BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

IMPACT ASSESSMENT AGENCY OF CANADA

BOAT HARBOUR REMEDIATION PROJECT

EXTERNAL TECHNICAL REVIEW

FINAL

PROJECT NO.: 2155001 DATE: January 29, 2021

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January 29, 2021
Project No.: 2155001

Miriam Padolsky, Ph.D.
Impact Assessment Agency of Canada
Place Bell; 160 Elgin Street
Ottawa, Ontario K1A 0H3

Dear Ms. Padolsky,

Re: External Technical Review of the Boat Harbour Remediation Project - FINAL

BGC Engineering Inc. is pleased to present this technical report that describes our findings associated with the External Technical Review (ETR) of the Boat Harbour Remediation Project. This report has been issued in final, following review and comment by the Impact Assessment Agency of Canada on the draft version, submitted on January 15, 2021.

We trust this meets your current needs and please feel free to contact us if you would like to discuss any portion of the report.

Yours sincerely,

BGC ENGINEERING INC.
per:

Sharon Blackmore, Ph.D., P.Geo.
Senior Hydrogeochemist

EXECUTIVE SUMMARY

The Boat Harbour Effluent Treatment Facility (BHETF), that had been commissioned in 1967 to treat wastewater and effluent received by the facility, ceased operation in 2020 following the 2015 passing of the *Boat Harbour Act* by the Government of Nova Scotia (the Province). During operations, treated effluent from the BHETF was discharged to Boat Harbour, known as A'se'k in Mi'kmaq. Boat Harbour was originally a tidal estuary connected to the Northumberland Strait and was transformed to a freshwater lake with the 1972 construction of a dam to isolate its marine connection.

The Province intends to remediate Boat Harbour and the lands associated with the BHETF to allow its restoration to a tidal estuary, which is the goal of the Boat Harbour Remediation Project (the Project). Waste to be removed as part of the Project's remediation activities is proposed to be stored within the existing containment cell, which would be redesigned to store larger volumes than its current capacity. Nova Scotia Lands Inc. is the Proponent for the Project, which is undergoing a federal Environmental Assessment (EA) review.

As part of the Project EA review, the Impact Assessment Agency of Canada (IAAC, the Agency) retained BGC Engineering Inc. (BGC) to provide an external technical review (ETR). An ETR is a tool through which independent, subject matter experts (SMEs) may examine difficult scientific or technical issues related to a proposed project going through an EA. The objective of this ETR was focused on two Charge Questions provided by the Agency, which were:

1. Review the Proponent's information and analysis for identifying the alternative means and selecting the preferred alternative (for containment of wastes to be removed from Boat Harbour), including the technical and economic feasibility of the alternative means considered.
2. Provide advice to the Agency on the robustness of the technical design of the preferred alternative (waste containment cell) and the likelihood that it will achieve its stated purpose.

The Charge Questions were evaluated based on information provided in a Scope Document set provided by the Agency, as well as Extra-Scope Documents requested by BGC during two review meetings held during the data review period. Therefore, the ETR was limited to the contents of the received document set as well as the effort in the approved work scope, and did not include detailed analytical studies nor extensive research of the results or claims presented in the documents provided.

There are seven remedial components associated with the Project, namely:

1. Waste Management.
2. Dredging.
3. Wetland Management.
4. Water Management.
5. Bridge at Highway 348.
6. Infrastructure Decommissioning.

7. Remediation Infrastructure.

In general, BGC finds the alternative assessment process presented by the Proponent within the reviewed documents, which identifies and considers a range of alternatives, to be reasonable. A staged approach was taken to filter the alternatives identified for each component, which included stakeholder engagement and other SME input, prior to this ETR. The details of these engagements were not provided as part of the ETR document set. Therefore, BGC did not review the basis for the elimination of select alternatives (based on these discussions).

A range of alternatives were identified by the Proponent for each component and then evaluated by considering various indicator categories to technically score the proposed alternatives. The highest score was identified as the preferred alternative; however, it was noted by BGC that in some scenarios the difference between the first and second option was within a 10% difference, which (at a preliminary design level) should be considered as a similar result. Therefore, it is BGC's opinion that a final short list of alternative means, carried forward to a 60% design level (at a minimum) and refined economic evaluation, would confirm the preferred alternative.

The second Charge Question focused on the design robustness and efficacy of the preferred alternative for the Waste Management component of the Project (i.e., waste containment cell). The preferred alternative proposed by the Proponent involves the modification of the existing containment cell to accommodate up to approximately a half an order of magnitude greater waste storage capacity compared to the original facility design (i.e., from 220,000 m^3 to up to 1,073,000 m^3).

The increase in containment cell capacity will be achieved through modifications to the base liner, berm height, side slopes and cover system. Dredged waste (i.e., sludge/sediment) would be placed as a slurry in Geotubes® (or similar technology) to facilitate dewatering and consolidation of the material and leverage the storage capacity of the containment cell.

The review of the information provided (associated with the containment cell) identified several assumptions that were based on limited data and/or carry a significant weight in the robustness and efficacy of the design. In particular, the ETR identified uncertainties related to the sludge/sediment volume reduction percentage and the consolidation rate of the material within the Geotubes® that have implications for the constructability, stability and storage capacity of the proposed containment cell design. Based on these uncertainties, the largest risk with the preferred alternative is that the designed storage capacity, even with its contingency for an additional 143,000 m^3 storage through modification of side slopes, may not be sufficient. Moreover, these concerns also circle back to the selection of the existing containment cell as the preferred alternative, as they highlight other alternatives (i.e., new on-site containment cell, off-site containment/disposal) that were either not selected or eliminated at an early assessment stage, that may require reconsideration as they present options for storage contingency.

Contact water from the Project would be managed on-site during active remediation phases, through an on-site temporary leachate treatment facility (TLTF) and/or through natural attenuation. In post-closure, leachate collected at the containment cell would be transported off-site for treatment and disposal. Results from pilot scale testing suggest the proposed treatment method is effective at reducing contaminant concentrations to below the applied comparison guidelines. However, this performance is yet to be confirmed at the full scale.

Based on the ETR, BGC has identified several questions and uncertainties regarding the containment cell design. Further information and/or clarification are required to fully assess the design's robustness. The assessment of the design's efficacy will be dependent on the resolution of the identified outstanding questions regarding the design's robustness.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES (ATTACHED)

LIMITATIONS

BGC Engineering Inc. (BGC) prepared this document for the account of Impact Assessment Agency of Canada. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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1.0 INTRODUCTION

BGC Engineering Inc. (BGC) was retained by the Impact Assessment Agency of Canada (IAAC, the Agency) in June 2020 to provide an External Technical Review (ETR) of the Boat Harbour Remediation Project (the Project) which is undergoing a federal Environmental Assessment (EA). Boat Harbour, known as A'se'k in Mi'kmaq, was originally a tidal estuary that was narrowly connected to the Northumberland Strait in north-central Nova Scotia. The project site is located immediately east of the Pictou Landing First Nation (PLFN) community. The Boat Harbour Effluent Treatment Facility (BHETF) was commissioned in 1967 to receive wastewater from the Kraft Point Pulp Mill and a dam was constructed in 1972 to isolate Boat Harbour from its connection to the Northumberland Strait, therein transforming the estuary into a freshwater environment.

In 2015, the Government of Nova Scotia (the Province) passed *The Boat Harbour Act* that ordered the receipt and treatment of waste effluent at the BHETF to cease by January 31, 2020. BGC understands that the Province intends to remediate Boat Harbour and the lands associated with the BHETF to allow its restoration as a tidal estuary, which is the goal of the Project that is being led by Nova Scotia Lands Inc. (NSLI; the Proponent).

External technical reviews are a mechanism used by the Agency or a Review Panel to support the scientific reviews conducted by federal experts. In this manner, independent experts provide advice on the rigour, credibility and clarity on specific topics related to a Project undergoing an EA.

1.1. Scope of Work

The objectives of the Boat Harbour ETR are defined in the following two Charge Questions:

1. Review the Proponent's information and analysis for identifying the alternative means and selecting the preferred alternative (for containment of wastes to be removed from Boat Harbour), including the technical and economic feasibility of the alternative means considered.
2. Provide advice to the Agency on the robustness of the technical design of the preferred alternative (waste containment cell) and the likelihood that it will achieve its stated purpose.

The scope of work (SoW) was divided into three main tasks:

1. Data review.
2. Review meetings with the Agency.
3. Reporting.

For the first task, the Agency provided BGC with the Scope Documents on November 9, 2020 to assist with addressing the above two Charge Questions, which included the following:

- Jacques Whitford Environment Ltd. (September 20, 1999). *Operational and Maintenance Manual - Boat Harbour Disposal Cell. Boat Harbour Treatment Facility, Boat Harbour,* *Nova Scotia.* [Report] Prepared for Nova Scotia Department of Transportation and Public Works. 45 pages.

- GHD Group Pty Ltd. (September 12, 2017). *Design Requirements Document – Boat Harbour Remediation Planning and Design.* [Report]. Prepared for Nova Scotia Lands Inc. Partial document – Sections 1, 2, 3, parts of 4 (i.e., 4.4, 4.7 only), and 5.
- GHD Group Pty Ltd. (May 1, 2018). *Remedial Option Decision Document – Boat Harbour Remediation Planning and Design.* [Report]. Prepared for Nova Scotia Lands Inc. Partial document - Sections 1, 2, 4 and Appendices A, B, D, E, F, G and H.
- GHD Group Pty Ltd. (February 12, 2020a). *Boat Harbour Sludge Disposal Cell HELP Modelling* [Memorandum]. 33 pages.
- GHD Group Pty Ltd. (February 12, 2020b) *Hydrogeologic and Hydraulic Assessment – Containment Cell, Boat Harbour Remediation Planning and Design, Pictou Landing, Nova Scotia.* [Report]. Prepared for Nova Scotia Lands Inc. 251 pages.
- Nova Scotia Lands Inc. (October 2020)[1]. *Volume II of the Environmental Impact Statement, Section 2 (Project Justification and Alternatives Considered) and Section 3 (Project Description), Boat Harbour Remediation Project, Pictou Landing, Nova Scotia*. 134 pages.

Within this ETR, the Remedial Options Decision Document (RODD) excerpt (GHD Group Pty Ltd. (GHD), May 1, 2018) and the excerpt from Volume II of the Environmental Impact Statement (EIS) (NSLI, October 2020) are referenced frequently. Therefore, for brevity, these documents are referred to herein as the RODD and EIS, respectively.

The above Scope Document set is in general agreement with the review documents understood by BGC to be part of the SoW, as discussed with the Agency prior to commencing the ETR and included in the approved proposal (BGC, June 10, 2020). The only exception between proposed and received documents was the Nova Scotia Industrial Approval, which was not provided in the November 9, 2020 data transmission.

As part of the two review (teleconference) meetings with the Agency (i.e., Meeting #1: December 1, 2020 and Meeting #2: December 15, 2020), BGC requested the following Extra-Scope Documents:

- Nova Scotia Department of Environment (August 16, 1994) 1994 Industrial Waste Permit Approval No. 94-032.
- GHD Group Pty Ltd. (December 23, 2019). *Pilot Scale Testing Construction Report – Boat Harbour Remediation Planning and Design, Pictou Landing, Nova Scotia*. [Report]. Prepared for: Nova Scotia Lands Inc. 580 pages.

This document reflects one (of two reporting deliverables) to be provided by BGC as part of the SoW; the second document is a Plain Language Summary of the findings.

[1] Reference date not provided in the document received, but inferred based on electronic communication from the Agency on October 13, 2020 indicating the revised EIS had been submitted by the Proponent.

1.2. Limitations and Exclusions

The ETR was subject to the following limitations and assumptions:

- The review was limited to the assessment of methodology, results and conclusions presented within the subject studies and did not include a detailed data quality review; therefore, the experience and engineering judgement of BGC's subject matter experts (SMEs) were relied upon in making determinations and conclusions within this review.
- Extra-Scope Documents were not reviewed to the same level of detail as the Scope Documents and were instead reviewed to a level sufficient to understand the source of the claims made and information presented in the Scope Documents only.
- If review conclusions were highly dependent on conclusions made in referenced reports that were not provided as part of the original Scope Document set, these dependences would be noted in BGC's findings.
- Evaluation of the reasonableness of the economic feasibility of the selected alternative was based on the data provided and BGC experience. An itemized cost estimate was not included in the SoW.
- The scope did not include a site visit; therefore, it was assumed the studies under review presented sufficient detail on relevant site conditions to evaluate the engineering design.
- It is understood that the EIS presents an updated formulation of the assessment of alternatives initially presented within the RODD. For this ETR, the EIS is assumed to supersede the RODD regarding any assessments that are in conflict. However, it is also assumed that the information within the RODD can otherwise be viewed as supporting the assessments made within the EIS, due to the additional detail and granularity provided therein.

2.0 BACKGROUND

The following descriptions of the Site and the preferred alternative means for the Project were primarily referenced from the RODD and EIS provided as part of the Scope Documents as well as a detailed Project Description by GHD (December 18, 2018)[2].

2.1. Site Description

The BHETF consists of a wastewater effluent pipeline, twin settling basins, an Aeration Stabilization Basin (ASB), and the stabilization lagoon (i.e., Boat Harbour, or BHSL) (Figure 2-1). Prior to the construction of the settling basins and the ASB, effluent was routed to a natural wetland area (Former Ponds 1, 2 and 3) before being discharged into Boat Harbour. Effluent from Boat Harbour discharges through a dam (northeast of Boat Harbour) into an estuary before being released to the Northumberland Strait. Suspended sediments were partially removed by the settling basins and chemical additions (i.e., urea and diammonium phosphate) was added to the conveyed effluent prior to the ASB. Floating aerators aerobically treated the effluent within the ASB prior to discharge into Boat Harbour. Discharge into and from Boat Harbour were monitored at Point C and D, respectively (Figure 2-1), which are governed by discharge criteria specified in the BHETF Industrial Approval (IA) (No. 2001-076657-A01).

A 6.7-hectare (ha) sludge disposal cell (i.e., the existing containment cell) is located southeast of the ASB, on provincially-owned lands and surrounded by undeveloped mixed woodlands and Indian Reserve Lands (Figure 2-1). The existing cell was constructed and permitted in 1994 (IA No. 94-032) and contains perimeter containment berms constructed of native till soil, a 0.6 m (thick) clay liner and an underdrain leachate collection system. The existing cell is permitted for a total sludge storage capacity of 220,000 m^3 and contains approximately 180,000 m^3 of sludge, which includes hydraulically dredged sludge from the ASB and sludge from the settling basins (from 1996 to 1998 only). Leachate from the cell is currently returned to the ASB.

The nature and extent of the contamination at Boat Harbour and the lands associated with the BHETF have been assessed by GHD through a multi-phase Environment Site Assessment as well as studies completed by others. The BHETF contains unconsolidated contaminated sludge/sediment which will need to be contained within a new cell, with the majority accounted for as follows:

1. 634,000 m^3 present within Boat Harbour.
2. 311,000 m^3 in wetlands.
3. 180,000 m^3 in the existing containment cell.
4. 129,000 m^3 in the ASB.

The proposed waste storage suggests that consolidation (via dewatering) is expected to reduce the sludge volume to between 770,000 m^3 and 922,000 m^3 (from 1.39 Mm^3). The sediment would be impacted with metals, polycyclic aromatic hydrocarbons and dioxins/furans and require

[2] This document can be accessed from the Proponent's website: https://www.boatharbourproject.ca/

adequate storage and management. In addition to the management of the solid wastes, the remediation of Boat Harbour will also require treatment of approximately 5,700,000 m^3 of water (prior to its discharge to the estuary).

2.2. Preferred Alternative Means

An Alternative Means assessment process was conducted by GHD to identify and evaluate the Alternative Means[3] to carry out the remedial components of the Project, namely:

1. Waste Management.
2. Dredging.
3. Wetland Management.
4. Water Management.
5. Bridge at Highway 348.
6. Infrastructure Decommissioning.
7. Remediation Infrastructure.

A preferred alternative was selected for each remedial component, which are discussed below for four of the seven components that are directly or indirectly related to the Charge Questions associated with the ETR (refer to Section 1.1). The alternatives associated with the remedial components Bridge at Highway 348, Infrastructure Decommissioning and Remediation Infrastructure were viewed by BGC as separate from the objective of the ETR, which was focused on the containment cell. However, a residual consideration to these remedial components was included as part of the evaluation of the Alternative Means assessment and process (i.e., Charge Question 1).

2.2.1. Waste Management

The presented preferred alternative for the waste management component involves storage of the solid waste in the existing containment cell location. Engineered modifications are required to allow for a larger storage capacity (than the cell's originally permitted capacity of 220,000 m^3) while maintaining its 6.7 ha footprint. Modifications to the existing containment cell includes the following (also shown in Figure 2-2):

1. Vertical expansion (i.e., increase perimeter berm height by 3 m and disposal waste height by 22 m to 24 m).
2. A single composite base liner system comprising a Geosynthetic Clay Liner (GCL) and a flexible membrane liner.
3. Final contours with 4 horizontal to 1 vertical (4H: 1V) side slopes to accommodate 930,000 m^3 of waste with a 0.75 m (thick) low permeable cover liner including a geomembrane liner.

Should additional capacity be needed, it is proposed to modify the side slopes to 3H:1V (Figure 2-2) to provide an additional 143,000 m^3 of capacity, for a total of 1,073,000 m^3. Waste

[3] Alternative means differ from alternatives in that they represent the various technical and economically feasible ways that a project can be carried out, and which are within the Proponent's scope and control.

slurries to be stored in the containment cell would be mixed with chemical amendments to improve workability (i.e., polymer, coagulant, lime) and placed in Geotubes®[4] or similar technology to support dewatering and consolidation. Leachate produced under post-closure conditions (i.e., post-capping of the containment cell) would be collected in a buried tank on-site and disposed and treated at an off-site Nova Scotia Environment (NSE) approved facility.

2.2.2. Dredging

The preferred alternative for the Dredging component is for extraction of sediments to be conducted in the wet, predominantly via hydraulic techniques. The slurry, obtained by dredging, would be pumped to a sludge management area in the containment cell for placement in Geotubes® for storage and subsequent wastewater dewatering.

Shorelines of the various areas at the Site would be mechanically excavated, with material ultimately transferred onto a truck for transport/disposal to the containment cell. If necessary, the mechanically excavated material would be made into a slurry for placement into Geotubes® prior to placement in the containment cell.

2.2.3. Wetland Management

The Wetland Management component of the Project considers the wetland area (Former Settling Ponds 1, 2 and 3), the BHSL and the estuary (located north of Highway 348 and the dam). A Human Health and Ecological Risk Assessment (HHERA) was completed for these areas (GHD, March 25, 2020), but was not provided as part of the Scope Documents (Section 1.1). Results from the HHERA were used to determine if remediation or additional risk management is required to be incorporated in the remedial design for the Project or if site-specific natural attenuation is a technically and socially feasible option.

The HHERA results determined that ex-situ remediation of portions of the wetlands, all of the BHSL and a portion of the estuary would require active remediation through dredging with sludge disposal into Geotubes®. These materials would ultimately be placed in the containment cell, as described above in Waste Management. Areas associated with Wetland Management that would not undergo ex-situ remediation would be left in place for natural attenuation.

2.2.4. Water Management

The Water Management component is subdivided into three sub-components, namely:

1. Bulk water refers to impacted surface water and groundwater needing to be managed prior to, during or post sludge/sediment removal (as described in Dredging) and does not include leachate from sludge/sediment treatment (following cessation of dredging operations). The preferred alternative for bulk water management during active

[4] Geotube® systems are used for shoreline erosion protection, land reclamation, island creation, wetlands creation, construction platforms, etc. Slurries placed in these systems are allowed to dewater through the permeable engineered fabric and gravity settlement creates a monolithic compacted structure.

remediation of the BHETF is natural attenuation with no physical or chemical treatment beyond that achieved through the use of Geotubes® dewatering process for dredged sludge/sediments.

2. Dewatering effluent refers to the wastewater generated from Geotube® dewatering and effluent from the containment cell that is considered to be contact water. The dewatering effluent will be collected and conveyed back to the BHSL in areas being dredged or those that have not been remediated. The dewatering effluent chemistry would be influenced by the chemical dosing of the dredged slurry upon placement in the Geotube® and mixing with bulk water is to be managed via natural attenuation.
3. Leachate effluent refers to the contact water released from the Geotube® or equivalent technology as the waste is consolidating, between the period of cessation of dredging to the placement of the containment cell cover. Leachate effluent is understood by BGC to differ from dewatering effluent, of which the latter refers to the initial effluent released from the Geotubes® or equivalent during dewatering versus the former that represents leachate released as part of progressive consolidation. The preferred alternative includes placing an interim cover on the containment cell during this interim period to minimize the amount of precipitation falling within the footprint and requiring management. Leachate collected would be conveyed to a nearby Temporary Leachate Treatment Facility (TLTF). Leachate meeting applicable criteria would be discharged to the BHSL, whereas leachate not meeting applicable criteria would be recirculated for re-treatment. Sludge from the TLTF would be stored in the containment cell. The TLTF would not be required in post-closure (i.e., following final cover placement) and, as discussed in Section 2.2.1, leachate produced in the post-closure period would be directed for off-site disposal.

2.3. Rationale for the ETR

As stated in Section 1.0, the purpose of the Project is to remediate Boat Harbour and the lands associated with the BHETF, with the goal to return Boat Harbour to its estuarine conditions from its existing freshwater lake state. This goal aligns with the vision of PLFN such that the community may re-establish its relationship with the water and land of A'se'k (i.e., Boat Harbour). To achieve this goal, contaminated sediments within the BHETF are required to be removed and appropriately stored, a process that is proposed to include multiple remedial components (as discussed above) and be completed over seven (or more) years.

The complexity of the proposed waste management options for the Project, from both technical and economic perspectives, suggests that the Project would benefit from an additional review by independent external technical experts with specific knowledge on the subject matter and technical areas of these elements of the proposed Project design.

3.0 REVIEW PROCESS

In accordance with the review scope assigned for the ETR, the assessment of information presented within the Scope Documents was primarily comprised of professional judgement and experience of the SMEs. Some research was undertaken in an attempt to verify various claims of the efficacy and applicability of presented technologies or approaches; however, quantitative/qualitative assessment or analysis was not undertaken and the presented results provided within the Scope Documents were relied upon as part of the ETR.

The methodology to complete the ETR included several (approximately) sequential steps:

1. Preliminary review of the Scope Documents by all the SMEs, with a more focused review on sections/reports by the SMEs pertaining to their relative area(s) of expertise.
2. Review meeting with the Agency (Meeting #1) to frame initial impressions of the Scope Documents under review, and identify and request additional information (i.e., ancillary to the Scope Document set) to support the Data Review task.
3. Receipt of Extra-Scope Documents to support the ETR.
4. Detailed review of the Scope Documents, with SMEs each focusing on agreed upon documents that address their area(s) of expertise.
5. Partial review of Extra-Scope Documents, as required, to clarify statements made in the Scope Documents.
6. Review meeting with the Agency (Meeting #2) to provide an update on the Data Review task following the receipt of the Extra-Scope Documents, and convey a preliminary synopsis of the Charge Question findings.
7. Completion of detailed review of the Scope Documents, compilation of review observations into summary findings, and Technical Review reporting (this document).

4.0 SUMMARY OF FINDINGS

Table 4-1 provides a summary of the main findings of the ETR, which is primarily based on the contents of the Scope Documents and in relation to the Charge Questions shown below (also described in Section 1.1).

Charge Question 1: *Review the Proponent's information and analysis for identifying the alternative means and selecting the preferred alternative (for containment of wastes to be removed from Boat Harbour), including the technical and economic feasibility of the alternative means considered.*

Charge Question 2: *Provide advice to the Agency on the robustness of the technical design of the preferred alternative (waste containment cell) and the likelihood that it will achieve its stated purpose*

For Charge Question 1, the following evaluation elements were considered:

a) Alternative assessment process.
b) Range of alternatives presented.
c) Assessment of presented alternatives – technical and economic feasibility.
d) Selection of the preferred alternative.

For Charge Question 2, the following evaluation elements were considered:

a) Robustness of the technical design.
b) Likelihood of design purpose achievement.

The findings presented in Table 4-1 adhere to the above evaluation elements specific to each Charge Question.

Table 4-1. Summary of ETR findings.

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
1a: Alternatives Assessment Process					
1	Evaluation of design requirements, evaluation criteria (and weighting), and the evaluation indicator categories	The Design Requirements Document (GHD, September 12, 2017) states that "*the design requirements were developed using a brainstorming approach with subject matter experts and a collaborative design requirements workshop with NS Lands Inc. and selected stakeholders to identify required design elements and gain consensus on the criteria to be used*." The Evaluation Criteria and Scoring Matrix Technical Memorandum (GHD, September 26, 2017; Appendix B of the RODD) states that the matrix "*was developed by GHD and collaborative workshop with NSLI and selected stakeholders, to identify and gain consensus on the evaluation criteria to assess the Feasible Concepts*." Further, it is stated within the RODD and EIS that the scoring matrix, including the five indicator categories (Regulatory, Technical, Environmental, Social and Economic) was determined collaboratively during the Evaluation Criteria and Weighting Matrix workshop.	The described engagement of stakeholders and SMEs in the alternatives assessment process is well conceived and appears to be undertaken at reasonable points in this process. However, detailed notes arising from the workshops where the design requirements, evaluation criteria, weighting and selected indicator categories were formulated were not included as part of the review documents (September 12, 2017; September 26, 2017). Within each of the five indicator categories (Regulatory, Technical, Environmental, Social and Economic), there are several criteria that appear relevant to a comprehensive analysis of options and align with the factors for consideration described within Clause 19 of *Canadian Environmental Assessment Act* (CEAA) 2012. In summary, the process followed, and categories utilized for the evaluation appear reasonable. However, conclusions on whether the selected design requirements and evaluation criteria adequately accommodate stakeholder input cannot be made with available information.	Design Requirements Document (GHD, September 12, 2017) EIS – Section 2.2.1.1 Evaluation Criteria and Scoring Matrix Technical Memorandum (GHD, September 26, 2017) RODD – Section 2.2; Appendix B	CEAA, 2012 (S.C. 2012, c. 19, s. 52)
2	Option Filtering Process	Alternative Means were initially evaluated within the RODD using two stages of binary screening filters to identify Feasible Concepts (FCs).	A staged approach, where identified alternatives are initially filtered for feasibility, is well conceived. However, the implementation of this approach must support the determinations clearly, due to the finality of failure at these initial filtering stages. Assessment of the implementation of the option filtering is discussed within the Assessment of Preferred Alternatives section below (Topic #4).	RODD – Section 2.2, including Figure 2.1; Section 4.2	
1b: Range of Alternatives Assessed					
3	Assessing the completeness of the range of alternatives assessed	*Impact Assessment Act* (IAA, 2019) states that the impact assessment must take into account "*any alternatives to the designated project that are technically and economically feasible and are directly related to the designated project*." However, it is understood the EIS was developed with application of CEAA (2012), rather than IAA (2019) and this earlier reference states that that an environmental assessment of a designated project must take into account factors, including "*alternative means of carrying out the designated project that are technically and economically feasible and the environmental effects of any such alternative means*" The identification of Alternative Means for each Project Component was stated to be "*largely based on technical expertise of the team, collaboration with subject matter experts, and research*." These Alternative Means were then "*refined through collaborative workshops with NSLI and select stakeholders*."	Alternative Means that were selected for further consideration from the workshops were presented as input to the filtering steps. However, while alternatives presented for filtering and further evaluation are agreed to be strong approaches, the range of alternatives that were considered and discarded within those workshops (prior to this final list), were not presented. While it is not practical to consider all alternatives, there appear to be some alternatives that were not recognized in the presented information. For example, relocation of waste via the existing pipeline back to the Pulp Mill property for containment may address some of the land constraints and conveyance challenge cited for the considered waste management Alternative Means. It is recognized there may be reasoning that this approach and others were discarded (and some reference to landfill constraints at the Pulp Mill site was made); but such reasoning is not presented explicitly.	RODD – Section 2.4.1 EIS – Section 2.2.1.1	CEAA, 2012 (S.C. 2012, c. 19, s. 52) IAA (S.C. 2019, c. 28, s. 1)
1c: Assessment of Presented Alternatives					
4	Options Filtering	The assessment of Alternative Means used two stages of binary screening filters to identify Alternative Means. The two filters applied were as follows: 1) the remedial approach must conform with project goals; and 2) the Alternative Mean must be technically and economically feasible.	Within the filtering of Alternative Means, Waste Management approaches to develop a new containment cell and use a combination of existing and new cells were discarded. The information presented regarding how these two approaches were discarded is not sufficient to confirm those decisions. In particular, it is considered that additional cell development is likely required as at least a contingency should the proposed cell capacity not be sufficient for the final volume of material to be managed.	EIS – Section 2.2.1.2 RODD – Section 4.2	

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
		These screening filters were applied to the identified approaches for the following components relating to this ETR: • Waste Management • Sediment Management • Wetland Management • Water Management	With regard to sediment management, stakeholder engagement indicated only one (removal) passed the first filter. The supporting discussion was brief but supported this conclusion. Both identified Alternative Means were noted to be carried forward for wetland management. With regard to water management, off-site management was considered cost prohibitive. This is a reasonable conclusion considering the volumes of bulk water estimated to be managed; however, it should be considered that there remain technical feasibility questions regarding the scope of on-site treatment necessary to meet the performance criteria. This is assessed further in Topics #23 and #25.		
5	Alternative Means Evaluations	The EIS follows the identification and evaluation of Alternative Means provided for various Project Components. As noted, Alternative Means were assessed for both technical and economic feasibility (as required within the CEAA 2012) as well as regulatory, environmental and social aspects. Alternative Means evaluated were assessed against the design requirements (functional, non-functional, performance, safety, operational and proven technology requirements) and application of the previously identified evaluation and weighting matrix.	Beyond the Scope Documents, the EIS references a Pilot Scale Testing Construction Report (GHD, December 23, 2019) and a HHERA study (GHD, March 25, 2020). It is noted that the EIS applied refinements included within these two additional studies in their assessment of the Alternative Means. It is assumed these cited “refinements” were relative to the Alternative Means and Feasible Concept assessments undertaken within the RODD. With the above recognition of “refinements” in the Alternative Means between the RODD and EIS, it is not explained how the technical and economic analysis varied from the RODD as a result of these refinements. For example, cost estimates (and associated quantities) appear to have been carried unchanged from the RODD to the EIS economic evaluation.	EIS – Section 2.2.1 Design Requirements document (September 12, 2017) Evaluation Criteria and Scoring Matrix Technical Memorandum (September 26, 2017)	Pilot Scale Testing Construction Report (GHD, December 23, 2019) HHERA (GHD, March 25, 2020)
6		Waste Management: Use of existing containment cell: Significant weight appears to have been given to the existing permit for the on-site containment cell (IA No. 94-032).	BGC has seen no verification that this permit can be extended to the proposed expansion and long-term use, which should be confirmed in the feasibility stage of the Project. Absent of that, it should be explored as the first step of any further planning. It is noted that the applicability of existing approvals for both the site containment cell and off-site facilities considered for disposal were discussed with Nova Scotia Environment (NSE). However, the parameters of these discussions, and documentation of any determinations made, were not contained within the Scope Documents. As noted within the Options Filtering discussion (Topic #4), the elimination of “new cell development”, as a standalone approach or coupled with use of the existing containment cell, from further assessment leaves open questions regarding both whether these approaches deserved further evaluation and how volumes exceeding the capacity of the selected preferred alternative might be managed. Further details regarding capacity concerns of the proposed re-design of the existing containment cell are outlined in Topics #19, #21 and #24.	RODD – Section 4.3.1 EIS – Section 2.3.1	1994 Industrial Waste Permit Approval No. 94-032
7	Technical Scoring of Alternative Means	The EIS presents the evaluation of the various evaluation components using a binary scoring system (Green or Red). Scoring within the RODD is more granular, employing a numerical score from 0 to 5. It is assumed that the Green designations within the EIS are intended to represent indicators with higher quantified scores within the RODD; and conversely, Red designations (within the EIS) are intended to represent indicators with lower quantified scores (within the RODD).	The methodology for quantitative scoring assignments within the RODD is not clearly presented. For example, for Waste Management: • Landfill disposal is considered less technically mature (score 4.7) than disposal with Geotubes® on site (score 5.0). The “track record” of traditional landfill disposal is significantly longer than Geotube® technology. • Reliability/effectiveness/durability is scored 4.6 for the Geotube® on-site disposal option; while off-site landfill disposal is scored 3.4. The score deficit for off-site disposal appears largely due to an interpreted deficit in likelihood of meeting performance criteria, and the impact thereof. • Community acceptance is scored the same (3.3) for the on-site and off-site disposal options. The reasoning for some of the sub-scores within that criteria category is not presented.	RODD – Section 4.4 and Appendix H EIS – Section 2.3	

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
			The interpretations leading to the above scores require further explanation, as it can be envisioned that alternate interpretations of the feasible concepts under these factors could be significantly different. The sub-scores provided in Appendix H provide some granularity to the overall indicator scores, but the determination of those indicator sub-scores is not presented.		
1d: Selection of Preferred Alternative					
8	Determination	The selected Alternative Means within the EIS are as follows: • Waste Management – Use Existing Containment Cell • Dredging – Removal in the Wet with Geotube® or Equivalent Dewatering • Wetland Management – Natural Attenuation (excepting portions designated to require ex-situ remediation within the HHERA) • Water Management o Bulk Water Management – Natural Attenuation o Leachate Management – Off-site Disposal	While BGC does not necessarily disagree with these selected Alternative Means being the strongest candidates, in BGC's opinion the deliberations toward these selections are not fully supported within the Scope Documents. It is assumed they are informed by the quantitative scoring presented within the RODD, and the roll up of this scoring presented within the EIS. It is noteworthy that the Waste Management decision (for example) resulted in weighted scores of 411 for use of the existing containment cell on site, and 375 for off-site disposal of waste. This is a difference of less than 10% and appears based on a design level that is preliminary. Therefore, some adjustment of scores based on alternative interpretations (as noted in Topic #7 above) or due to updated quantities, design details or implementation planning, might influence the determination of the preferred Alternative Means.	EIS – Section 2.3 RODD – Appendix H	HHERA (GHD, March 25, 2020)
9	Level of Design	The level of detail of the designs upon which the evaluation of Alternative Means was based appear to be varied between the two decision documents. It is understood that the EIS was produced later (2020 versus 2018 for the RODD) and is assumed to be based on a more detailed level of design for the Alternative Means.	Without a comparable level of detail of the design of Alternative Means, it is not clear how direct comparison of the options, or the evaluation components therein, was made. In addition to the level of design, some understanding of the implementation of the design is required to accurately evaluate the decision factors. Such information was not presented or referenced, so it is not clear that it exists to support the evaluations. It should be considered that final Alternative Means (a 'short list') be carried forward to at least a 60% design level to confirm that the selected approach is the strongest with respect to all of the design considerations.	EIS – Section 2.3 EIS – Section 3	
10	Economic Evaluation	The selection of the preferred alternative appears to have been undertaken at a conceptual level of design – based on the design details presented within the RODD and EIS reports. The identified preferred alternative is understood to have been progressed to detailed design.	BGC did not undertake a critical analysis of the cost estimates provided within the Scope Documents. However, given the magnitude and complexity of the remedial approaches (and the overall remediation approach) under consideration, economic comparison at a conceptual level of design has large margins of uncertainty. In addition, the logistical challenges and implementation details for the various remedial tasks would likely have significant impact on the costs, and not be quantifiable without more detailed design and potentially a preliminary execution plan (see Topic #9). It is noteworthy that the cost estimate numbers cited within the EIS relate to cost estimates developed within the RODD, where significantly different volumes were under consideration.	EIS – Section 2.3 RODD – Appendix D	
11	Uncertainty/ Risk	Uncertainty in the total volume of waste to be managed is recognized within the RODD and EIS. In addition, the pilot testing results indicates significant uncertainty in the achievable volume reduction of the managed waste to be contained, and the timing of achieving that (dewatered) volume reduction.	A significant variance in either total waste volume or achievable volume reduction could result in the volume to be manage exceeding the capacity of the on-site containment cell selected as the preferred alternative. This is further explored within the assessment of Charge Question 2 below (Topics #19 to #21, #24). However, the risk arising from this uncertainty does not appear to have been accommodated in the scoring or selection of the preferred alternative.	RODD – Section 4.4 and Appendix H EIS – Section 2.3.1 EIS – Section 3 – Project Description	Pilot Scale Testing Construction Report (GHD, December 23, 2019)
2a: Design Robustness					
12	Wetland Sludge Volume	The wetlands include approx. 311,000 m^3 of sludge. The preferred alternative for management of this sludge is by natural attenuation; however, portions of the wetland are impacted above the risk-based criteria established in the HHERA (GHD, March 25, 2020) and therefore will require dredging and disposal into the Geotubes® (EIS, Section 2.3.8).	Section 3.1.3 of the EIS states that interpreted limits of wetlands and estuary requiring remediation (dredging) have been established, however further sampling was being conducted to refine the limits. It is not evident in the EIS Report what percentage of the 311,000 m^3 wetland sludge will be stored in the Geotubes® and if there is a storage allowance/contingency for additional impacted wetland sludge if discovered by further sampling.	EIS – Sections 2.3.8 and 3.1.3	HHERA (GHD, March 25, 2020)

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
13	Fine-grained Subsurface Conditions and Berms	The existing containment cell liner consists of a 0.6 m (thick) clay liner. An estimated 0.15 m of existing clay liner will be removed during removal of the existing sludge due to disturbance from heavy equipment and increased moisture content. The new cell design includes a GCL placed directly on the existing clay liner. The existing cell containment berms were constructed of the fine-grained till borrowed from on-site excavations.	The existing clay liner and berms are comprised of fine-grained soils which are susceptible to deterioration under wet conditions, thawing, frequent heavy trafficking, etc. The condition of the existing clay liner following removal of the existing sludge is unknown; however, there is potential for the clay liner to be over-wet. Regarding the cell's containment berms, the Operation and Maintenance Manual for the existing containment cell (Jacques Whitford Environment Ltd., September 20, 1999) recommended that no traffic be allowed on the north and south berms during extended periods of inclement weather or during thawing periods. The fine-grained soils at the site will present challenges in terms of constructability, which could weigh heavily on potential construction schedule delays, increased construction costs, and even feasibility of the approach and it is unclear whether these risks have been assessed for the Project. Further, BGC is of the opinion that there is a potential for more than 0.15 m of existing clay liner to be removed during the waste removal work given the liner's susceptibility to deterioration under heavy equipment trafficking and increased moisture content.	EIS – Section 3.2.1.1	Nilex Bentomat/Claymax (Geosynthetic Clay Liners) Installation Guidelines Operational and Maintenance Manual (Jacques Whitford, September 20, 1999) Section 3 and Section 4.2.2
14	New Containment Cell Side Slopes	BGC understands that the proposed height of the stored waste will be approximately 25 m above the base liner. Further, during Phase 1 of the Geotubes® filling test trial (as part of the pilot scale study; GHD, December 23, 2019), each of the Geotubes® dewatered at slightly different rates resulting in differential settlement between the bags.	Based on Figure 3.1-3 (Figure 2-2 herein) of the EIS Report, waste will be stored as high as 25 m above the base liner at the southeast portion of the containment cell. The construction execution plan to achieve this height is not demonstrated in the available Scope Documents. Further, BGC has not been provided information or analyses that demonstrates that 3H:1V or even 4H:1V containment cell side slopes (shown on Figure 2-2) are stable, including the proposed perimeter containment berms. Although differential settlement was observed as part of the pilot scale study, no comments were provided on the potential for long-term consolidation of the Geotubes®. The GHD (December 23, 2019) study report noted that WSP were preparing a memorandum providing recommendations for the Geotube® stacking and containment cell side slopes (memorandum not provided to BGC).	EIS – Section 3.1.1	Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.5.5
15	Final Cell Cover System - Geomembrane	The proposed containment cell final cover system comprises a polyethylene geomembrane liner, underlaid and overlaid by sand layers, as noted in the RODD (Figure D6).	BGC has not been provided information that evaluates the impacts, if any, of long-term consolidation of the sludge. If long-term consolidation and/or differential settlement of the Geotubes® occurs (as discussed in Topic #14), the cover geomembrane liner may undergo high tensile strains resulting in stress cracking and the development of holes. The potential for holes in the geomembrane cover liner has not been considered as part of the 2020 Hydrologic Evaluation of Landfill Performance (HELP) model (GHD, February 12, 2020a).	RODD – Section 6 2020 Boat Harbour Sludge Disposal Cell HELP Modelling, Section 3.3 (GHD, February 12, 2020a)	Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.5.2
16	Final Cell Cover System – Sand Placement	Based on the Remedial Option Decision Document (RODD) Report (Figure D6), the proposed containment cell final cover system could comprise a polyethylene geomembrane liner, underlaid and overlaid by sand layers.	Based on Figure D6, the cover geomembrane liner is founded on a 0.3m thick layer of sand. BGC infers that this sand layer is placed directly over the Geotubes®/sludge material. BGC assumes that the sand layer would be placed and graded with a dozer and compacted to achieve a specified density for the geomembrane liner installation. BGC considers there may be a risk that the sand layer's subgrade materials (Geotubes®/sludge material) will not have sufficient bearing and shear capacity to support construction equipment during sand placement/compaction.	RODD – Section 6	
17	Cover System Hydrologic Modelling	The HELP Model (GHD, February 12, 2020a) assumed a final cover of 0.15 m topsoil and hydroseed, 0.3 m sand drainage layer, 60-mil high density polyethylene (HDPE) geomembrane and 0.3 m sand grading layer (Section 3.3). The entire cell was modelled with 4H:1V side slopes, as 94% of the conceptual final cover design is side slopes (Section 2.1). Results from the final cover scenario indicate 0.002 percent of precipitation is estimated to infiltrate the waste layer and contribute to leachate generation (Section 5).	Although most of the proposed final cell design is comprised of the side slopes, the omission of the crown of the landfill (i.e., 6%, or where runoff percent is anticipated to be lower) in the HELP modelling may contribute to an underestimation of the leachate generation from the containment cell in post-closure. As well, the final cover materials and 4H:1V side slopes assumed in the HELP closure model scenario do not align with the guidance outlined in Section 2(g) of the Nova Scotia Industrial Landfill Guidelines (Nova Scotia Environment and Labour, May 26, 2005), which would be required as part of an application for an amendment to the Industrial Approval for the existing containment cell (IA No. 94-032). Specifically,	Boat Harbour Sludge Disposal Cell HELP Modelling (GHD, February 12, 2020a)	1994 Industrial Waste Permit Approval (No. 94-032)

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
			Section 2(g) – Closure states the final cover should consist of "*approximately 1 m of silty clay underlying a minimum of 0.3 m of topsoil*" and "*the final grade is not to exceed 15%*".		
18	End-Dumped Sludge Placement	The EIS report indicates that sludge will be end-dumped in 1 m to 3 m thick lifts in the containment cell to fill the gaps (i.e., air space) between the Geotubes®, followed by compaction of the sludge.	The water content of the sludge is expected to be high and thus unlikely able to support conventional compaction equipment. Further, it is unclear how the end-dumped sludge will be contained during construction so that it does not flow over the perimeter berms. Further, it is unclear whether the end-dumped sludge has the potential of "blinding off" the Geotube® geotextile material, ultimately reducing the dewatering rate and/or decreasing the overall dewatering volume.	EIS – Section 3.2.2.1	
19	Mechanical Dredging	Mechanical dredging, using a CAT 320D excavator in dewatering areas, was performed as part of the pilot scale testing (GHD, December 23, 2019). The 2019 report indicates that it was difficult to differentiate between the sludge and BHSL sediments, as the two materials mixed throughout the operation.	Over-dredging, that is dredging of native sediment materials not intended to be removed, would result in a higher than expected volume of material requiring storage in Geotubes®, potentially exceeding the design containment cell storage volume.		Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.3.4
20	Slurry Percent Soils	During the pilot scale resting (GHD, December 23, 2019) the average slurry percent solids of dredged waste was 5.2% for Phase 1 and 2.4% for Phase 2, and as low as 1% – 1.5% during either phase. The target/planned slurry percent solids was 5% for the testing program.	The pilot study showed that pumped slurry had a lower than expected percent solids. If a lower than planned slurry percent solids is also realized during construction, the Geotube® dewatering period may be extended, resulting in potential construction schedule delays.		Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.2.2.2
21	Geotube® Sludge Volume Reduction	During the pilot scale testing (GHD, December 23, 2019) the Geotubes® rapidly dewatered initially; however, much of the volume reduction occurs over time. For example, during Phase 1 the first layer of Geotubes® went from a bulking factor of 35% to a 28% volume reduction overall (i.e., net volume change of 63%) after four months. Further, a Geotube® (G6) was filled to capacity four times before its sludge storage capacity was maximized.	As part of the 2019 pilot scale study, coagulation and flocculation techniques were used to separate suspended solids and contaminants from the dredged slurry. The process included the addition of an anionic acrylamide-based polymer. Some polymers can increase bulking in sediments (Hayes, Geobag Loading Analysis), which may have contributed to the 35% bulking during the 2019 pilot study. Extended Geotube® dewatering periods, due to sediment (waste) bulking in addition to the need to refill the Geotubes® to maximize their capacity, may lead to construction schedule delays. BGC understands that the rapid dewatering assumption was used to support the selection of the Alternative Means.		Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.5.5 Geobag Loading Analysis, Donald. F. Hayes
22	Compliance Assessment	A Hydrogeologic and Hydraulic Assessment (HHA) for the modified containment cell was undertaken by GHD (February 12, 2020b), which included a predictive water quality mass-balance calculation to assess future leachate quality under post-closure conditions. The water balance inputs were based on the HELP modelling (GHD, February 12, 2020a), whereas the site-specific leachate quality data was modelled based on the (single) underdrain liquid sample collected from MH-1 as part of the HHA study leachate quality. Findings presented in GHD (February 12, 2020b) state that leachate from the containment cell will be "*sufficiently attenuated to meet applicable provincial and federal standards and guidelines*…" (Section 6.3, GHD, February 12, 2020b)	The mass-balance calculation included a single sample collected from the current underdrain, which does not reflect a robust dataset nor does it consider the potential changes in chemistry following chemical dosing of the sludge/sediment with placement in the Geotubes®. The anticipated chemistry of the dewatering effluent, as noted in the bench-scale or pilot scale testing, does not appear to have been considered in this prediction of water quality compliance. As well, as noted above in Topic #17, a review of the HELP modelling suggests the future leachate volume estimates may be underestimated based on the model assumptions. Overall, the predicted post-closure leachate quality presented in the HHA may require revisions and the HHA recommendation that detailed design for the vertical expansion of the containment cell can proceed may need to be revised. If such revisions are realized, then a review of how the HHA original results were integrated in the decision of the selected Alternative Mean may be warranted.	Hydrogeologic and Hydraulic Assessment – Containment Cell (GHD, February 12, 2020b) Boat Harbour Sludge Disposal Cell HELP Modelling (GHD, February 12, 2020a)	
23	Compliance Monitoring	Monitoring plans to assess the design robustness of the proposed water treatment methods (i.e., natural attenuation, TLTF, off-site disposal) are not discussed widely within the received documents nor are details provided (e.g., frequency, location) beyond the proposed length of the monitoring program.	The Water Management component of the Project involves many types of leachate/effluent and treatment methods, which suggests a robust sampling/monitoring program and quality assurance and quality control (QA/QC) plan are warranted to understand the potential changes to chemical conditions of the effluent over the duration of the Project and in post-closure, as well as the ability for on-site treatment to meet site-specific performance criteria. Details of such plans or the roles and responsibilities of the parties to develop and implement these programs are not understood from the documents reviewed.	EIS - general	

Review Topic		Description of Topic	BGC Discussion	Scope Document(s)[1]	Extra-Scope Document(s)[2]
2b: Design Efficacy					
24	Sludge Volume and Overall Reduction	The results from pilot scale testing highlighted the uncertainty with several assumptions that have direct implications on the ultimate storage capacity of the proposed containment cell design.	Due to uncertainty in both the total volume of sludge to be contained and the achievable reduction in that volume during remediation, the redesign of the existing containment cell may have insufficient storage capacity, even if the 3:1 side slopes (see Figure 2-2) are achievable. Contingency sludge storage methods may need to be considered for final design.		Pilot Scale Testing Construction Report (GHD, December 23, 2019)
25	Temporary Leachate Treatment Facility (TLTF)	All water that comes in contact with the sludge/sediment will be managed as leachate (Section 3.1.4, EIS) and, during the interim period between dredging completion and final cover placement, leachate would be conveyed to a nearby TLTF. The anticipated time frame of the interim period is 1 to 2 years following dredging and a few months following closure of the cell. The TLTF will include four steps: coagulation, sedimentation, filtration and adsorption, which were tested at the bench scale (RODD) and pilot scale (GHD, December 23, 2019)	Pilot scale testing included analysis of the slurry, dewatering effluent from Geotubes® and effluent from the TLTF treatment method. The results shown in the pilot scale testing report are promising and suggest the proposed methods are adequate to reduce parameter concentrations to below the applied comparison criteria. However, the number of samples collected as part of the pilot scale is limited, when reviewing the results to assess the efficacy of the full-scale treatment system, and scaling these results to reflect the (up to) approximately 1 Mm^3 of sludge/sediment to be dewatered/stored presents uncertainty. It is not understood if this uncertainty will be captured by an appropriately sized monitoring and sampling program to be implemented as part of construction and initiation of the Project and who will be responsible for the development and implementation of this plan. As noted in the pilot scale testing report (Section 3.6.4; GHD, December 23, 2019), "*the selection of each treatment unit for full-scale design will highly depend on the final effluent discharge criteria currently being established in conjunction with NSE.*" Therefore, while pilot scale test results indicate the treatment methods are effective, there remains some uncertainty as to whether the on-site TLTF would comply with the performance criteria (in development), which would have a significant impact to the alternatives assessment carried out for the Water Management component of the Project. Pilot scale testing also included the treatment of bulk water, which was shown to be effective at reducing parameter concentrations to below comparison criteria with the addition of an organo-clay media to its four-step system (i.e., between the filtration and adsorption steps) to reduce the concentrations of long-chain organics (e.g., Total Petroleum Hydrocarbons). The preferred alternative for bulk water management assumed natural attenuation via discharge to the BHSL based on the assumption that water quality within the BHSL and at Point C will be improved with the cessation of effluent flow into the BHETF in 2020. Section 3.1.4 of the EIS indicated monitoring in 2020 showed decreasing concentrations of contaminants of concern (COCs), but this data has not been provided for review.	EIS - Section 3.1.4 RODD	Pilot Scale Testing Construction Report (GHD, December 23, 2019)
26	Disposal of waste in Existing Containment Cell	Use of the existing containment cell would require the temporary relocation of the waste currently residing there (~180,000 m3), while the base liner and leachate collection system is enhanced.	This step in the remediation does not seem to be considered in detail within available documentation.	RODD - Section 4.3.1, Appendix D and G	

Notes:
1. Scope Document set provided in Section 1.1
2. Extra-Scope Documents provided by the Agency following Meeting #1, as requested by BGC to support details provided within the Scope Document(s), as well as other documents publicly available for review. It should be noted that references of the HHERA (GHD, March 25, 2020) document were not reviewed. BGC assumes the presentation of these details in the EIS document are accurate and correct.

5.0 CONCLUSIONS

The following conclusions associated with Charge Question 1 and Charge Question 2, as summarized in Sections 5.1 and 5.2, respectively, are based on the review of the Scope Documents, with supplementary information supplied by the Extra-Scope Documents.

5.1. Charge Question 1

As discussed in Section 4.0, the evaluation of Charge Question 1 was divided into four elements to assess the alternative assessment process implemented to identify alternatives and select a preferred alternative for each of the remedial components of the Project. A summary of the main conclusions related to the evaluation elements is documented below.

1. Alternative Assessment Process: In BGC's opinion, the information presented within the Scope Documents did not fully support the development of the design requirements and evaluation criteria. The described engagement of stakeholders and subject matter experts in the alternatives assessment process is well conceived and appears to have been undertaken at reasonable points in this process. The details of the stakeholder input and discussions were not presented in the Scope Documents; therefore, conclusions on whether the selected design requirements and evaluation criteria accommodate that input cannot be made.
2. Range of Alternatives Assessed: The full range of alternatives assessed within Step 1 of the seven-step assessment project (i.e., removed from consideration during the workshops, prior to the application of screening) was not available in the documents reviewed by BGC. As such, it is not possible to make an assessment of the range of alternatives assessed. The Alternative Means selected for further consideration appeared reasonable; although, in BGC's opinion, confirmation of the reasoning regarding why some approaches were not carried to Step 2 is needed to confirm that the Alternative Means carried forward in the study were comprehensive.
3. Assessment of Presented Alternatives:
    a. Regulatory Assessment: The assessment refers to discussions with NSE regarding both the viability of adapting the permit (IA No. 94-032) of the existing containment cell and the challenges of accepting the waste at off-site permitted facilities. This assessment is crucial to the consideration of both on-site containment and off-site disposal alternatives; however, the details of these discussions were not available for review to assess this aspect of the evaluation.
    b. Technical Assessment: The removal of options that included development of a new containment cell on-site (either in addition to or in replacement of the existing cell) were not fully supported within the Scope Documents. The removed options (additional cell) are likely necessary as a contingency to increase the containment capacity beyond the maximum of the existing containment cell, due to uncertainty regarding the final dewatered sludge volume. Off-site disposal should also be preserved as a potential contingency for management of excess waste volume.

   c. Economic Assessment: The economic assessment of the two Feasible Concepts (for Waste Management) under consideration appears to have been undertaken with disparate levels of design. This leaves uncertainty regarding the comparability of the cost estimates within the economic assessment.

4. Selection of Preferred Alternative: The selected alternative identified within the EIS included use of the existing containment cell for waste storage, dredging (in the wet) and dewatering the sediment, (primarily) natural attenuation for the wetland management and bulk water management, and off-site disposal of post-remediation leachate. While BGC does not necessarily disagree that these Alternative Means may be the strongest candidates, the deliberations toward these selections are not fully supported in the Scope Documents. It is noteworthy that the quantified score differential between the two waste management Alternative Means (within the RODD) was within 10%. Given the level of design presented and the uncertainty in the waste quantities to be managed, it appears that a higher level of design of waste management (in BGC's opinion, a 60% design) is warranted to confirm the determination of the preferred alternative.

5.2. Charge Question 2

Charge Question 2 focused primarily on an assessment of the design robustness and efficacy of the preferred Alternative Mean (associated with the Waste Management component of the Project), which is to store contaminated sludge/sediment in the existing, but modified containment cell. BGC's review associated with this Charge Question also considered the preferred Alternative Mean associated with Dredging, Wetland Management and Water Management components of the Project as these alternatives are directly or indirectly associated with the containment cell design. A summary of the main conclusions related to the evaluation of the design's robustness and efficacy is documented below, which highlights several uncertainties and, therein, outstanding information/clarification needs.

1. Design Robustness:
   a. GCL Subgrade Preparation: The existing containment cell is currently storing up to 180,000 m^3 of sludge. For construction of the new containment cell, removal of this sludge is required which will expose the existing clay liner. The project site, including the existing clay liner (0.6 m thick), comprises native fine-grained soils that are susceptible to deterioration in quality due to an increase in moisture content (see Topic #13; Table 4-1). The existing clay liner is understood to be the subgrade for the proposed GCL, with a nominal thickness of 0.45 m left in-place following the sludge removal work. Insufficient information has been provided to assess how execution of the GCL subgrade preparation will be achieved, considering that adverse residual sludge and wastewater impacts are probable.
   b. End-dumped Sludge in Cell: Sludge will be end-dumped (in 1 m to 3 m thick lifts) to fill air space between the Geotubes®, followed by compaction. It's unclear if the end-dumped sludge will placed to the final sludge design elevation; however, insufficient information has been provided to demonstrate the sludge can be

satisfactorily compacted to maintain the design side slopes and provide a competent subgrade for the cover liner system (see Topics #16 and #18; Table 4-1). Furthermore, insufficient information was available in the BGC review to demonstrate how the end-dumped sludge will be contained without flowing in an uncontrolled manner out of the containment cell.

c. Containment Cell Geotube® Storage Capacity and Constructability: The results presented in the Pilot Scale Testing Construction Report (GHD, December 23, 2019) was noted to be thorough, but highlighted potential challenges with the storage capacity, timing and constructability of the proposed contaminant cell design. These uncertainties, in terms of the containment cell design in achieving the project objective, are discussed further below.

d. Slope Stability of Cell Perimeter Berms: The integrity and current condition of the existing perimeter containment berms is not discussed within the Scope Documents; however, BGC understands that the berms were constructed of sandy silt till in controlled, compacted fill lifts. The existing perimeter berms will form the lower portion of the proposed modified structure of the containment cell. An assessment of the lateral/slope stability of the perimeter berms to support the Geotubes®/sludge loading is not documented in the Scope Documents and thus it is unknown if such a stability analysis has been considered for design.

e. Slope Stability of Cell Final Cover System: Based on Figure 3.1-3 in the EIS Report (and reproduced in Figure 2-2), the stored sludge may extend as high as 25 m above the base liner system. Insufficient information has been provided to demonstrate that the containment cells 4H:1V or 3H:1V side slopes meet a minimum factory of safety criteria in terms of global stability. Furthermore, the performance of the final cover system considering potential consolidation of the stored sludge is not discussed within the provided documents. As well, the long-term integrity of the geomembrane liner has not been demonstrated in the available documents.

f. Sampling and Monitoring Program: A substantial volume of contact water and/or effluent produced as part of the Project will require a range of treatment methods (i.e., on-site, off-site natural attenuation). Therefore, the Water Management component of the Project warrants an appropriately robust sampling, monitoring and QA/QC plan to monitor the chemical changes of the treated and/or discharged effluent over the duration of the active remediation of the Project and assess its compliance with site specific performance criteria to be established. An adequate level of detail regarding such plan(s) or the roles and responsibilities of the parties to develop and implement these programs has not been demonstrated in the available documents.

2. Design Efficacy:

a. Handling of Existing Stored Sludge: It is unclear whether the cost for sludge removal from the existing cell, temporary storage in the existing Settling Basins or ASB and “double handling” for final storage in the new containment cell was considered as part of the cost estimate provided in the RODD.

b. On-site Treatment Facility: The pilot scale testing program carried out by GHD (December 23, 2019), to assess the proposed TLTF, presented promising results that were used to support the alternatives assessment for Water Management. However, the results presented as part of that study are considered to be limited in consideration of the anticipated volume of sludge/sediment to produce dewatering effluent and/or contact water from consolidating sludge or bulk water requiring treatment. Additionally, as the site-specific water quality performance criteria are in development, it is understood that the results of the pilot scale testing should be revisited to re-affirm the stated outcomes and recommendations from that study.

c. Potential for Insufficient Cell Storage Capacity: BGC have noted uncertainties related the total volume of sludge to be contained. In BGC's opinion, there are three main factors that can contribute to exceeding the containment cell's design storage volume, namely:

    i. An increased volume of sludge removed from the Wetland (Topic #12).
    ii. Over-dredging resulting in the removal of clean in-situ materials not intended to be stored in the cell (Topic #19).
    iii. An actual sludge volume reduction factor lower than that used for design (Topic #24).

    BGC's opinion aligns well with a statement provided in the Project Description document (GHD, 2018) being, "*The final volume to be disposed can only be determined once the remediation is complete*...". BGC is of the opinion that, should the identified preferred alternative (on-site containment) proceed, a secondary on-site containment cell and/or off-site containment/disposal should be reconsidered as a contingency design given the potential need for additional sludge to be managed and stored. A secondary on-site containment cell would likely enhance the constructability of the Project by adding more area for Geotube® placement, equipment accessibility, and improve construction sequencing. Such contingencies would need to be developed in advance of the work. In addition, as noted in the assessment of Charge Question 1 (conclusion 4) (Section 5.1), the decision to select the expanded on-site containment cell as the preferred alternative for waste management might require reconsideration.

d. Overall Constructability: The construction implementation of the Project is not discussed in detail within the Scope Documents, specifically related to the GCL subgrade preparation, placement, filling and refilling of Geotubes® and subgrade preparation and grading for the final cover geomembrane liner. For example, the documents do not explain how an empty Geotube® is placed at a height of 25m above the base liner (see Figure 2-2) and how Geotubes® at such a height are filled and refilled with sludge as needed. As such, after reviewing the Scope Documents there are several questions outstanding related to the constructability of the presented design.

e. Remedial Implementation: The remedial implementation timeline has the potential to be heavily influenced/altered by several factors associated with the proposed

Geotubes® technology, specifically, the construction execution details associated with placement of empty Geotubes®, filling of Geotubes® with sludge, expected dewatering duration, expected number of refills needed to maximize storage capacity and accessibility to placed Geotubes®. Further, below-freezing ambient temperatures will likely impact the Geotubes® filling, stability and dewatering as demonstrated in the 2019 Pilot Study. A construction execution plan that addresses these work components was not made available to BGC for review. BGC is of the opinion that a thorough Geotubes® construction execution plan, that is to be implemented during the work, is critical for the successful completion of the Project. In addition, differential dewatering/consolidation of the Geotubes® has implications for the design's overall slope stability, constructability, cover liner performance, and construction time frame. Such challenges may be overcome with, for example, appropriate contingency design(s), construction sequencing and detailed implementation designs; however, documentation of studies that address these challenges were not made available to BGC for review.

6.0 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:

<Original signed by>

<Original signed by>

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SB/EC/ne/mm

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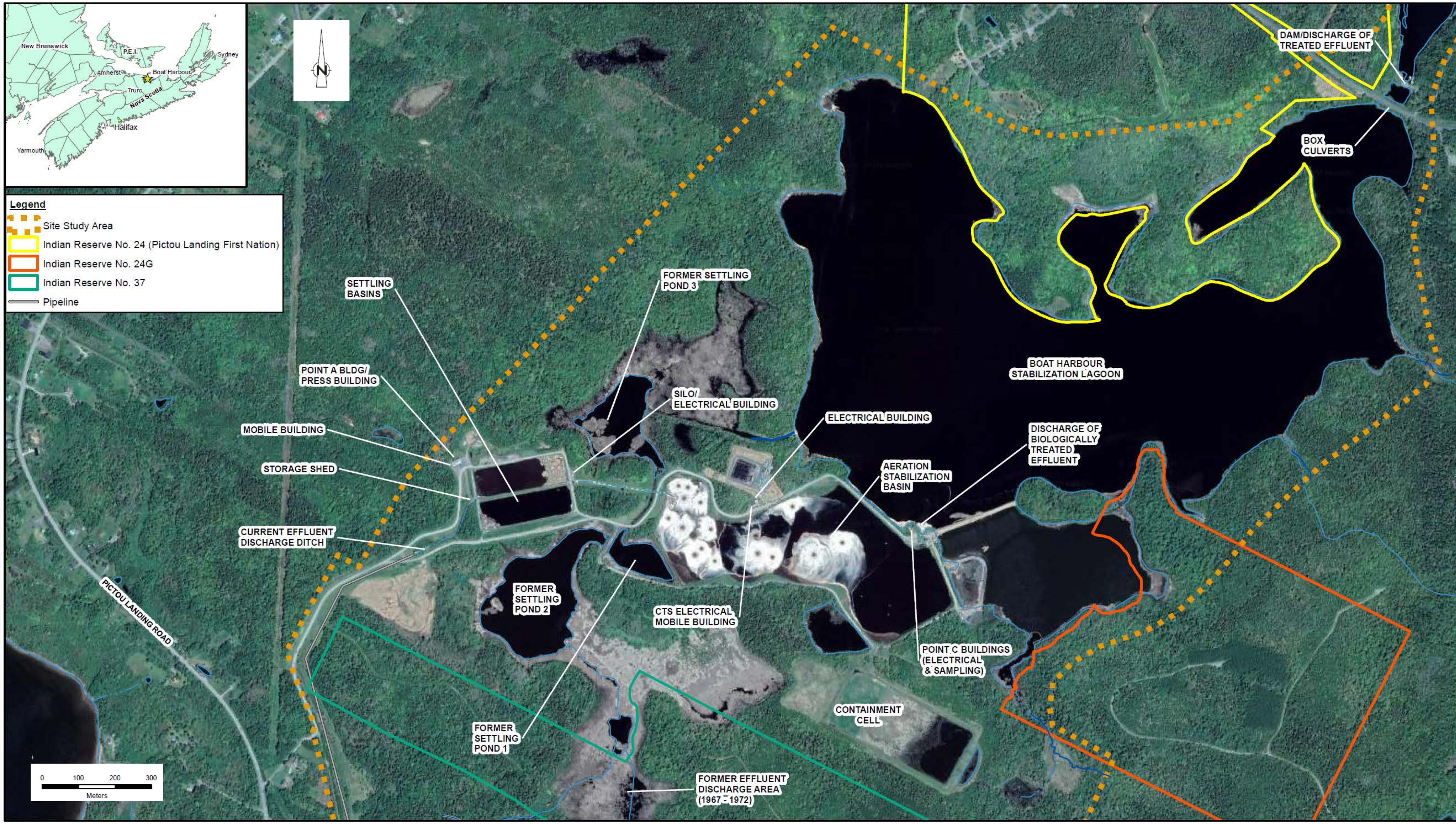
[5] Reference date not provided in the document received, but inferred based on electronic communication from the Agency on October 13, 2020 indicating the revised EIS had been submitted by the Proponent.

FIGURES



NOTES

1. This figure should be read in conjunction with BGC's report "Boat Harbour Remediation Project – External Technical Review – Final", dated January 29, 2021.
2. Figure modified from Figure 3.1-9 from the Project's Environmental Impact Statement (EIS), Volume II – Section 3 (NSLI, October 2020).
3. Source: Imagery @2017 Google CNES/Airbus, DigitalGlobe, Landsat/Copernicus; WSP Canada Inc.
4. Coordinate system is North American Datum (NAD) 1983 CSRS UTM Zone 20N.
5. Point D monitoring station not shown, but is understood by BGC to be consistent with "Dam/Discharge of Treated Effluent" location in northeast of the above figure based on Figure 2.1-1 from the EIS (NSLI, October 2020).

PREPARED BY: SB	FIGURE TITLE: SITE PLAN		
CHECKED BY: RC	CLIENT: IMPACT ASSESSMENT AGENCY OF CANADA		
APPROVED BY: EC	SCALE: AS SHOWN	PROJECT NO: 2155-001	FIGURE NO: 2-1

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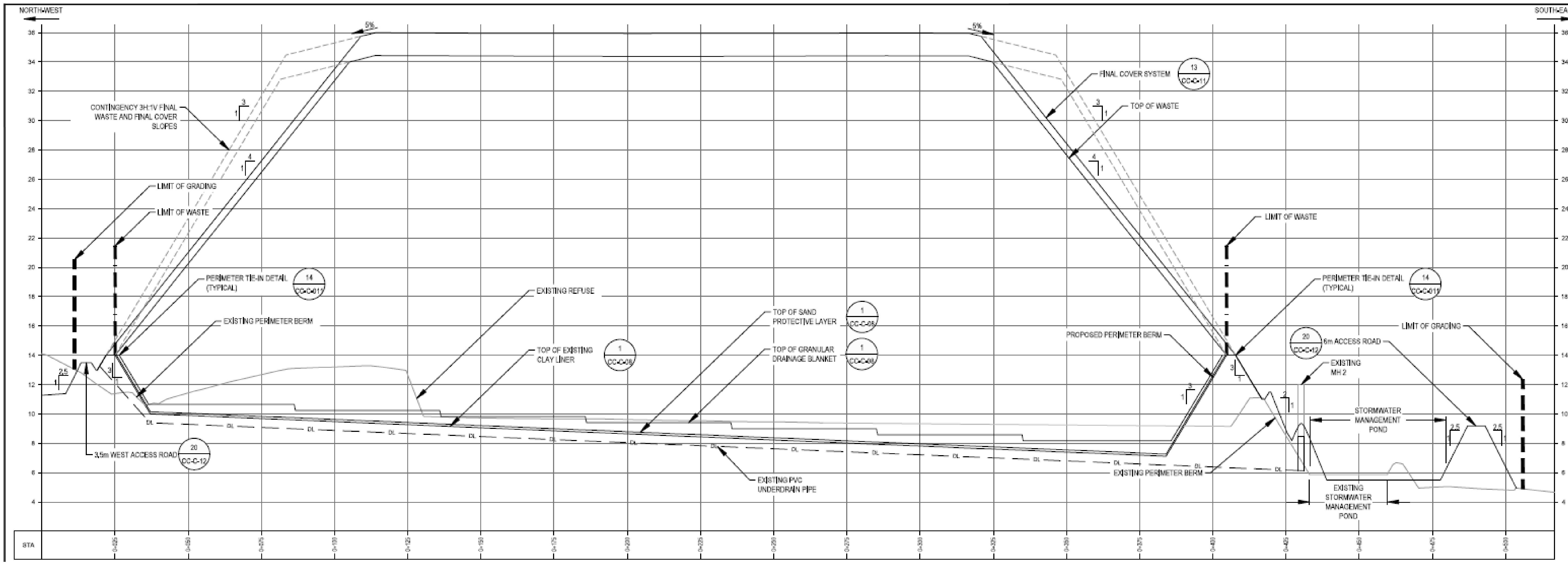

NOTES
1. This figure should be read in conjunction with BGC's report "Boat Harbour Remediation Project – External Technical Review – Final", dated January 29, 2021.
2. Figure modified from Figure 3.1-3 from the Project's Environmental Impact Statement (EIS), Volume II – Section 3 (NSLI, October 2020).

PREPARED BY: RC	FIGURE TITLE: CROSS-SECTION OF CONTAINMENT CELL		
CHECKED BY: SB	CLIENT: IMPACT ASSESSMENT AGENCY OF CANADA		
APPROVED BY: EC	SCALE: NTS	PROJECT NO: 2155-001	FIGURE NO: 2-2

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