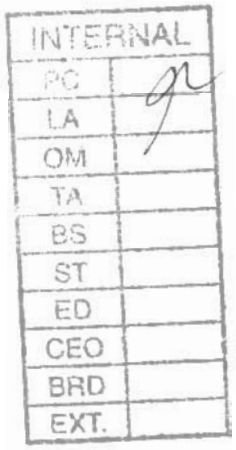
Arctic Bay Wetland Sewage Treatment Facility: Proposed Project Plan

Final Report
February 27th, 2002



Arctic Bay Wetland Sewage Treatment Facility: Proposed Project Plan

Government of Nunavut
Department of Community Government
& Transportation

02-9971-1000

Submitted by

Dillon Consulting Limited

February 27, 2002

DILLON CONSULTING

Community Government and Transportation
Government of Nunavut
PO BOX 1000
Iqaluit, NU X0A 0H0

Attention: Mr. David Parker

Arctic Bay Wetland Sewage Treatment Facility:
Proposed Project Plan

Dear Mr. Parker:

Dillon Consulting is pleased to provide you with 5 copies of the *Arctic Bay Wetland Sewage Treatment Facility: Proposed Project Plan* report.

The report is intended to provide regulators, namely the Department of Fisheries and Oceans, Canada, a detailed project plan for proposed upgrades to the present sewage treatment facility in Arctic Bay, Nunavut. Dillon Consulting Limited feels that the proposed project will not result in the loss of fish habitat. Furthermore, implementation of proposed mitigation measures during construction will prevent the potential movement of sediment to the downstream aquatic environment and any associated direct and indirect effects on fish and fish habitat.

We trust that this report is acceptable and we look forward to working with you on future projects. We will contact you shortly to receive any comments you may have.

Yours sincerely,
DILLON CONSULTING LIMITED

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Dillon Consulting
Limited

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1.0 INTRODUCTION

1.1 Background

The Department of Community Government and Transportation, Government of Nunavut (DCGT), proposes to upgrade the current sewage treatment facility in Arctic Bay. To address potential impacts to fish and fish habitat, Dillon Consulting Limited was retained to prepare a detailed project plan to submit to the Department of Fisheries and Oceans (DFO) prior to the initiation of construction activities.

Fisheries concerns associated with the proposed sewage treatment facility upgrades are related to the potential release of deleterious substances (silt/sediment) into the downstream aquatic environment and/or the harmful alteration, disruption or destruction of fish habitat (HADD), as outlined in Sections 36(1) and 35(1) of the Federal *Fisheries Act*, respectively. Through sound environmental practices and the implementation of effective mitigation measures, the DCGT anticipates that the proposed upgrades will not impact Arctic Bay's fisheries resources and will, in fact, improve existing sewage treatment conditions.

1.2 Wetland Systems in Nunavut and the Northwest Territories (NWT)

Over 70% of the communities in the Nunavut and the Northwest Territories presently use lagoon-based systems for the treatment of sewage. Most recently, the use of natural "wetland" systems have been identified as a promising and an economic alternative to traditional sewage lagoons in the north (Dillon, 1998).

Examples of northern wetland systems presently operating in the Nunavut are located in:

- Baker Lake;
- Repulse Bay; and
- Chesterfield Inlet.

Recent monitoring results for each of these systems indicate that the wetland treatment facilities are achieving tested removal rates of targeted parameters at efficiencies equal to or better than those expected from an annual storage lagoon (Dillon, 1998).

2.0 SITE DESCRIPTION

2.1 Location

Arctic Bay, also called *Ikpiarjuk* ("the pocket"), is located on the Borden Peninsula of Baffin Island, Nunavut (**Figure 1**). This northern community is connected by a 21 km road to the mining town of Nanisivik, which was developed in the mid-1970's. The present sewage lagoon, which services approximately 640 residents, is located 2.5 km west of the community of Arctic Bay.

2.2 Terrestrial Environment

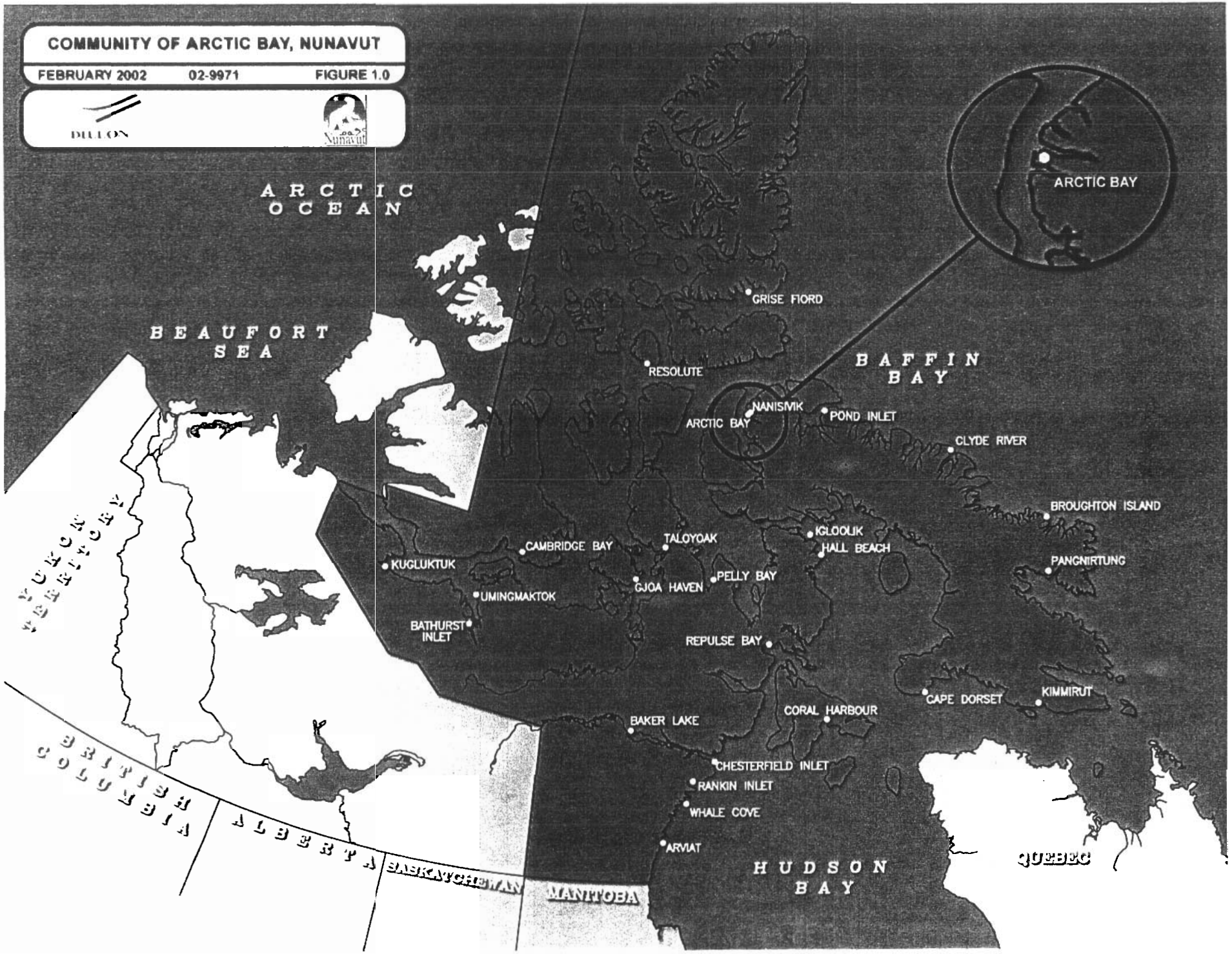
The present lagoon is situated on level ground, which slopes southwards for 400 m (17:1 slope) towards Arctic Bay (**Figure 2**; **Appendix A, Photo 1**). Vegetation characteristic of the region includes arctic willows, grasses, mosses, and lichens. More specifically, the area of the present lagoon is dominated by sedges (*family Cyperaceae*), cotton grasses (*Eriophorum spp.*) and willows (**Appendix A, Photo 2**).

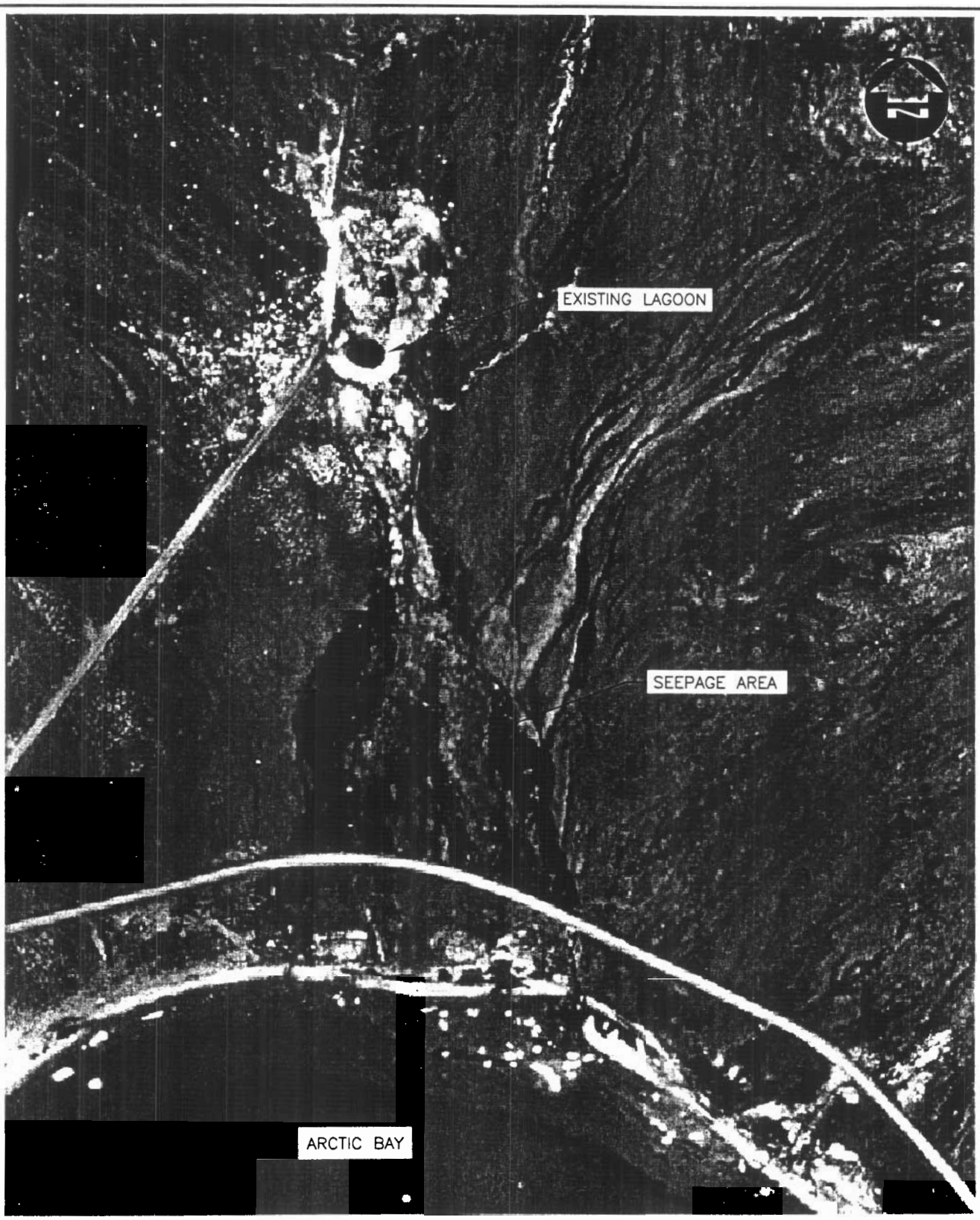
Underlying the terrestrial vegetation is a thin layer of clays and gravel which extends to a depth of approximately 0.5 m. Below this zone there is a continuous layer of permafrost.

2.3 Present Lagoon System

The sewage lagoon is located directly adjacent to several ephemeral watercourses that provide seasonal drainage (spring freshet) to the surrounding topography. The lagoon itself covers an area of approximately 1,200 m^2, and is surrounded by a permeable dyke (**Appendix A, Photo 3**). As portions of the dyke have become plugged, sewage has breached it, and presently leaks through the southern berm at an uncontrolled rate. The sewage seepage moves southward, via braided overland flow towards Arctic Bay (**Figure 2**).

The ratio of residential to commercial/industrial input is typically very high in sewage generated by small northern communities similar to Arctic Bay (Dillon, 1998). Consequently, it is assumed that the sewage composition is essentially "domestic" in nature.


COMMUNITY OF ARCTIC BAY, NUNAVUT
FEBRUARY 2002
02-9971
FIGURE 1.0
DILLON
Nunavut
ARCTIC OCEAN
BEAUFORT SEA
BAFFIN BAY
HUDSON BAY
ARCTIC BAY
GRISE FIORD
RESOLUTE
NANISIVIK
ARCTIC BAY
POND INLET
CLYDE RIVER
BROUGHTON ISLAND
IGLOOLIK
HALL BEACH
PANGNIRTUNG
TALOYOAK
CAMBRIDGE BAY
KUGLUKTUK
GJOA HAVEN
PELLY BAY
UMINGMAKTOK
BATHURST INLET
REPULSE BAY
CAPE DORSET
KIMMIRUT
CORAL HARBOUR
BAKER LAKE
CHESTERFIELD INLET
RANKIN INLET
WHALE COVE
ARVIAT
YUKON TERRITORY
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
QUEBEC



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DILLON CONSULTING

PROJECT: EXISTING SEWAGE TREATMENT LAGOON

TITLE: ARCTIC BAY WETLANDS SEWAGE TREATMENT CONCEPTUAL DESIGN - PROJECT PLAN

PROJECT NUMBER: 02-9971

DATE: FEBRUARY 2002

FIGURE NUMBER: FIG 2

The sewage entering the existing system (via truck hauls) receives minor settling prior to leaving the lagoon (**Appendix A, Photo 4**). The estimated retention time of the sewage entering the existing system during the summer months (June-September) is approximately 30 days. During the winter months (October-May) a sewage ice pack forms, with subsequent sewage inputs freezing immediately upon contact. The existing area containing the winter ice pack is located immediately southwest of the lagoon (**Figure 2**). As would be expected there are no discharges from the sewage ice pack to the seepage area during the winter months.

2.4 Fisheries Resources

The following information regarding existing fisheries resources in Arctic Bay was kindly provided by Ms. Johanne Coutu of the Department of Sustainable Development, Government of Nunavut, Arctic Bay (*personnel communication*, 2002).

Arctic Bay supports a variety of fish and marine mammals. Subsistence fishing near the community is limited to Arctic charr (*Salvelinus alpinus*) although marine stocks have been greatly impacted over the years. Arctic cod (*Boreogadus saida*) is also known to use the bay for foraging.

The town's potable water source, Pattatalik Reservoir, is also said to contain low numbers of landlocked charr. To date, no other freshwater fish species have been identified in the Arctic Bay area.

Marine mammals, which inhabit and/or frequent waters close to Arctic Bay, include:

- Ring Seals (*Pusa hispida*);
- Harp Seals (*Pagophilus groenlandicus*);
- Narwhal (*Monodon monoceros*);
- Bowhead Whale (*Balaena mysticus*); and
- Walrus (*Odobenus rosmarus*).

3.0 PROPOSED WETLAND SEWAGE TREATMENT DESIGN AND MITIGATION

The components of the proposed wetlands treatment area include an ice-pack holding area, a series of three berms for temporary ponding, and a redirection berm that will alter the flow path of runoff drainage located immediately east of the wetland seepage area. Proposed upgrades to the existing sewage lagoon will increase retention time of raw sewage and allow for more settling of these materials. The increased retention time is expected to lower total suspended solids (TSS) and contaminant levels entering Arctic Bay. **Figure 3** illustrates the conceptual lay-out of the proposed system.

3.1 Ice-Pack Holding Area

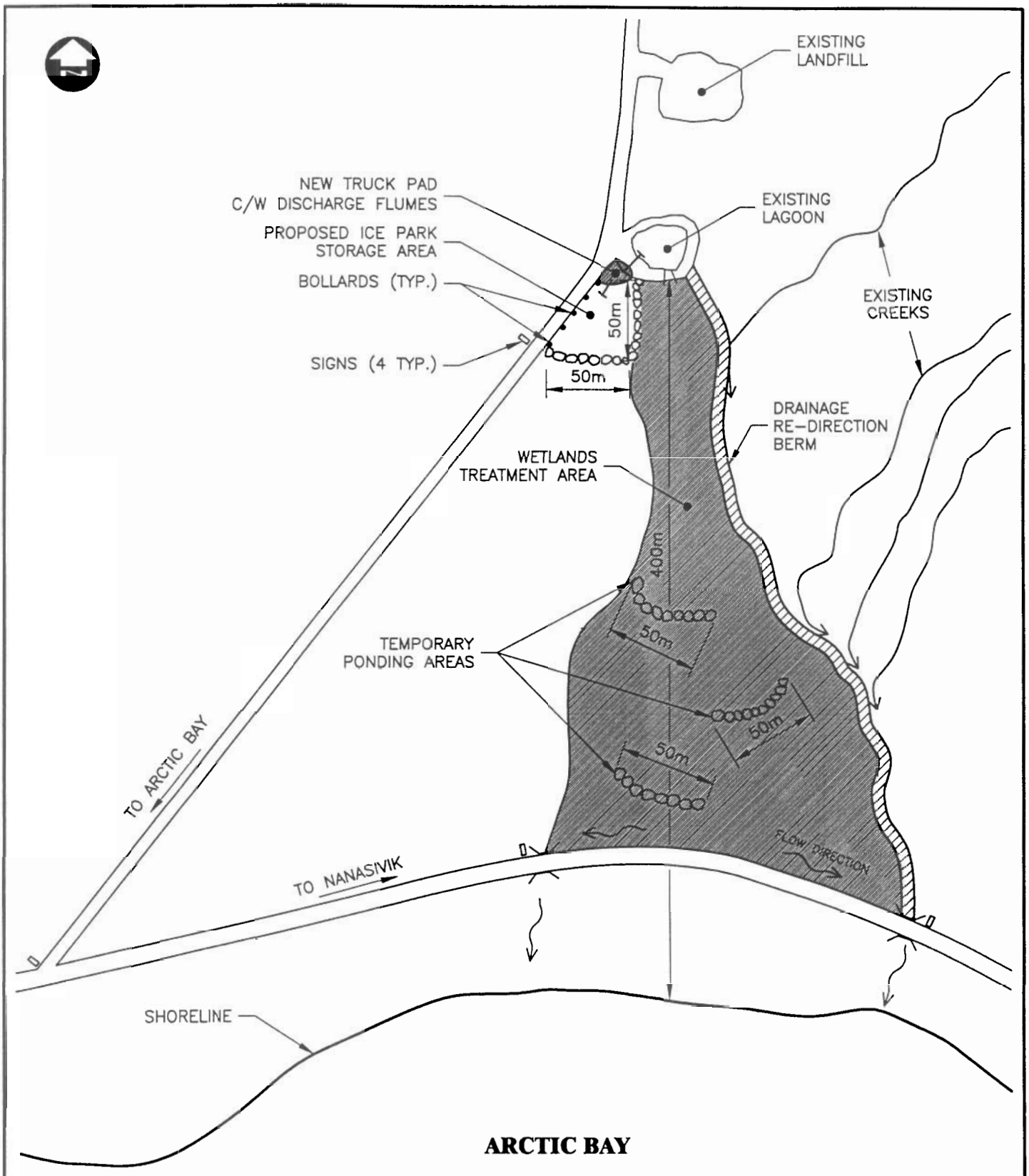
The objective of the ice-pack holding area is to provide controlled discharge for the eventual seepage (upon melting) of sewage accumulated over the winter period. The temporary holding of the melted sewage in the ice pack area would provide primary treatment through the physical settling of solids, thus reducing TSS loads to the downstream aquatic environment.

3.1.1 Preliminary Design

The proposed ice-pack holding area is located immediately southwest of the present lagoon, and is approximately 1,250m^2 in size (**Figure 3**). The proposed holding area berms will include a frozen core system which will allow the integrity of the holding area to be upheld during the extreme temperatures characteristic of the region.

During the construction phase, a 3m wide trench will be excavated following the path of the containment berm for the holding area. The excavation will extend to the interface with the underlying permafrost. All excavated materials will be stockpiled away from the wetland drainage area and surrounded by berms or sediment control fencing to prevent the runoff of silt and/or sediment into the downstream environment. The frozen core berm will then be constructed to a height of approximately 2m, using frost-susceptible silts (see **Figure 4**). Theoretically, the core berm will freeze directly to the underlying permafrost, thus facilitating the movement of frost up the core (Reid Crowther, 1997). A protective covering of the core berm will also be necessary to prevent erosion and to act as an insulating blanket. The materials used for this will be a mixture of the excavated overburden during core construction, and clean, coarse granular material.

A 1.5m wide corridor for the discharge of the melted sewage into the downstream wetland system will be included, as shown in Figure 3.



APPROXIMATE SCALE 1:3000

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PROJECT: PROPOSED WETLANDS TREATMENT SYSTEM

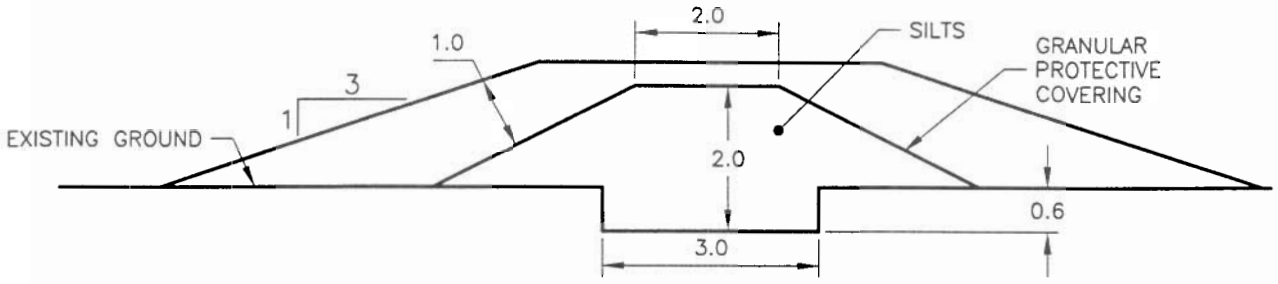
TITLE: ARCTIC BAY WETLANDS SEWAGE TREATMENT CONCEPTUAL DESIGN – PROJECT PLAN

PROJECT NUMBER: 02-9971

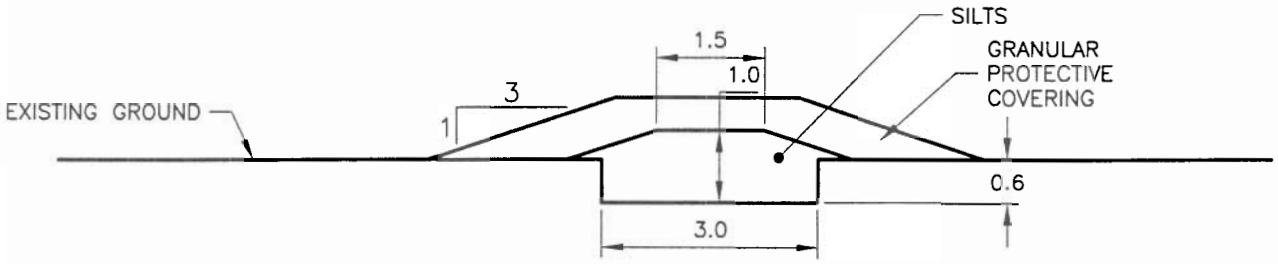
DATE: FEBRUARY 2002

FIGURE NUMBER: 3

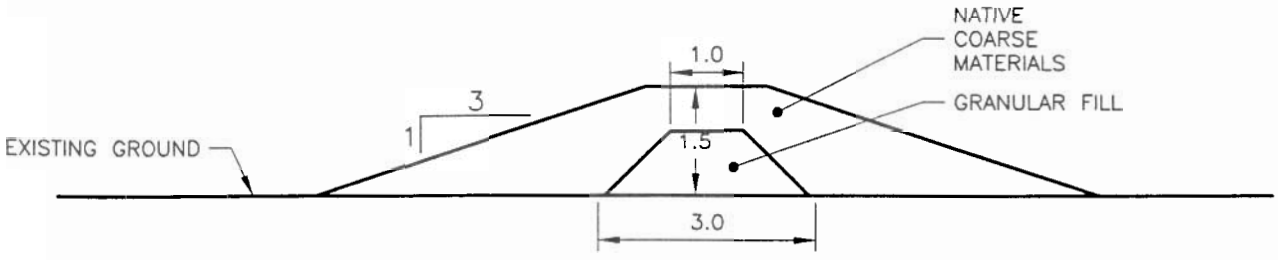
PROPOSED ICE PACK STORAGE AREA BERM:



PROPOSED PONDING AREA BERMS:



PROPOSED DRAINAGE RE-DIRECTION BERM:



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DILLON CONSULTING

PROJECT: CROSS SECTION OF BERM CONSTRUCTION

TITLE: ARCTIC BAY WETLANDS SEWAGE TREATMENT CONCEPTUAL DESIGN – PROJECT PLAN

PROJECT NUMBER: 02-9971

DATE: FEBRUARY 2002

FIGURE NUMBER: 4

3.2 Temporary Ponding Berm Series

The objective of the wetland berm series is to provide temporary ponding areas between the existing lagoon and the discharge to Arctic Bay. The proposed series of three berms will increase the overall retention time of the sewage in the wetland treatment area (each berm will provide approximately 3 days holding time). This will enhance the microbial breakdown of the organics in the sewage, thus reducing the biochemical oxygen demand (BOD) loading to the receiving environment. The flow of effluent between the berms and to the bay will also provide necessary aeration required for the microbial breakdown of natural contaminants.

3.2.1 Preliminary Design

The proposed temporary seepage ponds will be located within the wetland treatment area, downstream of the present sewage lagoon (**Figure 3**). It is proposed that three berms be constructed, to form a series of three ponds. The exact location of each of the three berms will be determined in the field at the time of construction ("field fit"). As with the ice-pack holding area, the design of the pond berms will include a frozen core system, which allows the integrity of the holding area to be upheld during the extreme temperatures inherent in the region.

During the construction phase, a 3m wide trench will be excavated following the path of the berm (located downstream of each pond) for each of the holding areas (**Figure 3**). The excavation will extend to the interface with the underlying permafrost. All excavated materials will be stockpiled away from the wetland drainage area and either surrounded with a berm or sediment control fencing to prevent the runoff of silt and/or sediment into the downstream environment. The berm core will then be built to a height of approximately 1m using frost-susceptible silts (**Figure 4**). A mixture of excavated overburden from the core construction, and clean, coarse granular material will subsequently be used to cover the silt core.

Discharge of the effluent will occur via seepage over and around the berms. The design target for the seepage retention is 3-days within each "pond".

3.3 Surface Drainage Re-direction

The objective of re-directing the flow of the adjacent ephemeral streams is to prevent additional hydraulic loading to the wetland system.

3.3.1 Preliminary Design

For the preliminary design of the controlled channel, it is assumed that a berm of native coarse materials, built upon a base of granular fill will be adequate to prevent the flow of surface drainage from entering the wetland system (**Figure 3**). The exact location of the channel wall/berm will be determined at the time of construction (i.e., in the field).

4.0 POTENTIAL IMPACTS TO FISH AND FISH HABITAT

4.1 Potential Indirect Impacts

Through careful design, implementation and on-site monitoring during construction, the potential for the release of any *deleterious substance* into the downstream aquatic environment is unlikely. Excavated materials will be stockpiled outside of the "wetted" area and will be adequately contained to prevent the runoff of silt and/or sediment into Arctic Bay.

As most wetlands in Nunavut and the NWT generally have nutrient deficiencies, concerns related to eutrophication are considered to be minimal. The controlled discharge of sewage to northern, nutrient deficient wetlands will actually enhance the growth of vegetation by providing increased levels of essential nutrients (Dillon, 1998). The increased productivity will further aid in retention time and in stabilizing the surrounding wetland from erosion during periods of high flow/runoff (spring freshet).

4.2 Potential Direct Impacts

Based on our understanding of the project and our familiarity with the existing environment it is opinion that the proposed Project Plan will not result in *the harmful alteration, disruption or destruction* of Arctic Bay fish and fish habitat.

According to the Department of Sustainable Development (Arctic Bay, Nunavut), freshwater fish do not inhabit the ephemeral streams located immediately east of the proposed wetland treatment facility at any time during the year. These waterbodies serve primarily as natural drainage for the adjacent hills, which border the community to the east. Redirection of the braided drainage entering into the existing wetland to a more defined channel will reduce potential erosion to the wetland area and improve sewage retention (treatment time) during periods of high flows.

4.3 Proposed Monitoring

Following construction, a detailed assessment will be conducted to monitor berm and channel performance during the high, mid and low flow periods. At this time, potential areas of instability and/or erosion will be identified and remediated.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed Project Plan, involving upgrades to the existing sewage treatment lagoon in Arctic Bay, Nunavut, will not have any adverse affects on fish and fish habitat. Through sound environmental planning, the implementation of appropriate, site-specific mitigation measures, and on-site monitoring, all impacts to the downstream aquatic environment will be prevented and/or minimized.

The proposed project will actually improve present sewage treatment conditions in Arctic Bay, by reducing the amount of organic loading to the downstream marine fisheries resources (by increasing overall retention time prior to release). This statement is substantiated by the results of recent monitoring of wetland treatment facilities in other areas of the north which indicate that these facilities are achieving the targeted removal of parameters at efficiencies equal to or better than those expected from an annual storage lagoon. It is for this reason that it has been recommended that the wetland sewage treatment conceptual design be implemented in Arctic Bay.

6.0 LITERATURE CITED

Department of Fisheries and Oceans, Canada. 1986. *Policy for the Management of Fish Habitat*. Fish Habitat Management Branch, Ottawa, Ontario.

Dillon Consulting Limited. 1998. *Sewage Treatment Using Tundra Wetlands*. Prepared for Prepared for the Municipal and Community Affairs Department of the Government of the Northwest Territories.

Reid Crowther & Partners Limited. 1997. *DESIGN BRIEF- Sewage Lagoon / Solid Waste Site Improvements for Arctic Bay, N.W.T.*

APPENDIX A

Site Photographs

APPENDIX A - SITE PHOTOGRAPHS

ARCTIC BAY WETLANDS SEWAGE TREATMENT
CONCEPTUAL DESIGN - PROJECT PLANT

PHOTO 1: Existing sewage lagoon, with seepage into Arctic Bay

PHOTO 2: Vegetation present at the site (grasses, mosses and sedges)

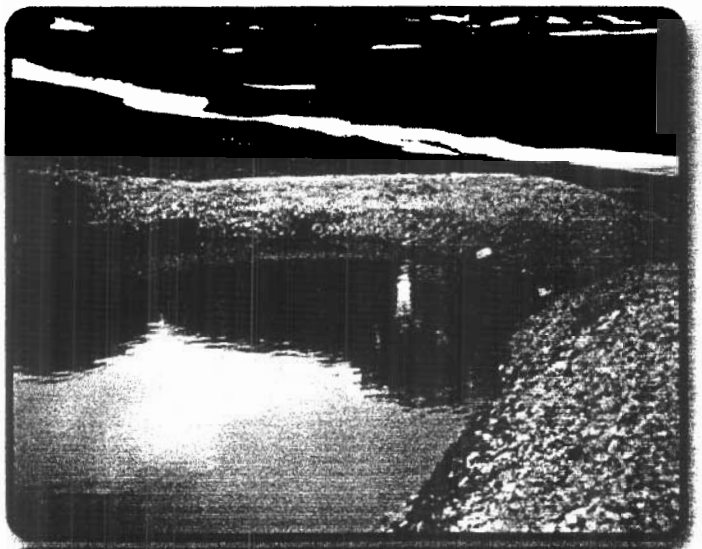

PHOTO 3: Permeable dyke enclosing existing lagoon

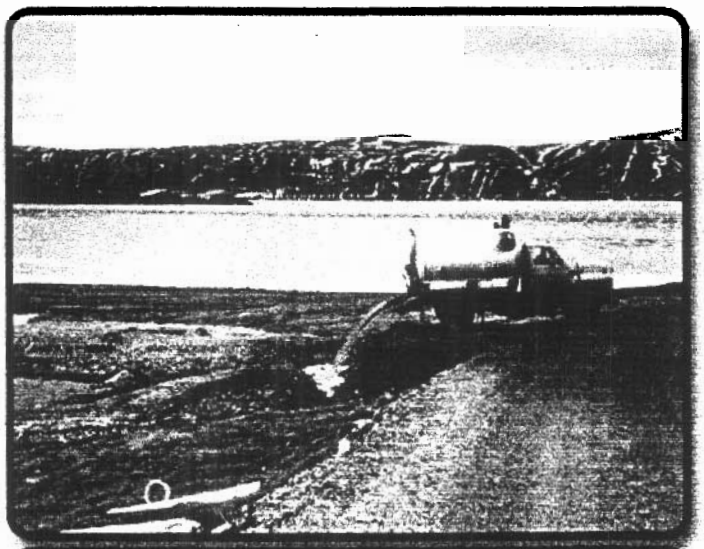

PHOTO 4: Present discharge method, via truck