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NUNAVUT WATER BOARD
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June 21st, 2006

Stephanie Joyce
Environmental Scientist
Dillon Consulting Limited

Subject: Cape Dorset Sewage Lagoon Water Licence Amendment – Meeting Discussion (June 20th, 2006) and NWB Technical Concerns

Dear Ms. Joyce:

As per our meeting at 14:00 hours on June 20th, 2006 the Nunavut Water Board (NWB) has formulated a response to technical concerns requiring additional information and further clarity from Dillon Consulting Limited (DCL). The Hamlet of Cape Dorset has authorized DCL and the Government of Nunavut Department of Community and Government Services (GN–CGS) to communicate on their behalf as indicated in a letter addressed to the NWB on May 12th, 2006 from Mr. Art Stewart. As denoted in my May 31st, 2006 letter to Art Stewart (Hamlet of Cape Dorset) the NWB has engaged the technical services of Mr. Holger Hartmaier of BGC Engineering Incorporated (BGC) and Mr. John Grainger of Associated Engineering Alberta Limited (AE). External expertise was retained to advise the NWB on technical considerations involved in the amendment application. Review comments generated by both Mr. Hartmaier and Mr. Grainger may be found within this document.

Meeting Discussion

In our June 20th, 2006 meeting the NWB outlined that the DCL response (received June 5th, 2006) will be circulated to Interveners for comment. Interveners will be given until June 27th, 2006 to file a response if they so choose. If a response is not filed with the NWB before June 27th, 2006 then the NWB will assume that the DCL response satisfies the Intervener concerns filed during the thirty (30) comment period. Within our meeting discussion the following was also addressed:

a) The need to provide confidence to Regulators through application materials and responses. There is a need for a final engineered design that communicates, qualitatively and quantitatively, how freshwaters will be used and how waste could be deposited and impact freshwaters.

b) GN-CGS indicated that AMEC may have been consulted by DCL for additional geotechnical information. DCL is to confirm if AMEC has provided additional information.

c) GN-CGS is to consult the Hamlet to obtain detailed records of the public consultation that was conducted with respect to this project. GN-CGS is to then provide a report to the NWB outlining the particulars of all public consultation carried through under this application.

d) Technical aspects of the project were only briefly discussed (site characterization, geotechnical components of the geosynthetic installation, berm, and lagoon subgrade condition etc.) with the proviso that specific technical detail would be provided in this letter.

e) A date for the issuance of the water licence amendment can not be forecasted at this time.

Meeting attendees: Stephanie Joyce (DCL), Brad Mueller (DCL), Philippe di Pizzo (NWB), Joe Murdock (NWB), Sarah Gagne (NWB), Anjan Joshi (GN-CGS), Pat Fuentes (GN-CGS)

Technical Concerns

The NWB retained the technical advisement services of Mr. Holger Hartmaier (BGC), and Mr. John Grainger (AE) to provide a review of the final design and tender application documents. The following remarks are those of our retained consultants with NWB alteration only made in document formatting. Any text highlighted in yellow indicates an addition by the NWB Technical Advisor to assist in formatting.

Comments from the Review of Mr. Holger Hartmaier (BGC) provided to the NWB

BACKGROUND INFORMATION

Dillon was retained by the Department of Community and Government Services (C&GS) of the Government of Nunavut (GN) to design a new sewage treatment system for the Hamlet of Cape Dorset. The community presently uses trucked services for both water delivery and sewage collection. The existing 3-cell sewage lagoon can supply treatment for the short-term. However, it cannot be viably upgraded to provide for a long term sewage treatment system due to a structural failure. 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. Over the next four years, CG&T and C&GS conducted planning studies, site selection studies and treatment alternatives assessment for a new sewage lagoon. Several site options were identified. Of the options identified, all but two were dismissed for various reasons:

- Use of “P” Lake and wetlands as a sewage lagoon.
- 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. This is the option presented in Dillon’s design report and the option that has been issued for tender and construction.

PROJECT DESCRIPTION

The proposed sewage lagoon will be located in the valley upstream of P Lake. The annual retention lagoon will be constructed using the natural topography in conjunction with an earthfill berm to create the desired storage volume (96,100 m3). P Lake downstream will be used as a secondary short retention lagoon. The wetlands downstream of P Lake will provide some nutrient and total suspended solids removal as well.

The maximum height of the berm will be 5 m, based on the following criteria:

- 1 m freeboard,
- 3.5 m operating depth,
- 0.5 m dead area (sludge retention at the base of the lagoon.

The berm construction will include:

- 4 m wide crest to facilitate construction.
- Inside (upstream slope) to have a 2.5:1 (H:V) slope.
- Outside (downstream slope) to have a 2.5:1 (H:V) slope.
- Riprap protection over the inside slope in areas subject to ice and wave action.
- 50 mm minus gravel protection on all exposed areas of fine grained material to prevent wind erosion.
- Emergency spillway to prevent overtopping of the berm.
- Vertical geosynthetic clay liner within the berm anchored 2-m into the sub-base.
- No liner in the lagoon base.

Sewage will be disposed from sewage trucks into the lagoon through a free fall discharge pipe. The effluent from the lagoon will be discharged annually in the fall over a 2 week open water period to P Lake. The sewage discharge system comprises:

- An intake structure to raise the inlet of the pipe above the sludge deposition level.
- A steel pipe through the lagoon berm.
- An access vault located within the berm, with a manhole located in the berm crest.
- A valve installed in the manhole on the discharge pipe.
- A pipe outfall and discharge channel. The outfall area has riprap protection to prevent erosion and to dissipate the energy of the discharge.

GEOTECHNICAL REVIEW COMMENTS

General Comments

The documents submitted by Dillon to the NWB are deficient in the following major areas that prevent BGC from completing a full geotechnical review of the project:

i. The figures included in the design report were marked “Preliminary Only, Not for Construction”.

ii. There was no discussion of the geotechnical design aspects of the sewage lagoon in the design report prepared by Dillon. Although Appendix G contained the Geotechnical Investigation report prepared by AMEC, the geothermal analysis was carried out for a different liner detail than the one shown in the Dillon drawings.

iii. The Tender documents did not include any of the construction drawings listed in the List of Tender Documents- Appendix A of the Construction Tender.

On the basis of these deficiencies alone, BGC would recommend that the NWB reject the submission until a complete set of documentation is provided. The following sections provide specific comments with respect to the information that was available for review by BGC.

Design Report

i. On the title page there is an inconsistency with respect to the type of report. The report is “Final Design Report” in the title, but “Preliminary Design Report” remains in the subsequent sub-title.

ii. The enclosed covering letter makes it clear that, this is, in fact the final report, including all comments received from C&GS, as well as the geotechnical assessment (was not included with filed copy). The intent of the report is to develop the Class “C” cost estimate for the construction phase.

iii. In Section 1.1, first paragraph, it is stated that “This document outlines the preliminary design plans for a new sewage lagoon treatment system…”.

iv. There should be some reference in the design report to tie this document to the construction specifications and construction drawings.

v. The climate data in the third paragraph of Section 1.1 needs to be qualified. What is the source (i.e. Canada Climate Normals from Year _ to Year _), are the temperatures mean monthly or daily max./min. ?

vi. In the last paragraph of Section 1.1, the required service life of 20 years + is given. Environment Canada has expressed concerns with the existing system. Subsequently in Section 1.2, first paragraph, it was noted that there was a structural failure with the existing three-cell lagoon. It would be useful for Dillon to provide some information on both the nature of the structural failure and the Environment Canada concerns, so that these can be assessed with respect to the proposed sewage treatment system. If structural failure occurred within a similar design to that proposed, previous lessons should be of critical importance.

vii. In Section 3.3 there are some minor inconsistencies noted in the maximum depth of P Lake. In the first paragraph, the maximum depth is 2.5 m. In the second paragraph, it is 2.75 m. Drawing C shows bathymetric contours down to 2.8 m.

viii. Section 3.6.1 Ground Water Movement in Permafrost, does not mention taliks as another mechanism of ground water flow in permafrost. The Geotechnical Investigation report (Appendix G) did not check for the presence of a talik by means of a thermistor in the vicinity of P Lake.

ix. In Table 4.4, it should be noted that the pH value of 10.1 is believed to be in error and should be re-measured.

x. There should be a geotechnical design section in the report prior to Section 5- Lagoon Construction to cover off the geotechnical design of the major lagoon components, such as:

a. Selection of berm alignment and location.
b. Selection of embankment materials and type of structure.
c. Foundation conditions- soil and bedrock, surficial geology plan. Longitundinal and cross-sections through upstream and downstream berms.
d. Assessment of depth and extent of frost-affected bedrock (FAB) unit.
e. Ground ice conditions.
f. Ground temperatures and taliks.
g. Permeability of active zone soils, especially in the abutment and foundation areas of the upstream and downstream berms.
h. Design of seepage cutoff and justification for selected liner option and configuration and decision for not using a lagoon liner.
i. Foundation preparation requirements.
j. Slope stability assessment and justification of upstream and downstream slopes.
k. Riprap design based on hydraulic design criteria.
l. Geothermal analysis for selected central GCL cutoff option.

It should be noted that the AMEC geotechnical investigations were insufficient to provide this information, as discussed in ~~Section 4.2.1~~ (**AMEC Geotechnical Report (Appendix G) see below**).

xi. There should be a section in the report to describe the hydrological and hydraulic design of the major lagoon components, such as:

a. Site hydrology.
b. Determination of design flood.
c. Design flood routing.
d. Design of spillway and discharge facilities.
e. Establishing operating water levels and freeboard requirements (validating the 1 m freeboard value used in setting the height of the berm).

xii. In Section 5.2, Berm Construction, the height of the berm does not mention any allowance for flood handling. For this facility, the design event would likely be based on an extreme precipitation event generating rainfall that falls directly into the lagoon as the surrounding berms have effectively diverted surface water runoff from entering the lagoon.

xiii. Slope stability analysis should be carried out to demonstrate the stability of the slopes under all operating conditions, especially rapid drawdown on the upstream slope due to annual pumping of the lagoon. Due to the lack of site investigations, there is no information on the potential ground ice content of the foundation soils, which could lead to excessive settlement or foundation instability when the lagoon is impounded on the upstream toe of the slope.

xiv. The spillway is an overflow weir located on the crest of the downstream berm, at the maximum berm section. This arrangement is not recommended due to the potential for uncontrolled erosion of the berm and loss of lagoon containment. An alternative spillway arrangement is recommended, preferably in the abutments, through or on rock. As noted above, spillway design criteria need to be presented and discussed.

xv. The impermeable liner proposed by Dillon will be placed vertically on the inside of the berm. The geothermal analysis done by AMEC was for a liner on the upstream face of the berm. This option showed that the foundation cutoff trench would remain frozen for the life of the structure. With the

vertical liner, this may not be the case. The warm lagoon water would saturate the upstream half of the berm and may result in thawed conditions around the cutoff trench. This may lead to seepage around the liner.

xvi. From BGC's experience, the installation of a vertical liner, as proposed by Dillon, is impractical and without precedent in northern Canada.

xvii. Since there is no design assessment presented that shows that the base of the lagoon is impervious, the proposed liner arrangement cannot be justified. Dillon incorrectly interprets AMEC's conclusions. The AMEC report (Section 8.4), last bullet "…AMEC has not assessed whether the proposed 2 m deep cut-off system under the dyke is sufficient, although thermal modelling suggests that the subgrade will remain frozen." AMEC is referring to the subgrade under the dam, in the vicinity of the cutoff trench, not the lagoon floor. The geothermal analyses clearly show that the lagoon floor will become thawed to a depth of over 6 m after thirty years of operation. The consequences of this will depend on the existing thermal regime, which has not been determined by actual measurements. Therefore, the validity of the geothermal analyses may also be called into question, since they are based on assumed site parameters, as no thermistors have yet been installed on site.

xviii. Section 5.5 describes the lagoon discharge structure. The proposed structure is a pipe through the berm at the maximum head section. The design report states that this will be a steel pipe, however the drawings (Drawing 111, Detail 6) shows a 300 mm HDPE pipe. There are several concerns with this arrangement:

a. Constructing a pipe or any conduit through an embankment dam is considered to be poor practice from a dam safety and stability perspective due to the potential for concentrated seepage flow, deformation or cracking of the pipe and inability to inspect its condition.
b. The pipe is composed of HDPE, which would be even less capable of withstanding imposed loads than the steel pipe mentioned in the design report.
c. There is no information on ground ice content in the foundation soils, which may lead to differential settlement if thawing occurs. This has not been taken into account in the design of the pipe.
d. The pipe may freeze up due to the cold ground temperatures at the dam toe.

xix. Dillon should provide some information concerning the performance of the gravity discharge system used at other Nunavut locations, with respect to the above concerns.

xx. In Section 5.6, the design report indicates that natural materials will be used to construct the lagoon berms. No discussion is presented on how these natural, permafrost affected materials will be excavated and processed for use in the berm.

xxi. No details are provided as to the construction of the lagoon berms in terms of:

a. Foundation preparation measures.
b. Cut-off trench depth and excavation.
c. Liner installation procedures in conjunction with fill placement.

xxii. The upstream berm is located on topographic saddle. The lagoon containment limit is at elevation 122.5 m, resulting in a head of about 4.5 m through the berm to the downstream side. There is no liner shown on the drawings for this section of the lagoon, even though this structure has to retain almost as much head as the downstream berm.

xxiii. The cutoff trench detail assumes there is 2 m of overburden. There is no detail for the liner if bedrock is encountered in the foundation, or the details for the liner configuration at the abutment ends of the structure.

xxiv. Since the drawings included in the Design Report are not issued for construction, there are no further comments at this time.

AMEC Geotechnical Report (Appendix G)

BGC has reviewed the AMEC report for information purposes only. The investigations were carried out at the request of Dillon, and as such, it is Dillon's responsibility to assess the adequacy or inadequacy of the information provided.

AMEC was requested to conduct a geotechnical investigation and geothermal modelling of the proposed sewage treatment system. Based on discussions with Dillon, AMEC's scope of work included:

- Conduct a review of available aerial photographs and relevant geotechnical information.
- Conduct a review of the climatic and permafrost historical data.
- Conduct a site reconnaissance and hand auger drilling program across the proposed lagoon site.
- Conduct a hand auger drilling program at select local borrow sources.
- Conduct a laboratory analysis on select samples obtained during the drilling program.
- Conduct a geothermal analysis of the proposed berm configuration to assess the potential effectiveness of a frozen core liner concept.
- Prepare geotechnical report that summarizes the results of the geotechnical investigation that includes:

    a. Discussions of subsurface conditions encountered at the borehole locations.
    b. Recommendations for the development of low permeability lagoon walls including geothermal analysis of the berm structures.
    c. Development of design requirements for lagoon wall stability.
    d. Discussion of borrow source materials, and;
    e. Recommendations for site grading and drainage, if required.

The following points are raised by BGC with respect to the information provided by AMEC and how it was applied by Dillon:

i. The source of information regarding the permafrost conditions was not provided by AMEC. It would appear that it was estimated from the mean annual air temperature data. No thermistors were installed at the site to provide site specific temperature data for design purposes.

ii. Due to fractured rock covering the site, only one hand auger borehole was able to be drilled to a depth of about 0.15 m. Therefore, no site-specific subsurface data was obtained for the lagoon foundations. The extent of the frost affected bedrock is critical for design of any water retaining structure.

iii. Borrow materials investigations comprised one disturbed sample obtained from each of the proposed borrow areas. No drilling was undertaken at the prospective borrow area locations to estimate soil composition. No information was provided as to the in situ condition of these areas in terms of frozen ground and ice conditions that may affect quantities available, time required for excavation and processing required to render them suitable for dyke construction.

iv. Subsurface conditions were inferred from air photos and the field reconnaissance observations. The values of overburden depth, overburden stratigraphy, mean annual permafrost temperature and active zone thickness have not been confirmed by drilling.

v. No information was provided regarding the ground ice content and potential behaviour of foundation materials under thawed conditions.

vi. There is no discussion provided regarding the design requirements to ensure stability of the lagoon slopes.

vii. AMEC did not carry out any seepage analysis to justify the design of the liner and cutoff trench.

viii. The liner configuration used in the geothermal analysis is not what Dillon is proposing. With the vertical liner, there will be a greater potential for thaw around the cut off trench that has not been evaluated.

ix. The geothermal analysis assumed that there was a 0.5 m thick layer of coarse rockfill protecting the dyke core. This detail is missing from the Dillon drawings ((Drawing 111) and significantly affects the depth of thaw within the berm.

x. The geothermal analysis did not include any component of global warming, which is typically applied to all northern designs.

xi. The predicted ground temperatures at the base of the dyke are a function of the initial temperature conditions, the physical and thermal soil properties and the boundary conditions, all of which were based on assumptions. AMEC did not assess whether the 2 m deep cut-off system under the dyke is sufficient. If actual conditions differ from the assumed parameters, then the actual temperatures in the dyke could vary from the predicted temperatures.

Tender and Construction Specifications

General

The construction tender was issued by the Department of Community and Government Services, Government of Nunavut. Various dates appear on the document, that require some explanation and updating:

- On the cover of the Construction Tender, “Revised: April 2000”
- On the addendum footer, “January 19, 2004”.
- Within the addendum, the text refers to changes taking effect “April 1, 2004”.
- Table of Contents, “August 2003”.
- Instructions to Tenderers footer, “August 2003”
- Tender form footer, “April 2000”.
- List of Tender Documents- Appendix A- footer “April 2000”.
- NNI Policy Forms footer- Appendix B, “March 2001”.
- Appendix B-1 General Contractors and Sub-Contractors Dollar Amount footer- “April 2000”.
- Schedule of Values- Appendix C footer, “February 2006”.
- List of Unit Prices- Appendix D footer, “April 2000”.
- Transportation of Materials- Appendix H footer, “August 2003”.
- Contractor’s Certificate of Insurance- Appendix I footer, “April 2000”
- NNI Policy- Appendix J, dated “March 17, 2000”.
- Contractor’s Obligation to Provide Inuit Content- Appendix K footer, “March 2, 2001”.
- Construction Contract cover page, “Revised: April 2000”.
- Articles of Agreement footer, “August 2003”.
- Terms of Payment footer, “March, 2003”.
- General Conditions Table of Contents, page 1 is dated “August, 2003” and page 2 is dated “February 2000”.
- General Conditions footer, August, 2003”.
- Special Provisions footer, “February 2006”.
- Specifications are generally dated “November 2005”.

Rather than using a footer date to identify a particular revision of the contract document or form, it is preferred that the contract documents all be consistently dated with the same date to identify that they are all part of the same tender package. This would indicate that some effort was made by the tendering authority, to ensure that all the contractual components are internally consistent and up to date.

General Conditions and Specifications

These need to be read in conjunction with the construction drawings. Since no construction drawings were filed, BGC can only comment on the adequacy of the specifications. In general, the specifications appear to be generic in nature and have not been specifically written for this project. As a result, the specifications contain some irrelevant provisions that don’t pertain to this project and leave out some important provisions that are required for execution of this work.

i. GC34 Changes in Soil Conditions and Neglect or Delay by Owner:

Since no sub-surface investigations were carried out, there is a good chance that the soil conditions assumed by Dillon will differ from the actual conditions. The contractor will likely claim additional expense related to type of material encountered, presence or absence of ground ice, depth to rock, volume of rock excavation required and volume of excavation required.

ii. Section 01110 Summary of Work:

a. The items listed do not include all the work that is required, such as mobilization and demobilization, provision of temporary utilities and construction facilities, site surveys and layout, borrow area permitting and development, disposal of soil and rock waste materials, commissioning, training and preparation of an operation and maintenance manual.
b. The contract method is a single fixed price contract. There is insufficient information provided in these documents to allow a contractor to prepare a fixed price contract that will cover all the potential unknowns associated with the work.

iii. Section 01410 Regulatory Requirements:

The references and codes listed that the contractor should meet or exceed should already be incorporated into the design and contract specifications. It is up to the Engineer (GN) to ensure that the work is carried out according to the design and specifications. It is the Engineer's responsibility to ensure that the design and specifications are in accordance with the National Building Code and other standards listed, not the Contractor's.

iv. Section 01450 Quality Control:

a. Under a fixed price lump sum contract, the Engineer has no opportunity to direct the Contractor to achieve the desired end product while the work is in progress.
b. There is insufficient information provided in this section regarding the basis upon which the Engineer will reject defective work. These details are also not adequately covered in the individual specifications.

v. Section 01561 Environmental Protection:

a. There is nothing covering stockpiling and disposal of waste soil and rock.
b. There should be a separate specification to cover drainage and dewatering works associated with construction of the lagoon.

vi. Section 01-31 Operations and Maintenance Manual:

a. It appears that this specification is generic in nature and not specifically written for this project. It seems to be written for a mechanical type sewage treatment plant, rather than for the lagoon design being proposed. The areas that need to be covered include pond operating levels, procedures for flood handling and routing, what to do in case of overtopping, pond drainage procedures (i.e. rates to prevent instability of slopes), inspection of berm slopes, dealing with seepage through the berm, etc.
b. In order to drain the lagoon during an emergency, someone has to drive up the road, cross the berm, access the manhole and manually open the valve. An Emergency Preparedness Manual is also required to address contingency requirements associated with operating this facility at this location.

vii. Section 02072 Geotextiles:

a. In the Special Provisions section of the contract, the Contractor is informed of the surplus Bentomat ® panels that are available at the C&GS warehouse in Iqaluit. Presumably these panels meet the requirements of this specification. If so, then C&GS should provide the material warranty because they are no longer directly supplied from the manufacturer. For instance, the panels should have been protected from hydration and damage.

b. If the Contractor elects to use these panels, he should only be responsible for the installation guarantee regarding defects and workmanship, which are under his direct control.
c. Part 3 Execution is a generic specification only. It does not provide details for installation of the vertical liner in the cut-off trench or within the body of the dyke. There are no details regarding abutment treatment or difference in installation in (or on) rock versus soil in the cut-off trench.

viii. Section 02315 Excavating, Trenching and Backfilling:

a. No information has been provided in the contract regarding the volumes of rock, common and waste materials to be excavated. Since the contract is fixed price/lump sum, the need to define the various classes of excavation is not necessary, as the contractor will have to carry out all excavation at the same price.
b. There is nothing in the specifications that prevents the Contractor from mixing all classes of excavation together and hauling to the designated disposal area.
c. The specification does not provide details on the number of samples, the materials to be sampled or the sampling protocol. Section 01330- Submittal Procedures covers shop drawings only.
d. Although no construction drawings were filed, it is important to note that the lines, grades and elevations shown on the drawings were based on assumed conditions, without the benefit of subsurface exploration. Since the Engineer will be required to establish the final lines and grades based on actual conditions exposed in the field, the Contractor can claim additional costs.
e. The specifications do not state what the quality of the dyke foundation has to be. Provisions should include the need to remove organics, compressible materials, ice lenses, boulders etc. Since frozen ground (permafrost) may be encountered, the provisions in 3.5.2, backfilling not on frozen ground, does not seem relevant.

ix. Section 02316 Rock Removal:

This specification does not adequately address the need for removal of frost affected bedrock under the footprint of the berms and dykes. Excavating only to the lines and grades shown on the drawings may result in frost affected bedrock being left under the water retaining structures. Since no subsurface investigations were carried out, the depth of the frost affected bedrock has not been determined for this site. In some areas, it may be in excess of 5 m thick. This contingency has not been addressed by these specifications.

x. Section 02317 Roadway Excavation Embankment and Compaction:

a. The classes of excavation are not consistent with those used in the Excavating, trenching and Backfilling specification (02315).
b. Not sure what the difference is between Common and Unclassified excavation according to the definitions given in the specification.

xi. Section 02371 Rip-rap:

The specification has not included any durability testing to assess the quality of the rip-rap. Laboratory testing of the proposed rip-rap materials should be carried out, including freeze-thaw, absorption and slake durability.

xii. Section 02661 Sewage Storage Lagoons:

a. This is the only specification that covers the construction of the dykes. No detail is given regarding the concurrent construction of the vertical liner and fill placement that is required to execute the proposed design.
b. The dam construction materials specifications are not described.
c. Section 3.5 seems to imply that the impervious liner will be placed on the bottom and sides of the lagoon. This is not what was presented in the Dillon design report.

Comments from the Review of Mr. John Grainger (AE) provided to the NWB

SEWAGE LAGOON TEATMENT SYSTEM AND DESIGN

In general we concur that the treatment and disposal system proposed by the community is a significant improvement over the present situation. The proposed system will produce effluent of a quality considerably better than the current license requirements (120 mg/L for TSS and 180 mg/L for BOD). We do, however, have several observations and comments.

We understand the proposed process includes the following unit operations:

- 8.0 m top all-weather, gravel access road
- Sewage truck pad & turn-around
- Discharge flume
- Dyked annual retention/treatment (identified as primary) lagoon
- P Lake lagoon (identified as secondary)
- Wetlands area
- Drainage course to Telik Inlet

The following comments comprise our review of the Dillon Final Design Report:

i. p. 2, Section 1.2 Background, last paragraph; while we agree that a lower maintenance lagoon system is fully appropriate for an arctic community such as Cape Dorset, it would have been useful if Dillon had summarized the noted previous studies that provide specific rationale as to why lagoons are preferred over mechanical treatment plants for the benefit of the Board and potential interveners.

ii. p. 13, Section 4.1.2.1 Water Quality, we are concerned that there is only one set of sampling data and question if the August time frame is representative of the proposed time of discharge?

iii. p. 16, Section 4.2.2.1, Habitat, P Lake; is there any information that indicates that P Lake freezes to the bottom, ruling out, or confirming, the presence of fish? We agree there is likely no fish there, however does DFO have any information in this regard?

iv. p. 18, Section 51 Lagoon Configuration; there is no mention in the report of the effects of winter temperatures on the operation of the lagoon system – is the 0.5 m allowance for sludge enough depth to prevent the lagoon from freezing to the bottom once it is discharged to that elevation in the fall ? If not it will freeze to the bottom and result in sheet flow freezing solid as sewage is discharged from the truck down the discharge flume. In the spring then the entire lagoon will be frozen and the possible impact on the system's treatment processes and capability should be further examined.

v. p.19, Section 5.2 Berm Construction; what is the size of the proposed rip rap protection on the inside slope ? We are concerned that the specified 95% SPD compaction (per the tendered construction specifications) of the berms will not be achieved using the weight and tracks of the machinery (per AMEC) – we would suggest bringing in proper compaction equipment. A bentonite liner may not be as effective as the synthetic liner (e.g. HDPE) AMEC recommends. Our interpretation of the AMEC report is that the concept of preventing leakage from this lagoon by relying on "freeze back" of the permafrost into the berms is tenuous, not proven and to use AMEC's words, "not technically feasible". Further AMEC indicates that they did not complete a seepage assessment under or through the cut-off curtain below the dyke. Certainly the use of a synthetic liner from the top of the berms, along its sides and across the base of the lagoon is an option that is not fully examined given the concerns with the recommended vertical liner system on the dykes that seem to emerge from this discussion.

vi. All of this is a serious consideration for the proposed design of this system as the requirement for a full liner across the entire bottom and sides of the pond may be necessary to contain the treated effluent and achieve the desired level of treatment. At the very least it warrants further discussion by the Board and this subject would likely come up in a hearing.

vii. p.20, Section 5.3 Truck Pad & Turn-around; Yukon experience dictates that a 20m radius should be considered, for ease of turning and for snow removal/storage.

viii. p.21, Section 5.6.1 Berm; for future lagoon berm/dyke stability the proper compaction of these granular materials is crucial. There is no mention in the report of any predictable thawing/settlement of the underlying permafrost, which could de-stabilize the berms/dyke, or necessary mitigation thereof. Is the underlying soil taw-stable?

ix. p.28, Section 6 Treatment Quality; how was the stated design criteria for BOD, TSS and Fecal Coliforms derived ? To what standards (or who's) are we trying to meet?

x. p.28/29, Section 6.1 Annual Lagoon Kinetics; While the kinetic formula utilized is a common text book formula, it would have been useful to see performance data from other similar systems across the NWT, Nunavut, Yukon or Alaska and provide some real-life back-up data for comparison . For example Old Crow, Yukon, had had a single celled lagoon with wetlands treatment and disposal in operation since the late 1980's. On page 29, the references for the assumed temperatures and treatment times are missing from the report text. These elements are fundamental and critical in the use of this formula however treatment times of 70 to 90 days appear to be reasonable in this case. Are there any typical temperatures available from other NWT or Nunavut systems to verify the 7 dC temperature limit?

xi. p.31, Section 6.3 Fecal Coliform Reduction; the reference for the influent fecal coliform figure is text book and it would be beneficial to confirm this with some typical similar data from other North of 60 communities. Table 6.4 relies on using Table 6.3 and this may be considered to be too generic an application – can this be verified with data from other northern community lagoon systems? Again it is stated that the "design standard" of 10 4 coming out of the constructed retention lagoon and then P Lake will be met but what is that standard based on?

xii. other than the reference to the general information found in Table 6.3, there is no discussion on the necessary reduction in Suspended Solids in the report.

xiii. p.32, Section 6.4 Wetland Sewage Treatment – Nutrient Removal; what are the regulated levels being referred to for nutrients, and which nutrients. While it is true that wetlands systems are quite efficient at renovating and polishing domestic sewage effluent, this report does not address specifics for this system, e.g. the retention times within the wetland, its size or capability to effectively treat the effluent and reduce levels of nitrogen (ammonia) and phosphorus. As this is the end of the treatment system or the 'end of pipe' compliance point if you will, this effluent must be non-toxic to fish (as measured by an LC50 bioassay test) in order to comply with the federal Fisheries Act and there is no discussion in the report in this regard. While intuitively effluent that reaches the levels of secondary treatment set forth in the stated design criteria may very well be non-toxic, there are no specifics in the report regarding the expected degree of nutrient removal and toxicity to fish with respect to the proposed system.

xiv. p.33, Section 6.6.2 Fort Liard; the performance of a two and three cell lagoon at a lower latitude may be better than the Cape Dorset system so the comparison may not be valid. Are there other systems across the north that can be more aptly used for comparison?

xv. p.36, Section 7.1; Sampling Protocol; we agree that the proposed sampling locations are appropriate, however, individual effluent parameters should be identified (e.g. BOD, TSS, pH, Oil & Grease, Fecal Coliforms, Total Coliforms, toxicity to fish, Biosassy Concentration (LC50), Toxic Organic Substances). We recommend that the Board consider establishing compliance points at certain locations within the license for certain parameters at specific locations.

xvi. p.36, Section 7.1 Sampling Protocol; the suggested wetland study could become a license term and we agree it is required

xvii. p.39, Section 9.2 DFO Approvals; refer to the above noted concerns regarding fish toxicity – did DFO ever respond to the Dillon September 2005 submission? Refer to EC letter of May 1/06 addressing fisheries concerns as well.

xviii. p.40, Section 9.3 Water License Application Requirements; we agree that all of the items listed in this section of the report should be followed up and possibly made license conditions for Board review and approval.

xix. p.40, Summary and Conclusions; we are concerned that we could not duplicate the volume of the proposed lagoon with the dimensions for useable liquid depth provided as being large enough to store the required 96,100 m3.

xx. We note that the Dillon report did not include a Certification Page and therefore does not appear to be sealed by a Professional Engineer registered in the Territory.

CONSTRUCTION TENDER DOCUMENTS FOR THE CAPE DORSET P-LAKE SEWAGE LAGOON (GOVERNMENT OF NUNAVUT, APRIL 2006)

The following comments on the tender package are provided for consideration:

i. We note that the tender package has been released by the Nunavut Government prior to the issuance of an approved amendment to the Cape Dorset license by the Board.

ii. Further the design is based on the Dillon Final Design report, which is still under review by the Board, regulatory agencies, potential interveners and the public.

iii. There is no indication in the 'Schedule of Values' (unit price table) or in the site work specifications that diversion ditches at the lagoon site or P Lake are included in the contract.

In closing, the NWB requests a detailed formulated response to all of the bulleted items in this letter. Sufficient detail and an avoidance of ambiguity should be followed in submitting response materials. In addition to the responses addressing the particulars of the Construction Tender documents the NWB requests detailed discussion in how engineering supervision will take place during the construction process. This discussion should highlight any limitations DCL believes the Construction Tender currently contains. Also as per DCL's letter addressed to the NWB (dated June 2nd, 2006) a detailed outline of the Operations and Maintenance Manual will be submitted to the NWB as part of the licence application. This is further to discussion the undersigned had with Mr. Anjan Joshi on May 24th 2006.

As per **Section 12** of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act (NWNSRTA),* e*xcept in accordance with the conditions of a licence no person shall deposit or permit the disposal of waste in waters in Nunavut or in any other place in Nunavut under conditions in which the waste, or any other waste that results from the deposit of that waste, may enter waters in Nunavut*. The NWB would also like to remind the Proponent that as per **Section 57** of the *NWNSRTA, the Board may not issue a licence unless the applicant satisfies the Board that any waste produced by the appurtenant undertaking will be treated and disposed of in a manner that is appropriate for the maintenance of the water quality standards and effluent standards that the Board considers acceptable*. The Proponent's past performance will also be considered to ensure the completion of the appurtenant undertaking is adequate and such measures as may be required in mitigation of any adverse impact are properly accounted for.

Should you have any questions regarding the above, please feel free to contact the undersigned at (867) 360-6338 or tech1@nwb.nunavut.ca .

Sincerely,

Original signed by:

Joe Murdock
Technical Advisor

cc. Art Stewart (Hamlet of Cape Dorset)
Anjan Joshi (GN-CGS)
Bhabesh Roy (GN-CGS)

Pat Fuentes (GN-CGS)
Brad Mueller (Dillon)
Gary Strong (Dillon)
Holger Hartmaier (BGC)
John Grainger (AE)
Jim Rogers (INAC)
David Abernethy (INAC)
Colette Spagnuolo (EC)
Mike Atkinson (GN DOE)
Tania Gordanier (DFO)
Claude Constantineau (Public Citizen)