the development of a mechanical plant the area will need to be graded level.
- Power supply to the site. Both site would require the installation of 3 phase power to the building location.
- Building Enclosure. A pre-engineered building is suggested for these facilities. The primary sewage treatment plant would require a building with approximately 525 square metres of floor space, The macerator will require a building with approximately 50 square metres of floor space.
- Process Equipment. Each facility will have process equipment requirements. The flow diagrams for the macerator and primary treatment plant are shown in ***Appendix I*** and ***H*** respectively.
- Domestic building services - this will include heat, domestic water, electrical distribution, lighting.
- Sewage effluent discharge - this will be unique to the facility type.

6.0 ECONOMIC ANALYSIS

The development of capital and life cycle costs have been completed using several data sources. The

development of quantities for the estimates is shown in Appendices E to I. The cost estimates for earth works are based on the data provided by the Director of Municipal Works for the supply and installation of the granular types required. Data for the unit costs is included in ***Appendix D***.

The cost for the installation and operation of the Primary Sewage Treatment Facility was developed with CECL. CECL is the general contractor and equipment supplier for the Fort Simpson Waster Water treatment Plant. The Fort Simpson project will treat waste for a community of approximately 1,500 people. The discharge criteria for the Fort Simpson plant is similar to the suggested criteria for the Cape Dorset site. The estimates have been adjusted for the increased cost of construction in Cape Dorset over those in Fort Simpson and the increased cost of operation in Cape Dorset over those experienced in Fort Simpson.

The capital and operating cost for the Macerator/grinder and deep Water Discharge was developed in part based on the actual construction costs for the facility installed in Rankin Inlet. The Rankin Inlet facility contains a fine drum screen. This is not required in Cape Dorset, and the cost of the is item has been removed from the construction costs. Mr. Joe Hidalgo, Public Works and Services, Rankin Inlet was kind enough to provide the required information on the Rankin Inlet system.

Table 6.1
Summary of Costs

Option	**Capital Cost**	**Annual Operation and Maintenance Cost**	**20 Year Life Cycle Cost 8% discount**	**20 Year Life Cycle Cost 4% discount**
1- Upgrade of the existing	$4,250,000	2% of Capital	$5,080,000	$5,405,000
2- Alternative Lagoon Site	$1,600,000	2% of Capital	$1,910,000	$2,030,000
3- Macerator and Deep Water Discharge	$1,300,000	5% of capital	$1,937,000	$2,180,000
4 - Primary Treatment and Shore Discharge	$2,420,000	7.5 % Capital	$4,200,000	$4,890,000

The above table does not include the cost of sewage collection or trucking. The estimates include a 10% contingency allowance and a 8% engineering allowance on the capital costs. GST is not included in the above amounts.

7.0 SUMMARY AND RECOMMENDATIONS

The Cape Dorset Sewage Treatment Facility was inspected on February 20 & 21, 2001. The existing system was designed to have 3 lagoon cells constructed in a series. The cells are located in a valley and are placed in a terraced formation. The lower two cells have failed due to a breach in the down gradient walls. The wall breach is the result of spring melt water entering the cells, and then over topping the down gradient walls. The granular material used for the construction of the cells is fine grained and subject to mass wastage (erosion).

The assessment of the existing lagoons also indicates that the cells are under sized for the community sewage generation, assuming that the original intent is an annual storage lagoon. There is insufficient space within the valley to construct a lagoon system with the required hydraulic capacity for an annual storage lagoon system. Expansion of the lagoon system in the existing location will require extensive rock removal to provide for the required hydraulic capacity.

An alternative lagoon site is identified to the north of the community in an area that has been used for granular resource extraction by the Airports Division. To construct a lagoon system in this area, a two celled system is recommended. The site has approximately 8 metres of grade across the site, and the use of two cells reduces the amount of earth work required at the site.

Two mechanical plants were identified for assessment. The use of primary sewage treatment with the effluent discharged at shoreline provides for similar treatment to a facultative lagoon. This system can be installed at the location of the exiting lagoon site. The discharge for this plant would be in the same location as the existing lagoon system.

The alternative to the primary treatment plant, is the use of a macerator and deep water discharge. The use of this approach meets the guidelines for treatment as set out by the previous Water Board. A site specific study would be required to determine the impact of the sewage discharge on the marine environment.

The most cost effective alternative to the near and long term sewage treatment and disposal for the community of Cape Dorset is the construction of a new sewage lagoon at the alternative site as shown in ***Figure 2***. The terms of reference for this study indicated that the option selection for the sewage disposal was to be based solely on a cost analysis. The cost difference between the alternative lagoon site and the deep water discharge is marginal, and at the level of class B estimates can be considered to be identical. Other issues that may need to be addressed in the final selection of the sewage treatment and disposal option are;

- Impact of effluent discharge point. We understand that the alternative site will have a discharge location in an area that there is a migration route for the whales. This information was provided to the author during the community investigation. It is beyond the scope of this project to investigate this aspect further.

- Impact of the alternative site on the granular resource. The future use of the Airports Division

granular resource in the area of the alternative site is unknown at this time. There maybe a cost implication to the Government of Nunavut in the loss of a potential resource by locating the lagoon at this site.

- Impact of the site on tourism. Cape Dorset can receive several cruise ships each year. Tourism is a significant part of the local economy through the sale of carvings, paintings, and other artwork. The approach to the community for the cruise ships will make the alterative site visible tot eh tourists. The existing site is not visible to the cruise ships.

- Acceptance of the deep water discharge to the regulators. We understand that he treatment system in Rankin Inlet is under review, and maybe upgraded to a secondary sewage treatment system in the future. The use of a deep water discharge is accepted in southern Canada, and has in the past been accepted in NWT/Nunavut. The future acceptability of this treatment system is unknown. Contained in ***Appendix J*** is a recent article published by the Nunavut water Board that would suggest the current guidelines will be accepted in the future.

Additional information required prior to proceeding with the acceptance off this recommendation includes;

- Conduct a site specific geotechnical study. This study is required to determine the location and depth to bedrock, availability and quality of construction materials, presence of thaw sensitive permafrost, and the development of recommendations for the construction of the lagoon walls.

- Submit the conceptual plans to the various regulatory agencies for review and comment.

- Conduct a site specific topographic survey to allow for tender quantity estimates. Conduct a bathymetric survey for the deep water discharge to determine the tender estimates, pipeline profile and length.

- Complete a Water Licence application to the Nunavut Water Board. The application should be for the construction of the proposed system.

- Review of the granular resources in the community area to determine the long term impact to the community granular supply created by the use of the proposed site.

- Discuss with the community government the acceptability of the proposed site to the residents and representatives of the community.

REFERENCES AND RELATED STUDIES

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