4th Floor, Centennial Building
1660 Hollis Street
Halifax, NS B3J 1V7

NSLands
nova scotia lands

July 18, 2022

Lachlan MacLean
Impact Assessment Agency of Canada

Re: Information Request Response – Round 2 Part 1

Dear Mr. MacLean;

Nova Scotia Lands Inc. is advising you that responses to Round 2 Part1 Information Requests (IRs) pertaining to the Boat Harbour Remediation Project Environmental Impact Statement (EIS) review are being submitted to the Agency today via posting to the Agency's Portal.

We trust that all is in order and if you have any concerns that you advise us as soon as possible.

Yours truly,

<Original signed by>

Ken Swain
Project Leader

Boat Harbour Remediation Project Response to Information Requests

Boat Harbour Remediation Project
Pictou Landing, Nova Scotia

Nova Scotia Lands Inc.

July 13, 2022

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Appendices

List of Acronyms

ASB	Aeration Stabilization Basin
ATSDR	Agency for Toxic Substance and Disease Registry
BH	Boat Harbour
BHETF	Boat Harbour Effluent Treatment Facility
BHSL	Boat Harbour Stabilization Lagoon
BHRP	Boat Harbour Remediation Project
CC	Containment Cell
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DABT	Diplomate American Board of Toxicology
DDOC	Decomposable Dissolved Organic Carbon
DFO	Fisheries and Oceans Canada
D/F	Dioxins/Furans
DPM	Diesel Particulate Matter
DTSC	Department of Toxic Substance Control
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
EDI	Estimated Daily Intake
EIS	Environmental Impact Statement
EMC	Environmental Monitoring and Compliance
EMP	Environmental Management Plan
EPC	Exposure Point Concentration
EQS	Environmental Quality Standards
ESA	Environmental Site Assessment
FCSAP	Federal Contaminated Sites Action Plan
FOC	Fraction of Organic Carbon
g	grams
GCL	Geosynthetic Clay Liner
GHD	GHD Limited
ha	Hectares
HC	Health Canada

HDPE	High Density Polyethylene
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
hr	Hour
IA	Industrial Approval
IAAC	Impact Assessment Agency of Canada
IPCC	Intergovernmental Panel on Climate Change
IR	Information Requests
IRR	Information Request Responses
ITRC	Interstate Technology & Regulatory Council
kg	kilograms
km	kilometres
LFG	Landfill Gas
m	metres
MECP	Ministry of the Environment, Conservation, and Parks
mg	milligrams
Mill	Kraft Pulp Mill
MRL	Minimum Risk Level
ng	nanograms
NOAEL	No Observed Adverse Effect Level
NMOC	Non-methane Organic Compounds
NSLI	Nova Scotia Lands Inc. or Proponent
NSECC	Nova Scotia Environment and Climate Change
OEHHA	Office of Environmental Health Hazard Assessment
PEPP	Project Environmental Protection Plan
pg	picograms
PHG	Public Health Goals
PLFN	Pictou Landing First Nation
POR	Point of Receptor
ppm	parts per million
PSTP	Pilot Scale Treatment Pad

PQRA	Preliminary Quantitative Risk Assessment
PRA-HHRA	Project Related Activities– Human Health Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose
RMP	Risk Management Plan
RMA	Risk Management Areas
RSC	Reduced Sulphur Compound
RSL	Regional Screening Levels
SAF	Soil Allocation Factor
SAR	Species at Risk
SPLP	Synthetic Precipitation Leachate Procedure
SSI	Supplemental Sampling
SSTL	Site Specific Target Levels
SWAC	Surface Weighted Average Concentration
TDI	Tolerable Daily Intake
TEQ	Toxic Equivalence
TLTS	Temporary Leachate Treatment System
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Value
TSERAWG	Tri-Service Environmental Risk Assessment Working Group
UCLM	Upper Confidence Level of the Mean
USEPA	United States Environmental Protection Agency
VC	Valued Component
VOC	Volatile Organic Compound
WHO	World Health Organization

1. Information Requirements for Boat Harbour Remediation Project Responses

The report documents the Information Request Responses (IRRs) prepared by Nova Scotia Lands Inc. (NSLI) in support of the Environmental Impact Statement (EIS) for the Boat Harbour Remediation Project (the Project or BHRP). NSLI received Information Requests (IRs) outlined in this document from the Impact Assessment Agency of Canada (IAAC) as follows:

– Round 2, Part 1 dated April 5, 2022

The Table of Concordance (Table 1.1) should be read in conjunction with this document. Each of the IRs are responded to in Section 2 of this document, with supporting information (where applicable) provided as a Figure or Appendices to this IRR document.

A number of the IRs included in the Round 2 document received from IAAC are related to future monitoring programs. NSLI would like to reiterate that the EIS outlined anticipated future monitoring requirements and programs in the Environmental Management Plan (EMP) and Project Environmental Protection Plan (PEPP), included as Appendix B of the EIS. Details of the programs will be included in the regulatory permitting required by Nova Scotia Department of Environment and Climate Change (NSECC), for the Project, and will be provided to the regulators following federal Environmental Assessment (EA) approval.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
Human Health Ecological Risk Assessment (HHERA)								
IAAC-33	IR(2)-33	**Project Effects Link to CEAA 2012:** 5(1)(c)(i) Aboriginal Peoples Health/ socio-economic conditions Choose an item.	HC	Section 7.3.7 - Mi'kmaq of Nova Scotia	HHERA (Appendix A), Section 6.4.3	Insufficient information/rationale is provided to support the soil allocation factors (SAFs) used to calculate the site-specific target levels (SSTLs) for vanadium and dioxins and furans. <u>Vanadium</u> The Proponent's response states, "[*a*]*n SAF of 1 was applied for vanadium, since background exposures (i.e., estimated daily intake or EDI) were included in the evaluation of risk for this contaminant.*" The EDI represents the total background exposure to a chemical and is not related to potential exposures to contaminants at the site. Any risks posed by contamination at the site should be determined by considering the SAFs. The inclusion of the EDI in the calculation of the SSTL is not related to the use of a specific SAF value. The SAF is the relative proportion which is allowable for soil (or sediment) to constitute in the Residual Tolerable Daily Intake (RTDI = TDI - EDI) from various environmental pathways. When a contaminant of potential concern (COPC) is present in all five media (i.e., air, soil/sediment, food, water, and consumer products), a SAF of 0.2 should be applied. If there is defensible, contaminant-specific evidence that exists which demonstrate that the contaminant is not present in a given medium, the RTDI may be distributed amongst fewer media and the SAF may be increased from 20% to a value given by: SAF = 100% / (number of applicable exposure media)[1] The Proponent excluded water and air from applicable exposure media for vanadium as levels in groundwater/surface water are below the guidelines and levels in soil are below the background concentration (Appendix A of the EIS). The Proponent concluded that, "*the only applicable exposure media remaining at the Site for vanadium are sediment and food*." However, when calculating a SAF, all environmental media in which the contaminant is present (even if it exists at levels below background concentrations and/or the applicable guidelines) should be considered. Given the potential exposures via ingestion of water and inhalation of airborne soil particulates at the site, water and air should be considered as applicable exposure media for vanadium, in addition to sediment and food. <u>Dioxins and Furans</u> The Proponent's response states "*since the EDI associated with background exposure to dioxins/furans is greater than the tolerable daily intake (TDI), theoretically,* residents/Pictou Landing First Nation (PLFN) cannot be safely subjected to any increased exposure. As a result, the Health Canada and CCME default SAF of 0.2 was assumed for dioxins/furans." However, the proposed approach is not consistent with the Canadian Council of the Ministers of the Environment (CCME) protocol recommended to be followed for the derivation of soil quality guidelines in cases where EDI > TDI.	A. Update the SAF and SSTL calculations for vanadium to include water and air as applicable exposure media. Should this re-calculation result in an unachievable remediation target, characterize the risk of not meeting the updated SSTL, provide detailed information about the mitigation measures and administrative controls that would be used to manage the risks (including impacts to future land use), and present a high level overview of the monitoring plan to re- evaluate the risk over time. B. Update the SSTL for dioxins/furans using one of the following recommended alternative methods: • Set the SSTL to background concentration[1] ; or • Calculate provisional SSTLs based on 20% of the TDI, as well as based on 10% of the EDI, in the equations used to calculate the SSTL[2,3]. Select the lower of the two provisional SSTL values as the SSTL. If the SSTL value is lower than background concentration, set the final SSTL to background concentration. When using this approach, chemical-specific scientific rationale should be provided to verify whether the derived SSTL is protective of human health and has considered relevant toxicological data. Alternatively, should another method be used, provide a detailed rationale for any deviation from the approaches recommended. If the re-calculated SSTL is not technically achievable, characterize the risk of not meeting the SSTL, provide detailed information about the mitigation measures and administrative controls that will be used to manage the risks (including impacts to future land use), and present a high level overview of the monitoring plan to re-evaluate the risk over time.	Information requested is provided in Section 2 below.
IAAC-35	IR(2)-35	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.3.7 - Mi'kmaq of Nova Scotia	HHERA (Appendix A), Sections 6.3 (Toxicity Assessment) and 6.4 (Risk Characterization), Tables H-2.10 to H-2.22 of Appendix H	The sub-chronic Toxicological Reference Values (TRVs) or Minimal Risk Levels (MRLs) set by the Agency for Toxic Substances and Disease Registry are typically meant to be applied for a single period of exposure of specific duration: up to 14 days (acute MRL) and 15 to 364 days (intermediate MRL), and may not be protective of intermittent, repeated annual exposures within these timeframes, which could occur at Boat Harbour. It is unclear from the Proponent's assessment whether the complete elimination of contaminants of potential concern (COPCs) is likely to occur in between exposure events, particularly as an increasing body burden of a COPC can act as an ongoing source of exposure in between exposure events. Information on the bioaccumulation potential and biological elimination half-life of each COPC is required to assess the potential health risks to current and future users of the site from intermittent, repeated annual exposures to sediment contact. The discussion should demonstrate how each sub-chronic TRV and the key study it is based on is appropriate, in place of a chronic TRV.	A. Provide a discussion on how the selected TRVs are appropriate for intermittent, repeated annual exposures on a chemical-specific basis. The discussion should include: - information on chemical half-lives; - duration of the key study that the TRV is based on; and - whether peak exposure or total concentration is driving toxicity using the tiered framework[4,5]. B. In the event the use of a sub-chronic TRV cannot be justified, update the risk assessment using chronic TRV values. Update any SSTLs, as necessary, based on the results of the risk assessment. If any re-calculated SSTLs result in an unachievable remediation target, characterize the risk of not meeting the updated SSTL, provide detailed information about the mitigation measures and administrative controls that will be used to manage the risks (including impacts to future land use), and present a high level overview of the monitoring plan to re-evaluate the risk over time.	Information requested is provided in Section 2 below.
IAAC-36	IR(2)-36	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.3.7 - Mi'kmaq of Nova Scotia	HHERA (Appendix A), Section 6.1.1.7, Section 4.3.4, Figure 12	The Proponent provided insufficient information/rationale to support the selection of plant species used as surrogates to establish background concentrations. Section 4.2.5.2 of the Appendix A of the Human Health and Ecological Risk Assessment (HHERA) outlines an overview of the plant samples collected at the project site, which include a single species of cattails, four species of herbaceous plants, and four species of berries. However, based on data in Table C-2.3 of the Appendix A, only two plant species (i.e., cattails and bugleweed) sampled from the reference wetland were used to establish background concentrations. It remains unclear how the two plant species can serve as adequate surrogates to establish background levels for all the plant species (land and wetland-based) sampled at the project site, including fruit-bearing plants (e.g., berries) and the remaining three species of herbaceous plants.	A. Provide a rationale for the selection of the plant species and tissues used as surrogates to establish background concentrations in all plant species/tissues sampled, including a discussion on uncertainties associated with the selected species.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
IAAC-37	IR(2)-37	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC NSL&F	Section 7.3.7 - Mi'kmaq of Nova Scotia	HHERA (Appendix A), Section 6.4.3.6, Table 6.25 (Uncertainty Analysis) HHERA (Appendix A) Table H-1.12 Occurrence, Distribution, and Identification of Chemicals of Concern (COC) in Game Meat HHERA (Appendix A), Section 6.1.1.10 Game Meat (Mammals) COPCs	The Proponent provided insufficient information/rationale to support the exclusion of human consumption of terrestrial game mammals as an operable exposure pathway. The Proponent's response states that, "*terrestrial game animals were not included in the HHERA since there were no soil COPCs carried through the HHERA. Further, concentrations of the primary contaminants within the Study Area (i.e., dioxins/furans)* in soils at the Site are less than CCME background levels for soils across Canada. Concentrations in terrestrial game animals are expected to be consistent with background levels and much lower compared to aquatic wildlife that are directly exposed to the elevated concentrations of dioxins/furans in the sediment and the aquatic food items that have bioaccumulated contaminants from the sediments." However, it is inappropriate to screen out COPCs for the country foods pathway based on soil quality guidelines not being exceeded because the CCME dioxins and furans soil quality guidelines for the protection of human health6 are only protective of human health from incidental soil ingestion (and not necessarily protective of the food consumption pathway). Health Canada guidance states that, in the absence of guidelines/standards/criteria available for screening an environmental medium (e.g., country foods), the COPCs should be carried forward into a quantitative risk assessment to determine whether there may be health risks associated with the predicted concentrations7,8 . Health Canada guidance also recommends that, if receptors may be exposed to COPCs through multiple pathways, all potential exposure pathways should be included, regardless of the COPCs levels as they can still contribute to the overall project-related exposure and associated risks to human health.7 Furthermore, terrestrial mammals (e.g., snowshoe hare and white-tailed deer) would consume vegetation or other vegetative materials such as seeds and berries and it is known that bioaccumulation can occur in terrestrial game animals.	A. Update the conceptual site model (CSM) for Human Receptors and the quantitative risk assessment to include consumption of wild game as an operable pathway.	Information requested is provided in Section 2 below.
Project Related Activities-Human Health Risk Assessment (PRA-HHRA) and Risk Management Plan								
IAAC-40 IAAC-41 IAAC-49 IAAC-50 IAAC-52	IR(2)-40/41/49/50/52	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC ECCC	Section 3.2.3- Spatial and Temporal Boundaries Section 7.3.7 - Mi'kmaq of Nova Scotia Part 2, Section 7.1.4 Riparian, wetland and terrestrial environments	EIS, Figure 7.1-1 EIS Section 7.3.9.4.3 PRA-HHRA (EIS-Appendix A) Figures 3.1 and 3.5 Risk Management Plan (Appendix K) of the HHERA (EIS-Appendix A) Coastal Hydraulic Modelling Report (EIS-Appendix Z)	There are still questions around the potential health risks from the resuspension of contaminated sediments remaining in the freshwater wetlands and estuary through the 'suspended sediment in the surface water exposure pathway' and 'country food exposure pathway' in Boat Harbour and out in the Northumberland Strait. The Proponent's response to concerns around the delineation of contaminants in the risk management areas (RMAs) includes only a short conclusive remark that "*Multiple sampling programs have been conducted in the Study Area between 2018 and 2019, and through these sampling programs, the presence of COPCs has been sufficiently characterized and significant data gaps are not present*". However, no detailed information or clear rationale is provided to verify that the freshwater wetlands and estuary RMAs are sufficiently delineated. For example, RMA2 (Figure K2 of Appendix K of Appendix A) and RMA5 (Figure K-5 of Appendix A) do not appear to be laterally delineated beyond 19-FSP2-SED-32 / 19FSP2-SED-36 and FSP3-SED-12, respectively. While sample FSP3-SED-12 exceeds the dioxins/furans TEQ SSTL, no additional samples were presented beyond this point. Therefore, it is unclear how the delineation of the RMA was determined to be inclusive of all areas exceeding the SSTL and uncertainties remain on whether "hot spots" (i.e., areas with concentrations above the SSTL and significantly higher than The Proponent's response to concerns regarding the resuspension and transport of un-remediated sediment with elevated levels of COPCs states "*While there may be some elevated concentrations of contaminants above the SSTLs remaining, exposure to these elevated concentrations over extended periods of time would be unlikely and exposure is better characterized based on an average concentration characterized by the 95 percent UCLM*." However, as indicated above there are still questions associated with the current delineation of the wetland and estuary RMAs and the amount of contaminants that will remain. Therefore, it remains unclear whether potential still exists for recontamination in the post-remediation phase (e.g. the potential for suspended contaminated material settling back onto the surface sediments and/or un- remediated areas of contaminated sediment above the SSTL migrating back into the dredged areas or out into the Northumberland Strait). The Proponent has not identified the mitigation/risk management measures that would be implemented if monitoring results show that the contaminant concentrations of surface water/sediment/country food reach or exceed predetermined changes in contaminant levels in any follow-up monitoring plan.	A. Provide a high-level confirmatory sampling plan, including information on: - the sediment sampling approach (including how sampling locations and number of samples will be determined); - the methodology/approach used to determine whether the residual contaminant levels would require additional remediation to adequately protect human health from all potential exposure pathways considered; - the methodology/approach used to delineate any additional remediation footprints, if applicable; and - the protocol that will be used for "hot spot" areas identified during confirmatory sampling. B. Identify available measures to be implemented in the post-remediation phase should COPC exceedances be identified during follow-up monitoring and sediments require additional management.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
IAAC-42 IAAC-43	IR(2)-42/43	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.3.7 - Mi'kmaq of Nova Scotia	PRA-HHRA (EIS-Appendix A), Section 2.1.4	Insufficient information is provided on persistent and bioaccumulative substances present in the sludge dewatering effluent, and associated potential impacts to country food in the BHSL, estuary and Northumberland Strait. Additionally, it remains unclear whether the pilot scale Geotube study results are sufficiently reliable to evaluate potential risks to human health through recreational water use and country food consumption. The Proponent's response to IAAC-42 states that "*As the predicted concentrations of various COPCs in surface water (including bioaccumulative substances) during project related activities are below guidelines for the protection of human health as well as ecological receptors, COPCs in surface water do not pose a risk to human health through direct ingestion or accumulation in country foods* ." However, the water quality guidelines (i.e., both the surface water quality guidelines for aquatic life protection[9,10] and recreational water quality guidelines defined by the Proponent as 10x values of the drinking water quality guidelines[11]) are not appropriate criteria to address potential contaminant accumulation in country foods via the aquatic food web. Even if concentrations of bioaccumulative contaminants are predicted to be below the water quality screening criteria at the discharge point of the sludge dewatering effluent, these contaminants can still be transported via surface water to the Northumberland Strait, and their characteristics may allow for bioaccumulation in country foods. The Geotube dewatering effluent quality from the Pilot Scale Study (Pilot Scale Testing Construction Report, pdf p.440 to 451) indicates the presence of multiple bioaccumulative chemicals, including mercury, cadmium, lead, and polycyclic aromatic hydrocarbons (PAHs). Additionally, multiple species of dioxins/furans were also detected in Geotube effluent samples. For example, the mass balance modelling in Table 5.2 predicts that the concentration of 2,3,7,8-tetrachlorodibenzofuran will increase in BHSL surface water during remediation. As the Geotube effluent data from the Pilot Scale Study has been used to model future water quality of the BHSL and estuary, as well as of discharge to the Northumberland Strait, the accuracy of the Geotube effluent quality data obtained during the pilot test is important for evaluating potential risks to human health through recreational water use and country food consumption. However, there are multiple inconsistencies concerning the Geotube effluent data shown in the Pilot Scale Testing Construction Report: - The number of samples collected is not clear. - Section 5.1.4 reports that concentrations of modified Total Petroleum Hydrocarbons (TPHs) in two of the three Geotube effluent samples are higher than the maximum Industrial Approval criteria. However, there appear to be five samples of pilot Geotube effluent, collected on different dates, showing TPH exceedances (Table 5.1, Table 5.2, Table 5.5, Table A1, and Table A4). - The presentation of exceedances is not consistent. Section 5.1.3 states that the concentration of all metals are in compliance with the assessment criteria for the composite one sample from the Geotube dewatering effluent, whereas the same sample results in Table A4 show exceedances of both cadmium and aluminum.	A. Update the CSM for Exposure Assessment for Human Receptors – Waste Management to include an operable exposure pathway for consumption of country foods in the Northumberland Strait. B. Provide a discussion on the potential impacts of the sludge dewatering effluent quality, especially bioaccumulative chemicals, to human health through recreational water use and consumption of country food harvested in the BHSL, estuary and Northumberland Strait. Propose monitoring and mitigation measures for potential exposure pathways. C. Provide data for the pilot Geotube effluent samples in a separate table, with clear indications of the type of sample (e.g., removal in the wet, removal in the dry, or composite) and any criteria exceedances. Confirm the number and identity of the pilot Geotube effluent samples tested for TPH. Provide a summary and interpretation of criteria exceedances identified.	Information requested is provided in Section 2 below.
IAAC-50	IR(2)-50	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	ECCC	Part 2, Section 7.3.7 Mi'kmaq of Nova Scotia Part 2, Section 7.1.4 Riparian, wetland and terrestrial environments	EIS Section 7.3.9.4.3 Risk Management Plan (Appendix K) of the HHERA (EIS - Appendix A)	The Proponent provided the additional detail requested in terms of how the SSTL is being utilized to further refine the area proposed for active remediation in each wetland and the estuary. However, it is unclear how this approach fits into the proposed Surface Weighted Average Concentration (SWAC) approach proposed to Environment and Climate Change Canada in June 2019 as a means of determining if the dredging has met the remedial goal. For such an approach, the SSTL would be the target, often with a caveat that no single individual sample will be above "X" concentration, even if the SWAC is achieved. It is unclear if this "X" concentration (maximum criteria) has been proposed. It is also unclear whether this approach will be used only for the wetlands and estuary or for the BHSL and associated basins.	A. Clarify how the SSTL approach fits in with the proposed SWAC approach that was proposed to Environment and Climate Change Canada in June 2019. Include whether the maximum criteria have been proposed. B. Clarify whether the SSTL approach will also be used to refine the areas to be dredged in the BHSL and associated basins or if it is proposed for the freshwater wetlands and estuary alone.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
Noise								
IAAC-44	IR(2)-44	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.1.1 Atmospheric Environment	Appendix W Noise Assessment Documentation Section 2 Methodology Appendix W- Noise Assessment Documentation, Table 3.2-1 Results of Background Sound Level Measurements (p. 5 to 11) Appendix W - Noise Assessment Documentation, Section 3.1 Observations (p. 4) Appendix W - Noise Assessment Documentation, Section 2 Methodology (p.2)	The baseline noise levels used will impact the calculations used in the determination of the change in percent of highly annoyed (%HA). If current baseline noise levels are lower than those monitored and are more representative of a quiet rural area at some points of reception (PORs), an adjustment may be warranted in the %HA calculations. When measuring baseline noise levels, Health Canada's guidance on evaluating noise impacts in environment assessments[12] recommends that wind speed should not exceed 14 kilometres per hour, any free-field monitor and microphone should be sheltered from exposed areas, there should be no precipitation, and all applicable conditions as per ISO 1996-2:2007[13] should be met. Information regarding baseline data collection and analysis is missing or insufficient: A. In the Proponent's response to IAAC-44, although it is indicated in the footnotes for table 8 that "*Measurements recorded during inclement weather (winds speeds greater than 14 km/h and/or rain) were disregarded*", the table appears to include measurements recorded during periods of wind speeds exceeding or equal to 14 km/h, as indicated in the right-hand column. It is therefore unclear whether all baseline noise measurements taken during periods of inclement weather (wind speeds ≥14 km/h; precipitation) were disregarded from the baseline data set, or if only the measurements taken during periods of rain were removed. B. Footnote 3 of Table 8 states that "*Bolded data represents the lowest measured Leq during the respective monitoring time period*." However, no data are bolded and it is therefore unclear to what this footnote is referring.	A. Clarify which noise measurement data points in Table 8 were taken during periods of rain and clarify which data points were disregarded due to inclement weather. B. Clarify what data are being referred to in footnote 3 of Table 8.	Information requested is provided in Section 2 below.
IAAC-45	IR(2)-45	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.2.1 Changes to the atmospheric environment Section 7.3.7 Mi'kmaq of Nova Scotia	EIS, Figure 7.3-2 - Point-Of- Reception & Operation Location Plan (p. 7-274) EIS, Section 7.3.3.3 - Predicted Changes to Noise (p. 7-273) EIS, Section 7.3.3.5 Project Activities and Noise Interactions and Effects and Mitigation Measures (starting p. 7-275) EIS, Section 7.3.3.6 Noise Monitoring (p. 7-288) EIS, Section 7.3.3.5.4 - Bridge at Highway 348 (p. 7-281) and Section 7.3.3.5.7 - Dam (p. 7-287) EIS, Figure 3.1-8 - Pipeline (p. 3- 20) EIS, Table 7.3-49 - Potential Interaction Between Pipeline Decommissioning and Noise and the Significance of the Resulting Potential Effects from the Interactions (p. 7-284) EIS, Table 8.1-2 Summary Table of Environmental Impact Assessment (p. 8-11) 9.2 Monitoring	Given that specific activities are expected to also occur during the night-time hours, evaluating sleep disturbance resulting from nighttime nose from each project component is relevant for receptors located near the project site and along the truck traffic routes. The Noise Model Output File (Appendix C of the Proponent's response to IRs) appears to show the noise levels modelled separately for each noise source (e.g., construction on-site haul route, bulldozer, etc.) and for each POR. The Proponent does not appear to provide any calculations demonstrating how these modelled levels were combined/summed to determine the overall predicted noise levels at each POR indicated in Tables 2.13 and 2.14 in Section 2.2.16 of the Proponent's response. Sample calculations are required to verify whether or not all noise sources were considered collectively or only individually.	A. Provide sample calculations demonstrating how the modelled levels for each noise source in the Noise Model Output File were combined/summed to determine the overall predicted noise levels at each POR indicated in Tables 2.13 and 2.14 in Section 2.2.16 of the Proponent's response. B. If modelled levels for each noise source were not combined/summed to determine the overall predicted noise levels at each POR, either: - Redo the quantitative noise assessment using the appropriately summed sources (and the updated baseline, if applicable); or -Provide a discussion to justify how the current quantitative assessment results are representative of future levels, including an explanation of the uncertainties/limitations in the assessment and identification of appropriate mitigation measures.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
IAAC-48	IR(2)-48 b)	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.2.1 Changes to the atmospheric environment Section 7.3.7 Mi'kmaq of Nova Scotia	EIS, Section 7.3.3.3 Predicted Changes to Noise (p. 7-273) EIS, Section 7.3.1.1 Predicted Changes to Air Quality and Odour, *PM Impacts – Scenario 1 and 7* (p. 7-232) EIS, Figure 7.3-2 Point-Of-Reception & Operation Location Plan (p. 7-274) EIS, Section 3.1.2 Dredging (p. 3-11) EIS, Section 3.2 - Project Activities, *Site Preparation and Construction* (p. 3-32) EIS, Section 3.2.1.2 Dredging (p. 3-38) EIS, Table 7.3-43 Potential interactions Between Wetland Management and Noise and the Significance of the resulting Potential Effects from the Interactions (p. 7-280)	The number of truck trips included in the assessment does not appear to be adequately supported, and it is unclear whether or why some project activities are excluded from the quantitative noise assessment. The Proponent's response lists the assumptions used to calculate truck trips per hour: 10 trucks/daytime hour during construction activities; 2 trucks/daytime hour during remediation; and 2 trucks/daytime hour during demolition activities. In the evaluation of noise impacts, construction, remediation, and demolition are considered to occur simultaneously for what would appear to be a total of 14 truck trips/daytime hour. While the 10 truck trips/daytime hour during construction activities do include 2 truck trips per hour to support the bridge construction, it is unclear how the assumptions were used to calculate a total number of 10 truck trips per daytime hour for the construction/remediation/demolition activities, and at what POR location(s) the 'worst-case scenario' applies to. According to Figures 7.3-5 and 7.3-6 in the Proponent's response, dredging activities in the estuary do not appear to be included in the updated assessment as a noise source. This is particularly important given that the main source of project-related noise at night will be dredging, for which the impact to human health was determined as being moderate in the original noise assessment. In the original noise assessment (EIS Vol IV of V), a +5 dB adjustment for tonality was included, whereas there is no such adjustment in the updated assessment as per the Proponent's response (pdf p. 117). Based on Health Canada guidance (2017), which states that "*in situations where more than one source characteristic adjustment is applicable (e.g. impulsive or tonal), only the higher of the adjustments is used* ," it is assumed that the tonality adjustment has been removed as a result of the application of the +12 dB impulsive sound adjustment. However, it is unclear whether the +5 dB tonality adjustment was retained for the prediction of noise levels at PORs that are unaffected by impulsive pile driving noise and to which the +12 dB impulsive sound adjustment was not applied. This is particularly relevant for back-up alarms or other types of tonal noise from project related activities. The Proponent's response states, "*Construction of access roads and vegetation clearing were not considered in the noise assessment as the project preparation and construction will only include upgrades to existing road networks which would not require any new roads*" (pdf p.119). However, it is unclear why activities associated with upgrading roads are excluded from the quantitative noise assessment as vegetation clearing and any upgrades to existing road networks can still involve activities that produce noise and any potential source(s) of noise should be included in the quantitative assessment.	A. Provide clarification on how the number of truck trips/daytime hour was determined. Clarify which POR location(s) will be affected by the 'worst-case scenario', especially considering that some vehicles may be travelling along routes near Pictou Landing First Nation, which may increase noise in the community. B. Clarify whether noise from dredging in the estuary was included in the quantitative noise assessment. If not, update the noise assessment to include noise from dredging in the estuary. Alternatively, provide justification for why it should be excluded. C. Clarify whether the +5 dB adjustment for tonality was applied in the updated quantitative noise assessment for PORs that are unaffected by impulsive pile driving noise (i.e., to which the +12 dB adjustment was not applied). If it was not applied to those PORs, revise the updated noise assessment accordingly. Note that all time-of-day adjustments and the quiet rural area adjustment are to be added to the highest of the applicable source adjustments in the updated noise assessment. D. Include the upgrading of access roads and associated vegetation clearing activities in the quantitative noise assessment. Alternatively, provide additional justification for why this component was excluded from the quantitative noise assessment. **Editorial comment:** E. In Table 2.14 of the Proponent's response, the baseline noise levels for POR9 appear to be incorrect as they are indicated as zero. The other associated noise measures in the table for POR9 therefore appear to be incorrect as well. These should be corrected in the final IR submission that will be posted to the registry.	Information requested is provided in Section 2 below.
Drinking Water								
IAAC-53	IR(2)-53	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC NSECC PLFN	Section 7.3.7 Mi'kmaq of Nova Scotia	EIS: Section 4.4.1.2; Section 7.1.4.1.3; Section 7.3.6.2; Section 7.3.6.4.2 PRA-HHRA (Appendix A): Section 3.1.4.2.2 PRA-HHRA (Appendix A), Section 3.1.4.2, human health screening table H.1.2	The Proponent states that if future monitoring shows exceedances of Health Canada's Guidelines for Canadian Drinking Water Quality, a potable water exclusion zone could be established as part of the provincial *Contaminated Sites Regulation* and Ministerial Protocol framework. However, according to the provincial *Contaminated Sites Regulations* and Ministerial Protocol framework the site is considered potable, regardless of current groundwater use. The Notification Protocol defines potable as "*all groundwater in the Province outside of municipal water serviced areas, and as determined following Appendix 2, Figure 3 in this protocol* ." As per the Remediation Levels Protocol, "*the determination and applicability of land use and potential groundwater potability must be as described in PRO-100, Notification of Contamination Protocol* ." Therefore, it is inappropriate to remove the potable groundwater exposure pathway based simply on current groundwater use at the site. The remediation project cannot rely on the "likelihood" of future well locations or groundwater use at the site or defer evaluation to potential future developers. The site must be assessed against potable criteria and the potable groundwater pathway must be considered as part of the remediation project.	A. Update the CSM for Human Receptors and the quantitative risk assessment to include potable groundwater as an applicable exposure media. Provide detailed information about the mitigation measures and administrative controls that will be used to manage any risks identified (including impacts to future land use), and present a high level overview of the monitoring plan to re-evaluate the risk over time.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
Air Quality								
IAAC-57	IR(2)-57	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Section 7.2.1. Changes to the atmospheric environment	Appendix U, Air Quality Impact Analysis (GHD 2020), Table 7.3-2 Air Quality Modelling Scenarios (p.6): Scenario 4, Sources. EIS, Section 3.1.2 Dredging (p.3- 11) EIS, Section 7.3.9.4.2 Dredging – Project Activities and Wetlands Interactions and Effects and Mitigation Measures (p.7-423) EIS, Section 7.1.10.3 Human Health, Figure 7.1-54 (p.7-200) Appendix A Human Health Risk Assessment (GHD, 2020), Table 3.1 (p.16) Appendix U Air Quality Impact Analysis (GHD 2020), Table 1.2 (p.6)	It is unclear whether the air quality assessment considers potential air quality changes caused by trucks used for the transportation of excavated waste. The Proponent's response states that "*Dredged material described in Scenario 4 (Shoreline Dredging) will not be transported by trucks but pumped by the hydraulic dredges to the containment cell*" and that "*There is no provision for dry shoreline excavation*". However, the Proponent's response does not provide an explanation for a contradictory description in the EIS (Section 3.1.2) where "*The shorelines of the ASB [aeration stabilization basin], BHSL [Boat Harbour stabilization lagoon], wetlands and estuary, and the settling basins, and effluent ditches (current and historical) would be mechanically excavated. The material would be loaded directly into a truck (if at shore) or barge (if on the water) and subsequently loaded into a truck for transport for disposal in the containment cell …*".	A. Confirm that the description of the dry shoreline excavation provided in Section 3.1.2 of the EIS should be replaced with the description provided in the IR response and no trucks would be used to transport excavated waste from the shoreline. B. If excavated waste would or may be transported by trucks, confirm that air quality modelling scenarios consider associated air contaminant emissions from these trucks or update the air quality effects assessment to include related air contaminant emissions.	Information requested is provided in Section 2 below.
IAAC-54b IAAC-56 IAAC-58	IR(2)-54 b)/56/58	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC NSECC	Section 7.3.7. Mi'kmaq of Nova Scotia	Appendix A Human Health Risk Assessment (GHD, 2020), Section 3.1.4.5.2 BHRP-Related Activities Scenario (p.38) PRA-HHRA (located at end of HHERA (Appendix A)), Section 3.3.1 Appendix U - Air Quality Impact Analysis Technical Report Section 2.1.2	The health risks posed by air contaminants associated with diesel exhaust (DE) emissions are not sufficiently assessed. The Proponent states that "The health effects data published for DPM [diesel particulate matter] include the range of organic species (including PAH and VOCs) that make up DPM. For this reason, additional analyses of the inhalation impact of the individual compounds contained in DPM was not warranted" (Section 2.2.21). However, the full breadth of adverse effects posed by project-associated PAHs and VOCs emissions are not likely to be captured by assessing the health effects of DPM only, given that the component(s) of DE emissions, which is the most toxicologically relevant to the development of lung cancer or other health effects, has not yet been identified. Furthermore, PAHs and VOCs can also be emitted from sources other than diesel vehicles/machinery (e.g., gasoline vehicles). The Proponent provided insufficient rationale for why air deposition of contaminants from diesel emissions onto soil and country foods is not an operable pathway. The Proponent's response states that "*While PAHs do make up a significant portion of DPM, the uptake of PAHs by plants is limited and not considered a viable exposure pathway*". However, air contaminants may directly deposit onto the surface of edible plant tissues, as well as accumulate internally through root uptake. Deposition of contaminants onto the surface of plant tissues and subsequent human consumption may be an operable exposure pathway depending on food preparation and preservation methods, such as washing, peeling, cooking (raw, boiled, fried, baked, grilled, etc.), used by local country food consumers. In addition to emissions from truck traffic, fugitive dust emissions may be released as a result of the construction of the containment cell, including the relocated materials currently in the containment cell, the open face of the containment cell, and the materials end-dumped in the containment cell and allowed to dry out. In addition, the Proponent's response did not adequately explain why 80% dust control efficiency was selected nor did it justify how an 80% control efficiency can be achieved and maintained using water suppression twice per day under the prevalent meteorological conditions in the Site Study Area. For reference, Table 4 of the *Road Dust Emissions from Unpaved Surfaces: Guide to Reporting*[14] document, indicates a control efficiency of 55% when water is used for dust suppression twice per day.	A. Should the post-construction monitoring program identify elevated risks for health impacts (including, but not limited to country foods) from project-associated emissions of VOCs, PAHs, and DPM, describe the mitigation measures or administrative/land use controls in addition to those already proposed, that could be used to manage the risk. B. Provide quantitative evidence to justify a dust control efficiency of 80%. Alternatively, adjust the control efficiency and/or modify the dust suppression plan to be more in line with published data.	Information requested is provided in Section 2 below.
IAAC-60	IR(2)-60	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC PLFN	Section 9.2. Monitoring	EIS, Section 9.2 - Monitoring Programs, Table 9.2-1 (p.9-11) EIS, Section 3.2.3.1- Waste Management (p.3-47) EIS, Table 9.1-1 (p.9-5) Appendix A- Human Health Risk Assessment (GHD, 2020), Section 3.1.2 Identification of Human Receptors (p.17)	It is still unclear whether air contaminants of potential health concerns, including VOCs and Reduced Sulfur Compounds (RSCs) that may be released as part of Landfill Gas (LFG), will be monitored after the site closure (i.e. Containment Cell Final Capping and Grading). The Proponent's response states that "*LFG monitoring will be included as part of post closure care of the containment cell. A LFG monitoring program will be included in the application submitted to NSE for the Industrial Approval Application*". However, it is not certain if these contaminants are considered in the post-closure LFG monitoring program.	A. Update the list of air contaminants for the LFG monitoring plan for the post-closure phase to include VOCs, RSCs, and methane emissions.	Information requested is provided in Section 2 below.

Table 1.1 INFORMATION REQUIREMENTS FOR THE BOAT HARBOUR REMEDIATION PROJECT - TABLE OF CONCORDANCE

IR-1 Reference # (Original IR) Number	IR-2 Number	Project Effects Link to CEAA 2012	External Reviewer ID	Reference to EIS Guidelines	Reference to EIS (including appendices)	Context and Rationale	Specific Question/Information Requirement	Response
Country Foods								
IAAC-62 IAAC-63 IAAC-65	IR(2)-62/63/65	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Part 2, Section 7.3.7	HHERA, Table H-1.15, Section 6.1.1.12, Section 5.2 HHERA (EIS- Appendix A) 6.4.3 Quantitative Interpretation of Health Risks HHERA (EIS- Appendix A) Table H-1.11 Occurrence, Distribution, and Identification of Chemicals of Concern (COC) in Fish (Fillet) Tissue	The Proponent's responses are insufficient to support the conclusion that COPCs in fish and shellfish from the Northumberland Strait do not pose human health concerns. • Insufficient rationale to support sediment screening and exclude aluminum, lead and manganese from further consideration in an assessment of health risks from consumption of shellfish The Proponent's response states that "*Aluminum, lead, and manganese were not identified as COPCs in sediment within the Study Area (Freshwater Wetland Areas, the BHSL and Associated Basins, the Estuary, or the Northumberland Strait) as the concentrations of these metals were below applicable screening guidelines* ." However, the exposure point concentration (EPC) (i.e., 95% upper confidence limit of mean, or 95% UCLM) for manganese is greater than the sediment quality guideline value for human health protection or the 95% UCLM background concentration (Tables H-1.6 and H-1.7). While the EPCs for aluminum and lead are below the guideline values, screening out COPCs in country foods against sediment quality guidelines is not appropriate[7,8]. Furthermore, alternative screening criteria, such as background concentrations of lead or aluminum in sediment, are not provided for comparison. The Proponent further states, "*In particular, the maximum concentrations of these three metals (aluminum, lead and manganese) in sediment samples collected from the Northumberland Strait in the vicinity of the shellfish sample locations were below human health screening values for direct contact (aluminum - 3100 milligrams per kilogram [mg/kg]; lead – 3.7 mg/kg; and manganese – 440 mg/kg).*" However, the Proponent's conclusion is based on analytical data from only two samples of the Northumberland Strait sediment (Table H-1.8). • Insufficient rationale to support that aluminum, lead and manganese in sediment are not bioaccumulative in shellfish The Proponent's response states that aluminum, lead and manganese "*are not considered to be bioaccumulative COPCs*". However, there is evidence in the literature that indicates lead partitions primarily to sediments and bioaccumulates in benthic organisms, and no evidence is provided to support that aluminum and manganese are not bioaccumulative in shellfish. • Insufficient rationale to support use of background levels for screening of aluminum, lead, manganese and dioxins/furans in shellfish (clams) No rationale was provided to support how the proposed background contaminant concentrations from crab, lobster, and mussels can support proper screening of contaminants in clam tissue and assessment of potential human health risks. • Insufficient rationale to support screening of arsenic, lead, mercury and dioxins/furans in fish and shellfish No scientific rationale was provided to support how the use of the CFIA guideline values can adequately protect the health of Indigenous and non-Indigenous consumers of non-commercial fish and shellfish from the Northumberland Strait, including how their consumption patterns (e.g., serving size and consumption frequency) are comparable to the consumption patterns used in the development of the CFIA guidelines. Specific issues for each contaminant are also explained below. ***Arsenic*** The Proponent assumes that the measured arsenic levels in whole fish, fish fillet and shellfish samples (Tables H-1.10, H-1.11 and H-1.15) are comparable to background concentrations as both levels are below the analytical detection limit. However, it remains unknown whether the sample measurements are truly different from background levels. Additionally, contrary to the Proponent's statement, background concentrations of COPCs in shellfish are not provided. ***Cadmium*** The Proponent also assumes that cadmium levels in whole fish, fish fillet and shellfish samples (Tables H-1.10, H-1.11 and H-1.15) are comparable to background concentrations, which is not properly supported, as explained above. Additionally, the detection limit (0.3 µg/g) appears to be far greater than the health-protective screening criteria value (0.0846 µg/g), which adds further uncertainty about the screening of cadmium. ***Lead*** The Proponent's response (Section 2.2.26) states that "*In shellfish (clams) collected from Northumberland Strait, lead was detected at concentrations marginally greater than the human health guideline and background. Lead was not identified as COPC in sediment within the Study Area, lead is not associated with the historical activities of the BHETF, and lead is not considered bio-accumulative in sediment* ." However, the 95% UCLM (i.e., 1.592 µg/g) appears to be greater than the background concentration (i.e., 0.9 µg/g) although the two groups are not compared with a statistical test. **Mercury** While the Proponent's response (Section 2.2.25) states that mercury was not detected in shellfish (clams), it appears that no clam samples were analyzed for mercury (Table H-1.15). ***Dioxin/Furans*** As the 95% UCLM of dioxins/furans in fish is provided only for the contaminated samples, but not for the reference samples (Table H-110), it is unclear whether the levels of dioxins/furans in fish are statistically comparable to background levels as stated by the Proponent (Section 2.2.25). Additionally, the 95% UCLM of dioxins/furans in clams (2.104 µg/g) is greater than background level (0.965 µg/g) (Table H-1-15) and the two values are not compared with a statistical test.	A. Provide quantitative risk assessments of aluminum and manganese for consumers of shellfish (i.e., clams) harvested from the Northumberland Strait. B. Provide updated screening of arsenic, cadmium, lead, mercury, and dioxin/furans in fish and shellfish harvested from the Northumberland Strait against health protective criteria for country food consumers addressing all the data issues that Health Canada noted. Update the quantitative risk assessment where a contaminant exceeds the health- protective criteria. C. In the absence of such a screening, provide a quantitative risk assessment of these contaminants (arsenic, cadmium, lead, mercury and dioxin/furans) for consumers of fish and shellfish harvested from the Northumberland Strait.	Information requested is provided in Section 2 below.

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IAAC-64	IR(2)-64	5(1)(c)(i) Aboriginal Peoples Health/ socio- economic conditions	HC	Part 2, Section 7.3.7	HHERA (EIS-Appendix A), Section 6.4.3.6 (p.143)	The Proponent's response states that "*The discussion of the alternative absorption factors in Section 6.4.3.6 of the HHERA (Appendix A of the EIS) provides support that assuming 100 percent absorption of the COPCs is an overly conservative approach given* that the available absorption factors published in the literature indicate a lower absorption from oral exposure." No additional rationale was provided.	A. In the absence of an additional rationale to support the use of the proposed US EPA gastrointestinal absorption factors of less than 1.0, the proponent is required to provide detailed information about mitigation measures, residual effects, and follow-up monitoring plan associated with the risk assessment results based on an absorption factor of 1.0 for cadmium and vanadium.	Information requested is provided in Section 2 below.
Migratory Birds and Species at Risk								
IAAC-18	IR(2)-18		IAAC ECCC	Part 2, Section 7.3.5	Section 7.3.13.5	The Proponent's response provided a prediction of temporary or permanent bird habitat loss, however the size (in hectares) of the regional and local study areas are required for the Agency to assess the effects of the Project on migratory birds and the significance of the effects.	A. Provide the available migratory bird habitat area (in hectares) of the regional study area and local study area.	Information requested is provided in Section 2 below.
IAAC-21	IR(2)-21		NSECC	Part 2, Section 7.1.8 Part 2, Section 7.4	Section 7.1.7 Appendix CC, Section 2.1, Table 2.2 Section 2.3.4, Figure B3	The Proponent's response to IAAC-21 states: *"Monitoring requirements for potential SAR to be removed are included in the PEPP and are also outlined below."* An explanation is required of what "removal" means in the context of the Project. Removal is not an acceptable mitigation option. Any removal of SAR or impacts to habitat that occurs on private or provincial Crown land unless under permit is a contravention of the Nova Scotia *Endangered Species Act* . The response to IAAC-21 also states the Proponent will *"Establish a 300 m buffer around Piping Plover nests found during surveys (to remain in place until the young have naturally left)."* A reference for this buffer distance was not provided.	A. Clarify what "removal" means in this statement: *"Monitoring requirements for potential SAR to be removed are included in the PEPP and are also outlined below."* B. Provide a reference for using a 300 m buffer around Piping Plover nests.	Information requested is provided in Section 2 below.
Waste and Water Management								
IAAC-73	IR(2)-73		IAAC NSECC	Part 2, Section 2.2	RODD – Section 4.4 and Appendix H EIS – Section 2.3.1 EIS – Section 3 – Project Description EIS – Section 3.2.2.1 Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.3.4 Pilot Scale Testing Construction Report (GHD, December 23, 2019) - Section 3.5.5 Geobag Loading Analysis, Donald F. Hayes Pilot Scale Testing Construction Report (GHD, December 23, 2019) EIS – Sections 2.3.8 and 3.1.3 HHERA – Appendix A	The Proponent's response to IAAC-73 states *"If the cell were to reach capacity, the excess contaminated soil, deemed non-hazardous, would be disposed off-site. The remedial sequencing is planned to remove all material that may be potentially hazardous prior to the removal of non-hazardous contaminated soil."* It remains unclear how much contaminated soil is considered non-hazardous and how it will be segregated and stored for possible off-site disposal. It is also unclear whether this scenario has been considered in the Accidents and Malfunctions assessment.	A. Describe how non-hazardous material will be identified, segregated and stored for off-site disposal if the containment cell reached capacity before remedial activities were concluded. B. Update the Accidents and Malfunctions assessment, as necessary, to consider the transportation of non-hazardous materials to an off-site disposal facility.	Information requested is provided in Section 2 below.
IAAC-74 IAAC-75	IR(2)-74/75		IAAC PLFN	Part 2, Section 2.2	EIS Section 3.2.2.1	The Proponent's response to IAAC-74 indicates that non-dredged loose sludge will be placed in the cell after bulk dewatering has been complete. It is unclear from the information provided how infilling between Geotubes will occur or whether the approach could result in cavities within the cell that could result in Geotubes shifting during vertical placement. It also remains unclear from the Proponent's response to IAAC-75 whether conventional compaction equipment would be able to maneuver on the Geotubes.	A. Describe how conventional compaction equipment can be maneuvered on the containment cell considering the presence of Geotubes, including any limitations or potential issues.	Information requested is provided in Section 2 below.
IAAC-76	IR(2)-76		NSECC	Part 2, Section 2.2	EIS Section 3.1.1 EIS Figure 3.1-3 EIS Section 3.2.2.1 Pilot Scale Testing Construction Report (GHD, 2019)	The Proponent's response to IAAC-76 indicated that material would be dewatered or allowed to dry out prior to placement in the containment cell to ensure it is of reasonable quality to permit compaction. However, it is unclear how materials will be dried out, where the materials will be staged during the drying out process, and how the associated dewatering leachate will be managed. In addition, it is unclear whether conventional compaction equipment would be able to maneuver on the Geotubes. Nova Scotia Environment and Climate Change noted that the final cover materials and 4H:1V side slopes assumed in the HELP closure model scenario, as well as the contingency option of 3H:1V side slopes do not align with the guidance outlined in the *Nova Scotia Industrial Landfill Guidelines* . Approach could result in cavities within the cell that could result in Geotubes shifting during vertical placement. It also remains unclear from the Proponent's response to IAAC-75 whether conventional compaction equipment would be able to maneuver on the Geotubes. Insufficient information has been provided to demonstrate the containment cell location and design have been established in accordance with the criteria set out in *CCME National Guidelines for Hazardous Waste Landfills* . NSECC noted that potential issues with the design of the containment cell include depth and permeability of substrate below the cell, thickness of clay and composite layer.	B. Describe whether cavities would have the potential to occur, and how they would impact the containment cell and Geotubes. C. Describe how materials will be permitted to dry out, where the drying out process will take place, and how the associated dewatering leachate will be managed. D. Clarify whether the *Nova Scotia Industrial Landfill Guidelines* and *CCME National Guidelines for Hazardous Waste Landfills* were used when designing the containment cell and determining its location.	Information requested is provided in Section 2 below.

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IAAC-13	IR(2)-13		NSECC	Part 2, Section 3.1 Part 2, Section 7.2.2	Section 3.1.1	The response to IAAC-13 indicates that the forecasted leachate quality was projected based on the pilot scale testing results and reflects maximum concentrations. The forecasted leachate quality presented in Table 2.19 was reported to meet NSE groundwater criteria except for TPH (Lube); however, no information was provided to indicate that TPH (Lube) exceedances would be treated. In addition, forecasted leachate quality in Table 2.19 was compared to NSE Tier 2 Table 3 Groundwater Discharge to Surface Water (Marine) Greater than 10 m from the Surface Water Body. However, if the "pre-treated effluent" characterized within Table 2.19 is proposed to be discharged directly into the estuary, as reported, then the analytical results should be compared to surface water criteria (i.e. Table 3 - Nova Scotia Tier I Environmental Quality Standards (EQS) for Surface Water and Groundwater Discharging to Surface Water (µg/L)) - in particular the values for Surface Water (Including Groundwater < 10m from Surface Water Body). Comparison to the Marine surface water criteria in Table 3, applicable to a direct discharge scenario, would identify exceedances of several parameters beyond those reported. Comparison should also be made to potable groundwater criteria.	A. Update Table 2.19 to compare to proper criteria and identify any parameters that exceed guidelines. Describe additional mitigation or treatment measures to ensure compliance.	Information requested is provided in Section 2 below.
IAAC-15	IR(2)-15		NSECC	Part 2, Section 7.2.2	Section 7.3.6 Appendix Z	The Proponent proposes to place impermeable silt curtains between the active dredging area and other cells and open water. During a meeting with PLFN (March 3, 2022), it was stated by the Proponent that double silt curtains would be used. It is unclear from the EIS whether a single wall of curtains with no redundancy is proposed, or if double silt curtains will be used. The response to IAAC-15 states: "Drawing DR-C-34, detail 1 in Appendix A provides details of how the silt curtains will be installed." However, this figure could not be found in Appendix A.	A. Clarify whether single or double silt curtains will be used during dredging activities. B. Provide the location of Drawing DR-C-34 which provides details of how the silt curtains will be installed.	Information requested is provided in Section 2 below.
General Methodology								
IAAC-01 IAAC-61	IR(2)-01/61		IAAC HC	Part 1, Section 4.3 Part 2, Section 7.5	Sections 7.2.6, 7.3.1.6, 7.3.2.6, 7.3.3.7, 7.3.4.6, 7.3.5.5, 7.3.6.6, 7.3.7.6, 7.3.8.6, 7.3.9.6, 7.3.10.6, 7.3.11.5, 7.3.12.5, 7.3.13.5, 7.3.14.5, 7.3.15.6, 7.3.16.7, 7.3.17.5, 7.3.18.5	No additional information or rationale was provided regarding Valued Component (VC)- specific definitions of each category of magnitude. The EIS describes magnitude categories of environmental effects in general terms in Table 7.2-4. Although the EIS defines what a significant adverse effect to each VC would be, it does not provide clear VC-specific definitions for each category of magnitude. The magnitude of residual effects in Table 7.2-4 of the EIS were determined partly based on whether the effects deviate from the baseline conditions within (or outside of) "the range of natural variation" or whether the effects "marginally" exceed the guideline values. For each VC it is unclear what the range of natural variation is and what the marginal exceedance scale is in relation to the baseline conditions and applicable guideline values, respectively. VC-specific magnitude definitions are important for the Agency and other readers to understand the basis for the Proponent's determination, so that it can be assessed objectively.	A. Provide VC-specific definitions for each category of magnitude in a table, using quantifiable terms when possible. B. When using a comparison to guidelines, thresholds, or other measurable parameters to define magnitude, identify the specific guidelines or thresholds used. If magnitude definitions include terms such as "range of natural variation" or "marginal exceedance", specify the range of natural variation and marginal exceedance scale in relation to the baseline/background conditions or specific guidelines, respectively. C. Where magnitude definitions change, indicate if updates also result in changes to the effects assessment, required mitigation, and conclusions on the potential for significant adverse effects.	Information requested is provided in Section 2 below.

Notes

[1] CCME. 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. Available at: https://ccme.ca/en/res/a-protocol-for-the-derivation-of-environmental-and-human-health-soil-quality-guidelines-en.pdf.
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[3] CCME. 2018. Scientific Criteria Document for the Development of the Canadian Soil Quality Guidelines for Zinc, Protection of Environmental and Human Health. Available at: https://ccme.ca/en/res/2018-zinc-csqg-scd-1577-en.pdf.
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2. IAAC Responses

2.1 Human Health and Ecological Risk Assessment (HHERA)

2.1.1 IAAC-33

Item A | The following excerpt was taken from Health Canada's (HC's) Preliminary Quantitative Risk Assessment (PQRA) guidance document:

> *Not all identified COPC/pathway/receptor combinations necessarily need to be further evaluated quantitatively; for example, a quantitative assessment is not required if a qualitative analysis identifies those certain pathways are inoperable, or that the level of potential exposure is negligible (e.g., if there is no possibility for a person to come into contact with the contamination). Pathways may also be excluded on the basis of monitoring data showing that the pathway is not currently active, or on the basis of mitigative measures that effectively prevent exposure; such situations may change with time and may require ongoing management or monitoring.*

The Conceptual Site Model (CSM) of the Human Health and Ecological Risk Assessment (HHERA; Appendix A of the EIS) indicates that potable water exposure and air exposure are inoperable exposure pathways and therefore were excluded from the quantitative Human Health Risk Assessment (HHRA). Currently, **potable water is not consumed from the Site** and there is no expectation that a potable well will be installed at the Site in the immediate future as Pictou Landing First Nation (PLFN) obtain their potable water from an off-Site potable water supply that does not contain detectable concentrations of vanadium (see response to IAAC-33 in Report-41, previous response to IRs dated September 2021). In addition, groundwater samples collected from the Site between 2017 and 2018 indicate concentrations of vanadium in groundwater at the Site are below laboratory detection limits excluding one well located directly adjacent to the Aeration Stabilization Basin (ASB) (see Table C-1.2 of the HHERA in Appendix A of the EIS). The laboratory detection limit for vanadium is below the drinking water quality guideline. Based on the above noted rationale, it is considered reasonable to assume that the potable water pathway specific to vanadium at the Site is considered inoperable as potable water wells are not present on-Site and on-Site groundwater generally does not contain detectable concentrations of vanadium.

In addition to the above noted rationale for exclusion of the potable water pathway, as indicated in response to IAAC-53 (see below, Section 2.4.1) the potential requirement to implement a potable water exclusion zone was previously referenced to potentially restrict future construction of potable water wells in the vicinity of ASB and Containment Cell (CC). NSLI acknowledges that establishment of a potable water exclusion zone may be required if the marginally elevated concentrations of specific metals persist in the groundwater wells immediately adjacent to the ASB post-remediation. This will be determined post-remediation and would require approval by NSECC as part of the Contaminated Sites Regulation and Ministerial Protocol framework. The monitor wells that currently have concentrations of metals marginally above potable water drinking guidelines (vanadium is not one of the parameters) are limited to areas of the Site in close proximity to the ASB and CC. It is noted that under the Provincial framework and other similar guidance, construction of potable water wells is restricted within 300 metres (m) of a hazardous waste landfill. As such, the establishment of a potable water exclusion zone would, if required, be part of institutional controls associated with operational approval of the CC. Implementation and development of institutional controls, such as potable water exclusion zones, if required, will be managed under provincial NSECC regulatory approvals and the Industrial Approval (IA) process.

Regarding exposure to vanadium in air, the Site consists primarily of wetland habitat and the terrestrial areas are currently heavily vegetated and naturalized which significantly limits the potential for dust generation or exposure to vanadium in air, as this parameter is also non-volatile. Furthermore, dusts would not be generated from wet sediments that contain marginally elevated concentrations of vanadium, and therefore exposure to vanadium through inhalation of particulates will not occur. It is further noted that the Site is not expected to be an area where dusts would be generated through future industrial operations, construction activities, subsurface activities, or heavy traffic. It is acknowledged that dust has the potential to be generated during the remediation activities, but evaluation of dusts generated from Project related activities was evaluated separately as part of the Project related HHRA (included as Appendix A of the EIS) and determined that the Project does not pose an unacceptable risk to human health utilizing appropriate mitigation measures such as dust suppression. **As such, inhalation of vanadium in air now or in the future is an inoperable pathway for consideration in the development of Site-Specific Target Levels (SSTLs) for sediment.**

Given the information presented above, exposures to air and water located at the Site are currently inoperable exposure pathways, pathways that result in negligible exposure, and/or pathways that result in exposure levels that are consistent with background levels, and these background levels have been incorporated into the SSTL calculations through the use of the Estimated Daily Intake (EDI). On this basis, it is unreasonable to consider potable water and air exposure in the Soil Allocation Factor (SAF) and SSTL calculations and exclusion of these pathways is in accordance with HC's PQRA guidance document.

The reviewer indicates that the SAF may be increased from 20 percent to a value given by: SAF = 100 percent/(number of applicable exposure media), depending on the number of applicable exposure media. As indicated above, NSLI strongly advocates that the level of potential exposure to vanadium associated with the Site is negligible excluding potential future exposure to vanadium in sediment through the direct contact or incidental ingestion pathway. However, if the above noted equation was applied to calculate a sediment SSTL, the addition of one exposure media (in addition to exposure to sediment) would result in a significant reduction in the current sediment SSTL (70 milligrams/kilograms [mg/kg]) to levels approximately equal to the human health screening guideline applied in the HHERA for sediment (39 mg/kg). The addition of two or more additional exposure media would further reduce the SSTL to values well below the screening value. As such, it is unreasonable to generate an SSTL that is equivalent to or below the screening guideline.

The human health screening guideline applied in the HHERA is Nova Scotia's residential soil screening guideline which was calculated by the Ontario Ministry of the Environment, Conservation and Parks (MECP, 2011). For vanadium, the Ontario MECP used an oral reference dose (RfD) (0.0021 mg/kg-day) taken from California's Public Health Goals (PHGs) for Chemicals in Drinking Water (California's Office of Environmental Health Hazard Assessments [OEHHA], 2000). Using this RfD, Ontario calculated a soil risk-based concentration of 39 mg/kg for residential land use, which is less than Ontario's background soil concentration (86 mg/kg) as well as Nova Scotia's background soil concentration (42 mg/kg). On this basis, Ontario's soil risk-based concentration of 39 mg/kg is very conservative and considered to over-estimate the potential for risk. It is noted that the California's Department of Toxic Substances Control (DTSC) is recommending an oral/dermal RfD of 0.005 mg/kg-day for vanadium in risk-based approaches (DTSC, 2019). This oral/dermal RfD is also recommended by the United States Environmental Protection Agency (USEPA) and is used in the development of USEPA Regional Screening Levels (RSLs) for soil (USEPA, 2021). USEPA's RSL for residential soil is 79 mg/kg (based on a hazard quotient [HQ] of 0.2) using the preferred oral/dermal RfD of 0.005 mg/kg-day. USEPA's RSL for residential land use assumes exposure to vanadium 24 hours per day and 350 days per year, and soil ingestion rates (child = 200 mg/day) that are higher than those recommended by HC (toddler = 80 mg/day), and therefore highly conservative for assessing seasonal recreational exposure to sediment found in the Boat Harbour Effluent Treatment Facility (BHETF).

It is further noted that the approach of screening sediment for human health protection using residential soil screening guidelines is recommended and consistent with HC guidance (HC, 2017). It is further noted, the Exposure Point Concentrations (EPCs) calculated for vanadium currently in sediment of the freshwater wetlands, Boat Harbour Stabilization Lagoon (BHSL) and estuary are below the USEPA's residential soil RSLs (vanadium EPCs for the freshwater wetland and the estuary including the BHSL were 45 and 50 mg/kg, respectively). **As such, if the USEPA's RSL is applied in the screening for vanadium in sediment, vanadium would have been screened out as a contaminant of potential concern (COPC) in sediment associated with the BHETF. Based on the above noted rationale, the currently proposed SSTL for protection of seasonal recreational user exposure to vanadium in sediment of the BHETF (70 mg/kg) is conservative and is lower than the USEPA's residential soil RSL (79 mg/kg) and acceptable for use as a remedial benchmark. Alternatively, vanadium should be ruled out as a COPC in sediment at the Site as the sediment EPCs are well below the USEPA's residential soil RSL.**

Further to the rationale provided above, the only operable exposure pathways that were carried through the HHRA was ingestion/dermal contact with sediment and ingestion of country foods (game organs and waterfowl). The inclusion of country foods in the calculation of risk was considered highly conservative as vanadium was only detected in beaver and waterfowl tissue samples slightly above laboratory detection limits (detection limit of 2 mg/kg, maximum concentration detected was 6 mg/kg). In addition, it is considered unlikely these types of game meats would serve as significant source of food for PLFN or recreational users given that these organisms are not currently collected from the BHETF for human consumption (previous communications from PLFN community members). It is further noted that other country foods collected from the Site which have a much higher probability of being consumed now or in the future such as shellfish, finfish and herbaceous vegetation generally had concentrations of vanadium approximately equal to or below laboratory detection levels. Further, a subsequent country food survey will be completed following remediation and NSLI will use this information to further inform a post-remediation monitoring plan that includes country foods for review and approval by regulators. The requirements of the monitoring program are outlined in the EMP and PEPP, included in Appendix B of the EIS and details of the future monitoring program will be included in the regulatory permitting required by NSECC for the Project.

Table A.1 in Appendix A of this document presents the EPCs for vanadium, the calculated exposure associated with the operable exposure pathways at the Site, the calculated background exposure, and the HQ based on the comparison of the total exposure (Site + Background) to the toxicity reference value (TRV). Exposure to vanadium for the PLFN resident/recreational user included the following exposure media: sediment, food, air, water, soil, cigarette smoke, and vitamins. It is reasonable to assume that all potential exposure to the PLFN resident/recreational user have been accounted for in the calculation of health risks. As indicated in Table A.1 in Appendix A, the HQs meet the target HQ of one for the freshwater wetlands and estuary which also included the BHSL and associated basins. This indicates that vanadium does not require remediation. It is also noted that the EPCs for vanadium in freshwater wetlands (45 mg/kg) and the estuary (50 mg/kg) are similar to the background vanadium soil concentration for Nova Scotia (42 mg/kg).

A pilot scale testing program was completed in a cove of the BHSL by GHD Limited (GHD) in 2018/2019 to determine the performance of specific dredging technologies (GHD Report-19, dated December 23, 2019, previously submitted to IAAC, and referenced in the EIS). Results of the pilot scale testing indicated that the concentration of vanadium in sediment post-remediation ranged from 47 to 51 mg/kg and are consistent with the EPCs calculated for current conditions but are well below the SSTL as well as the USEPA RSL as discussed above. If HC deems a remediation target specific to vanadium is required that is less than the SSTL previously developed and cited above (70 mg/kg) or the existing EPC values, this remedial target would be technically unachievable based on the results of the pilot study. **As stated above, NSLI considers the SSTL previously generated for vanadium to be conservative and consistent with established risk assessment frameworks. The results indicate that there are no unacceptable risks to human health or the environment that require future management if the sediments are remediated to the proposed SSTL, and therefore, no administrative controls are required. As such, if a technically unachievable remedial criteria below the SSTL currently proposed by NSLI is deemed warranted by HC, it is unlikely the BHRP would proceed with actual sediment remediation and would continue as a managed Site by NSLI for the foreseeable future.**

Based on the above discussion, it has been clearly shown that current concentrations of vanadium in various media at the Site pose a low risk to the PLFN resident/recreational user and that the remedial action plan should be focussed on managing the risks associated with dioxins/furans (D/F) in the sediments. Further information regarding the toxicity of vanadium is also presented in the response to IAAC-35. In addition, as indicated in the EIS and supporting documentation, NSLI will develop a Monitoring Plan that includes confirmatory sediment sampling post-remediation as well as country foods for review and approval by regulators following federal EA approval. Based on the above noted rationale and NSLI's commitment to implementing a post-closure monitoring program with requirements outlined in the EMP and PEPP included in Appendix B of the EIS, it is GHD's informed and professional opinion additional consideration of vanadium specific to sediment remediation is not required or warranted.

Item B | In the previous response to IAAC-33 (Memorandum-93 dated November 10, 2021), GHD incorrectly stated the following: *since the EDI associated with background exposure to dioxins/furans is greater than the tolerable daily intake (TDI), theoretically, residents/Pictou Landing First Nation (PLFN) cannot be safely subjected to any increased exposure. As a result, the HC and CCME default SAF of 0.2 was assumed for dioxins/furans*. In fact, background exposure (i.e., represented by the estimated daily intake or EDI) to dioxins/furans for the First Nation resident/recreational user has not been calculated and therefore, it is currently unknown whether background exposure for the PLFN resident/recreational user is greater than or less than the tolerable daily intake.

In the absence of an EDI, the SSTL was calculated using the SAF of 0.2, which is consistent with Health Canada's *Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3, March 2021*.

Based on the above discussion, the SSTLs calculated for vanadium and D/F based on the PLFN resident/recreational user direct contact exposure to sediment (ingestion/dermal contact) are considered appropriate for use as remedial benchmarks (calculated SSTLs of 70 mg/kg and 29 picogram/gram [pg/g], respectively). Please see response to related comment IAAC-35 below (Section 2.1.2) for additional rationale specific to the toxicity of D/F and confirmation that the SSTLs generated are appropriate.

As indicated in Item A above, a pilot scale testing program was completed in a cove of the BHSL by GHD in 2018/2019 to determine the performance of specific dredging technologies (GHD Report-19, dated December 23, 2019). Pilot scale testing program results were submitted to IAAC and referenced in the EIS. The concentration of D/F Toxic Equivalence (TEQ) in the sludge/sediment of this specific BHSL cove prior to completion of the pilot study was 323 pg/g. Results of the pilot scale testing indicated that the concentration of D/F TEQ in sediment post-remediation significantly decreased concentrations. As such, results of pilot scale study indicate that hydraulic dredging can significantly reduce the concentration of D/F TEQ in sediment of the BHETF to levels below the most conservative SSTLs generated for future PLFN resident/recreational usage. However, if HC deems that the SSTL for D/F TEQ must be set to background (approximately 1.6 pg/g based on reference sediment conditions or 4 pg/g based on background soil conditions), this remedial target would not be technically achievable. **Similar to vanadium discussed in Item A above, NSLI considers that reducing the D/F TEQ to background concentrations as suggested by HC to be highly conservative and not consistent with established risk assessment frameworks. The results indicate that there are no unacceptable risks that require future management if the sediments are remediated to the proposed SSTL, and therefore, no administrative controls required. As such, if a technically unachievable remedial criteria below the SSTL currently proposed by NSLI is deemed warranted by HC, it is unlikely the BHRP would proceed with actual sediment remediation and would continue as a managed Site by NSLI for the foreseeable future.**

The current SSTLs for vanadium and D/F for the various scenarios that are recommended to be carried forward based on the above noted rationales are presented in Appendix B of this document.

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Ontario MECP. 2011. Ontario Ministry of the Environment, Conservation, and Parks. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15, 2011.

OEHHA. 2000. Office of Environmental Health Hazard Assessment. Proposed Action Level for Vanadium, August 24, 2000; PAL for Vanadium (ca.gov).

HC. 2017. Health Canada. Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments.

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2.1.2 IAAC-35

Item A | The HHRA completed for the Project considers exposures to sediment to be less than 365 days per year and thus the use of sub-chronic toxicity values for D/F and vanadium were applied. Additional rationale for the use of the sub-chronic toxicity values in the calculation of the SSTLs is provided below.

This response has been prepared by Diplomate of the American Board of Toxicology (DABT) Certified Toxicologists Ms. Tamara House-Knight, Ph.D., DABT and Mr. Hyland Herring, Ph.D., DABT.

Dioxins/Furans

Although D/F are known to be persistent and bioaccumulate in humans, the use of a sub-chronic value is considered appropriate under the assumed exposure scenarios that were used to assess risk to human health from future usage of the lands and waters of Boat Harbour. Based on the results of the HHRA, dermal route of exposure is the primary driver of risk for the PLFN resident/recreational user exposure to sediment. Greater than 80 percent of dioxin concentrations are absorbed via the oral route; however, only 10-40 percent is absorbed via dermal exposure, thus limiting uptake and contribution to dioxin body burden (Agency for Toxic Substances and Disease Registry [ATSDR],1998). Studies conducted in areas with elevated dioxins in soil have shown that exposure to dioxins in either soil or household dust does not result in increased dioxin body burden as evident in serum dioxin levels (Garabrant et al., 2009; Tohyama et al., 2011; Demond et al., 2012). To determine whether children younger than 18 years of age (3-15 years old) may accumulate more dioxins from soil through increased dermal contact and soil ingestion, Tohyama et al. (2011) compared the blood dioxin levels in children playing outdoors in areas with elevated dioxin in soils (dioxin concentrations greater than the environmental standard for soil of 1,000 pg TEQ/g) to children not playing in soils with elevated dioxin levels in Japan. Children aged 3-15 were divided into two groups depending on two criteria: (1) children who played with soil in playgrounds in the apartment complex until the time of the health survey; and (2) children who did not play with soil at the apartment complex at the time of the health survey but had experienced playing in the soil before. Those two groups were then divided into groups that who had frequent chances to put pieces of soil into the mouth and those that did not. The researchers concluded that children living around the dioxin-contaminated area did not accumulate excess levels of dioxins from the soil of the playground and residential areas. Dioxin body burden is highly correlated with tissue and serum concentration (World Health Organization [WHO], 1998).

The above studies evaluated exposure to dioxins in soil, however, dioxins deposited on both soils and sediment strongly adsorb to organic matter (ATSDR, 1998; Tri-Service Environmental Risk Assessment Working Group [TSERAWG], 2013). Unless co-located with acids or strong organic solvents, dioxins are not expected to mobilize once bound (TSERAWG, 2013), further limiting uptake and contribution to an individual’s body burden following exposure to contaminated soil or sediment. As stated in the USEPA Risk Assessment Guidance for Superfund (RAGS) Vol 1, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004):

> *“…particulate-bound chemicals in an aqueous medium (e.g., suspended sediment particles) would be considered to be much less bioavailable for dermal absorption, due to inefficient adsorption of suspended particles onto the skin surface and a slower rate of absorption into the skin.”*

Based on this information, it is not expected that individuals that come into contact with Site sediment would be exposed to dioxin concentrations that would result in increased dioxin blood levels.

The WHO (1998) states that due to the relatively long half-lives of dioxins in humans, steady-state body burden estimates usually reflect a stable condition and brief intake above background will not result in significant changes in body burden. Generally, observed adverse health effects of chemical substances depend more on blood concentrations and the amount present in the body rather than the daily exposure level. As in the case of the recreational user at the Site, it is unlikely that intake slightly above the average daily intake of dioxins would significantly contribute to overall body burden since metabolism and excretion are also taking place. Also as noted by Kerger et al. (1995), seasonal dermal exposure to dilute 2,3,7,8-TCDD residues resulted in little or no change in 2,3,7,8-TCDD body burden following occupational exposures.

The ATSDR intermediate Minimum Risk Levels (MRL) is an estimate of continuous daily human exposure of at least 15 days and up to 364 days to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects. In the HHRA, the PLFN resident/recreational user at the Site was assumed to be exposed to sediment for a period of 210 days, which is within the range of exposure assumed in the development of the ATSDR intermediate MRL. The intermediate oral MRL for D/F is based on a no observed adverse effect level (NOAEL) of 0.0007 microgram/kilogram/day (µg/kg/day) for immunological effects in Hartley guinea pigs fed 2,3,7,8-TCDD in the diet for 90 days (DeCaprio et al., 1986). An uncertainty factor of 30 (three for extrapolation from animals to humans and 10 for human variability) was applied to develop the intermediate oral MRL of 0.00002 µg/kg/day.

In other intermediate-duration studies, blocked estrous cycle was observed in female C57BL/6 mice exposed by gavage to 3 µg/kg/day, 3 days a week for 25 weeks, but no reproductive effects were seen in male mice 1 day/week for 30 weeks to the same dose (Umbreit et al., 1988). In the same study, no developmental effects were found in the offspring of C57BL/6 male mice. Animal data suggest that the most sensitive effects of dioxin exposure are immunotoxicity, and reproductive and developmental toxicity (ATSDR, 1998). As evidenced by the above studies, reproductive and developmental effects observed after 30 weeks of exposure (210 days) occurred at doses significantly higher than those for immunotoxicity. In keeping with ATSDR methodology, the intermediate MRL was derived using the most sensitive end point in the animal model and thus the most sensitive in humans.

The use of an intermediate oral MRL derived from a study conducted with one of the most sensitive species to dioxin toxicity (ATSDR, 1998) to evaluate intermittent dermal exposure to dioxins in sediment is conservative and is expected to be protective of human health. In addition, the lowest calculated SSTL of 29 pg/g using the sub-chronic TRV is approximately two times lower than the ATSDR recommended soil screening level of 50 pg/g which assumes 365 days of exposure (residential exposure).

Based on the information provided in the calculation of MRLs, ATSDR (2012) determined that exposure at the intermediate MRL (0.02 nanogram/kilogram/day [ng/kg/day]) corresponds to a body burden (0.66 ng/kg/day) that is less than human background body burden (1 ng/kg/day) and well below the human body burden resulting in toxicological effects (31 – 6600 ng/kg/day). Also, exposure to sediment (combined ingestion/dermal) for the PLFN resident/recreational user at the existing EPC for D/F (357 pg/g) in the BHETF (this assumes most conservative mudflat scenario and no dose averaging, except 4 hours per day) is 0.052 ng/kg/day, which is slightly higher than the intermediate MRL value. **At the proposed remediation target of 29 pg/g, total ingestion, and dermal exposure to sediment for the recreational user would be 0.0042 ng/kg/day which will not result in an increase in body burden.**

<u>Vanadium</u>

Like D/F, absorption of vanadium through the skin is expected to be minimal due to its low lipid/water solubility. Adverse health effects have been observed following exposure to vanadium via the inhalation and oral routes, with the respiratory tract being the most sensitive target. No studies were available regarding adverse health effects following dermal exposure. Vanadium is poorly absorbed in the gastrointestinal tract and skin (WHO, 2000; Ścibior et al., 2020). Since vanadium is poorly absorbed in the gastrointestinal tract, more than 80 percent of the administered dose of ammonium metavanadate or sodium metavanadate accumulated in the feces after 6 or 7 days (ATSDR, 2012). Gastrointestinal effects have been observed following ingestion of greater than 14 milligrams (mg) vanadium and no effects in subjects ingesting capsules containing 7.8 mg vanadium (ATSDR, 2012). Most studies involving human subjects reported that gastrointestinal effects only occurred during the first week or two of the study suggesting that with repeated exposure humans develop a tolerance to these effects (ATSDR, 2012). In addition, there is no evidence of long-term accumulation of vanadium; vanadium has low solubility in lipids; and animal studies indicate that the half-life of vanadium is approximate 14-16 days in various tissues following 1 week exposure to 8.2 mg vanadium/kg/day as sodium metavanadate or vanadyl sulfate administered in a liquid diet (ATSDR, 2012). Although bones may act as a reservoir for vanadium, the half-life is only 4-5 days (Rehder, 2013).

The intermediate oral MRL for vanadium is based on NOAEL of 0.01 mg vanadium/kg/day. Human subjects were administered capsules containing either 0 or 0.12 mg vanadium/kg/day for 12 weeks (Fawcett et al., 1997). No significant alterations in measured blood parameters or body weight. An uncertainty factor of 10 (human variability) was applied to develop the intermediate oral MRL of 0.01 mg/kg/day. Children have not been shown to be more sensitive to vanadium toxicity than adults.

It is also worth noting that ATSDR did not develop a chronic-duration oral MRL. As stated in the toxicological profile for vanadium:

"No studies examining the chronic toxicity of vanadium in humans were identified. Although several laboratory animal studies have examined the chronic toxicity, most tested low doses and did not find effects….Because the most sensitive target of vanadium toxicity following chronic-duration oral exposure have not been identified, the animal studies that mostly identified free-standing NOAEL values were not considered suitable for derivation of an MRL."

Based on the available information, the use of an intermediate oral MRL to evaluate intermittent, repeated dermal exposure to vanadium in sediment is conservative and is expected to be protective of human health. The most sensitive exposure scenario assumes a toddler directly in contact with sediment 4 hours a day, 7 days per week for 30 weeks per year. This level of exposure is considered very conservative and would be highly unlikely in any community setting.

This response has been prepared by DABT Certified Toxicologists Ms. Tamara House-Knight, Ph.D., DABT and Mr. Hyland Herring, Ph.D., DABT.

Item B | Sufficient justification for the use of the sub-chronic TRVs in the calculation of the SSTLs for vanadium and D/F is provided in Item A (by American Board of Toxicology Certified Toxicologists) along with information provided in response to IAAC-33. Updates to the SSTLs previously developed for vanadium or D/F are not considered warranted, in the professional opinion of two board certified toxicologists (DABT).

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2.1.3 IAAC-36

Item A | Most of the plants collected from the freshwater wetlands and estuary (approximately 80 percent) were cattails and bugleweed. The plant species collected from the reference wetland included cattails and bugleweed, which are the same plant species that were collected at the freshwater wetlands and estuary, and therefore are considered appropriate as determining background concentrations. Of the plant species previously identified by PLFN to potentially be used in the future for traditional purposes, only a very limited number of these vegetation species were identified to be present at the Site. Cattails and bugleweed were identified during the vegetation surveys to be the dominant herbaceous plant species of the species listed (or in the same Family of vegetation listed by PLFN). A select few additional plant species (e.g., berries and other herbaceous plants) were collected from the Site when present to better represent the potential consumption exposure to the PLFN community. However, there were few of these plants available for sampling and these same plants were not found in the reference areas. Since the majority of the plants collected from the freshwater wetland and estuary were the same species of plants collected from the reference areas (i.e., cattails and bugleweed), there is limited uncertainty associated with the plant species utilized as background concentrations in the HHERA. In addition, the cattail and bugleweed samples collected from the Site had concentrations of the primary COPCs (e.g., D/F) that were very similar and consistent to the concentrations of COPCs observed in the berry and other herbaceous samples collected from the Site (both aquatic and upland). This information provides another line of evidence to indicate that the two reference sample species can be used as surrogates to establish background levels for comparison to various plant species at the Site. In addition, only a very limited number of the consumable vegetation species were identified to be present at the Site, and thus, only species present could be collected for analysis. Uncertainties in the data collected and used in the HHERA was provided as part of the risk assessment report (included in Appendix A of the EIS) and further discussion on uncertainties is not considered warranted.

In addition, an EMP and PEPP has been developed and included in the EIS that outlines monitoring programs to be completed during and/or post-remediation that includes country foods. Details on the proposed monitoring programs will be provided for review and approval by regulators following EA approval. **Based on the above noted rationale and NSLI's commitment to developing and implementing a Monitoring Plan, it is our opinion a revised Project document or additional information specific to uncertainties associated with vegetation samples collected as part of the HHERA is not required.**

2.1.4 IAAC-37

Item A | The CSM (Figure 12) was updated in previous response to IAAC-36 (Memorandum-93, dated November 10, 2021) to identify consumption of wild game as an operable exposure pathway and the pathway was included in the HHRA evaluation included as Appendix A of the EIS. As indicated in response to IAAC-33 above, the inclusion of country foods in the calculation of risk was considered highly conservative as vanadium was generally only detected in beaver and waterfowl tissue samples marginally above laboratory detection limits and concentrations of D/F in country foods collected from the Site was consistent with background concentrations. The previously submitted Memorandum-93 is included as Appendix C of this document for reference purposes.

2.2 Project Related Activities-Human Health Risk Assessment (PRA-HHRA) and Risk Management Plan (RMP)

2.2.1 IAAC-40, IAAC-41, IAAC-49, IAAC-50, and IAAC-52

Item A | Details of the confirmation sampling program is currently under development and will be provided for regulatory review following EA approval. In general, the purpose of the confirmatory sampling program will be to ensure remediation of the BHETF results in sediment quality protective of human health and ecological receptors. In particular, the confirmatory sampling program will ensure concentrations of D/F remaining in sediment of the BHSL as well as the estuary and wetland areas are below the SSTL of 29 pg/g. As indicated in IAAC-50 below, surface weighted average concentrations, also referred to as spatially weighted average concentrations, or SWACs, is the method previously presented to Environment and Climate Change Canada (ECCC) for determining if the SSTL (or remedial objective) has been achieved. SWACs are calculated by defining the areal extent represented by each confirmation data point, multiplying the area by the concentration of the COPC, and repeating for each data point. The products are then summed and divided by the total surface area of the assessment area.

As it is likely humans would be exposed to COPCs at multiple locations at the Site and not a single point, SWACs integrate exposure and uptake of COPCs over the entire assessment area. The Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance (ECCC, 2012) indicates that SWACs can be used to estimate incidental soil ingestion (or in this case sediment ingestion) as samples can be weighted by their spatial 'area-of-influence', and/or by their relative probability of use by a receptor. This allows the confirmatory sampling program to focus (or be weighted) on shallow water areas of the BHETF that have a higher likelihood of exposure to humans in the future (following remediation). The SWAC approach was used being used as part of the Randle Reef Sediment Remediation Project (Stage 2) located in Hamilton, Ontario, to confirm whether or not SSTLs have been met following dredging of sediment. The Randle Reef Sediment Remediation Project (Stage 2) was led and completed by the federal government between 2018 and 2021. The SWAC approach has also be successfully applied and endorsed by the USEPA and state agencies at numerous sites across the United States (GHD personnel experience; Interstate Technology & Regulatory Council [ITRC], August 2014).

Several methods are available for calculating the area represented by each data point for inclusion in the SWAC calculation. Construction of Thiessen polygons is one of the more common methods. Thiessen polygons are constructed using geospatial software programs, such as ArcMap, to draw boundaries between adjacent data points. The number and size of polygons is a function of the number and spatial distribution of data points. For comparison purposes, the Star Lake Superfund site in Texas is a coastal (estuarine) marsh that is approximately 145 hectares (ha) in size and impacted with both organic and inorganic contaminants (USEPA, 2022). The Star Lake site is very similar to the conditions (size, environment, and contaminants) of the BHETF. The assessment and confirmation sampling area for Star Lake has 134 polygons, a density of approximately 0.92 polygons per ha.

As indicated above, the confirmation sampling program for the BHRP is currently under refinement and will be provided for regulatory review following EA approval but it is anticipated that a similar density of polygons would be created for the BHETF with one composite sample initially collected from each polygon to calculate the SWAC. Given the large size of the BHSL and complexity of the remedial actions, it is anticipated that remediation activities for the BHSL will be completed over multiple years and remedial sub-units within the BHETF will likely be defined based on predicted yearly remediation production rates (e.g., the BHSL will likely be divided into 5 or 6 sub-units for remediation scheduling purposes, the freshwater wetlands would be individual sub-units and the estuary would be another sub-unit). As such, post remediation SWACs for each BHSL sub-unit would be calculated to ensure the annual remediation activity has met the remedial objective (e.g., SWAC is equal to or below the D/F TEQ SSTL of 29 pg/g) before remedial activities can proceed in another sub-unit. If the calculated SWAC for a specific sub-unit exceeds D/F TEQ of 29 pg/g, additional remediation activities (i.e., dredging) would be completed in the polygons with the highest COPC concentrations followed by additional confirmatory sampling.

This process of additional remediation (dredging) and subsequent confirmation sampling within specific polygons would be completed until the SWAC for the sub-unit achieves (or is below) the SSTL. This approach ensures that the post remedial SWACs calculated for each sub-unit using the confirmation samples meets the SSTL. Remediation will be deemed complete when the SWACs for each remedial sub-unit and the entire BHETF (BHSL plus the wetlands and estuary) are equal to or below the SSTL. In addition to the SWAC, more concentrated confirmation sampling is anticipated to occur in areas expected to be frequented by PLFN residents or recreational users in the future (e.g., shallow water areas or exposed tidal mudflats) to ensure these areas of the BHETF have concentrations of COPCs, specifically D/F, below SSTLs.

Multiple sediment samples have been collected from the BHSL and associated wetlands and estuary through a multi-year sampling program and it is NSLI's opinion that sufficient sediment characterization has been conducted for the purposes of identifying areas of the BHETF that have concentrations of D/F exceeding applicable remedial criteria and require remediation (or risk management). In particular, the 2018 supplemental sampling (SSI) program was based on results obtained during the Phase II Environmental Site Assessment (ESA) and Supplemental Phase II ESA programs completed in Fall 2017 and Spring 2018, respectively. Based on recommendations presented in the draft HHERA report completed in 2019 as well as comments received from HC and ECCC, an additional SSI field program was developed and implemented in Fall 2019. The objectives of the 2019 SSI were to obtain supplemental information on the vertical and horizontal extent of D/F in sediment within the wetlands and estuary to refine potential Risk Management Areas (RMAs).

Emphasis was placed on sampling edges of the wetlands and estuary where humans are most likely to contact sediment, and to subsequently refine the proposed RMP for these areas. To address the comments received from HC and ECCC and limit uncertainties identified in the draft HHERA, the 2019 SSI field program also included collection of game meat (waterfowl), where possible, as well as fish and invertebrate tissue from the estuary. The assessment programs also included soil and groundwater sampling in areas surrounding the waterbodies to provide lateral delineation of the impacted sediment and to characterize any potential impacts to the surrounding upland soils associated with past operations of the BHETF. For conservatism, the entire footprint of the BHSL and associated basins below the high-water mark has also been identified as requiring remediation. It is noted that the primary sediment COPCs, D/F and vanadium, are present in soils surrounding the waterbodies at concentrations consistent with background levels, which provides confirmation that the impacts associated with sediment of the BHETF has not migrated to upland soil areas.

It is acknowledged that the RMAs were established based on the existing dataset and estimated using the mid-point between samples that meet and exceed the SSTLs and other conservative assumptions. This approach is consistent with industry practice for estimating areas potentially requiring remediation and is not intended to be the exact limit of the area requiring remediation. The final area to be remediated will be based on the existing dataset along with confirmation samples collected during the active remediation process (again, standard industry practice in North America). The purpose of the confirmatory sampling program will be to ensure remediation of the BHSL, freshwater wetland and estuary results in overall sediment quality protective of human health and ecological receptors. In particular, the confirmatory sampling program will ensure concentrations of D/F remaining in sediment of the BHSL including the estuary and wetland areas are below the SSTL of 29 pg/g (based on SWAC or similar EPC evaluation). As indicated above, the confirmatory sampling program will specifically focus on sampling dredge boundary areas as well as near shore environments where humans are most likely to contact sediment to ensure compliance with the remedial objectives.

The confirmation sampling program and data interpretation methodology will be finalized for regulatory review following federal EA approval, as per standard industry practice. As such, additional characterization, or delineation of COPCs in sediment of the wetlands or estuary are not warranted at this time.

Item B | NSLI will develop a monitoring plan that includes country foods, sediment, and surface water of the BHSL and Northumberland Strait. Requirements of the post-closure monitoring program are outlined in the EMP and PEPP, included in Appendix B of the EIS, and will be included in the regulatory permitting required by NSECC for the Project. This Monitoring Plan will also incorporate adaptive management or additional risk management measures to be implemented in the event elevated concentrations of COPCs are identified in environmental media post-remediation. The adaptive management plan will include updating the HHERA using the post-remediation dataset to identify, manage, and/or mitigate risks to human health or the environment. If the updated risk assessment indicates the potential for risk, the adaptive management plan could include but is not limited to supplemental targeted remediation of identified “hot spots” or administrative controls such as restricted access in specific areas. However, a robust quality control program will be implemented during the dredging program which will be tied to contractor payment, so exceedances are not expected to be identified following project completion.

As indicated in response to Item A above and IAAC-50, the purpose of the confirmatory sampling program will be to ensure remediation of the BHETF results in sediment quality protective of human health and ecological receptors with unrestricted future usage. In particular, the confirmatory sampling program will ensure concentrations of D/F remaining in sediment of the BHSL as well as the estuary and wetland areas are below the SSTL of 29 pg/g. In addition, post-remediation SWACs or EPCs for each BHSL sub-unit would be calculated to ensure the annual remediation activity has met the remedial objective (e.g., SWAC is equal to or below the D/F TEQ SSTL of 29 pg/g) before remedial activities can proceed in another sub-unit. This methodology will limit the potential for exceedances in sediment following completion of the Project. The requirements of the monitoring programs are outlined in the EMP and PEPP included in Appendix B of the EIS and details of the programs will be included in the regulatory permitting required by NSECC for the Project.

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2.2.2 IAAC-42, and IAAC-43

Item A | The Waste Management CSM from the Project-Related HHRA (Figure 3.4; Appendix A of the EIS) has been updated to include the potentially operable exposure pathway for sludge dewatering to be discharged to

Northumberland Strait and COPC accumulation within country foods (fish and shellfish) (see Appendix D of this document). While this pathway may potentially be operable, it was not carried through the HHRA for further assessment based on the rationale outlined below.

Geotube® water will be directed back to the BHSL at a location downstream of the active work area, which will also be segregated by silt curtains, and will be tested. Water will only be discharged over the dam if it meets approved water quality guidelines protective of human and ecological health. During remediation including sludge dewatering, concentrations of COPCs in the BHSL and discharges to the estuary are predicted to remain at the same or very similar to concentrations as observed currently in the BHSL and estuary (see Memorandum-96 included in Appendix D). Currently, concentrations of potentially bioaccumulative COPCs such as mercury and D/F in fish and shellfish samples collected from the estuary and the adjacent Northumberland Strait area are consistent with background conditions in other areas of the Strait**. As such, water discharged to the estuary and Northumberland Strait during remediation that has similar or lower concentrations of COPCs in water compared to historical discharge conditions is not anticipated to adversely affect country foods such as fish and shellfish compared to existing conditions.** This discussion has been included in the CSM Figure 3.4, which is provided as D.1 in Appendix D of this document.

Item B | As indicated in the PRA-HHRA (Appendix A of the EIS), swimming, fishing, or collection of country foods does not currently occur at the Site based on communications with PLFN. Establishment of Water Treatment Compliance Criteria (Memorandum-96 which was updated from Memorandum-57 included in Appendix A of the EIS) identifies criteria for water discharging to the estuary during active remediation and associated operation of the Temporary Leachate Treatment System (TLTS) and sludge dewatering (Memorandum-96 is included in Appendix D of this document for reference purposes). Mass balance projections provided in the document indicates the average water quality in the BHSL (and thus discharge over the dam) significantly improves (lower COPC concentrations) following the cessation of the Kraft Pulp Mill (Mill) effluent. This improvement in water quality is primarily due to the cessation of Mill effluent as an input into the BHSL as well as naturally occurring groundwater and surface water from upgradient areas that discharge into the BHSL. The trends in improved water quality (decreasing COPC concentrations) were corroborated through a 2020-2021 surface water sampling program completed following cessation of the Mill effluent.

During remediation including sludge dewatering, concentrations of COPCs in the BHSL and discharges to the estuary are predicted to remain at the same or very similar concentrations as are observed currently in the BHSL. As indicated in response to IACC-62 to IACC-65 (see responses below and IR responses previously provided in Report-41 dated September 2021 and Memorandum-93 dated November 2021 [Memorandum-93 is included in Appendix C of this document for reference purposes]), concentrations of potentially bioaccumulative COPCs such as mercury and D/F in fish and shellfish samples collected from the estuary and the adjacent Northumberland Strait area are consistent with background conditions in other areas of the Strait. **As such, water discharged to the estuary during remediation that has similar or lower concentrations of COPCs in water compared to historical discharge conditions will not adversely affect country foods such as fish and shellfish compared to existing conditions.**

With respect to direct contact of surface water during remediation and sludge dewatering, the PRA-HHRA included in the EIS document compared predicted concentrations of COPCs in effluent discharged during remediation activities to guidelines protective of human health. The predicted concentrations of COPCs in water to be discharged to the estuary and Northumberland Strait are below guidelines protective of recreational water usage.

To validate the above noted predictions and as indicated in the EIS and supporting documentation, monitoring programs that include country foods, sediment, and surface water will be completed and are outlined in the EMP and PEPP included in Appendix B of the EIS. Details of the programs will be in included in the regulatory permitting required by NSECC for the Project.

Item C | Forecasted leachate quality presented in Table 2.19 was previously included in response to IAAC-13 (Report-41, dated September 2021) and has been updated to include the new NSECC screening values (revised September 30, 2021) and risk-based screening values provided in updated Memorandum-96 (Memorandum-96 is included as Appendix D of this document). Updated Table 2.19 is included as Appendix F of this document.

As part of the pilot work completed, a total of four grab and three composite Geotube® effluent samples were collected on different days from the Geotube® effluent collection system and analyzed for Total Petroleum Hydrocarbons (TPH). Average and maximum concentrations from the sample results are included on Table 2.19

(Appendix F). All Geotube® effluent samples were collected from sediment that was removed from the BHSL in the wet. Geotube® effluent samples of sediment removed from the BHSL in the dry as part of the Pilot Scale Study were not collected for laboratory analysis.

Analytical results for grab samples of the Geotube® effluent collected from the hydraulically dredged sediment reported a maximum TPH concentration of 1,500 µg/L and average concentration of 1,070 µg/L (lube oil fraction), which exceeded the NSECC Tier 2 (Table 3) groundwater discharge to surface water >10 m from a marine surface water body and the risk-based discharge value for the protection of marine aquatic life. The NSECC Tier 2 for groundwater >10 m from a surface water receptor and the risk-based values were used specifically for comparison to individual carbon fractions in the Geotube® effluent. Analytical results for composite samples of the Geotube® effluent collected reported a maximum TPH (lube oil fraction) concentration of 590 µg/L and average concentration of 360 µg/L. The maximum concentration exceeded the NSECC Tier 2 (Table 3) criteria and the risk-based discharge value for the protection of aquatic life. The average composite concentration only exceeded the NSECC Tier 2 criteria and was below the risk-based discharge value. Concentrations of TPH in the bulk sludge samples previously collected from the BHSL ranged from 810 to 37,000 mg/kg (Table C-1.3C of the HHERA included as Appendix A of the EIS) which is likely the source of the dissolved TPH concentrations observed in the Geotube® effluent.

It is important to note that Geotube® effluent data presented in Table 2.19 (included as Appendix F of this document) represents analytical results of the raw effluent samples collected during the pilot scale testing. Memorandum-96, included as Appendix D of this document, outlines the predicted water quality at Point D in the BHETF during active remediation including the assumption that the Geotube® effluent will be returned to the BHSL, at a location downstream of the active work area, which will also be segregated by silt curtains. The results of the mass balance predictions included in Memorandum-96 clearly indicate that the concentration of dissolved TPH in the BHSL during active remediation, including receipt of Geotube® effluent, will be well below applicable NSECC guidelines and proposed risk-based values prior to being released to the estuary. Memorandum-96 also outlines the proposed water discharge criteria and sampling approach for water discharged during the BHRP. Based on the modelling, the concentrations of TPH observed in Geotube® effluent and returned to the BHSL will meet the proposed risk-based discharge criteria for water conveyed to the estuary. The proposed risk-based water discharge criteria are reasonable from an environmental risk perspective in that they will ensure discharges at Point D (release of water to the estuary) are unlikely to adversely affect aquatic biota and will be of equal or higher quality than historical precedent. This risk-based approach is also consistent with the approach used in the HHERA to develop the remedial target levels for the BHRP which was included in Appendix A of the EIS. Further, implementation of the treatment strategies during active remediation (e.g., physical separation using double silt curtains and chemical/physical treatment in Geotube®) as well as lowering of the BHSL normal operating level will provide multiple levels of protection during remediation efforts ensuring that the quality of water discharging from the BHSL is compliant with the discharge criteria.

2.2.3 IAAC-50

Item A | The SWAC approach is analogous to the approach for defining the RMAs using an EPC except that SWACs integrate exposure and uptake of COPCs over the entire assessment area. The SWAC method utilizes polygons to identify specific confirmation sampling points. One confirmation sediment sample would initially be collected from each polygon to calculate the SWAC. As indicated in response to IAAC-40, 41, 49, 50 and 52 above, given the large size of the BHETF and complexity of the remedial actions, the remediation activities for the BHETF will be completed over multiple years and remedial sub-units within the BHETF will be defined based on predicted yearly remediation production rates (e.g., the BHSL will likely be divided into 5 or 6 sub-units for remediation scheduling purposes). As such, post remediation SWACs for each BHETF sub-unit would be calculated to ensure the annual remediation activity has met the remedial objective (e.g., SWAC is equal to or below the D/F TEQ SSTL of 29 pg/g) before remedial activities can proceed in another sub-unit.

If the calculated SWAC for a specific sub-unit exceeds D/F TEQ of 29 pg/g, additional remediation activities (i.e., dredging) would be completed in the polygons with the highest COPC concentrations followed by additional confirmatory sampling. This process of additional remediation (dredging) and subsequent confirmation sampling within specific polygons would be completed until the SWAC for the sub-unit achieves (or is below) the SSTL. This approach ensures that the post remedial SWACs calculated for each sub-unit using the confirmation samples meets the SSTL. Remediation will be deemed complete when the SWACs for each remedial sub-unit and the entire BHSL are equal to or below the SSTL.

The confirmation sampling program is currently under refinement and will be provided for regulatory review following federal EA approval. As previously stated, the purpose of the confirmatory sampling program will be to ensure remediation of the BHSL results in sediment quality protective of human health and ecological receptors. In particular, the confirmatory sampling program will ensure concentrations of D/F remaining in sediment of the BHSL including the estuary and wetland area are below the SSTL of 29 pg/g (based on SWACs and/or EPCs) with a specific emphasis on ensuring that near shore and shallow water environments that have the potential to be frequented by humans have concentrations of D/F below the SSTL. Maximum criteria have yet to specifically be developed but the confirmatory sampling program will ensure that maximum concentrations of D/F TEQs in the nearshore environment (specifically areas that have the potential to be frequented by humans) do not exceed the SSTL of 29 pg/g in addition to the integrated exposure over each dredging sub-unit as well as the entire assessment area being below 29 pg/g for protection of human health. This approach is protective of ecological receptors with the lowest SSTL being 32 pg/g D/F TEQ for avian Species at Risk (SAR).

Item B | The SSTL approach has been used to define and refine areas to be dredged in the BHSL and associated basins. The same SSTLs are applied across all areas of the BHETF. As indicated in response to IAAC-40, 41, 49, 50 and 52 above, conservatively, the entire footprint of the BHSL and associated basins below the high-water mark was assumed to require remediation.

2.3 Noise

2.3.1 IAAC-44

Item A | GHD had removed datapoints which had bad weather interference from the baseline noise assessment due to wind and rain. In GHD's opinion, specifically describing data that was removed from the dataset due to inclement weather is not required as it does not change the result and requires further screening of the baseline data and updates to table sets for no value to the analysis. However, an updated Table 8 Baseline Noise Monitoring Summary provided as Table E.1 in Appendix E of this document shows the updated notations and the periods of wind and rain separately, as requested.

Item B | Note 3 of the baseline noise tables in IAAC-44 (Report-41, dated September 2021) detailed that the bolded data represents the hour of lowest sound recorded. During formatting, the bolded highlighting was removed in error and has been corrected in the updated version of the Table 8 Baseline Noise Monitoring Summary provided as Table E.1 of Appendix E. **This does not change the findings of the noise assessment**.

2.3.2 IAAC-45

Item A | The commenter is asking to provide sample calculations demonstrating how the modelled levels for each noise source was cumulatively evaluated to determine the overall noise levels at each Point of Receptors (POR).

An updated Table 9 Point of Reception Partial Level Noise Impact Summary Table is included as Table E.2 in Appendix E of this document, which provides sample calculations, as requested. Table 9 is the cumulative total sound level at each POR based on the partial sound levels of modelled equipment/operations.

Item B | The modelled levels for each noise source were cumulatively evaluated to determine the overall predicted noise levels at each POR and, therefore, a revision to the noise assessment is not required. An updated Table 9 – Noise Impact Partial Level Summary showing the cumulative evaluation has been provided as Table E.2 of Appendix E of this document.

GHD's current quantitative assessment results are representative of volumes, operations and impacts associated with the entire duration of the Project at each stage of construction, operation, and demolition and, therefore, any assessment of any additional future impacts is not warranted or required. Limitations or certainties associated with noise impact assessments are based upon the quality and accuracy of the acoustical modelling and associated inputs such as changes in volumes of vehicles, changes to equipment types and timing/length of operations in addition to potential vehicle operator variability. Acoustical modelling has an inherent margin of error of +/- 3 dBA and GHD's conservative approach to noise assessments is to model worst-cast potential equipment locations relative to nearby sensitive residential areas to reduce this margin of error and include best practices for operations to reduce off-site noise impacts.

As indicated in preceding responses, NSLI has identified future monitoring requirements as outlined in the EMP and PEPP, included in Appendix B of the EIS, and details of the programs will be included in the regulatory permitting required by NSECC. Noise monitoring will include daily monitoring to ensure compliance with mitigation measures with weekly written reports completed by the contractor's environmental manager and submitted to the construction management and oversight services consultant. Further, regular inspections of the work area will be completed by the Proponent's representative to identify and document excessive noise that may need additional mitigation (if required).

2.3.3 IAAC-48

Item A | GHD previously provided detailed assumptions and back-up for number of trucks estimated along haul routes during the previous round of IRs (IAAC-48 included in Report-41, dated September 2021). In determining the number of trucks per hour on the main haul route, a review was conducted of the various construction tasks for each year of the project and modelled the worst-case trip count to simplify the evaluation and be conservative in assumptions. These updated assumptions were cross-referenced with other disciplines to ensure assumptions are appropriate and updated as required.

The following assumptions were used to calculate trucks trips per hour:

- Construction Activity **|** Worst-case evaluation will have 112 trucks per day over 16-hours for Geosynthetic Clay Liner (GCL), High Density Polyethylene (HDPE), Sand Layers removal which will have an estimated volume of 70,000 cubic metres (m^3) of material over 5 months utilizing 15 yard (approximately 13.72 m^3) capacity trucks. GHD has conservatively used a trips/hour count of 10 trucks per daytime hour which includes two trips per hour to support the bridge construction.
- Remediation Activities **|** Worst-case evaluation will have 15 trucks per day over 16-hours for dredging/berm removal which will have an estimated volume of 25,365 m^3 of material over 75 days utilizing 15 yard (approximately 13.72 m^3) capacity trucks. GHD has conservatively used a trips/hour count of two trucks per daytime hour.
- Demolition Activities **|** Worst-case evaluation will have 36 trucks per day over 16-hours for dredging/berm removal which will have an estimated volume of 1,800-5,500 m^3 of material over 45 days utilizing 15-yard (approximately 13.72 m^3) capacity trucks. GHD has conservatively used a trips/hour count of two trucks per daytime hour.
- Operational Activities **|** Worst-case evaluation will have two trucks per day over 16-hours for sludge basin material removal during daytime hours only.

Based on these anticipated trips per hour for each activity it is assumed on-Site haul route trucks will be 10 trucks per hour travelling at 25 kilometre per hour (km/hr) or less during daytime periods for construction, remediation, and demolition and two per hour during the operational phase.

Item B | Noise from dredging in the estuary was not included in the quantitative noise assessment for two reasons: 1) the majority of the open water dredging activities are associated with the BHSL which includes numerous dredges over multiple years; and 2) the nearest PLFN residence to the open water dredging related noise impacts is associated with the northwest arm of the BHSL (closer proximity than the estuary) which represents a worst-case location with respect to noise from dredging.

Item C | Adding a + 5 dBA penalty to each POR (residential receptor) due to annoyance from equipment that produces hums or high pitches (e.g., transformers, high CFM blower fans, etc.) is not appropriate in this instance as the primary noise generation is operation of construction equipment. If this were warranted, it would be applied to each individual piece of equipment instead of the total and our review of proposed equipment has ruled this out as the equipment evaluated as part of this Project typically does not exhibit this tonal quality.

Item D | Including noise from "construction of access roads and vegetation clearing" in the quantitative noise assessment is not required. As indicated in the previous round of Noise related IR responses (IAAC-48 included in Report-41, dated September 2021), this was previously addressed to indicate construction of access roads and vegetation clearing were not considered in the noise assessment as the Project preparation and construction will only include upgrades to existing road networks which would not require any new roads and therefore very limited (if any) vegetation clearing requirements. Any minor road construction upgrades on existing roads would be less than or equal to the already modelled moving trucks and therefore insignificant.

Item E | Table 2.14 of the previous IR responses regarding baseline noise levels for POR9 (Report-41 dated September 2021) has been updated per below (Table 2.1) to correct the typo's associated with POR9 which does not change the findings of the noise assessment:

Table 2.1 Operational Noise Impacts and %HA Analysis (Updated Table 7.3-57 from EIS)

Receptor ID	Receptor Description	Baseline Day/Night (dBA)			Baseline %HA	Operational Noise Impacts (dBA)			Operation Noise Impacts + Baseline	Operation Noise Impacts + Baseline	Delta of Baseline-Baseline/ Operation Δ%HA	Δ%HA Criteria	Compliance?
		(Ld)	(Ln)	(LRdn)	(%HA)	(Ld)	(Ln)	(LRdn)	(LRdn)	(%HA)	(%HA)	(%HA)	(Yes/No)
POR1	Residential Property	48	44	47	1.4%	48	47	48	50	2.3%	0.9%	6.5%	Yes
POR2	Residential Property	48	44	47	1.4%	45	42	41	48	1.6%	0.2%	6.5%	Yes
POR3	Residential Property	48	44	47	1.4%	42	38	41	48	1.6%	0.2%	6.5%	Yes
POR4	Residential Property	37	40	38	0.5%	40	38	40	42	0.8%	0.3%	6.5%	Yes
POR5	Residential Property	37	40	38	0.5%	46	46	46	47	1.4%	1.0%	6.5%	Yes
POR6	Residential Property	45	41	44	1.0%	40	40	40	45	1.2%	0.2%	6.5%	Yes
POR7	Residential Property	40	37	39	0.5%	31	31	31	40	0.6%	0.0%	6.5%	Yes
POR8	Residential Property	40	37	39	0.5%	46	46	46	47	1.4%	0.9%	6.5%	Yes
POR9	Residential Property	37	40	38	0.5%	41	41	41	43	0.9%	0.4%	6.5%	Yes

2.4 Drinking Water

2.4.1 IAAC-53

Item A | Based on the analysis completed as part of the EIS, the potable water supply for PLFN is located over 500 m east of the Study Area and **water quality will not be influenced by Project-related activities** (see previous response to IAAC-67 in Report-41, dated September 2021). Potable exposure to groundwater was, therefore, indicated in Table 6.1 of the HHERA (Appendix A of the EIS) as an inoperable exposure pathway based on current conditions (no potable water wells at the Site). Based on that information, updates to the Human Health CSM are not required. NSLI acknowledges that establishment of a potable water exclusion zone may be required if the marginally elevated concentrations of metals persist in the groundwater wells immediately adjacent to the ASB post-remediation. This will be determined post-remediation in consultation/approval from NSECC as part of the Contaminated Sites Regulation and Ministerial Protocol framework. The monitor wells that currently have concentrations of metals marginally above potable water drinking guidelines are limited to areas of the Site in close proximity to the ASB and CC. It is noted that under the Provincial framework and other similar guidance, construction of potable water wells is restricted within 300 m of a hazardous waste landfill. As such, the establishment of a potable water exclusion zone would, if required, be part of institutional controls associated with operational approval of the CC. Implementation and development of institutional controls, such as potable water exclusion zones, if required, will be managed under provincial NSECC regulatory approvals and the IA process.

With respect to the request for a high-level overview of the Monitoring Plan to re-evaluate risk over time, as indicated in the preceding responses, both the EMP and the PEPP (Appendix B of the EIS) provide details on the groundwater mitigation measures and monitoring program requirements. As outlined in the EMP (Section 8.2.4.1), “the groundwater quality and quantity monitoring program will at a minimum involve the locations, frequency, and parameters of the existing program in place at the Site. Groundwater quality monitoring will be conducted every week.” Further information is available for HC's review within the EMP and the PEPP and are attached to the EIS document (Appendix B).

2.5 Air Quality

2.5.1 IAAC-57

Item A | It is confirmed that the dredged material described in Scenario 4 (Shoreline Dredging) will not be transported by trucks but pumped by the hydraulic dredges to the containment cell. The following text replaces and clarifies what was intended to be stated in Section 3.1.2 of the EIS:

> “*The shorelines of ASB, BHSL, wetland and the effluent ditches (current and historical) above the waterline may be mechanically excavated if hydraulic dredging is not feasible and removal of the material is deemed required. The material would be loaded directly into a truck (where access exists or is planned and when the waste is in a solid form) for transport and disposal in the containment cell. All other mechanically excavated waste would be loaded into a barge, made into a slurry (sludge-water mixture), and transferred via a pipe to the Geotubes or equivalent technology located within the containment cell.”*

As noted in Section 2.2 of the EIS, the BHETF contains approximately 1,390,000 m^3 of unconsolidated contaminated sludge/sediment including 634,000 m^3 in the BHSL, 311,000 m^3 in the wetlands, and 129,000 m^3 in the ASB all of which is planned to be hydraulically dredged. As such, the use of trucks for the hauling of waste to the CC may be used for minor amounts of wet sludge in a solid form only, similar to historical activities carried out for maintenance of the BHETF.

Item B | Hauling of waste by trucks was not modelled in the air monitoring scenarios as it is considered to be low volume, low frequency. In addition, waste would still be wet when handling and therefore, it would not pose a significant potential for dust release. The air modelling completed was based on major Project related activities anticipated to have the highest potential of adversely affecting air quality. **Further evaluation of this minor Project component (if trucking of excavated waste is required at all) is not warranted with respect to air quality**.

2.5.2 IAAC-54b, IAAC-56, and IAAC-58

Item A | The rationale for this IR is related to diesel emissions associated with the Project. Specifically, the commenter is concerned with organic COPCs from diesel exhaust sources. Based on information provided in HC, California Air Resource Board (CARB), and USEPA reports and other guidance documents on the subject, the approach undertaken in the air quality assessment meets the approach for assessing inhalation exposure to diesel emissions (CARB, 1998; USEPA, 2002, 2003; HC, 2016). Since diesel emissions are a complex mixture of volatile and semi-volatile organic compounds bound to fine carbon particles, all the risk analyses conducted by these government agencies has considered diesel particulate matter (dpm or dep) as a surrogate for the complex mixture of diesel emissions and is consistent with the approach applied in the air quality assessment in the PRA-HHRA.

With respect to the construction activities taking place during the Project, potential deposition to soils and uptake within plants have been evaluated in the PRA-HHRA for direct contact (ingestion, dermal contact, and inhalation of dusts) and consumption of plants. The predicted worst-case soil and plant concentrations over the course of the entire Project (plus baseline levels) were compared to human health screening guidelines protective of residential exposure and background concentrations. There were no COPCs identified for these exposure pathways. Therefore, the construction activities conducted during the Project will not result in unacceptable risks to human health through deposition to soils and uptake in plants. The requirements of the monitoring programs, including country foods, soil, sediment, and surface water, are outlined in the EMP and PEPP included in Appendix B of the EIS. Details of the programs will be included in the regulatory permitting required by NSECC for the Project.

The monitoring program incorporates adaptive management and or additional risk management measures to be implemented in the event elevated concentrations of COPCs are identified in environmental media post remediation. The adaptive management plan will include updating the HHERA using the post-remediation dataset to determine if these specific concentrations pose an unacceptable risk to human health or the environment. If the updated risk assessment indicates the potential for risk, the adaptive management plan could also include but is not limited to supplemental targeted remediation of identified “hot spots” or administrative controls such as restricted access in specific areas, restrictions on collection/consumption of country foods amongst other potential controls. As indicated above, it is NSLI’s opinion that post-remediation administrative controls will not be required given the mitigation measures planned for the Project and results of the predictive modelling studies.

Item B | The control efficiency for dust suppression for unpaved roads using twice-daily watering was adjusted to 55 percent as referenced in Table 4 of ECCC’s Information Page: *Road Dust Emissions from unpaved surfaces: guide to reporting* (Government of Canada, 2021). Updated modelling of the Project’s highest road dust generation condition using the adjusted dust control efficiency is documented in updated Memorandum-88 (referred to as GHD Project Number 12572494, Memorandum-04), included as Appendix G of this document. Results of the revised modelling indicate expansion of paving to 1.07 kilometre (km) of the access road and twice-daily watering of paved and unpaved sections of the access road on days without rain (assuming 55 percent dust suppression efficiency as indicated above) will eliminate exceedances of total suspended particulate (TSP) and PM_{10} at the Site boundary which is consistent with previous model findings.

As indicated in preceding responses, future monitoring programs are outlined in the EMP and PEPP, included in Appendix B of the EIS. Details of the programs will be in included in the regulatory permitting required by NSECC for the Project. Further, Ambient Air Monitoring Programs including real-time monitoring will continue during remediation. Real-time monitoring measures air quality on a continual basis and allows for the comparison of monitoring data to approved short term action levels, aiding contractors, and construction managers in immediately modifying site activities to prevent exceedances of health-based compliance criteria.

CARB. 1998. California Air Resource Board. Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, June 1998.

Government of Canada. 2021. Road dust emissions from unpaved surfaces: guide to reporting. Retrieved https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions/road-dust-unpaved-surfaces-guide.html.

HC. 2016. Health Canada. Human Health Risk Assessment for Diesel Exhaust, March 2016.

USEPA. 2002. United States Environmental Protection Agency. Health Assessment Document for Diesel Engine Exhaust, May 2002.

USEPA. 2003. United States Environmental Protection Agency. Report on Diesel Engine Exhaust, February 2003.

2.5.3 IAAC-60

Item A | Landfill gas (LFG) is produced by the biological decomposition of wastes placed in a landfill. LFG composition is highly variable and depends upon a number of Site-specific conditions including solid waste composition, density, moisture content, and age. The specific composition of LFG varies significantly from landfill to landfill and even from place to place within a single landfill. However, LFG is typically comprised of methane (approximately 50 percent by volume) and carbon dioxide (approximately 50 percent by volume). LFG may also contain nitrogen (N_2), oxygen (O_2), and trace quantities of other gases (such as hydrogen sulfide (H2S) and mercaptans). In addition to the above methane related LFG constituents, non-methane organic compounds (NMOCs) such as vinyl chloride, may also be generated and emitted at a landfill.

The release of LFG into the air may contribute to odours in the vicinity of the Site and addition of greenhouse gases into the atmosphere. LFG odours are primarily a result of the presence of hydrogen sulfide and mercaptans. These compounds may be detected by sense of smell at very low concentrations (0.005 and 0.001 parts per million [ppm] for hydrogen sulfide and mercaptans, respectively). It is generally recognized that the impacts related to these compounds are nuisance odours.

For post-closure conditions, LFG generation was estimated based on the fraction of organic carbon (FOC) samples collected from consolidated sludge and sediment during the pilot scale tests. It was assumed that 100 percent of FOC is degradable. The Intergovernmental Panel on Climate Change (IPCC) has published Guidelines for National Greenhouse Gas Inventories that provide equations for decomposable dissolved organic carbon (DDOC) from waste and resulting methane generation potential. It was assumed that up to 10 percent of the total waste mass would be other, non-dredged organics. The LFG generation from these wastes used default methane generation potential for organic waste from Ontario MECP guidelines. The combined methane generation potential was used to determine the peak gas production the year after all waste is placed in the CC. The peak production rate was estimated 102 m^3/hr, which is considered low.

The post-closure LFG monitoring will be conducted at select gas probes located within the waste and select gas probes located at locations near the Site boundaries. All gas probe locations will be monitored for pressure and percentage methane concentration by volume three times per year, in February, May, and September or as otherwise specified in the provincial IA. As requested, speciated samples will also be collected from selected gas probes within the waste and analysed for volatile organic compounds (VOCs) and reduced sulfur compounds (RSCs) at the frequencies and locations described in the provincial IA.

Trigger Levels

A trigger level of 2.5 percent gas by volume has been established for the gas probes installed within the subsurface near the property boundary. This criterion is in accordance with Ontario Regulation (O. Reg.) 232/98.

The proposed trigger level should reflect an average of at least three consecutive monitoring events. As such when a methane level exceeds the trigger level, the monitoring frequency will be increased to confirm the recorded level. Should the methane level remain above the trigger level, contingency measures will be evaluated promptly.

Similarly, should odour complaints be received, follow-up activities will be completed to determine the source of the odour. If related to LFG, contingency measures will be evaluated promptly. Monitoring programs are outlined in the EMP and PEPP, included in Appendix B of the EIS and details of the programs will be included in the regulatory permitting required by NSECC for the Project. Development and implementation of specific monitoring requirements related to LFG will be covered in the IA. Monitoring will be completed in accordance with the requirements outlined in the provincial IA for the lifetime of the CC.

2.6 Country Foods

2.6.1 IAAC-62, IAAC-63, and IAAC-65

Item A | Based on the specific IR presented, it does not appear that HC considered the responses provided in previous IRRs included in Memorandum-93, dated November 10, 2021 (included in Appendix C for reference purposes) regarding aluminum, lead, and manganese in clam tissues. Background concentrations of metals in softshell clams in the Northumberland Strait area were identified through correspondence with a graduate student from Dalhousie University (Ms. Megan Fraser, Master of Environmental Studies Candidate). In 2018, Ms. Fraser was involved with research related to metal concentrations of invertebrates in the Northumberland Strait. As part of this work, a total of 10 soft shell clams were collected from the Northumberland Strait in the vicinity of Pomquet (approximately 65 km east of the BHETF). The clams collected were composited and analyzed for metals on an "as collected" basis (not depurated) consistent with the data used in the HHERA. Laboratory results obtained from the composited soft shell clam sample had concentrations of aluminum, lead, and manganese of 197, 2.6 and 86 mg/kg, respectively (data publication in preparation and available upon request). The concentrations of aluminum, lead, and manganese in these background samples are approximately equal to or less than the 95 Upper Confidence Level of the Mean (UCLM) concentrations of the Study Area clam tissue data for these same metals (109, 1.6 and 115 mg/kg, respectively). Although the 95UCLM concentration for manganese was slightly higher than the background sample, 8 of the 10 clam samples collected from the Study Area had manganese concentrations less than the background sample. **This background soft shell clam data provides clear evidence that the concentrations of aluminum, lead, and manganese in the clam tissue collected from the Study Area are consistent with background concentrations in clams from the Northumberland Strait. As previously indicated in numerous IRs including IAAC-33, 35 and 36 above, the primary COPC associated with the BHETF is D/F and concentrations of D/F in clam tissue collected from the Northumberland Strait near the estuary were also similar to the background clam tissue samples and other shellfish collected from the area. The concentration of D/F identified in clam tissues collected are also an order of magnitude below the Canadian Food Inspection Agency guidelines for D/F in fish tissue (see below). On this basis, no further assessment of risks for consumption of clams from the Northumberland Strait related to the BHRP is required.** All other fish and shellfish tissues were collected from freshwater wetland and the estuary. As indicated in previous responses, NSLI will monitor country foods within the Study Area post-closure as outlined in the EMP and PEPP, included in Appendix B of the EIS. Details of the monitoring program will be included in the regulatory permitting required by NSECC for the Project.

Item B | Provided below is an overview of the screening of selected COPCs in fish and shellfish of the Northumberland Strait previously completed as part of the HHERA and additional rationale that supports previous justifications for their exclusion in HHERA.

Fish and shellfish (clams) analytical results were provided in Tables C-1-8 and C-1-12, respectively, of Appendix C-1 of the HHERA, Appendix A of the EIS. The background fish data are presented in Table C-2-5 of Appendix C-2 of the HHERA, Appendix A of the EIS. Shellfish data collected by Dalhousie University from Northumberland Strait in 2019 (crab, lobster, and mussels) are provided in Table C-1.13 of Appendix C-1 of the HHERA and are representative of typical background levels in shellfish from Northumberland Strait. **Fish and shellfish tissue data were compared to human health guidelines based on consumption and background concentrations which is considered a standard practice in risk assessments completed in North America.**

<u>Arsenic, Cadmium and Mercury</u>

Arsenic and cadmium were not detected in fish or clam tissues (Tables H-1.10, H-1.11, and H-1.15 of Appendix H-1 of the HHERA) collected from the wetlands, estuary or the Northumberland Strait and the detection limits were the same as the background samples. The detection limit for arsenic in the fish and

shellfish samples is less than the human health screening guideline. While it is recognized that the detection limit for cadmium (0.3 mg/kg) is greater than the human health screening guideline (0.0846 mg/kg), the human health screening guideline is based on a theoretical calculation of potential exposure and risk and does not address whether or not these screening guidelines are achievable by the laboratory. The laboratory analysis of cadmium followed applicable guidance and the laboratory that completed the analysis is CALA accredited.

Mercury was not detected in the fish samples collected from the freshwater wetland or estuary (Tables H-1.10 and H-1.11 of Appendix H-1 of the HHERA). Mercury was not analysed in the clam tissue samples collected from Northumberland Strait; however, mercury was not detected in other shellfish samples collected by Dalhousie University from Northumberland Strait in 2019 (crab, lobster, and mussels) (Table C-1.13 of Appendix C-1 of the HHERA).

As these three parameters (arsenic, cadmium, and mercury) were not detected in the fish or shellfish samples collected from the on-Site freshwater wetland, estuary, or Northumberland Strait and the detection limits are comparable to background samples, further evaluation of these parameters in the quantitative HHERA with respect to fish and shellfish of the Northumberland Strait is not deemed warranted.

Lead

Lead was not detected in fish fillet samples collected from the estuary as part of the HHERA (Table C-1.11 of Appendix C-1 of the HHERA). Although lead was detected in the clams collected from Northumberland Strait, the concentrations reported in the clams collected are similar to or less than the concentrations in background clams reported for other areas of the Northumberland Strait (see response for Item A above). **As such, further evaluation of lead in the quantitative HHERA with respect to fish and shellfish of the Northumberland Strait as it relates to the remediation project is not deemed warranted.**

Dioxins/Furans

D/F were detected in fish and clams collected from the freshwater wetland, estuary, and Northumberland Strait adjacent to the BHETF; however, the concentrations were found to be statistically similar to background concentrations of D/F identified in fish samples collected from reference locations and shellfish samples collected from the Northumberland Strait. In addition, the maximum concentration of dioxins/furans (4.18 pg/g) in fish collected from the on-site freshwater wetland and estuary were less than the maximum concentration identified in the background fish samples collected (6.6 pg/g) and well below HC's 20 pg/g guideline in fish (*List of contaminants and other adulterating substances in foods - Canada.ca*). Furthermore, the concentrations of D/F in the fish from the on-site freshwater wetland and estuary are statistically similar to the concentrations in the background fish samples collected from the area. The statistical test showing that the concentrations of D/F in clams are statistically similar to background shellfish levels of the Northumberland Strait (crab, mussels, and lobster) is provided in Appendix G-2 of the HHERA (Appendix A of the EIS).

Item C | As indicated in the previous responses, the concentrations of COPCs in fish and shellfish collected from the Northumberland Strait near the estuary, specifically D/F, which is the primary COPC associated with the BHETF, are similar to background fish and shellfish tissue samples collected from other areas of the Strait. Based on the above noted rationale (Items A and B), completion of a quantitative risk assessment of arsenic, cadmium, lead, mercury and D/F in fish and shellfish of the Northumberland Strait is not considered warranted. In addition, NSLI will monitor country foods within the Study Area post-closure as outlined in the EMP and PEPP, included in Appendix B of the EIS. Details of the monitoring program will be included in the regulatory permitting required by NSECC for the Project.

2.6.2 IAAC-64

Item A | The fact that the USEPA applies gastrointestinal absorption factors almost two orders of magnitude lower than the ones for cadmium (USEPA gastrointestinal absorption factor = 0.025) and vanadium (USEPA gastrointestinal absorption factor = 0.026) is supportive of the rationale that the use of an absorption factor of one in the quantitative HHRA is overly conservative. However, this was only one line of discussion used in the risk characterization specific to human consumption of game organs. GHD provided additional lines of discussion (see Section 6.4.3.6 of the HHERA, Appendix A of the EIS) to justify that the calculated risks were likely to be overly conservative with respect to human consumption of game organs. It is also noted that based on communication with PLFN, consumption of country foods within the Study Area (specifically the BHSL) is not currently conducted, and therefore, consumption of game organs is not currently an operable pathway and will not be an operable exposure pathway during remedial activities. **As noted in the previous responses, NSLI will be monitoring country foods in the Study Area as part of the post-closure monitoring programs as outlined in the EMP and PEPP, included in Appendix B of the EIS.**

2.7 Migratory Birds and Species at Risk

2.7.1 IAAC-18

Item A | There are over 100 migratory birds that frequent Nova Scotia and its nearshore waters each year. Each of these species have different habitat preferences ranging from open marine waters to derelict buildings. The majority, if not all, of the lands and waters found within the Local Study Area and Regional Study Area are potential habitat for at least one species of migratory bird or resident bird protected under the federal Migratory Birds Convention Act. Available migratory bird habitat area in the Local Study Area is approximately 964.5 ha, mostly forested area, with some coastal habitat. Available migratory bird habitat in the Regional Study Area is approximately 17,219.5 ha of terrestrial and coastal habitat, as well as areas of open brackish and salt water.

2.7.2 IAAC-21

Item A | Original response to IAAC-21 stated: "*Monitoring requirements for potential SAR to be removed are included in the PEPP and are also outlined below*". It should be clarified that "removed" was not the correct word to use in the response, and the statement should read: "*Monitoring requirements for potential SAR to be **encountered** are included in the PEPP and are also outlined below*."

Item B | The original response to IAAC-21 stated that the Proponent will "*Establish a 300 m buffer around Piping Plover nests found during surveys (to remain in place until the young have naturally left).*" A 300 m buffer around Piping Plover nests was conservatively assumed based on professional opinion and previous commitments made for other projects in Eastern Canada. The established conservative buffer is a mitigation measure to further avoid potential impacts on Piping Plovers nesting, outside of the predetermined construction blackout period occurring between May 1 to July 31, which implements complete avoidance of Piping Plover birds and/or nests during this time. The blackout period refers to a period of time where there are no planned activities for the Project in the previously identified areas of known Piping Plovers to avoid the most critical part of the Piping Plover nesting season. In addition to the buffer and blackout period, as stated in the PEPP, daily site monitoring will be completed for any work scheduled between August 1 and September 30, or April 15 and April 30 in the vicinity of Piping Plover habitat, and in the event that a migratory bird and/or nest is identified, it will be reported to the Contractor's Environmental Manager, Construction Management and Oversight Consultant Environmental Manager, and ECCC's Canadian Wildlife Services.

2.8 Waste and Water Management

2.8.1 IAAC-73

Item A | The remaining capacity of the CC will be routinely calculated and compared to the estimated volume of waste remaining to be disposed of in the CC. This will allow for advanced planning should the CC be projected to reach capacity prior to all the waste being placed in the cell. In accordance with the Import and Export of Hazardous Waste Regulation, and as applicable to this Project, hazardous waste is sediment or soil with a D/F TEQ equal to or greater than 100 ng/kg.

The works are planned to proceed from upstream to downstream, which also represents remediation from higher concentrations to lower concentrations of D/F, which are the contaminants of concern that have the potential to have the waste classified as hazardous, followed by removal of soil from the core of the ASB and BHSL berms. Based on assessment work completed to support the EIS, 45 of the 56 sediment samples analyzed from the BHETF had calculated D/F TEQ below the hazardous waste thresholds; and no samples collected from the raw effluent ditches, settling basins, ASB nor the estuary had samples exceeding the hazardous waste threshold.

The first contingency plan is to change side slopes from 4:1 to 3:1 which will provide an additional capacity of 143,000 m^3, as detailed in the EIS. The second contingency would be to characterize dewatered sediment and segregate the material which is below the hazardous waste threshold for disposal/treatment off-Site. The Pilot Scale Treatment Pad (PSTP) would be used for dewatering of the sediment from areas such as the estuary and the cores of the berms, where the concentration of D/F waste are likely to be below the hazardous waste concentration once dredged and dewatered. We note that the PSTP was designed for the dewatering of sediment at all levels of contamination. The PSTP is a lined cell with leachate collection system; and would be operated in accordance with the conditions of the IA, similar to those conditions required for the pilot scale testing program.

Item B | As described in the PEPP (Appendix B of the EIS), mitigation measures with respect to accidental spills will require that the contractor(s) ensure the spills management plan is in effect and its procedures are fully communicated to staff. While this plan will be focused on on-Site activities, the contractor will be required to ensure a spills management plan is in place for their fleet, including tanker trucks or trucks hauling soil/materials for off-Site disposal. The spills management plan includes having spill response resources ready for immediate implementation to control accidental releases which includes (but not limited to) absorbent materials, small hand-held equipment, and fire extinguishers. In addition, spills on and off-Site would follow the applicable provincial legislation and protocols through the NSECC, via the Environmental Monitoring and Compliance (EMC) division and the Emergency Spill Regulations, Nova Scotia Regulation (NS Reg) 59/95, as well as Federal regulations where appropriate.

Based on typical mitigation and monitoring measures, it is reasonable to assume that an unlikely accident or malfunction event would be short-term and managed to ensure minimal impacts to the environment. Although each accidental release is unique and requires a detailed assessment of the contaminant released as well as the receiving environment, the PEPP provides a framework for spill reporting, source containment, clean-up procedures, testing, and monitoring to limit long-term effects of the release. In addition, Site-specific mitigation measures would be evaluated and implemented including involvement of Provincial and Federal (i.e., DFO/ECCC) agencies during the spill response and remedial activities to ensure any required re-establishment of terrestrial or aquatic habitat occurs in a timely fashion. It is acknowledged that the nature and duration of the impact on the environment from any release is dependent on a number of factors, including the receiving environment, type of contaminant released, response time and recovery activities. However, accidental releases on- and off-Site will be effectively managed following the PEPP given the chemical and toxicological characteristics of the contaminant, available collection and remediation technologies and natural attenuation (e.g., biodegradation) that support recovery in a timely fashion.

2.8.2 IAAC-74, and IAAC-75

Item A | The Geotube® (or its equivalent) layout will be designed to optimize the capacity of the CC to achieve sufficient dewatering and shear strength in the lower Geotube® layers to support the upper layer(s). Several Geotubes® in one layer will be filled simultaneously to minimize the shifting of the Geotubes® during filling. Geotubes® without an adjacent tube being filled simultaneously will be supported with dewatered material or strawbales prior to filling.

As the tubes dewater, they form and mould to the shape of the bags around them minimizing voids between the tubes. As they dewater the shear strength increases. Low ground pressure equipment (like a D6 Dozer) will push loose material over the bags to shape the final cover and fill any voids between the tubes in the upper layer. The manufacture of the bags will typically specify the minimum amount of fill that needs to be placed in advance of the equipment advancing over the Geotubes®. Once this minimum amount of material is placed, conventional soil compaction equipment will be able to compact the loose placed sediment and final cover materials.

2.8.3 IAAC-76

Item B | As noted in the response to IAAC-74 and 75, as the Geotubes® dewater, they form and mould to the shape of the bags around them minimizing voids between the tubes. Each Geotube® is filled to manufactures recommended capacity and allowed to dewater for a period of one to a few days, and then is refilled again to capacity followed by a dewatering period. This process is repeated to optimize Geotube® capacity and to maintain a constant elevation of the top of the Geotubes® to accommodate placement of the next layer of Geotubes®. As the CC is filled, areas of differential settlement are expected, and is addressed through the placement and filling of the next layer of Geotubes®. Following completion of dredging and filling of the Geotubes®, the CC will be completed with interim cover (flexible membrane cover) for a period of 1-2 years. During this period final dewatering of the Geotubes® will occur. Prior to the placement of final cover, reshaping, if needed, will be completed to fill in any low area resulting from differential settlement.

Item C | As noted in the original response to IAAC-76 Round 1, the material that is described as being end-dumped in Section 3.2.2.1 of the EIS is anticipated to be material that is mechanically excavated from the influent ditches, berms, causeway, or the temporary treatment pad (this material does not meet the toxic waste threshold). This material will be in a solid form and permitted to dewater prior to placement in the CC. Any material that is not dewatered (i.e., dredgeate or slurried material) would be directly pumped to a Geotubes® placed within the CC. Once dewatered, the material will be able to be graded and compacted with low ground pressure equipment.

As noted in response to IAAC-73, impacted sludge/sediment and excess soil may be pumped to Geotubes® in the PSTP for dewatering and characterization. Other existing basins, such as the SB or ASB, may also be suitable for dewatering and temporary storage of excess sediment. The SB, ASB, and PSTP are all contained systems and collected dewatering effluent would be returned to the active dredge area of BHSL or processed through the TLTS before discharged to the estuary. It is noted that if the settling basins are used, NSECC would likely require a liner to be placed prior to use for such purposes.

Item D | The existing CC is located on Provincial lands adjacent to the BHETF and has Provincial Approval to receive impacted sludge and sediment form the BHETF. As noted in Section 3.1.1 of the EIS, the Nova Scotia Municipal Solid Waste Landfill Guidelines were reviewed when developing the design of the modified CC with respect to service life, leachate management, and accepted materials. Canadian Council of Ministers of the Environment standards provides general guidance and objectives on the site selection, design, and construction of hazardous waste landfills as well as the types of waste that should be generally prohibited. The guidelines consider both “natural attenuation” and “engineered” landfills and provides design information for selected landfills as case studies. The CC at the site has been previously sited and approved by NSE and as such, the existing provincial landfill Ontario Regulation (O. Reg.) 232/98, which provides the design requirements for landfills, was considered a reasonable guideline to apply. Table 3.1-1 in the EIS provides a comparison of the CC Design to O. Reg. 232/98.

2.8.4 IAAC-13

Item A | The forecasted leachate quality provided in Table 2.19 of Appendix F is based on testing completed as part of the pilot scale study and represents the maximum worst case leachate quality to be generated during remediation and was used as the Basis of Design (input parameters) for the CC and the TLTS.

During pilot scale testing, the impacted sediment/sludge dredged was mixed with water from the BHSL to create a slurry and then pumped to the Geotubes® for dewatering. The dewatering effluent quality represents a combination of water from the BHSL as well as the pore water within the sediment dredged, and the water retained within the sediment. The sludge, in place, was approximately 9 to14 percent solids and the slurry was approximately 1.5 to 7.5 percent solids. This demonstrates that >60 percent of the dewatering effluent is represented by the water quality in BHSL at the time of dredging.

As demonstrated in Establishment of Water Treatment Compliance Criteria (Memorandum-96 which was updated from Memorandum-57 included in Appendix A of the EIS, Memorandum-96 is included as Appendix D of this document), with cessation of the Mill effluent to the BHETF in January 2020, the water quality in BHSL is predicted to improve, and as such the dewatering effluent quality will also improve. Notwithstanding this anticipated improvement, an assessment of the impact of returning dewatering effluent to an area of the BHSL, at a location downstream of the active work area, was undertaken to determine that the dewatering effluent could be returned to BHSL and meet the proposed risk-based discharge criteria for water being conveyed to the estuary.

During remediation, a monitoring program will be undertaken to monitor the dewatering effluent quality and the water quality entering the estuary from BHSL. Mitigation measures, such as lowering the water elevation in the BHSL to provide a buffer volume, and silt curtains to prevent migration of suspended solids during dredging operations, will also be in place to allow time to address water quality being conveyed to the estuary, if needed.

The dewatering effluent quality characterized during dredging operations will also be used to refine the TLTS design for the treatment of leachate to be directly discharged to the estuary. The TLTS will manage leachate from the CC for the period of time between removal of sediment in the BHSL and completion of remediation including final capping of the CC. Following final capping, leachate will be collected and transported off-site for disposal. To gain an understanding of the anticipated leachate characteristics post remediation, sediment samples from the Geotubes® were collected and submitted for Synthetic Precipitation Leaching Procedure (SPLP) analysis. This test represents the max concentration of contaminants that may be released from the sediment once the initial dewatering is complete. The results are presented in Table 2.19 and compared to the NSECC Environmental Quality Standards (EQS) for surface water, groundwater discharge to surface water >10 m from a marine surface water body and to the risk-based discharge criteria. No exceedances were observed in the parameters analyzed. Updated Table 2.19 is provided in Appendix F.

The forecasted leachate quality was also compared to NSECC EQS for surface water and groundwater discharge to surface water >10 m from a marine surface water body for use in assessing contaminants of concern that may migrate from the CC into groundwater. The CC footprint is greater than 10 m from a surface water body.

2.8.5 IAAC-15

Item A | The silt curtains selected to be used during dredging activities are impermeable double silt curtains.

A sediment monitoring program will be prepared as part of the IA Application in consultation with NSECC to verify performance of the silt curtains. As noted in the draft PEPP (Appendix B of the EIS), the TSS will be monitored in the estuary before beginning remediation work. Monitoring will include the enforcement of limits on specific contaminants of concerns that may be associated with the suspended solids (i.e., metals, D/F). The purpose of the monitoring program is to ensure regulatory requirements are met, to evaluate if modifications of construction activities are required and that silt curtains are placed in a manner that is protective of the environment including previously remediated areas (e.g. remediated areas are not being re-contaminated).

Item B | Drawing DR-C-34 is provided in Appendix A of the Round 1 IRR (Report-41, dated September 2021). Specifically, it is on Page 200 of the PDF.

2.9 General Methodology

2.9.1 IAAC-01, and IAAC-61

Item A | The methodology and rationale used to characterize the residual effects to Valued Components (VCs) including the criteria used (e.g., magnitude, geographic extent, timing, duration, frequency, reversibility, and ecological or social context) is based on IAAC guidance documents, a review of other projects of a similar nature in Canada and discussions with various agencies through the development of the Project Description and EIS.

As per the methodology outlined in Section 7.2.6 of the EIS, a magnitude of “Negligible”, “Low”, “Moderate”, or “High” was assigned to each potential residual effect using the standard definitions presented in Table 7.2-4 of the EIS in conjunction with the VC-specific thresholds for determining significance provided in Section 7.3 for each respective VC. As such, VC specific definitions of “Negligible”, “Low”, “Moderate”, or “High” magnitude have not been provided.

Item B | The sub-sections "Thresholds for Determination of Significance" included in Section 7.3 of the EIS for each VC, includes VC-specific guidelines, regulations, standards, or other measurable parameters as appropriate that were used in determining significance of adverse residual effects. Specific quantifiable guidelines/standards are available for Air Quality, Geology, Geochemistry and Soil, Groundwater, and Surface Water. The "Thresholds for Determination of Significance" for the remaining VCs use quantifiable terms where appropriate, however in several instances, it was more appropriate to provide qualitative parameters. The VC-specific significance thresholds outlined in the EIS were used to characterize residual environmental effects associated with each criterion including magnitude, which as defined in the EIS is the size or degree of the effects compared against baseline conditions or reference levels, and other applicable measurement parameters (i.e., guidelines, objectives).

Based on the comment received, we are updating the characterization definitions for magnitude presented in Table 7.2-4 of the EIS to remove "natural variation" as it is not applicable to a majority of the VCs, nor was it factored in when determining the magnitude of the impact. The proposed revisions to the magnitude characterization definitions are as follows:

– **Negligible** - Differing from the average value for the existing environment/baseline conditions to a small degree, and below a threshold value.
– **Low** - Differing from the average value for the existing environment/baseline conditions, but less than or equal to appropriate guideline or threshold value.
– **Moderate -** Differing from the existing environment/ baseline conditions, and marginally exceeding a guideline or threshold value.
– **High** - Differing from the existing environment/baseline conditions and exceeding a guideline or threshold value.

Although natural variation would apply to the Groundwater and Surface Water VCs, the associated natural variations are documented within the existing environment/baseline conditions for the Site, so the proposed revised standard definitions for the characterization of magnitude would still apply to those respective VCs.

Marginal exceedance is qualified as slightly going over the established threshold but not by a significant amount. Marginal exceedances for each VC are described in their respective potential effects sections along with the justification as why it can be classified as only a marginal exceedance.

Item C | As the proposed changes to the magnitude definitions are editorial in nature, they will not result in changes to the effects assessment, required mitigation, and conclusions on the potential for significant adverse effects.

Appendices

Appendix A

Risk Summary for Vanadium

Table A.1

Summary of Calculated Hazard Quotients for Vanadium at Boat Harbour
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Parameter	Exposure Point Concentration (mg/kg)	Site Intake Levels (mg/kg-day)		Background Exposure (EDI) mg/kg-day	Total Exposure (Site + Background) (mg/kg-day)	Sub-Chronic TRV (mg/kg-day)	Hazard Quotient	Comments
		Ingestion/Dermal Contact with Sediment	Ingestion of Country Foods					
Freshwater Wetland								
Vanadium	45	5.74E-03	1.68E-03	2.27E-03	9.69E-03	1.00E-02	1	HQ=1
Estuary (incluidng BHSL and Associated Basins)								
Vanadium	50	6.41E-03	1.68E-03	2.27E-03	1.04E-02	1.00E-02	1	HQ=1

Appendix B

Vanadium EDI and Various Scenario Based SSTLs for Vanadium and Dioxins/Furans

Table B.1
Estimated Daily Intakes for Human Health (Non-Carcinogenic Substances)
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

$$\text{Total EDI} = EDI_{soil} + EDI_{air} + EDI_{water} + EDI_{food} + EDI_{cigarettes} + EDI_{vitamins}$$

$$EDI_{soil} = \frac{BSC \times SIR}{BW} \qquad EDI_{air} = \frac{BAC \times INR}{BW} \qquad EDI_{water} = \frac{BWC \times WIR}{BW}$$

$$EDI_{cigarette\ smoke} = \frac{BCS \times CSR}{BW} \qquad EDI_{vitamins} = \frac{BVIT}{BW}$$

Parameter	Parameter	Value	Units	EDI_{soil}	EDI_{air}	EDI_{water}	EDI_{food} (1)	$EDI_{cigarette\ smoke}$	$EDI_{vitamins}$	Total EDI
VANADIUM										
Resident - Toddler										
Estimated Daily Intake	EDI_{soil}	calculated	µg/kg-day	0.21	0.030	0.073	0.62	0.80	0.55	2.3
Exposure Frequency	EF	365	days/year				(1-4 yrs old)			
Background Soil Concentration (2)	BSC	42.4	µg/g							
Background Air (Outdoor/Indoor) Concentration (3)	BAC	0.0595	µg/m³							
Backround Water Concentration (4)	BWC	2	µg/L							
Background Cigarette Smoke Concentration (5)	BCS	0.33	µg/cigarette							
Daily Vitamins Consumed (6)	BVIT	9	µg/day							
Soil Ingestion Rate (7)	SIR	0.08	g/day							
Inhalaton Rate (7)	INR	8.3	m³/day							
Water Ingestion Rate (7)	WIR	0.6	L/day							
Cigarette Smoking Rate (8)	CSR	40	cigarettes/day							
Body Weight (7)	BW	16.5	kg							

Notes:

(1) As presented in Appendix D of DFO Surface Soil Criteria (SSC) Report prepared by AMEC Foster Wheeler Environment & Infrastructure (March 2015).
Calculated as a weighted avg. of highest intakes (male) within each age group - Canadian Total Diet Study (Health Canada, 1999).
The EDI_{food} (0.62 µg/kg-day) is higher than the range (0.26 - 0.41 µg/kg-day) presented in Environment Canada and Health Canada (2010) for 0.5 to 4 year olds.
The EDI_{food} (0.62 µg/kg-day) is higher than the value (6.5 µg/day divided by body weight of 16.5 kg = 0.39 µg/kg-day) presented in ATSDR's Toxicological Profile for Vanadium (ATSDR, 2012) for 2 year olds.

(2) PWGSC, Review of Environment Canada's Background Soil Database (2004-2009) Report, Table 10: Summary Statistics Highlands Zone, March 2011.

(3) Maximum vanadium concentration of 59.5 ng/m3 in ambient air PM2.5 fraction, as presented in Environment Canada and Health Canada (2010).
The study consisted of eight samples across Canada, and the maximum value was detected in Montreal, Quebec

(4) Concentrations measured in the well network used to supply potable water to the PLFN community.
Vanadium was not detected in the most recent sampling conducted from the potable water well network, and therefore a detection limit of 2 µg/L was assumed.

(5) Concentration of vanadium measured in cigarette smoke, as presented in ATSDR's Toxicological Profile for Vanadium (ATSDR, 2012).

(6) Intake of vanadium through consuming vitamins and supplements obtained from ATSDR's Toxicological Profile for Vanadium (ATSDR, 2012).

(7) Obtained from Health Canada (2021) - toddler.

(8) Assumes resident smokes 2 packs per day, with each pack containing 20 cigarettes. Toddler would be exposed to second hand smoke.

Sources:

Environment Canada and Health Canada, 2010. Screening Assessment for the Challenge, Vanadium Oxide (Vanadium Pentoxide), September 2010.
Agency for Toxic Substances and Disease Registry (ATSDR), 2012. Toxicological Profile for Vanadium, September 2012.
Public Works and Government Services Canada (PWGSC), 2011. Review of Environment Canada's Background Soil Database (2004-2009), Version No. 1, March 2011.
Health Canada, 2021. Federal Contaminated Site Risk Assessment in Canada. Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0. March 2021.
Amec Foster Wheeler Environment & Infrastructure (AFWEI), 2015. Surface Soil Criteria, Volume 2, Fisheries and Oceans Canada Maritimes and Gulf Region, dated March 23, 2015.

Table B.2

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler
(Intertidal Mudflats Scenario)
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia
Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler
Exposure Scenario: Intertidal Mudflats
Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF $_{oral}$	RAF $_{lung}$	RAF $_{derm}$	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	7.0E+01	70
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	2.9E-05	29

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF $_{oral}$ =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF $_{lung}$ =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF $_{derm}$ =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	72	Health Canada (2017; 2021a)
SA $_{hands}$ =	surface area of hands (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SA $_{arms}$ =	surface area of lower arms (cm^2)	450	Health Canada (2017; 2021a) - Toddler
SA $_{legs}$ =	surface area of lower legs (cm^2)	845	Health Canada (2017; 2021a) - Toddler
SA $_{feet}$ =	surface area of feet (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SL $_{hands}$ =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	58	Health Canada (2017)
SL $_{arms}$ =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	11	Health Canada (2017)
SL $_{legs}$ =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	36	Health Canada (2017)
SL $_{feet}$ =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	24	Health Canada (2017)
D1 =	hours per day	4	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
D3$_{SUB\text{-}CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + (((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Table B.3

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler (In-Water Activities Scenario)
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia
Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler
Exposure Scenario: In-Water Activities
Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	2.1E+03	2080
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	1.1E-03	1073

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	7.7	Health Canada (2017; 2021a)
D1 =	hours per day	8	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB-CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3)} + BSC$$

Table B.4

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Child (Reed Gathering Scenario)
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia

Receptor: Pictou Landing First Nations Resident/Recreational User - Child

Exposure Scenario: Reed Gathering

Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF $_{oral}$	RAF $_{lung}$	RAF $_{derm}$	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	1.0E+03	999
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	5.0E-04	505

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	32.9	Health Canada (2021a) - Child
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF $_{oral}$ =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF $_{lung}$ =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF $_{derm}$ =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	57	Health Canada (2017; 2021a)
SA $_{hands}$ =	surface area of hands (cm^2)	590	Health Canada (2017; 2021a) - Child
SA $_{arms}$ =	surface area of lower arms (cm^2)	740	Health Canada (2017; 2021a) - Child
SA $_{legs}$ =	surface area of lower legs (cm^2)	1535	Health Canada (2017; 2021a) - Child
SA $_{feet}$ =	surface area of feet (cm^2)	720	Health Canada (2017; 2021a) - Child
SL $_{hands}$ =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	0.66	Health Canada (2017)
SL $_{arms}$ =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	0.036	Health Canada (2017)
SL $_{legs}$ =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	0.16	Health Canada (2017)
SL $_{feet}$ =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	0.63	Health Canada (2017)
D1 =	hours per day	4	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
D3$_{SUB-CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + (((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Table B.5

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler (Sandy Beach Scenario)
Boat Harbour Remediation and Planning Design
Nova Scotia Lands

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia
Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler
Exposure Scenario: Sandy Beach
Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	1.6E+02	160
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	7.5E-05	75

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	72	Health Canada (2017; 2021a)
SA_{hands} =	surface area of hands (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SA_{arms} =	surface area of lower arms (cm^2)	890	Health Canada (2017; 2021a) - Toddler
SA_{legs} =	surface area of lower legs (cm^2)	1690	Health Canada (2017; 2021a) - Toddler
SA_{feet} =	surface area of feet (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SL_{hands} =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	0.49	Health Canada (2017)
SL_{arms} =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	0.17	Health Canada (2017)
SL_{legs} =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	0.70	Health Canada (2017)
SL_{feet} =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	21	Health Canada (2017)
D1 =	hours per day	8	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB-CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + ((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Appendix C

Supporting Information for IAAC-37 and IAAC-15

Memorandum

November 10, 2021

To	Angela Swaine, NS Lands		
Copy to	Christine Skirth, Blair Shoniker		
From	Troy Small/Vincent Nero/April Gowing/vl/093	**Tel**	+1 613 727 0510
Subject	Response to Information Requests Conformity Review IAAC-16, 33, 36, 39, and 62 Boat Harbour Remediation Project	**Project no.**	11148275

1. Information Requirements for Boat Harbour Remediation Project Responses

This memorandum has been prepared to address comments received from the Impact Assessment Agency of Canada (IAAC) on October 18, 2021, following conformity review for Information Requests (IR) submitted on September 20, 2021, in support of the Environmental Impact Statement (EIS) for the Boat Harbour Remediation Project (the Project or BHRP). The notification of the conformity review identified that additional information was required for IAAC-16, IAAC-33, IAAC-36, IAAC-39, and IAAC-62. The responses to the conformity review are provided on Table 1 Conformity Review Response Table, provided below, with further details in Sections 2 to 6.

Table 1 - BHRP IR Conformity Review Responses

Information Requirement (IR) Number	Expert Department(s)	Context and Rationale	Specific Question/Information Requirement	Conformity Response	NSLI Response
IAAC-16	DFO	The Environmental Impact Statement (EIS) Guidelines require a description of the marine environment in the estuary and along the strait shorelines immediately outside of the mouth of Boat Harbour. Ground truth analysis was used to validate the Light Detection and Ranging (LIDAR) data in Appendix BB of the EIS. The majority of the ground truth data are not evenly distributed throughout the LIDAR study area, with few located immediately outside of Boat Harbour or within the area predicted to be impacted in the sediment transport modeling conducted by WSP (2020) in Appendix Z. The uneven distribution of the ground truth points may bias the LIDAR data outputs. In addition, sediment and vegetation mapping was created using LIDAR data; however, ground truthing showed some classifications were not accurate (e.g., mud with only 25 percent agreement). This information is required to assess the potential effects on the marine environment and fish and fish habitat, including the commercial fishing industry.	A. Provide justification as to why the ground truth data points were not evenly distributed throughout the LIDAR study area. B. Provide evidence that the uneven distribution of ground truth points did not bias the LIDAR data outputs. C. Explain how the sediment and vegetation mapping was created, given some ground truth classifications were not accurate, and how any uncertainty was factored into the effects assessment for the marine environment and fish and fish habitat.	A. Conforms. B. Conforms. C. The proponent was requested to explain how the sediment and vegetation mapping was created in light of the discrepancies between the LIDAR measurements and ground truthing and how this discrepancy or uncertainty was factored into the effects assessment for the marine environment and fish and fish habitat. ● The IR response did not explain how the mapping products were created. The response did indicate that the use of LIDAR for the purpose of mapping sediment and vegetation is experimental and thus an unproven methodology. The response also indicated that a portion of the sediment classes in the mapping products (mud) is inaccurate. ● The IR response did not explain how the uncertainty in mapping was factored into the effects assessment for the marine environment and fish and fish habitat. NS Lands is required to: ● Describe how the LIDAR data was used to create the sediment and vegetation mapping. ● Discuss how the uncertainty of ground truthing was factored into the effects assessment for the marine environment and fish and fish habitat.	Information requested is provided in Section 2, below.
IAAC-33	HC	The EIS Guidelines require a description and analysis of how changes to the environment caused by the Project will affect the Mi'kmaq of Nova Scotia, including their health. In Section 6.4.3 of the Human Health and Ecological Risk Assessment (HHERA – Appendix A of the EIS), it is stated that *"Since vanadium was either not detected or detected at concentrations less than the guidelines for groundwater and surface water, exposure to vanadium through water is considered to be negligible. Therefore, exposure to water can be eliminated for vanadium. Vanadium is not volatile. Furthermore, vanadium was not identified as a COPC [contaminant of potential concern] in soil and the Upland Study Area soil concentration is less than the background soil concentration. Furthermore, exposure to vanadium in airborne particulates is expected to be negligible for sediments. Therefore, exposure to air can also be eliminated for vanadium. Vanadium is also not expected to be associated with any consumer products at the Site. Therefore, the only applicable exposure media remaining at the Site for vanadium are sediment and food. Using the equation presented above, the target Hazard Quotient (HQ) value can be increased from 0.2 (100%/5 exposure media) to 0.5 (100%/2 exposure media) for assessing potential hazards at the Site from vanadium."* Health Canada does not support the methodology used to adjust the target Hazard Quotient for vanadium to 0.5 in the Risk Characterization section of the HHERA. While this methodology may be appropriate for adjusting the Soil Allocation Factor (SAF – a numerical parameter used in site-specific target level (SSTL) calculations[2]), it is not an appropriate basis to adjust the target HQ. For example, although vanadium was "*not detected or detected at concentrations less than the guidelines for groundwater and surface water*", it is not possible to A target HQ of ≤ 0.2 should be applied when background (i.e., off-site) exposures to the same substance may occur from other sources unrelated to the subject contaminated site and at locations other than the contaminated site. If these background exposures are not quantified (as is the case in the HHERA), they cannot be assumed to be absent. Therefore, applying a target HQ value of ≤ 0.2 minimizes the likelihood that total exposure (i.e., site + background) will exceed the toxicity reference value from all sources and locations to which a person may be exposed to the substance. The HHERA identified SSTLs for both vanadium and dioxins/furans toxic equivalency (TEQ) values in sediment but the report did not consider non-soil on-site exposure pathways in its equation. Health Canada notes that a SAF of 0.2 is recommended[3] for soil in the default scenario for guideline development to allow for 80% of the remaining tolerable incremental exposure for other on-site exposures to air, water, food, and consumer products. This information is required to ensure appropriate risk estimates for assessing how changes to the environment caused by the Project would potentially affect human health.	A. Revise the risk estimates considering that project-related sources of exposure should achieve a HQ of ≤0.2. Alternatively, provide justification for the appropriateness of using a HQ >0.2 for a specific pathway. B. Provide a numerical SAF in the SSTL equation to account for exposure to COPCs in other on-site media and update the effects assessment as necessary. Alternatively, provide a detailed rationale as to why the current equation is sufficiently protective of human health.	A. Conforms. B. The response did not include a numerical Soil Allocation Factor (SAF) into calculations for Site-Specific Target Level (SSTL)[1] nor a rationale as to why it was not required. The SAF value could not be found in the SSTL equations in Table 2 through 5 for vanadium and dioxins/furans (pdf p. 180-183 of the IR submission document). NS Lands is required to: ● Provide a numerical SAF in the SSTL equation to account for exposure to COPCs in other on-site media and update the effects assessment as necessary. Alternatively, provide a detailed rationale as to why the current equation is sufficiently protective of human health.	Information requested is provided in Section 3, below.

Table 1 - BHRP IR Conformity Review Responses

Information Requirement (IR) Number	Expert Department(s)	Context and Rationale	Specific Question/Information Requirement	Conformity Response	NSLI Response
IAAC-36	HC	The EIS Guidelines require a description and analysis of how changes to the environment caused by the Project would potentially affect the Mi'kmaq of Nova Scotia, including health. It is unclear from the EIS if plant tissue is an operable exposure pathway in the Uplands Area. Section 6.1.1.7 of the Human Health and Ecological Risk Assessment report (HHERA – Appendix A) states that "*the PLFN [Pictou Landing First Nation] community is likely to collect and consume plants throughout the entire Site in the future.*" However, plant tissue data appears to have only been collected from the Freshwater Wetlands and the Estuary portions of the site (see Section 4.3.4, Tissue Analytical Results), while no samples appear to have been collected from the Upland Areas. In addition, the conceptual site model shown in figure 12 of the report indicates that vegetation uptake of COPCs from contaminated soil is a viable transport pathway, via vegetation and wild game uptake. However, vegetation consumption is considered an inoperable exposure pathway due to *"COPC – None (no exceedances and bio-accumulative COPC limited and/or within background in Soil)"*. It is unclear whether this pathway (consumption of country food, i.e., plants) is inoperable in the Uplands Area given the statement that plants are likely to be collected and consumed throughout the site. It is also unclear whether plant tissues from the Uplands Area are contaminated as no plant tissue samples have been collected. This information is required to assess the potential risks to human health for future users of the site.	Revise the country food exposure assessment to incorporate the vegetation transport pathway in the Uplands Area and provide information on the operability of the country foods exposure pathway in the Uplands Area. Update the effects assessment, as applicable. Alternatively, provide a rationale for why this pathway is inoperable.	No response information was provided on whether consumption of plant tissues is an operable exposure pathway in the Uplands Area. NS Lands is required to: ● Revise the country food exposure assessment to incorporate the vegetation transport pathway in the Uplands Area and provide information on the operability of the country foods exposure pathway in the Uplands Area. Update the effects assessment, as applicable. Alternatively, provide a rationale for why this pathway is inoperable.	Information requested is provided in Section 4, below.
IAAC-39	HC	The EIS Guidelines require a description and analysis of how changes to the environment caused by the Project would potentially affect the Mi'kmaq of Nova Scotia, including health. Health Canada notes that an exposure pathway is considered operable if one or more receptors can be exposed to a COPC. However, in the Project Related Activities-Human Health Risk Assessment report (Appendix A of the EIS), potentially operational pathways were eliminated based on the concentration of the COPCs, not whether receptors could be exposed. For example, figure 3.5 of the report (Appendix A of the EIS) depicts the conceptual site models for human receptors during dam removal-related activities. For the source media "Sediment", the exposure pathways of "Sediment Dermal Contact/Incidental Ingestion" and "Consumption of Country Foods" were both identified as inoperable based on concentrations of COPC and not the potential for exposure. In addition, as receptors may be exposed to COPCs through multiple pathways, Health Canada recommends that the risk associated with human health should be based on the total exposure, as lower level exposures still contribute to the overall project-related exposure and risk to human health. For example, sediment released in the re-naturalization process (opening Boat Harbour up to the Northumberland Strait) may impact recreational water use areas in the Northumberland Strait, within Boat Harbour, and in the estuary, all of which may result in sediment dermal contact and/or accidental ingestion of potentially contaminated sediment that may pose a risk to human health. For additional information Health Canada refers the proponent to: Health Canada's Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment (Health Canada, 2019). https://www.canada.ca/en/health- canada/services/publications/healthy-living/guidance-evaluating-human-health-impacts-risk- assessment.html Determining which exposure pathways are operable is important for assessing the potential adverse environmental effects of the Project on Mi'kmaq of Nova Scotia health.	Revise and re-evaluate the operability of potential exposure pathways in the Project Related Activities-Human Health Risk Assessment (PRA-HHRA) report in accordance with Health Canada guidance. Update the effects assessment in the EIS, as appropriate. Alternatively, provide rationale for why the operability of the exposure pathways provided in the report were appropriate.	No additional information/rationale is provided for why the operable exposure pathways are not updated for the PRA-HHRA. The proponent's response (Section 2.2.8 and Table 2.11, pdf p.109 to 110) reiterates that both soil and groundwater were "Not carried forward as concentrations of COPCs below screening levels or background." However, as noted in the IR, Health Canada considers an exposure pathway operable if one or more receptors can be exposed to a COPC. Potentially operational pathways should not be eliminated based on the concentration of the COPCs if there is a possibility that receptors could be exposed to any level of COPC. Additionally, Health Canada recommended in IR IAAC-39 that, as receptors may be exposed to COPCs through multiple pathways, lower level exposures should not be excluded as they can still contribute to the overall project-related exposure and risk to human health. The Conceptual Site Model in Figures 3.2 to 3.5 (Appendix A, pdf p.5339 to 5342) are not updated to reflect this. NS Lands is required to: ● Revise and re-evaluate the operability of potential exposure pathways in the PRA-HHRA report in accordance with Health Canada guidance. Update the effects assessment in the EIS, as appropriate. Alternatively, provide rationale for why the operability of the exposure pathways provided in the report were appropriate.	Information requested is provided in Section 5, below.

Table 1 - BHRP IR Conformity Review Responses

Information Requirement (IR) Number	Expert Department(s)	Context and Rationale	Specific Question/Information Requirement	Conformity Response	NSLI Response
IAAC-62	HC	The EIS Guidelines require a description and analysis of how changes to the environment caused by the Project will affect the Mi'kmaq of Nova Scotia, including their health. The EIS must consider the current and future availability and contamination of country foods in its analysis. Table H-1.15 and table C-1.12 of the Human Health and Ecological Risk Assessment report (HHERA – Appendix A of the EIS) reported that shellfish tissue collected from the Northumberland Strait, at the outfall of the estuary, have concentrations of aluminum, lead and manganese above the shellfish tissue screening guidelines and background level concentrations. The HHERA stated that these contaminants were not evaluated further because: the distinct exceedances were observed only in three (3) out of ten (10) clam tissue samples and the contaminant levels of the remaining seven (7) samples were similar to or below the selected screening criteria or background concentrations; aluminum and manganese are ubiquitous in sediment and the elevated levels are not necessarily related to the BHETF; and the clam tissue samples were not depurated prior to laboratory analysis (i.e. contaminants in stomach could have been detected in addition to the ones truly accumulated in tissue). However, it is noted that aluminum and manganese concentrations in all ten clam tissue samples were above their respective background concentrations. Furthermore, the high concentrations of aluminum, manganese and lead in clam samples are not observed consistently from the same samples (i.e. samples higher in aluminum do not necessarily have corresponding higher manganese or lead, which is what you might expect if it was just background). The analytical results, although limited in sample size, appear to be normally distributed. Therefore, the elevated contaminant concentrations in all clam tissue samples should be properly evaluated in the HHERA. Furthermore, contaminant concentrations in clam tissue from the project site were compared to "background concentrations" if the site concentrations were above the screening guidelines. However, section 6.1.1.12 of the HHERA indicates that the background concentrations used for comparison were collected from several shellfish tissues, including crab, lobster and mussels, rather than from clam. It is inappropriate to determine COPCs or characterize potential health risks from consuming contaminated clams based on the background data collected from crustacean shellfish and other bivalve species. The Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products (CFIA guidelines)[7] were used to determine whether arsenic, lead, mercury and dioxins/furans be qualified as COPCs in fish and shellfish. However, they are not valid screening guidelines for arsenic and lead in fish and shellfish as these values are specifically designed for fish protein or a standardized concentrated product (described under B.021.027 of the Food and Drug Regulations), but not for the commonly consumed muscle tissue of finfish or shellfish. Health Canada also does not recognize these guidelines as a safety standard for dioxins/furans in fish as the value does not consider the current approach to deriving dioxin/furan toxicity or concentrations. Furthermore, the CFIA guidelines are developed to determine compliance of commercial foods and thus the underlying assumptions (e.g., consumption pattern) may not be directly applicable to the screening of country foods. Therefore, the guidelines for mercury is also not an appropriate screening criteria for the project. Clarification and additional information about the screening criteria used to determine COPC in fish and shellfish is required to assess the potential adverse effects of the Project on country foods, which can impact Mi'kmaq of Nova Scotia health.	A.Carry forward the aluminum, lead, and manganese in clam tissue samples to a full HHERA. Alternatively, provide additional rationale to support screening them out of the HHERA. B. Determine COPCs in fish and shellfish country foods based on a comparison to the levels observed at a reference site (i.e. background concentrations). In the absence of such background data, the contaminants (i.e. lead, vanadium, arsenic, mercury, and dioxin/furans in fish) should be carried forward as COPCs to a full HHERA. Alternatively, provide evidence-based rationale supporting the use of the selected screening criteria; include a discussion on the uncertainties in using this criteria. C. Provide a detailed rationale on how the proposed background contaminant concentrations from crab, lobster, and mussels can support proper screening of contaminants in clam tissue and assessing potential human health risks.	A. Conforms. B. Conforms. C. The proponent's response (Section 2.2.25, pdf p.128) provides rationale for not carrying forward the contaminants that were identified at elevated concentrations in clam tissue: *"In shellfish (clams) collected from Northumberland Strait, lead was detected at concentrations marginally greater than the background shellfish samples (crab, lobster, and mussels). Lead was not identified as a COPC in sediment within the Study Area, lead is not associated with the historical activities of the BHETF, and lead is not considered bio-accumulative in sediment. As such, lead in clam tissue was not considered further as part of the HHERA specific to the Boat Harbour Remediation project"*. However, this response does not justify the proponent's screening of the contaminant levels in clam tissue against the background contaminant concentrations in other shellfish, such as crab, lobster, and mussels. NS Lands is required to: ● Provide a detailed rationale on how the proposed background contaminant concentrations in crab, lobster, and mussels (i.e., other species) can appropriately support screening of contaminants in clam tissue to assess potential human health risks.	Information requested is provided in Section 6, below.

2. IAAC-16 Response

Description of how LIDAR data was used to create the sediment and vegetation mapping

The bathymetric lidar (bathy-lidar) survey was conducted by Dr. Tim Webster at Nova Scotia Community College (NSCC), a foremost expert in the field. Dr. Webster has been a research scientist with NSCC Applied Research Group for over 20 years. The work was completed during favourable weather and sea conditions.

The maps were developed from the bathy-lidar data gathered and adjusted, as appropriate, based on the ground truthing. The following paragraph is taken from the conclusion section of the report (refer to Appendix BB of the EIS):

> *Ground truth data collected by AGRG with the help of Pictou Landing First Nation in August 2016 resulted in a thorough collection throughout the study area, and were helpful in determining water clarity, bottom type, and distribution of vegetation throughout the area at the time of the ground truth survey. This dataset was presented on a series of maps overlaid with the orthophoto mosaic. A seabed cover map was constructed from the aerial photos and the lidar derivatives and validated using the ground truth data.*

As discussed in the report prepared by NSCC, the correlation between the bathy-lidar data and the ground truthed data was poor (25 percent) for the mud substrate. More importantly, the bathy-lidar data had an excellent correlation (87.5 percent) with ground truthed points for eelgrass beds. The goal of the survey was to determine the location of eelgrass beds prior to remediation as they are an important habitat for fish species and a lidar survey can be readily repeated in a post remediation condition, as a high-level indicator of improved (or depleted) fish habitat. While bathy-lidar is a well proven technology, it does have limitations in deep water and dark coloured water (as was the case in Boat Harbour proper, where no eelgrass beds would be expected as the baseline condition, since it is for all intents and purposes, a freshwater environment and eelgrass is a saltwater plant species).

The bathy-lidar results were presented to the Boat Harbour Environmental Advisory Committee (BHEAC) in April of 2017, which included notable marine biologists, scientists and regulators, including Department of Fisheries and Oceans (DFO) for the sole purpose of seeking guidance/feedback. Nova Scotia Lands Inc. (NSLI) did not receive any specific guidance/feedback on the results at this time.

It is further noted that the survey included a portion of the East River where the effluent pipeline is buried. At the time of the survey, NSLI was considering removal of the effluent pipeline as part of the Project but has since determined that removal of the pipeline has the potential for negative effects to fish habitat in that area. As such, the Project plans put forward for the environmental impact assessment include capping and managing the pipeline in place. The pipeline is currently void of effluent and has been inspected by Northern Pulp during their site decommissioning activities overseen by Nova Scotia Environment. The areas characterized as mud substrate are largely located in the East River and Moodie Cove area which are currently outside the area of any Project-related effects related to fish and fish habitat.

Uncertainty in the Effects Assessment for Marine Environment and Fish and Fish Habitat

Uncertainty was factored into the Impact Assessment and was described where appropriate within the EIS. As described in Section 7.2.3 of the EIS "*If the potential adverse effects resulting from an interaction between a Project component and Valued Component (VC) were moderate or major, then the activity was carried forward for further assessment.* ***<u>Where there was uncertainty</u>*** *with the significance of the potential adverse effects that could result from an interaction between a Project component activity and VC, then a conservative approach was taken, and the activity was also carried forward for further assessment.*"

As it relates to bathy-lidar and ground truthing data, potential interactions between the Marine Environment and the Fish and Fish Habitat Valued Components (VC's) reviewed the potential interactions of proposed activities for wetland management, dredging and dam removal and identified moderate or major rankings with respect to "Potential Significant of Effects Resulting from Interaction". These elements were carried forward for further assessment and is in keeping with the application of the methodology described above in terms of taking a conservative approach with respect to elements of uncertainty.

Further, while it is recommended through IAAC Guidance documents that "*Caution should be exercised if the degree of uncertainty is unusually large*", uncertainty in the bathy-lidar and ground truthing data is not unusually large (87.5 percent correlation with ground truthed eel grass beds) and has been relied on to determine the location of eelgrass beds prior to remediation to assist in identifying potential changes in the marine environment.

Additional analysis on effects to Marine Environment (including eelgrass) was provided in response to IAAC-14, including additional coastal modelling as it relates to Total Suspended Solids (TSS) following dam removal activities and potential effects in the marine environment. In addition to the results presented in the response to IAAC-14, a commitment has been made to confirm effects predictions to the marine environment and fish/fish habitat and validate the effects assessment. In particular, NSLI intends to confirm model assumptions and outputs along with effects predictions by completing marine habitat surveys and monitoring of water quality (specifically TSS) and sediment deposition/flux to confirm current conditions in the Northumberland Strait embayment area directly north of the estuary (pre and post dam removal). The monitoring program will be specifically completed prior to dam removal activities to document water quality and marine habitat conditions in the Northumberland Strait pre-dam removal. Updated baseline conditions will focus on sediment transport (TSS and bed morphology/deposition evaluations) during the late fall or early winter periods when the timing of the dam removal is being proposed. In addition, underwater benthic habitat surveys (or similar evaluation techniques) will be used to document habitat conditions with a special emphasis placed on mapping and delineating seagrass beds in the area (including biomass and biodiversity). Based on the initial results of the bathy-lidar survey, this technology can be readily repeated in a post remediation condition, as an indicator of improved (or depleted) fish habitat, specifically related to eelgrass beds to support future ground truthing and associated effects evaluation. This information will be used to validate the effects assessment predictions post-dam removal and further refine potential uncertainties.

3. IAAC-33 Response

Tables 2 to 5 that were previously provided in response to IAAC-33 have been revised to include the soil allocation factor (SAF). An SAF of 1 was applied for vanadium, since background exposures (i.e., estimated daily intake or EDI) were included in the evaluation of risk for this contaminant. Since the EDI associated with background exposure to dioxins/furans is greater than the tolerable daily intake (TDI), theoretically, residents/Pictou Landing First Nation (PLFN) cannot be safely subjected to any increased exposure. As a result, the Health Canada and CCME default SAF of 0.2 was assumed for dioxins/furans. The revised Tables 2 to 5 previously included in response to IAAC-33 are provided in Attachment A.

4. IAAC-36 Response

GHD collected berries and herbaceous plants from the upland areas as well as aquatic plants from the wetland areas and this data were included in the Human Health and Ecological Risk Assessment report (HHERA) included as Appendix A of the EIS.

Section 4.2.5.2 of the HHERA provides a summary of the plant samples collected from the Study Area. The following plant samples were collected: cattails (*Typha*), bugleweed (*Lycopus uniflorus*), sensitive fern (*Onoclea sensibilis*), nightshade berries (*Solanum dulcamara*), holly berries (*Ilex verticillate*), curled dock (*Rumex crispus*), marsh hedge nettle (*Stachys palustris*), raspberries (*Rubus idaeus*), and bayberries (*Myrica* *pensylvanica*). Section 6.1.1.7 of the HHERA presents the chemical screening of the plant/berry tissue analytical results. Section 6.1.1.13 of the HHERA summarizes the chemicals of potential concern (COPCs) identified for plant/berry tissue that were carried through the HHERA for quantitative assessment and include: 1-Chloronaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, perylene, phenanthrene, pyrene, benzo(a)pyrene total potency equivalents [B(a)P TPE], nickel, tin, and uranium. These COPCs were identified to have concentrations greater than the background concentrations and therefore were carried through the HHERA for consumption of plants. Table 6.9 of the HHERA presents the exposure assumptions that were used to calculate dose/intake for consumption of plants. Table H-2-16 of Appendix H-2 of the HHERA presents the calculated dose/intake and risks for consumption of plants. These risks were summarized and discussed in Section 6.4.3.5 of the HHERA. The calculated cancer risks and hazard quotients (HQs) for all COPCs in plants are less than or equal to the Health Canada target cancer risk of 1E-05 and HQ value of 0.2. This indicates that there are currently no unacceptable health risks associated with the PLFN resident consuming vegetation from the Study Area.

It is noted that consumption of plants (from soils) was incorrectly identified as an inoperable exposure pathway in the human health Conceptual Site Model (CSM) that was provided in the HHERA report (Appendix A of the EIS). This human health CSM has been updated to show that the consumption of plants from upland areas is an operable exposure pathway (Attachment B). Relevant tables (Table H-2.9 and Table H-2.16) that were included in the HHERA report for the operable consumption of plants are provided in Attachment B of this memorandum for reference purposes. These tables indicate that consumption of plants from upland areas was considered an operable exposure pathway and assessed in the HHERA. As indicated in Table H-2.16, HQ values for all COPCs were equal to or less than 0.2 for plant consumption, and therefore, there are no current unacceptable health risks associated with the PLFN resident consuming plants from the Study Area.

The above assessment of plant consumption provided in the HHERA assumed exposure to current conditions. Please review the response below to IAAC-39, which provides an assessment of plant consumption as a result of soil disturbance and deposition to nearby residences and uptake into vegetable gardens – this pathway was assessed in the Project-Related Activities Human Health Risk Assessment (PRA-HHRA), which assessed potential human health risks to residences outside the Study Area during remediation of the Boat Harbour Stabilization Lagoon (BHSL). It is noted that this exposure pathway was identified as not operable in the PRA-HHRA as predicted concentrations in plants were below human health screening guidelines and/or background concentrations. Concentrations of COPCs that are less than applicable screening guidelines and/or background levels are not typically identified as COPCs and, therefore, do not require further assessment and typically are not carried through to the next step of the risk assessment. This initial COPC identification step is common industry practice for completing risk assessments in Canada and the United States. However, for the purposes of the conformity review, this pathway was carried forward specific to iron and manganese from the deposition of dust during remediation. As indicated in the response below to IAAC-39, the predicted concentrations of iron and manganese in plant tissue as a result of deposition to soils at nearby residences and uptake in garden vegetables do not pose an unacceptable risk through the consumption pathway and/or are consistent with the background concentrations in plants collected from areas outside the Study Area.

The revised human health CSM and the tables that present the exposure assumptions and calculated risks for consumption of plants for a resident/PLFN are presented in Attachment B.

5. IAAC-39 Response

In response to the conformity review related to IAAC-39, further assessment of human health risks was conducted for the COPCs that were identified in the PRA-HHRA (Appendix A of the EIS). Further details of this additional assessment of human health risks are provided below.

As indicated in the original response to IAAC-39, concentrations of COPCs in soil, groundwater, surface water, and country foods were below screening guidelines or similar to background concentrations and therefore, COPCs were not identified for these specific pathways consistent with standard industry practices. In particular, COPCs such as manganese in potable groundwater are known to be naturally elevated in Nova Scotia, specifically in the Pictou area (Province of Nova Scotia Department of Lands and Forestry website accessed November 2021, "Manganese in Well Water"). The Nova Scotia Energy and Mines Open File Report ME 2021-002 specific to manganese (Kennedy, 2021[1]) indicates that bedrock mapped as the Pictou and Cumberland Groups along the Northumberland Strait have naturally elevated manganese in groundwater with concentrations exceeding the Canadian Drinking Water Quality Maximum Acceptable Concentration (MAC) of 0.12 mg/L in 15 to 35% of the wells sampled, respectively. Consideration of local background conditions is, therefore, an important factor in the evaluation of potentially operable pathways and the potential for incremental risk. In addition, direct contact/ingestion with sediment and surface water at the Site, specifically within the BHSL, was considered not operable for residents or PLFN as access to the BHSL (including the wetland areas and portions of the estuary) will be restricted during active remediation activities. Exposure to sediment and surface water post-remediation could potentially occur but this exposure scenario was evaluated as part of the HHERA completed for the BHRP (Appendix A of the EIS). In addition, post-remediation monitoring to evaluate the effectiveness of the remediation activities is planned as outlined in the EIS.

Health Canada's Human Health Risk Assessment (HHRA) process includes four primary steps:

- problem formulation.
- exposure assessment.
- toxicity assessment.
- risk characterization.

The problem formulation is the first step of the HHRA and includes a screening of analytical data to identify COPCs in various media. COPCs, in the various media, are identified through a comparison of the media concentrations to the applicable screening guidelines. If the concentrations of COPCs in a specific medium are above the applicable screening criteria, then they are identified as COPCs that require further assessment and are carried through to the next step of the HHRA (i.e., exposure assessment). <u>Concentrations of COPCs that are less than applicable screening guidelines and/or background levels are not typically identified as COPCs and, therefore, do not require further assessment and typically are not carried through to the next step of the HHRA.</u> This initial COPC identification step is common industry practice for completing risk assessments in Canada and the United States. At the completion of the problem formulation, a human health CSM is developed that links the COPCs to their media sources along with release mechanisms, transport pathways, and exposure routes to identified receptors. The absence of COPCs indicates a break in this link, resulting in exposure pathways that are not complete and, therefore, not typically carried through the HHRA for further assessment. The above noted process is consistent with the following information presented in Health Canada's HHRA guidance (Section 7.1.2)[2]:

> *All chemicals that may be elevated in environmental media as a result of project activities may be initially considered as COPCs. However, if the modelled concentrations plus the baseline concentrations are calculated to be below guidelines/standards/criteria for the impacted media, the problem formulation phase of the risk assessment may conclude that the chemicals do not need to be carried forward as COPCs in a quantitative risk assessment.*

This process was followed during the completion of the HHERA and the PRA-HHRA (Appendix A of the EIS). If there are no COPCs identified in a particular environmental medium, then no further assessment of this medium is required or evaluated in the quantitative risk assessment.

For the purposes of the conformity review, COPCs identified to exceed screening values in one or more media as part of the PRA-HHRA have now been carried forward for other potentially operable exposure pathways to evaluate the potential for risk to residents and PLFN. The COPCs that were identified in the PRA-HHRA for the resident/PLFN included total suspended particulate matter (TSP), particulate matter with aerodynamic

[1] Kennedy, G.W., 2021. A Manganese in Well Water Risk Map for Nova Scotia, Nova Scotia Energy and Mines, Geological Survey Division, Halifax, Nova Scotia, March 2021.

[2] Health Canada, 2019. Guidance for Evaluating Human Health Impacts in Environmental Assessments: Human Health Risk Assessment, June.

diameters less than or equal to 10 microns (PM_{10}), iron, and manganese in ambient air dusts while BHRP related activities are occurring. The activities that result in the generation of dusts involve construction-related activities resulting in truck traffic, the movement of imported material, and the disturbance of soils located within the remediation area. It is noted that TSP and PM_{10} are strictly ambient air related COPCs associated with residential inhalation exposure and not applicable to other media. As such, TSP and PM_{10} were not carried through this additional assessment. The COPCs carried through this assessment include the following: iron and manganese.

Exposure Pathway Analysis

- Figure 1 that follows this response in Attachment C includes an updated human health CSM for the potentially operable exposure pathways associated with the PRA-HHRA that require further assessment for iron and manganese.
- Operable Exposure Pathways:
  - Incidental ingestion and dermal contact with soil (noted that iron and manganese concentrations are below applicable human health screening guidelines).
  - Household use of potable groundwater (limited to off-Site potable water wells or PLFN community water supply as groundwater wells for potable water usage are currently not located on the Site).
  - Inhalation of soil particulates in ambient air.
  - Incidental ingestion and dermal contact with surface water (this would be generally limited to surface water of the estuary or Northumberland Strait as access to the BHSL or freshwater wetlands will be restricted during active remediation).
  - Incidental ingestion and dermal contact with sediment (this would be generally limited to sediment in areas of the estuary or Northumberland Strait as access to the BHSL, freshwater wetlands and areas of the estuary will be restricted during active remediation).
  - Consumption of plants.
  - Consumption of shellfish.
- Inoperable Exposure Pathways:
  - Inhalation of soil vapours in ambient air – COPCs are not volatile and therefore not present in vapour form.
  - Inhalation of soil vapours in indoor air – COPCs are not volatile and therefore not present in vapour form.

Exposure Assessment

- Table 1 (Attachment C) summarizes the Exposure Point Concentrations (EPCs) that were used to calculate daily intake/dose levels for soil, groundwater, air, surface water, sediment, plants, and shellfish.
  - *Soil* - predicted concentrations in soil as a result of soil disturbance and deposition to nearby residences – these predicted soil concentrations were presented in the PRA-HHRA (Table 1b) and are the sum of baseline soil concentrations (i.e., background soil concentrations for outside the Study Area) and concentrations associated with dust deposition from BHRP related activities.
  - *Groundwater* - measured groundwater concentrations obtained from Pictou Landing Production Wells #1, #3, and #8 used for drinking water supply[3]. The groundwater concentrations represent the maximum detected concentrations for groundwater samples collected between 2004 and 2010. As indicated above, COPCs such as manganese are known to be naturally elevated in potable water supplies of Nova Scotia (Province of Nova Scotia website, "Manganese in Well Water", accessed November 2021). In particular, bedrock units along the Northumberland Strait have been identified as

[3] Pictou Landing IR24, 2010 Groundwater Monitoring Program - Final Report, August 2011, prepared by Dillon Consulting Ltd.

having concentrations of manganese in groundwater exceeding the Canadian Drinking Water Quality MAC in 15 to 35 % of the wells sampled (Kennedy, 2021).

- *Air* – predicted concentrations in air as a result of soil disturbance and deposition to nearby residences – these predicted air concentrations (24-hour) were presented in the PRA-HHRA (Table 7b) and are the sum of baseline air concentrations (i.e., background air concentrations for outside the Study Area) and concentrations associated with soil disturbance from BHRP related activities.
- *Surface Water* - predicted concentrations in surface water discharged from the BHSL during the first 5 years of active remediation[4]. The surface water concentrations represent the maximum concentrations over the 5-year period.
- *Sediment* – measured concentrations in sediment collected from the estuary and BHSL – these measured sediment concentrations were presented in the HHERA (Appendix F) and are representative of the 95th percent upper confidence limit of the mean (95UCLM). Although nearby residents would not be directly exposed to these sediments, it was conservatively assumed that these sediments could be released to the Northumberland Strait following remediation activities and available for direct contact/ingestion during recreational use of the Northumberland Strait.
- *Plants* – predicted concentrations in plants as a result of soil disturbance and deposition to nearby residences and uptake into vegetable gardens – these predicted plant concentrations were presented in the PRA-HHRA (Table 5b) and are the sum of baseline plant concentrations (i.e., background plant concentrations for outside the Study Area) and concentrations associated with deposition from BHRP related activities.
- *Shellfish* - measured concentrations in mussels, clams, lobster, and crab collected from Northumberland Strait – these measured shellfish concentrations were presented in the HHERA (Appendix C) and are representative of the 95UCLM. Note that the 95UCLM concentrations for combined shellfish samples were not provided in the HHERA, however, the United States Environmental Protection Agency (USEPA) ProUCL software output for 95UCLM calculations is presented in the supporting information provided following this response (Attachment C).

– Tables 2 to 7 of Attachment C present the exposure assumptions that were used to calculate daily intake/dose levels for the resident/PLFN. Given that iron and manganese are non-carcinogenic COPCs, the daily intake/dose levels were calculated for toddler receptors, which are considered to be the most sensitive of the life stages. All exposure assumptions that were applied in this assessment are Health Canada default assumptions for a resident receptor (Health Canada, 2021[5]), with the exception of the following assumptions:

- For dermal contact with groundwater, an exposure time (ET) of 0.54 hours per day was assumed based on the weighted average of 90th percentile time spent bathing for child (birth to 6 years) and adult (21 to 78) presented in USEPA (2014)[6].
- For exposure to surface water and sediment, resident exposure to surface water and sediment during recreational activities was assumed to occur for 4 hours per day, 7 days per week during the months between April and October (30 weeks). However, as this is considered less than chronic exposure, consistent with Health Canada (2021), no dose averaging was assumed (i.e., D3 was set to 30 weeks/30 weeks=1, rather than averaging over 52 weeks per year).
- For dermal contact with surface water, skin permeability constants (PDerm) were obtained from USEPA's Regional Screening Levels (RSLs)[7].

[4] GHD, 2021. Memorandum – Update to Memorandum 057, Establishment of Water Treatment Compliance Criteria, Boat Harbour Remediation Planning and Design, November 2021.
[5] Health Canada. 2021. Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0. March.
[6] USEPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER 9200.1-120, February 6, 2014.
[7] USEPA, 2021: Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table, May.

- For exposure to sediment, the sediment ingestion rates, skin surface areas, and sediment loading rates for the most conservative dermal exposure scenarios (child playing along shoreline, out of water, within mud) from Health Canada (2017)[8] were assumed.
- Ingestion rates for plants and shellfish were obtained for the First Nations in the Atlantic (FNFNES, 2017)[9] and are based on an adult heavy consumer (95th percentile, unless otherwise noted). Since these ingestion rates are based on adult receptors, they were adjusted using child to adult ratios for plant ingestion rates presented in Health Canada (2012) (Health Canada PQRA guidance, Version 2.0) and shellfish ingestion rates presented in Health Canada (2007)[10].

Toxicity Assessment

– As indicated above, iron and manganese are both non-carcinogenic compounds. Therefore, chronic oral/dermal non-carcinogenic reference dose (RfD) toxicity values (Table 8 of Attachment C) and chronic inhalation non-carcinogenic reference concentration (RfC) toxicity values (Table 9 of Attachment C) were identified, where available.

– Iron – Health Canada (2021)[11] does not provide toxicity values for iron. Therefore, the oral Provisional Peer Reviewed Toxicity Value (PPRTV)[12] for iron (0.7 milligrams/kilogram-day [mg/kg-day]) was applied as the oral/dermal RfD in the assessment.

– Manganese – Health Canada (2021) provides an oral toxicity value (0.025 mg/kg-day) for manganese, which was applied as the oral/dermal RfD in the assessment.

– Health Canada (2021) does not provide inhalation toxicity values for iron or manganese. Therefore, the inhalation toxicity values were based on the Ontario Ambient Air Quality Criteria[13].

Risk Characterization

– The potential for non-carcinogenic health effects from exposure to a COPC is evaluated by comparing the intake/dose to the RfD/RfC. This ratio, termed the hazard quotient (HQ), is calculated according to the following general equations:

  - Oral/Dermal Exposure: HQ = Dose (mg/kg-day)/RfD (mg/kg-day)
  - Inhalation Exposure: HQ = Dose (mg/m^3)/RfC (mg/m^3)

– Calculated HQ values equal to or less than the Health Canada target HQ of 0.2 are considered protective of human health.

– Table 10 of Attachment C presents the HQ values for iron and manganese for each operable exposure pathway as well as the cumulative HQ. A summary of the results is provided below:

  - Iron - inhalation exposure to air (2.4), direct contact with sediment (160), and consumption of shellfish (0.34) resulted in HQ values greater than 0.2. All other operable exposure pathways had HQ values less than 0.2. Direct contact with sediment contributed 98 percent of the cumulative HQ (160).
  - Manganese - inhalation exposure to air (1.1), direct contact with sediment (260), consumption of plants (3.6), and consumption of shellfish (1.3) resulted in HQ values greater than 0.2. All other operable exposure pathways had HQ values less than 0.2. Direct contact with sediment contributed 98 percent of the cumulative HQ (270).

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[8] Health Canada, 2017: Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathway, March 2017.

[9] FNFNES, 2017: Laurie Chan, Olivier Receveur, Malek Batal, William David, Harold Schwartz, Amy Ing, Karen Fediuk and Constantine Tikhonov. First Nations Food, Nutrition and Environment Study (FNFNES): Results from the Atlantic. Ottawa: University of Ottawa, 2017. Print. Ingestion rates are based on combined male and female heavy consumer (consumers only).

[10] Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption, Bureau of Chemical Safety Food Directorate, Health Products and Food Branch, March 2007.

[11] Health Canada, 2021: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.

[12] Provisional Peer Reviewed Toxicity Values (PPRTVs) for Iron and Compounds. Derivation of Subchronic and Chronic Oral RfDs, USEPA Superfund Technical Support Center, September 2006.

[13] Ontario MOE, 2019: Ministry of the Environment, Ontario Regulation 419/05, Schedule 3: Standards with Variable Averaging Periods, 2019. (https://www.ontario.ca/laws/regulation/050419).

- Inhalation of soil particulates in ambient air during BHRP related activities was also identified as a potential concern to nearby residences in the PRA-HHRA. The elevated concentrations of iron and manganese are primarily related to truck traffic on the Site access road during final capping of the containment cell with the area of concern generally confined to the access area of Simpson's Road from Highway 348. Current land use in the area of predicted elevated dust concentrations is generally undeveloped forested areas but residential properties are located in close proximity to the area of impingement. Real time air quality monitoring has been recommended during BHRP activities, specifically during increased truck traffic on Simpson's Road during final containment cell capping. Air monitoring along with Site-specific mitigative measure such as paving of access roads, additional watering, reduced daily truck traffic, and reduced speeds will be used to ensure protection of residential receptors in the area. No additional measures are required for iron and manganese based on this assessment.
- As indicated above, sediment exposure was the primary contributor to the cumulative HQ for iron and manganese. However, it was conservatively assumed that the receptor would be exposed to sediment from the estuary/BSHL. This is an overly conservative assumption as access to the BHSL including areas of the estuary will be restricted during active remediation activities which limits direct contact with sediment by residents and PLFN. Furthermore, current concentrations of iron and manganese in sediment within the Study Area were compared to background levels using the USEPA's ProUCL Wilcoxon two-sample test. There were two comparisons completed: (1) concentrations of iron and manganese within sediments collected from the estuary/BHSL were compared to concentrations of iron and manganese within sediments collected from a nearby reference lake (Chance Harbour Lake); and (2) concentrations of iron and manganese within sediments near the outfall to Northumberland Strait were compared to concentrations of iron and manganese within sediments collected from a reference area of Northumberland Strait (near Fergusons Pond located approximately 2 kilometres [km] east of the Study Area). The reference lake and reference area of the Northumberland Strait used in this evaluation are also the reference locations and data used in the HHERA (Figures 8A and 8B of the HHERA, Appendix A of the EIS). The ProUCL outputs for these statistical comparisons are provided in Attachment C.

  Results of the statistical analysis indicate that the concentrations of iron and manganese in sediments collected from the BHSL and estuary are statistically similar to (or lower than) the concentrations of iron and manganese from Chance Harbour Lake. Similarly, concentrations of iron and manganese in sediment of the Northumberland Strait are statistically similar to concentrations of iron and manganese in other areas of the Northumberland Strait. As the concentrations of iron and manganese in sediments from the BHSL and estuary are similar to or lower than background concentrations, additional risk management or remediation specific to iron and manganese in sediment is not considered warranted.
- The concentration of manganese predicted in plants (150 mg/kg) through soil deposition resulting from soil disturbance during BHRP related activities is within the range of background plant concentrations collected outside the Study Area (21 – 315 mg/kg; 95UCLM = 156 mg/kg). These background plant concentrations were based on plant samples (cattail and bugleweed) collected from a reference location that was also used in the HHERA (Figure 8A of the HHERA, Appendix A of the EIS). As the concentrations of manganese predicted in plants are consistent with background plant concentrations, additional risk management or remediation specific to manganese in plants is not considered warranted.
- The majority of the risks due to consumption of shellfish are a result of elevated concentrations of iron and manganese measured in clams collected near the outfall of Northumberland Strait. As indicated above, iron and manganese are not present within the Study Area sediments at concentrations that are statistically higher than background levels. As such, the concentrations of iron and manganese in the clams are likely consistent with background levels. Furthermore, the clams analyzed as part of the HHERA were not depurated prior to analysis and therefore, the metals concentrations associated with the clam tissue has the potential to be biased high dependent on the mineral content within the clam gut. Additional discussion on concentrations of COPCs in clam tissue is provided in Section 6 below.

– Several shellfish tissues (crab, lobster, and mussels) were also collected from Northumberland Strait by representatives of Dalhousie University in 2019 (Chaudhary et al., 2020[14]). These shellfish samples were collected from the Northumberland Strait shoreline near the estuary, but also several kilometres away from the Study Area. Based on the analytical results for these shellfish samples, the concentrations of iron and manganese were similar to or lower in the shellfish samples (crab, lobster, and mussels) collected near the Study Area versus those collected several kilometres away. The locations of these shellfish samples were shown on Figure 7C of the HHERA and the analytical results are presented in Appendix C of the HHERA (Appendix A of the EIS). As the concentrations of iron and manganese are similar in the various shellfish samples collected from Northumberland Strait in the vicinity of the Study Area as well as several kilometres away from the Study Area, additional risk management or remediation specific to iron and manganese in shellfish is not considered warranted. As indicated previously, NSLI has committed to monitoring country foods following completion of the remediation activities which will include shellfish in the marine environment to confirm project related activities have not negatively impacted country foods compared to current conditions.

Supporting information that was referenced in this response is provided in Attachment C.

6. IAAC-62 Response

As indicated in the original response to IAAC-62, the clam tissue included in the HHERA (Appendix A of the EIS) were collected from the Northumberland Strait shoreline directly adjacent to the estuary in 2019. The clams collected were observed to be moving with the tide and deposited on the shoreline surface at the high tide waterline. In an effort to collect background clam samples, the Northumberland Strait shoreline area near Ferguson's Pond which was used for reference sediment and surface water samples was also inspected for the presence of clams, but none were identified at this time. Given the absence of reference clam tissue for comparison to clams collected in the Study Area, a desktop literature review was completed to evaluate potential reference concentrations of metals (and other COPCs) in clam tissue of the Northumberland Strait. Limited information on potential background concentrations of COPCs in clam tissue was available in the literature reviewed. In particular, Department of Fisheries and Oceans (DFO) monitoring of toxins in shellfish (including clams) is primarily focused on marine biotoxins related to paralytic shellfish poisoning (PSP). In addition, Stewart et al. (2019[15]) prepared a review of environmental contaminants in various marine habitats in the Maritimes on behalf of DFO. Findings of this review determined limited recent information is available on inorganic contaminants in clams of the Maritimes region. Although a variety of metals influence marine organisms and have been the subject of studies, mercury and its organic form as methyl mercury has been a particular focus of research in the bioregion in response to concentrations which have been increasing in the environment from various sources (Engel et al., 2006[16]).

Although there was limited information available for COPC in clam tissue specific to the Northumberland Strait, the review completed by Stewart et al. (2019) et al. did identify concentrations of inorganic parameters are available for mussels and lobster from various marine habitats of the Maritimes. In particular, the study noted that blue mussels are commonly used as a bio-indicator to monitor metal levels in the environment because of their common occurrence and relatively easy access for sampling (Stewart et al., 2019). These findings are consistent with the evaluation completed by Chaudhary et al. (2020) which used American lobster, rock crab and mussels to evaluate chemical concentrations in invertebrates along the coastline of Pictou Harbour to a

[14] Chaudhary, M., Walker, R., Willis, R., Oakes, K. (2020). Baseline characterization of sediments and marine biota near industrial effluent discharge in Northumberland Strait, Nova Scotia, Canada. Marine Pollution Bulletin 157 (2020) 111372. Panneerselvam, E.

[15] Stewart, P., Kendall, V., Breeze, H. (2019). Marine Environmental Contaminants in the Scotian Shelf Bioregion: Scotian Shelf, Bay of Fundy and Adjacent Coastal and Offshore Waters – 1995 to Present. Canadian Technical Report of Fisheries and Aquatic Sciences 3291.

[16] Engel, M., Kim, K., St. Jean, S., Gagne, F., Burnison, K. and Losier, R. 2006. Contaminant concentrations and biomarker activity in wild mussels near point sources of contaminants in the Lower Bay of Fundy. Environment Canada, EPS Surveillance Report, EPS-5-AR-06-03. August 2006. 46 p.

maximum distance of 7.5 km from Boat Harbour. Results of the study indicated there was no significant impact on marine biota, except for exceedances of arsenic in lobster and rock crabs which is naturally elevated in water and sediments across Nova Scotia (Chaudhary et al., 2020). Considering the economic importance of fishing in the Northumberland Strait and the known human consumption of these invertebrates, it was suggested that the sediment and shellfish samples collected as part of this study could be used as a baseline for future sediment and biota monitoring (using the same species as this study) following completion of the BHETF remediation project.

Given the absence of reference clam tissue from the Northumberland Strait for comparison to Study Area samples, other shellfish that are known to be harvested from the Northumberland Strait for human consumption, specifically American lobster, crab, and mussels, were used as a surrogate for background clam tissue. The purpose of utilizing this surrogate reference shellfish data was to determine if concentrations of COPCs in the clam tissue collected was similar to other shellfish in the Northumberland Strait that are known to be consumed by humans. As indicated in the original response to IAAC-62, the concentrations of COPCs in the clam tissue collected in 2019 was statistically similar to concentrations of COPCs in other shellfish collected from the Northumberland Strait (Chaudhary et al., 2020), and therefore, additional evaluation of risk related to potential consumption of clam tissue was not considered warranted. The exception was aluminium, lead, and manganese in the clam tissue which were identified at concentrations greater than the background shellfish samples. As indicated in the original response to IAAC-62, these three metals in clam tissue were not further evaluated in the HHERA as the concentrations of these metals in surface water and sediment associated with the BHETF (including the estuary and adjacent Northumberland Strait area) are below applicable screening values and/or statistically similar to background conditions in the area (see statistical comparison provided in Section 5 for manganese in sediment).

Following completion of the HHERA and previous correspondence related to IAAC-62, reference concentrations of metals in softshell clams in the Northumberland Strait area were identified through correspondence with a graduate student from Dalhousie University (Ms. Megan Fraser, Master of Environmental Studies Candidate). In 2018, Ms. Fraser was involved with research related to metal concentrations of invertebrates in the Northumberland Strait. As part of this work, a total of 10 soft shell clams were collected from the Northumberland Strait in the vicinity of Pomquet (approximately 65 km east of the BHETF). The clams collected were composited and analysed for metals on an "as collected" basis (not depurated) consistent with the data used in the HHERA. Laboratory results obtained from the composited soft shell clam sample had concentrations of aluminium, lead and manganese of 197, 2.6 and 86 mg/kg, respectively (data publication in preparation and available upon request). A statistical comparison of this reference sample data to the site data could not be completed given the limited number of reference tissue samples (one composite sample). However, the concentrations of aluminium, lead and manganese in the reference sample are approximately equal to or less than the 95UCLM of the site clam tissue data for these same metals (109, 1.6 and 115 mg/kg, respectively). Although the 95UCLM for manganese was higher than the reference sample, 8 of the 10 clam samples collected from the site had a manganese concentration less than the reference sample. This reference soft shell clam data provides an additional line of evidence that concentrations of metals in the clam tissue collected from the Study Area are consistent with background concentrations of metals in shellfish in the Northumberland Strait, including aluminium, lead and manganese.

As indicated by Stewart et al. (2019), metals are natural and ubiquitous in the marine environment of coastal and offshore waters reflecting principally the local geology and sediment composition. Contaminant metals reach the marine environment in freshwater runoff and atmospheric transport of particulate matter (e.g., dust) and are accumulated by organisms at various levels in the food chain. As there are a number of potential anthropogenic influences of metals in the coastal environment near Pictou Landing such as wastewater treatment outfall(s), long range transport of atmospheric pollutants, and industrial outfalls in the Pictou River (amongst others), the scope of the HHERA did not include additional evaluation of potential COPCs in biota, specifically clam tissue, that are not associated with the BHETF. Given the uncertainties associated with metal concentrations in clam tissue and the potential influence of undigested granular material within the gut of the clam (depurated versus undepurated samples) as well as limited background or reference data, it is recommended future monitoring of shellfish associated with the BHRP and evaluation of risk from consumption of country foods focus on American lobster, crab, and mussels.

Regards

Troy Small
Business Group Leader-Impact Assessment

Christine Skirth
Business Group Leader- Contaminated Sites

Attachments

Attachment A

Supporting Information for IAAC-33

Table 2

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler (Sandy Beach Scenario)
Boat Harbour Effluent Treatment Facility
Pictou Landing, Nova Scotia

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia

Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler

Exposure Scenario: Sandy Beach

Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	1.6E+02	160
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	7.5E-05	75

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	72	Health Canada (2017; 2021a)
SA_{hands} =	surface area of hands (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SA_{arms} =	surface area of lower arms (cm^2)	890	Health Canada (2017; 2021a) - Toddler
SA_{legs} =	surface area of lower legs (cm^2)	1690	Health Canada (2017; 2021a) - Toddler
SA_{feet} =	surface area of feet (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SL_{hands} =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	0.49	Health Canada (2017)
SL_{arms} =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	0.17	Health Canada (2017)
SL_{legs} =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	0.70	Health Canada (2017)
SL_{feet} =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	21	Health Canada (2017)
D1 =	hours per day	8	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB\text{-}CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI - EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + ((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Table 3

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler (Intertidal Mudflats Scenario)
Boat Harbour Effluent Treatment Facility
Pictou Landing, Nova Scotia

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia

Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler

Exposure Scenario: Intertidal Mudflats

Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	7.0E+01	70
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	2.9E-05	29

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	72	Health Canada (2017; 2021a)
SA_{hands} =	surface area of hands (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SA_{arms} =	surface area of lower arms (cm^2)	450	Health Canada (2017; 2021a) - Toddler
SA_{legs} =	surface area of lower legs (cm^2)	845	Health Canada (2017; 2021a) - Toddler
SA_{feet} =	surface area of feet (cm^2)	430	Health Canada (2017; 2021a) - Toddler
SL_{hands} =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	58	Health Canada (2017)
SL_{arms} =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	11	Health Canada (2017)
SL_{legs} =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	36	Health Canada (2017)
SL_{feet} =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	24	Health Canada (2017)
D1 =	hours per day	4	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB\text{-}CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + (((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Table 4

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Child (Reed Gathering Scenario)
Boat Harbour Effluent Treatment Facility
Pictou Landing, Nova Scotia

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia

Receptor: Pictou Landing First Nations Resident/Recreational User - Child

Exposure Scenario: Reed Gathering

Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	1.0E+03	999
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	5.0E-04	505

Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021a); CCME (2006)
BW =	body weight (kg)	32.9	Health Canada (2021a) - Child
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	57	Health Canada (2017; 2021a)
SA_{hands} =	surface area of hands (cm^2)	590	Health Canada (2017; 2021a) - Child
SA_{arms} =	surface area of lower arms (cm^2)	740	Health Canada (2017; 2021a) - Child
SA_{legs} =	surface area of lower legs (cm^2)	1535	Health Canada (2017; 2021a) - Child
SA_{feet} =	surface area of feet (cm^2)	720	Health Canada (2017; 2021a) - Child
SL_{hands} =	sediment loading rate to exposed skin of hands (kg/cm^2-event)	0.66	Health Canada (2017)
SL_{arms} =	sediment loading rate to exposed skin of lower arms (kg/cm^2-event)	0.036	Health Canada (2017)
SL_{legs} =	sediment loading rate to exposed skin of lower legs (kg/cm^2-event)	0.16	Health Canada (2017)
SL_{feet} =	sediment loading rate to exposed skin of feet (kg/cm^2-event)	0.63	Health Canada (2017)
D1 =	hours per day	4	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB\text{-}CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI - EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3) + (((SA_{hands} \times SL_{hands}) + (SA_{arms} \times SL_{arms}) + (SA_{legs} \times SL_{legs}) + (SA_{feet} \times SL_{feet})) \times RAF_{derm} \times D2 \times D3)} + BSC$$

Table 5

Site Specific Target Levels for Human Health
(Non-Carcinogenic Substances) - Toddler (In-Water Activities Scenario)
Boat Harbou Effluent Treatment Facility
Pictou Landing, Nova Scotia

Site Name: Boat Harbour Effluent Treatment Facility, Pictou Landing, Nova Scotia

Receptor: Pictou Landing First Nations Resident/Recreational User - Toddler

Exposure Scenario: In-Water Activities

Exposure Pathway: Direct Contact with Sediment

COPC	RfD (oral/dermal)	RfC (inhalation)	EDI	SAF	BSC	RAF_{oral}	RAF_{lung}	RAF_{derm}	SSTL (mg/kg)	SSTL (mg/kg; pg/g for dioxins/furans)
Vanadium	1.00E-02	Not Applicable	0.0023	1	1.0E+01	1	Not Applicable	0.026	2.1E+03	2080
Dioxins/Furans TEQ	2.00E-08	Not Applicable		0.2	1.6E-06	1	Not Applicable	0.03	1.1E-03	1073

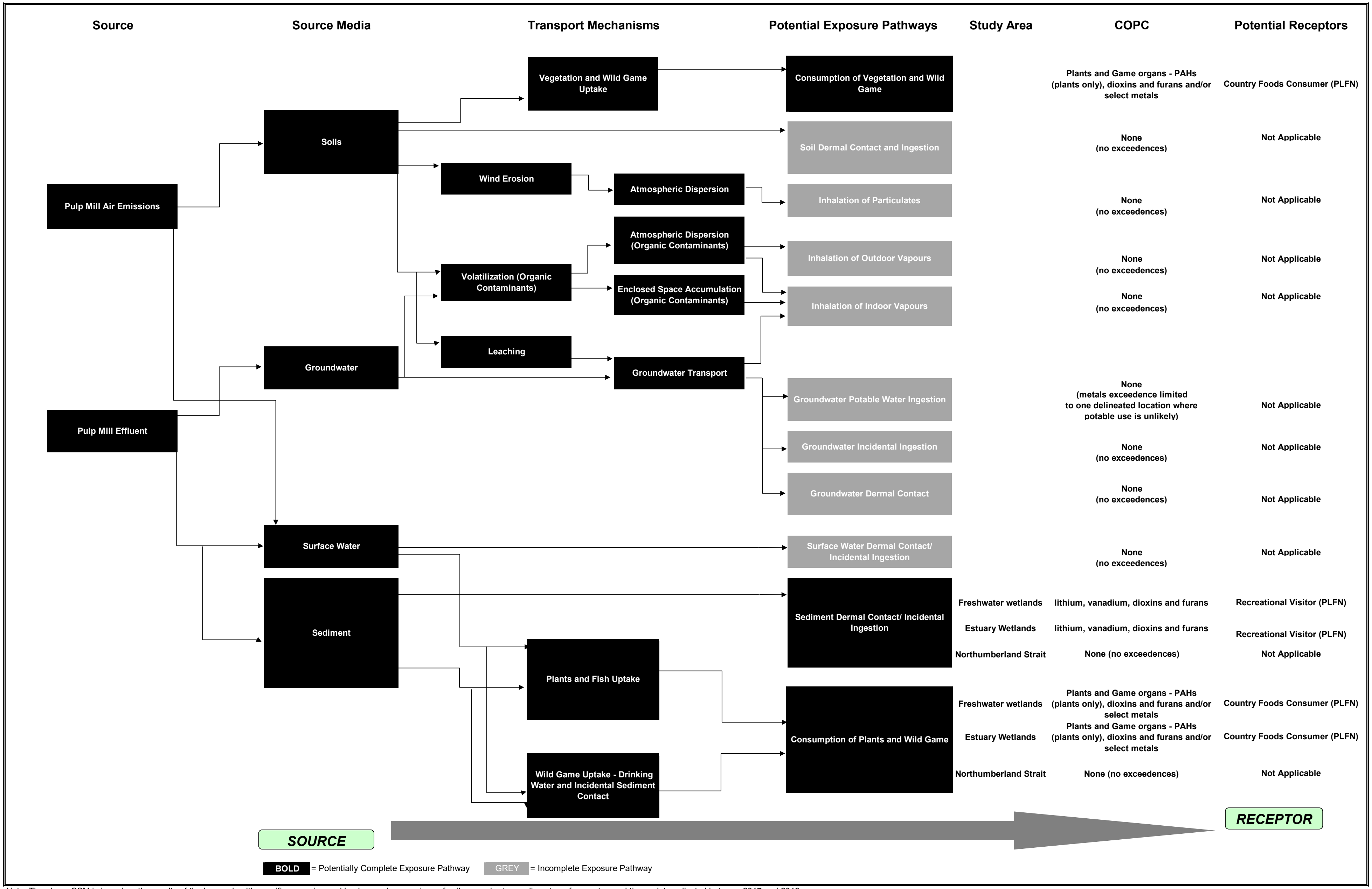
Parameter	Definition (units)	Default Value	Reference
RfD =	reference dose (mg/kg bw-day)	chemical specific	ATSDR intermediate duration minimum risk levels (MRLs)
RfC =	reference concentration (mg/m^3)	chemical specific	Not applicable
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	See Table 1 for vanadium; no EDI available for dioxins/furans
SAF =	soil allocation factor (unitless)	chemical specific	Health Canada (2021); CCME (2006)
BW =	body weight (kg)	16.5	Health Canada (2021a) - Toddler
BSC =	background sediment concentration (mg/kg)	chemical specific	Based on calculated 95% upper confidence limit (UCL) using ProUCL Version 5.1 of background data collected from Chance Harbour Lake and an unnamed wetland.
RAF_{oral} =	relative absorption factor for from the gastrointestinal tract (unitless)	chemical specific	Assumed 1.
RAF_{lung} =	relative absorption factor by inhalation (unitless)	chemical specific	Not applicable
RAF_{derm} =	relative dermal absorption factor (unitless)	chemical specific	0.026 for vanadium (USEPA, 2004); 0.03 for Total TEQ (Health Canada, 2021b).
SIR =	sediment ingestion rate (mg/hour)	7.7	Health Canada (2017; 2021a)
D1 =	hours per day	8	Health Canada (2021a) - assumed
D2 =	7 days per week exposed/7 days	1	Health Canada (2021a) - assumes 7 days per week
$D3_{SUB-CHRONIC}$ =	30 weeks per year exposed/30 weeks	1	Health Canada (2021a) - assumes 30 weeks/30 weeks exposed (non-winter)
CF =	conversion factor (kg/mg)	1.0E+06	Health Canada (2017; 2021a)

$$SSTL = \frac{(TDI-EDI) \times SAF \times BW \times CF}{(SIR \times RAF_{oral} \times D1 \times D2 \times D3)} + BSC$$

Attachment B

Supporting Information for IAAC-36

Figure 12 Revised Conceptual Site Model for Human Receptors - Quantitative HHERA - Boat Harbour Effluent Treatment Facility



Note: The above CSM is based on the results of the human health specific screening and background comparison of soil, groundwater, sediment, surface water, and tissue data collected between 2017 and 2019.

Table H-2.9

Values Used for Daily Intake Calculations - Resident Consumption of Traditional Country Foods
Quantitative Human Health and Ecological Risk Assessment
Boat Harbour Effluent Treatment Facility
Pictou Landing, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Traditional Foods
Exposure Medium: Traditional Foods
Receptor Population: Traditional Foods Consumer
Receptor Age: Toddler, Child, Teen, & Adult (1)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/ Model Name
Ingestion	Cp	Chemical Concentration in Plants	mg/kg	(2)	(2)	Dose (predicted daily intake) (mg/kg-day) =
	Cgo	Chemical Concentration in Game Organs	mg/kg	(2)	(2)	Cf x IRf x D_i x RAFo x D4 x 1/BW x 1/365 x 1/LE
	Cw	Chemical Concentration in Waterfowl	mg/kg	(2)	(2)	
	IRp - toddler	Ingestion Rate of Plants/Berries	kg/day	0.010	FNFNES (2017) (3)(4)	Note D4 and LE only used for carcinogens
	IRp - child	Ingestion Rate of Plants/Berries	kg/day	0.015	FNFNES (2017) (3)(4)	
	IRp - teen	Ingestion Rate of Plants/Berries	kg/day	0.022	FNFNES (2017) (3)(4)	This equation is used for each food item
	IRp - adult	Ingestion Rate of Plants/Berries	kg/day	0.018	FNFNES (2017) (3)	that is consumed.
	IRgo - toddler	Ingestion Rate of Game Organs	kg/day	0.0044	FNFNES (2017) (3)(4)	
	IRgo - child	Ingestion Rate of Game Organs	kg/day	0.0065	FNFNES (2017) (3)(4)	
	IRgo - teen	Ingestion Rate of Game Organs	kg/day	0.0091	FNFNES (2017) (3)(4)	
	IRgo - adult	Ingestion Rate of Game Organs	kg/day	0.014	FNFNES (2017) (3)	
	IRw - toddler	Ingestion Rate of Waterfowl	kg/day	0.00031	FNFNES (2017) (3)(4)	
	IRw - child	Ingestion Rate of Waterfowl	kg/day	0.00046	FNFNES (2017) (3)(4)	
	IRw - teen	Ingestion Rate of Waterfowl	kg/day	0.00065	FNFNES (2017) (3)(4)	
	IRw - adult	Ingestion Rate of Waterfowl	kg/day	0.0010	FNFNES (2017) (3)	
	D_i	Exposure Frequency (days per year consumption occurs)	days/year	365	Health Canada, 2012 (5)	
	D_4 - toddler	Exposure Duration (total years exposed to Site) - carcinogens only	years	4.5	Health Canada, 2010a	
	D_4 - child	Exposure Duration (total years exposed to Site) - carcinogens only	years	7	Health Canada, 2010a	
	D_4 - teen	Exposure Duration (total years exposed to Site) - carcinogens only	years	8	Health Canada, 2010a	
	D_4 - adult	Exposure Duration (total years exposed to Site) - carcinogens only	years	60	Health Canada, 2010a	
	BW - toddler	Body Weight	kg	16.5	Health Canada, 2010a	
	BW - child	Body Weight	kg	32.9	Health Canada, 2010a	
	BW - teen	Body Weight	kg	59.7	Health Canada, 2010a	
	BW - adult	Body Weight	kg	70.7	Health Canada, 2010a	
	LE	Life Expectancy - carcinogens only	years	79.5	Health Canada, 2010a	
	RAFo	Relative Absorption Factor - gastrointestinal tract	%/100	1	Health Canada, 2010b	

Notes:

(1) Carcinogenic risk evaluates a composite receptor which consists of a toddler, child, teen, and adult averaged over a 79.5-year lifetime.
Non-carcinogenic hazard quotient evaluates toddler exposure that being the most sensitive receptor.

(2) For concentrations in plants, game meat (organs), and waterfowl, refer to Tables H.2.2, H.2.3, and H.2.4, respectively.

(3) The ingestion rates obtained for the First Nations in the Atlantic (FNFNES, 2017) and are based on an adult heavy consumer (95th percentile, unless otherwise noted). Note that the consumption rate for game organs reflects the consumers only maximum ingestion rate reported in FNFNES study, due to the low number of individuals who reported consuming game organs.

(4) For plants/berries, the ingestion rates for the toddler, child, and teen were calculated by multiplying the adult ingestion rate by the ratio of the ingestion rate for each life stage to the ingestion rate for the adult presented for root vegetables in Health Canada (2012).
For game and waterfowl, the ingestion rates for the toddler, child, and teen were calculated by multiplying the adult ingestion rate by the ratio of the ingestion rate for each life stage to the ingestion rate for the adult presented for wild game in Health Canada (2012).

(5) The traditional food ingestion rates as presented in FNFNES (2017) already assume meal size and frequency. Therefore, exposure frequency assumes 365 days per year.

References:

FNFNES, 2017: Laurie Chan, Olivier Receveur, Malek Batal, William David, Harold Schwartz, Amy Ing, Karen Fediuk and Constantine Tikhonov. First Nations Food, Nutrition and Environment Study (FNFNES): Results from the Atlantic. Ottawa: University of Ottawa, 2017. Print. Ingestion rates are based on combined male and female heavy consumer (consumers only)
Health Canada, 2010a: Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2010, Revised 2012.
Health Canada, 2010b: Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-specific Factors, Version 2.0, September 2010.

Table H-2.16

Calculation of Chemical Cancer Risks and Non-Cancer Hazards for Pictou Landing First Nations Resident Exposure to Traditional Foods
Quantitative Human Health and Ecological Risk Assessment
Boat Harbour Effluent Treatment Facility
Pictou Landing, Nova Scotia

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Toddler to Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Contaminants of Potential Concern (COPC)	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer	Intake/Exposure Concentration		RfD/RfC		Hazard
					Value	Units	Value	Units	Value	Units	Risk	Value	Units	Value	Units	Quotient
Plants	Plants/ Berries	Site	Ingestion	1-Chloronaphthalene	2.40E-03	µg/g	7.29E-07	mg/kg-d	--	--	NC	1.45E-06	mg/kg-d	8.00E-02	mg/kg-d	2E-05
				Acenaphthene	9.30E-03	µg/g	2.82E-06	mg/kg-d	--	--	NC	5.64E-06	mg/kg-d	6.00E-02	mg/kg-d	9E-05
				Acenaphthylene	6.50E-03	µg/g	1.97E-06	mg/kg-d	--	--	NC	3.94E-06	mg/kg-d	6.00E-02	mg/kg-d	7E-05
				Anthracene	2.30E-03	µg/g	6.98E-07	mg/kg-d	--	--	NC	1.39E-06	mg/kg-d	3.00E-01	mg/kg-d	5E-06
				Fluoranthene	1.36E-02	µg/g	4.13E-06	mg/kg-d	--	--	NC	8.24E-06	mg/kg-d	4.00E-02	mg/kg-d	2E-04
				Fluorene	5.90E-03	µg/g	1.79E-06	mg/kg-d	--	--	NC	3.58E-06	mg/kg-d	4.00E-02	mg/kg-d	9E-05
				Perylene	1.20E-03	µg/g	3.64E-07	mg/kg-d	--	--	NC	7.27E-07	mg/kg-d	3.00E-02	mg/kg-d	2E-05
				Phenanthrene	1.16E-02	µg/g	3.52E-06	mg/kg-d	--	--	NC	7.03E-06	mg/kg-d	2.00E-02	mg/kg-d	4E-04
				Pyrene	5.00E-03	µg/g	1.52E-06	mg/kg-d	--	--	NC	3.03E-06	mg/kg-d	3.00E-02	mg/kg-d	1E-04
				B(a)P TPE	8.77E-03	µg/g	2.66E-06	mg/kg-d	2.30E+00	(mg/kg-d)-1	6E-06	5.32E-06	mg/kg-d	--	mg/kg-d	NC
				Nickel	3.34E+00	µg/g	1.01E-03	mg/kg-d	--	--	NC	2.02E-03	mg/kg-d	1.10E-02	mg/kg-d	2E-01
				Tin	3.00E+00	µg/g	9.11E-04	mg/kg-d	--	--	NC	1.82E-03	mg/kg-d	6.00E-01	mg/kg-d	3E-03
				Uranium	1.09E-01	µg/g	3.31E-05	mg/kg-d	--	--	NC	6.61E-05	mg/kg-d	6.00E-04	mg/kg-d	1E-01
Game	Game Organs	Site	Ingestion	Cadmium	2.10E+00	µg/g	4.14E-04	mg/kg-d	--	--	NC	5.60E-04	mg/kg-d	1.00E-03	mg/kg-d	6E-01
				Copper	4.00E+00	µg/g	7.89E-04	mg/kg-d	--	--	NC	1.07E-03	mg/kg-d	9.10E-02	mg/kg-d	1E-02
				Manganese	1.20E+01	µg/g	2.37E-03	mg/kg-d	--	--	NC	3.20E-03	mg/kg-d	1.22E-01	mg/kg-d	3E-02
				Vanadium	6.00E+00	µg/g	1.18E-03	mg/kg-d	--	--	NC	1.60E-03	mg/kg-d	5.00E-03	mg/kg-d	3E-01
				Zinc	3.60E+01	µg/g	7.10E-03	mg/kg-d	--	--	NC	9.60E-03	mg/kg-d	4.80E-01	mg/kg-d	2E-02
				Total TEQ	1.80E-06	µg/g	3.55E-10	mg/kg-d	--	--	NC	4.80E-10	mg/kg-d	2.30E-09	mg/kg-d	2E-01
Waterfowl	Duck	Site	Ingestion	Copper	9.00E+00	µg/g	1.27E-04	mg/kg-d	--	--	NC	1.69E-04	mg/kg-d	9.10E-02	mg/kg-d	2E-03
				Mercury	8.00E-02	µg/g	1.13E-06	mg/kg-d	--	--	NC	1.50E-06	mg/kg-d	2.00E-04	mg/kg-d	8E-03
				Vanadium	4.00E+00	µg/g	5.63E-05	mg/kg-d	--	--	NC	7.52E-05	mg/kg-d	5.00E-03	mg/kg-d	2E-02
				Zinc	1.50E+01	µg/g	2.11E-04	mg/kg-d	--	--	NC	2.82E-04	mg/kg-d	4.80E-01	mg/kg-d	6E-04
				Total TEQ	1.30E-06	µg/g	1.83E-11	mg/kg-d	--	--	NC	2.44E-11	mg/kg-d	2.30E-09	mg/kg-d	1E-02

Notes:

NC Not Calculated

(shaded) Calculated cancer risk or hazard quotient exceeds target cancer risk of 1E-05 or target hazard index of 0.2, respectively.

Attachment C

Supporting Information for IAAC-39

Figure 1 Conceptual Site Model for Human Receptors

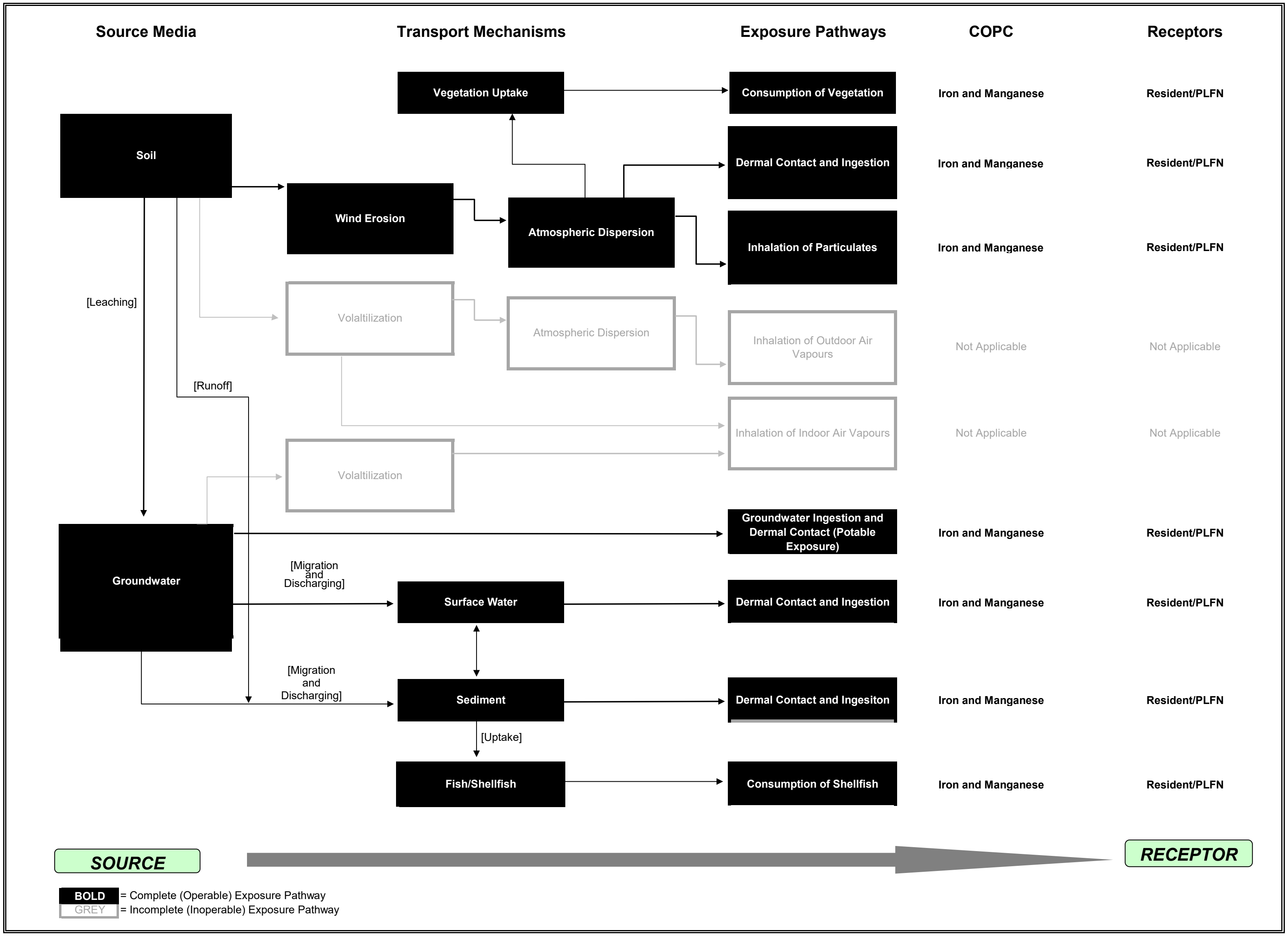


Table 1

Human Health Exposure Point Concentration (EPC) Summary
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

COPC	Exposure Point Concentration (EPC)						
	Soil (1) mg/kg	Groundwater (2) mg/L	Air (3) mg/m3	Surface Water (4) mg/L	Sediment (5) mg/kg	Plants (6) mg/kg	Shellfish (7) mg/kg
Iron	3800	0.52	0.0097	0.326	26244	180	204
Manganese	69	0.10	0.00042	0.623	1532	150	27.38

Notes:

(1) Predicted soil concentrations as a result of deposition of soils (dust) during project related activities (see PRA-HHRA).
(2) Measured groundwater concentrations (maximum concentration, 2004-2010) obtained from Pictou Landing Production Wells #1, #3, and #8 used for drinking water supply. Pictou Landing IR24, 2010 Groundwater Monitoring Program - Final Report, August 2011, prepared by Dillon Consulting Ltd.
(3) Predicted air concentrations as a result of soil disturbance during project related activities (see PRA-HHRA).
(4) Predicted surface water concentrations (maximum) of the BHSL during project related activities. GHD, 2021. Memorandum - Establishment of Water Treatment Compliance Criteria, Boat Harbour Remediation Planning and Design, October.
(5) Measured sediment concentrations (95% Upper Confidence Limit of the Mean) from Estuary/BHSL (see HHERA).
(6) Predicted plant concentrations as a result of deposition of soils (see PRA-HHRA).
(7) Measured concentrations (95% Upper Confidence Limit of the Mean) from mussels, clams, lobster, and crab collected from Northumberland Strait (see USEPA ProUCL output at end of this attachment).

Table 2

Exposure Assumptions for Direct Contact with Soil
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Soil
Exposure Medium: Soil
Receptor Population: Resident/ Recreational User
Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	(2)	(2)	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR	Ingestion Rate of Soil	mg/day	80	Health Canada, 2021a	CS x IR x RAFo x CF x D_2 x D_3 x 1/BW
	CF	Conversion Factor	kg/mg	1.00E-06	--	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021a	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021a	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFo	Relative Absorption Factor	%/100	1	Health Canada, 2021b	
Dermal	CS	Chemical Concentration in Soil	mg/kg	(2)	(2)	CDI (mg/kg-day) =
	SAh	Surface Area Exposed - hands	cm^2	430	Health Canada, 2021a - hands	[(CS x CF x SAh x SLh) + (CS x CF x SAo x SLo)]
	SAo	Surface Area Exposed - other	cm^2	1,290	Health Canada, 2021a - 1/2 arms and 1/2 legs	x RAFd x D2 x D3 x 1/BW
	SLh	Soil Loading Rate - hands	$mg/cm^2/day$	0.1	Health Canada, 2021a - hands	
	SLo	Soil Loading Rate - other	$mg/cm^2/day$	0.01	Health Canada, 2021a - other surfaces	
	CF	Conversion Factor	kg/mg	1.00E-06	--	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021a	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021a	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFd	Relative Absorption Factor	%/100	1	Assumed (3)	

Notes:

(1) Calculations evaluate toddler exposure that being the most sensitive receptor.
(2) See Table 1.
(3) No RAFd available for iron and manganese, therefore assumed 100% absorption.

References:

Health Canada, 2021a: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.
Health Canada, 2021b: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.

Table 3

Exposure Assumptions for Direct Contact with Groundwater (Household Use)
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Tapwater (Household Use)
Receptor Population: Resident/ Recreational User
Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	(2)	(2)	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR	Ingestion Rate of Water	L/day	0.6	Health Canada, 2021a	CW x IR x RAFo x D_2 x D_3 x 1/BW
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021a	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021a	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFo	Relative Absorption Factor	%/100	1	Health Canada, 2021b	
Dermal	CW	Chemical Concentration in Water	mg/L	(2)	(2)	CDI (mg/kg-day) =
	SA	Surface Area Exposed - whole body	cm^2	6,130	Health Canada, 2021a	CW x CF x DAevent x SA x EV x D_2 x D_3 x 1/BW
	CF	Conversion Factor	L/cm^3	0.001	--	
	EV	Event Frequency	event/day	1	Health Canada, 2021a	DAevent (cm/event) - Inorganics=
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021a	PDerm x ET
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021a	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	ET	Exposure Time	hours/day	0.54	USEPA, 2014 (3)	
	PDerm	Permeability Dermal constant	cm/hour	chemical-specific	USEPA, 2021 (4)	

Notes:

(1) Calculations evaluate toddler exposure that being the most sensitive receptor.
(2) See Table 1.
(3) Based on weighted average of 90th percentile time spent bathing for child (birth to 6 years) and adult (21 to 78).
(4) Dermal absorption of contaminants from contact with water during activities such as bathing and showering should be derived employing dermal permeability constants (PDerm) and methods described by the USEPA (Health Canada, 2021a). The following PDerm values for the COPCs are: 0.001 for both iron and manganese.

References:

Health Canada, 2021a: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.
Health Canada, 2021b: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.
USEPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER 9200.1-120, February 6, 2014.
USEPA, 2021: Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table, May.

Table 4

Exposure Assumptions for Inhalation of Ambient Air
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future Medium: Air Exposure Medium: Ambient Air Receptor Population: Resident/ Recreational User Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	Assumption Value	Assumption Rationale/Reference	Intake Equation/ Model Name
Inhalation of Particulates	CA	Chemical Concentration in Air	mg/kg	(2)	(2)	Dose (predicted daily intake) (mg/m^3) = CA x RAFinh x D_1 x D_2 x D_3
	D_1	Exposure Frequency (hours per day exposed/24 hours)	unitless	1	Health Canada, 2021	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021	
	RAFinh	Relative Absorption Factor - inhalation	%/100	1	Assumed	

Notes:

(1) Calculations evaluate toddler exposure that being the most sensitive receptor.
(2) See Table 1.

References:

Health Canada, 2021: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.

Table 5

Exposure Assumptions for Direct Contact with Surface Water (Recreational Use)
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Surface Water
Exposure Medium: Surface Water
Receptor Population: Resident/ Recreational User
Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	mg/L	(2)	(2)	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR	Ingestion Rate of Water	L/day	0.06	Health Canada, 2021a (3)	CW x IR x RAFo x D_2 x D_3 x 1/BW
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1 (7 days/7 days)	Assumed (4)	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1 (30 weeks/30 weeks)	Assumed (4)	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFo	Relative Absorption Factor	%/100	1	Health Canada, 2021b	
Dermal	CW	Chemical Concentration in Water	mg/L	(2)	(2)	CDI (mg/kg-day) =
	SA	Surface Area Exposed - whole body	cm^2	6,130	Health Canada, 2021a	CW x CF x DAevent x SA x EV x D_2 x D_3 x 1/BW
	CF	Conversion Factor	L/cm^3	0.001	--	
	EV	Event Frequency	event/day	1	Health Canada, 2021a	DAevent (cm/event) - Inorganics=
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1 (7 days/7 days)	Assumed (4)	PDerm x ET
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1 (30 weeks/30 weeks)	Assumed (4)	
	BW	Body Weight	kg	16.5	Health Canada, 2021a	
	ET	Exposure Time	hours/day	4	Assumed (4)	
	PDerm	Permeability Dermal constant	cm/hour	chemical-specific	USEPA, 2021 (5)	

Notes:

(1) Calculations evaluate toddler exposure that being the most sensitive receptor.
(2) See Table 1.
(3) Since recreational users are not drinkning surface water, the potable water ingestion rate was reduced by a factor of 10.
(4) Resident exposure to surface water during recreational activities was assumed to occur for 4 hours per day, 7 days per week during the months between April and October (30 weeks).
This is considered less than chronic exposure. Consistent with Health Canada (2021a), no dose averaging was assumed (i.e., D_3 was set to 30 weeks/30 weeks =1, rather than averaging over 52 weeks per year)
(5) Dermal absorption of contaminants from contact with surface water should be derived employing dermal permeability constants (PDerm) and methods described by the USEPA (Health Canada, 2021a).
The following PDerm values for the COPCs are: 0.001 for both iron and manganese.

References:

Health Canada, 2021a: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.
Health Canada, 2021b: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.
USEPA, 2021: Regional Screening Level (RSL) Chemical-specific Parameters Supporting Table, May.

Table 6

Exposure Assumptions for Direct Contact with Sediment
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Sediment (mudflats)
Exposure Medium: Sediment (Mudflats)
Receptor Population: Resident/ Recreational User
Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	Assumption Value	Assumption Rationale/Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical Concentration in Sediment	mg/kg	(2)	(2)	Dose (predicted daily intake) (mg/kg-day) =
	SIR - toddler	Ingestion Rate of Sediment	mg/hr	72	Health Canada, 2017	CS x SIR x RAFo x CF x D_1 x D_2 x D_3 x 1/BW
	CF	Conversion Factor	kg/mg	1.00E-06	--	
	D_1	Exposure Frequency (hours per day)	hr/day	4	Assumed (3)	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1 (7 days/7 days)	Assumed (3)	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1 (30 weeks/30 weeks)	Assumed (3)	
	BW - toddler	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFo	Relative Absorption Factor - gastrointestinal tract	%/100	1	Health Canada, 2021b	
Dermal	CS	Chemical Concentration in Sediment	mg/kg	(2)	(2)	Dose (predicted daily intake) (mg/kg-day) =
	SAh - toddler	Surface Area Exposed - hands	cm^2	430	Health Canada, 2017	CS x CF x [(SAh x SLh) + (SAa x SLa) + (SAl x SLl) +
	SAa - toddler	Surface Area Exposed - lower arms	cm^2	450	Health Canada, 2017	(SAf x SLf)] x RAFd x D2 x D3 x 1/BW
	SAl - toddler	Surface Area Exposed - lower legs	cm^2	845	Health Canada, 2017	
	SAf - toddler	Surface Area Exposed - feet	cm^2	430	Health Canada, 2017	
	SLh	Sediment Loading Rate - hands	$mg/cm^2/day$	58	Health Canada, 2017 (4)	
	SLa	Sediment Loading Rate - arms	$mg/cm^2/day$	11	Health Canada, 2017 (4)	
	SLl	Sediment Loading Rate - legs	$mg/cm^2/day$	36	Health Canada, 2017 (4)	
	SLf	Sediment Loading Rate - feet	$mg/cm^2/day$	24	Health Canada, 2017 (4)	
	CF	Conversion Factor	kg/mg	1.00E-06	--	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1 (7 days/7 days)	Assumed (3)	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1 (30 weeks/30 weeks)	Assumed (3)	
	BW - toddler	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFd	Relative Absorption Factor - dermal	%/100	1	Assumed (5)	

Notes:

(1) Non-carcinogenic hazard quotient evaluates toddler exposure, that being the most sensitive receptor.
(2) See Table 1.
(3) Resident exposure to sediment during recreational activities such as clam digging was assumed to occur for 4 hours per day, 7 days per week during the months between April and October (30 weeks). This is considered less than chronic exposure. Consistent with Health Canada (2021a; 2017), no dose averaging was assumed (i.e., D_3 was set to 30 weeks/30 weeks =1, rather than averaging over 52 weeks per year)
(4) For the scenario of the intertidal mudflats, adherence factors for mud (maximums) were applied.
(5) No RAFd available for iron and manganese, therefore assumed 100% absorption.

References:

Health Canada, 2021a: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.
Health Canada, 2021b: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.
Health Canada, 2017: Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathway, March 2017.

Table 7

Exposure Assumptions for Consumption of Country Foods
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/ Future
Medium: Country Foods
Exposure Medium: Plants/Shellfish
Receptor Population: Traditional Foods Consumer
Receptor Age: Toddler (1)

Exposure Route	Parameter Code	Parameter Definition	Units	Assumption Value	Assumption Rationale/Reference	Intake Equation/ Model Name
Ingestion	Cp	Chemical Concentration in Plants and Shellfish	mg/kg	(2)	(2)	Dose (predicted daily intake) (mg/kg-day) = Cf x IRf x D_2 x D_3 x RAFo x 1/BW
	IRp - toddler	Ingestion Rate of Plants/Berries	kg/day	0.010	FNFNES (2017) (3)(4)	
	IRs - toddler	Ingestion Rate of Shellfish	kg/day	0.019	FNFNES (2017) (3)	
	D_2	Exposure Frequency (days per week exposed/7 days)	unitless	1	Health Canada, 2021a	
	D_3	Exposure Frequency (weeks per year exposed/52 weeks)	unitless	1	Health Canada, 2021a	
	BW - toddler	Body Weight	kg	16.5	Health Canada, 2021a	
	RAFo	Relative Absorption Factor - gastrointestinal tract	%/100	1	Health Canada, 2021b	

Notes:

(1) Non-carcinogenic hazard quotient evaluates toddler exposure that being the most sensitive receptor.
(2) See Table 1.
(3) The ingestion rates obtained for the First Nations in the Atlantic (FNFNES, 2017) and are based on an adult heavy consumer (95th percentile, unless otherwise noted).
(4) For plants/berries, the ingestion rate for the toddler was calculated by multiplying the adult ingestion rate by the ratio of the ingestion rate for each life stage to the ingestion rate for the adult presented for root vegetables in Health Canada (2012).
For shellfish, the ingestion rates for the toddler was calculated by multiplying the adult ingestion rate by the ratio of the ingestion rate for each life stage to the ingestion rate for the adult presented for fish in Health Canada (2007).
(5) The traditional food ingestion rates as presented in FNFNES (2017) already assume meal size and frequency. Therefore, exposure frequency assumes 365 days per year.

References:

FNFNES, 2017: Laurie Chan, Olivier Receveur, Malek Batal, William David, Harold Schwartz, Amy Ing, Karen Fediuk and Constantine Tikhonov. First Nations Food, Nutrition and Environment Study (FNFNES): Results from the Atlantic. Ottawa: University of Ottawa, 2017. Print. Ingestion rates are based on combined male and female heavy consumer (consumers only)
Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption, Bureau of Chemical Safety Food Directorate, Health Products and Food Branch, March 2007.
Health Canada, 2021a: Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0, March 2021.
Health Canada, 2021b: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.

Table 8

Non-Cancer Toxicity Data - Oral/Dermal Route of Exposure
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

COPHC	Chronic/ Subchronic	Oral Reference Dose (RfD)	Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ (3)	Dates of RfD: Target Organ (MM-YY)
Metals										
Iron	chronic	7.00E-01	mg/kg-d	100%	7.00E-01	mg/kg-d	no effects	1.5	PPRTV	Sep-06
Manganese	chronic	2.50E-02	mg/kg-d	100%	2.50E-02	mg/kg-d	neuro-developmental effects	1000	Health Canada	Mar-21

Notes:

-- Not Available
(1) Default value of 100% was applied.
(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor
(3) Health Canada, 2021: Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs), Version 3.0, March 2021.
PPRTV: Provisional Peer Reviewed Toxicity Values (PPRTVs) for Iron and Compounds. Derivation of Subchronic and Chronic Oral RfDs, USEPA Superfund Technical Support Center, September 2006.

Table 9

Non-Cancer Toxicity Data - Inhalation Route of Exposure
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

COPC	Chronic/ Subchronic	Inhalation Reference Concentration (RfC)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC: Target Organ (1)
Metals						
Iron	24-hour	4.00E-03	mg/m^3	--	--	Ontario MOE, 2019
Manganese	24-hour	4.00E-04	mg/m^3	--	--	Ontario MOE, 2019

Notes:

-- Not Available

(1) Ontario MOE, 2019: Ministry of the Environment, Ontario Regulation 419/05, Schedule 3: Standards with Variable Averaging Periods, 2019. (https://www.ontario.ca/laws/regulation/050419).

Table 10

Calculation of Non-Cancer Hazards for Pictou Landing First Nations Resident/ Recreational User
Project Related Activities HHRA
Boat Harbour Effluent Treatment Facility
Pictou County, Nova Scotia

Scenario Timeframe: Current/Future
Receptor Population: Resident/ Recreational User
Receptor Age: Toddler

Medium	Exposure Medium	Exposure Point	Exposure Route	Contaminants of Potential Concern (COPC)	EPC		Non-Cancer Hazard Calculations					Contribution (%)
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient	
					Value	Units	Value	Units	Value	Units		
Soil	Soil	Study Area	Ingestion	Iron	3.8E+03	mg/kg	1.8E-02	mg/kg-d	7.00E-01	mg/kg-d	2.6E-02	
				Manganese	6.9E+01	mg/kg	3.3E-04	mg/kg-d	2.50E-02	mg/kg-d	1.3E-02	
			Dermal	Iron	3.8E+03	mg/kg	1.3E-02	mg/kg-d	7.00E-01	mg/kg-d	1.8E-02	
				Manganese	6.9E+01	mg/kg	2.3E-04	mg/kg-d	2.50E-02	mg/kg-d	9.4E-03	
										Iron Total Hazard Soil	**4.5E-02**	0
										Manganese Total Hazard Soil	**2.3E-02**	0
Groundwater	Tapwater	Household	Ingestion	Iron	5.2E-01	mg/L	1.9E-02	mg/kg-d	7.00E-01	mg/kg-d	2.7E-02	
				Manganese	1.0E-01	mg/L	3.6E-03	mg/kg-d	2.50E-02	mg/kg-d	1.5E-01	
			Dermal	Iron	5.2E-01	mg/L	1.0E-04	mg/kg-d	7.00E-01	mg/kg-d	1.5E-04	
				Manganese	1.0E-01	mg/L	2.0E-05	mg/kg-d	2.50E-02	mg/kg-d	8.0E-04	
										Iron Total Hazard Groundwater	**2.7E-02**	0
										Manganese Total Hazard Groundwater	**1.5E-01**	0
Air	Air	Study Area	Inhalation	Iron	9.7E-03	mg/m^3	9.7E-03	mg/m^3	4.00E-03	mg/m^3	2.4E+00	
				Manganese	4.2E-04	mg/m^3	4.2E-04	mg/m^3	4.00E-04	mg/m^3	1.1E+00	
										Iron Total Hazard Air	**2.4E+00**	1
										Manganese Total Hazard Air	**1.1E+00**	0
Surface Water	Surface Water	Northumberland Strait	Ingestion	Iron	3.3E-01	mg/L	1.2E-03	mg/kg-d	7.00E-01	mg/kg-d	1.7E-03	
				Manganese	6.2E-01	mg/L	2.3E-03	mg/kg-d	2.50E-02	mg/kg-d	9.1E-02	
			Dermal	Iron	3.3E-01	mg/L	4.8E-04	mg/kg-d	7.00E-01	mg/kg-d	6.9E-04	
				Manganese	6.2E-01	mg/L	9.3E-04	mg/kg-d	2.50E-02	mg/kg-d	3.7E-02	
										Iron Total Hazard Surface Water	**2.4E-03**	0
										Manganese Total Hazard Surface Water	**1.3E-01**	0
Sediment	Sediment Intertidal Mudflats	Northumberland Strait	Ingestion	Iron	2.6E+04	mg/kg	4.6E-01	mg/kg-d	7.00E-01	mg/kg-d	6.5E-01	
				Manganese	1.5E+03	mg/kg	2.7E-02	mg/kg-d	2.50E-02	mg/kg-d	1.1E+00	
			Dermal	Lithium	2.6E+04	mg/kg	1.1E+02	mg/kg-d	7.00E-01	mg/kg-d	1.6E+02	
				Vanadium	1.5E+03	mg/kg	6.6E+00	mg/kg-d	2.50E-02	mg/kg-d	2.6E+02	
										Iron Total Hazard Sediment	**1.6E+02**	98
										Manganese Total Hazard Sediment	**2.6E+02**	98
Plants	Plants	Study Area	Ingestion	Iron	1.8E+02	mg/kg	1.1E-01	mg/kg-d	7.00E-01	mg/kg-d	1.6E-01	
				Manganese	1.5E+02	mg/kg	9.1E-02	mg/kg-d	2.50E-02	mg/kg-d	3.6E+00	
										Iron Total Hazard Plants	**1.6E-01**	0
										Manganese Total Hazard Plants	**3.6E+00**	1
Shellfish	Shellfish	Northumberland Strait	Ingestion	Iron	2.0E+02	mg/kg	2.3E-01	mg/kg-d	7.00E-01	mg/kg-d	3.4E-01	
				Manganese	2.7E+01	mg/kg	3.2E-02	mg/kg-d	2.50E-02	mg/kg-d	1.3E+00	
										Iron Total Hazard Shellfish	**3.4E-01**	0
										Manganese Total Hazard Shellfish	**1.3E+00**	0

HQ > 0.2

Total Hazard for Iron (Soil, Groundwater, Air, Surface Water, Sediment, Plants, Shellfish) **1.6E+02**
Total Hazard for Manganese (Soil, Groundwater, Air, Surface Water, Sediment, Plants, Shellfish) **2.7E+02**

	A	B	C	D	E	F	G	H	I	J	K	L
1	95 Percent Upper Confidence Limit of the Mean (95UCLM) Concentrations for Shellfish (Mussels, Clams, Lobster, Crab)											
2	UCL Statistics for Data Sets with Non-Detects											
3												
4	User Selected Options											
5	Date/Time of Computation			ProUCL 5.110/22/2021 11:00:34 AM								
6	From File			WorkSheet.xls								
7	Full Precision			OFF								
8	Confidence Coefficient			95%								
9	Number of Bootstrap Operations			2000								
10												
11	Iron											
12												
13	General Statistics											
14	Total Number of Observations					44	Number of Distinct Observations					22
15	Number of Detects					23	Number of Non-Detects					21
16	Number of Distinct Detects					21	Number of Distinct Non-Detects					1
17	Minimum Detect					51	Minimum Non-Detect					50
18	Maximum Detect					553	Maximum Non-Detect					50
19	Variance Detects					21577	Percent Non-Detects					47.73%
20	Mean Detects					185.3	SD Detects					146.9
21	Median Detects					95	CV Detects					0.793
22	Skewness Detects					1.018	Kurtosis Detects					0.186
23	Mean of Logged Detects					4.922	SD of Logged Detects					0.792
24												
25	Normal GOF Test on Detects Only											
26	Shapiro Wilk Test Statistic					0.823	Shapiro Wilk GOF Test					
27	5% Shapiro Wilk Critical Value					0.914	Detected Data Not Normal at 5% Significance Level					
28	Lilliefors Test Statistic					0.294	Lilliefors GOF Test					
29	5% Lilliefors Critical Value					0.18	Detected Data Not Normal at 5% Significance Level					
30	Detected Data Not Normal at 5% Significance Level											
31												
32	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs											
33	KM Mean					120.8	KM Standard Error of Mean					19.1
34	KM SD					123.9	95% KM (BCA) UCL					158.3
35	95% KM (t) UCL					152.9	95% KM (Percentile Bootstrap) UCL					152.9
36	95% KM (z) UCL					152.2	95% KM Bootstrap t UCL					159.7
37	90% KM Chebyshev UCL					178.1	95% KM Chebyshev UCL					204
38	97.5% KM Chebyshev UCL					240	99% KM Chebyshev UCL					310.8
39												
40	Gamma GOF Tests on Detected Observations Only											
41	A-D Test Statistic					1.497	Anderson-Darling GOF Test					
42	5% A-D Critical Value					0.757	Detected Data Not Gamma Distributed at 5% Significance Level					
43	K-S Test Statistic					0.27	Kolmogorov-Smirnov GOF					
44	5% K-S Critical Value					0.184	Detected Data Not Gamma Distributed at 5% Significance Level					
45	Detected Data Not Gamma Distributed at 5% Significance Level											
46												
47	Gamma Statistics on Detected Data Only											
48	k hat (MLE)					1.814	k star (bias corrected MLE)					1.606
49	Theta hat (MLE)					102.2	Theta star (bias corrected MLE)					115.4
50	nu hat (MLE)					83.43	nu star (bias corrected)					73.88
51	Mean (detects)					185.3						
52												

	A–E	F	G–K	L
53	**Gamma ROS Statistics using Imputed Non-Detects**			
54	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
55	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
56	For such situations, GROS method may yield incorrect values of UCLs and BTVs			
57	This is especially true when the sample size is small.			
58	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
59	Minimum	0.01	Mean	97
60	Maximum	553	Median	55
61	SD	140.7	CV	1.45
62	k hat (MLE)	0.184	k star (bias corrected MLE)	0.186
63	Theta hat (MLE)	528.1	Theta star (bias corrected MLE)	520.7
64	nu hat (MLE)	16.16	nu star (bias corrected)	16.39
65	Adjusted Level of Significance (β)	0.0445		
66	Approximate Chi Square Value (16.39, α)	8.24	Adjusted Chi Square Value (16.39, β)	8.044
67	95% Gamma Approximate UCL (use when n>=50)	193	95% Gamma Adjusted UCL (use when n<50)	197.7
68				
69	**Estimates of Gamma Parameters using KM Estimates**			
70	Mean (KM)	120.8	SD (KM)	123.9
71	Variance (KM)	15359	SE of Mean (KM)	19.1
72	k hat (KM)	0.949	k star (KM)	0.9
73	nu hat (KM)	83.54	nu star (KM)	79.18
74	theta hat (KM)	127.2	theta star (KM)	134.2
75	80% gamma percentile (KM)	195.9	90% gamma percentile (KM)	285.3
76	95% gamma percentile (KM)	375.6	99% gamma percentile (KM)	586.7
77				
78	**Gamma Kaplan-Meier (KM) Statistics**			
79	Approximate Chi Square Value (79.18, α)	59.68	Adjusted Chi Square Value (79.18, β)	59.1
80	95% Gamma Approximate KM-UCL (use when n>=50)	160.2	95% Gamma Adjusted KM-UCL (use when n<50)	161.8
81				
82	**Lognormal GOF Test on Detected Observations Only**			
83	Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**	
84	5% Shapiro Wilk Critical Value	0.914	Detected Data Not Lognormal at 5% Significance Level	
85	Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**	
86	5% Lilliefors Critical Value	0.18	Detected Data Not Lognormal at 5% Significance Level	
87	**Detected Data Not Lognormal at 5% Significance Level**			
88				
89	**Lognormal ROS Statistics Using Imputed Non-Detects**			
90	Mean in Original Scale	106.7	Mean in Log Scale	3.916
91	SD in Original Scale	134.3	SD in Log Scale	1.304
92	95% t UCL (assumes normality of ROS data)	140.7	95% Percentile Bootstrap UCL	141.6
93	95% BCA Bootstrap UCL	144.2	95% Bootstrap t UCL	148
94	95% H-UCL (Log ROS)	201.9		
95				
96	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**			
97	KM Mean (logged)	4.44	KM Geo Mean	84.77
98	KM SD (logged)	0.753	95% Critical H Value (KM-Log)	2.116
99	KM Standard Error of Mean (logged)	0.116	95% H-UCL (KM -Log)	143.6
100	KM SD (logged)	0.753	95% Critical H Value (KM-Log)	2.116
101	KM Standard Error of Mean (logged)	0.116		
102				
103	**DL/2 Statistics**			
104	**DL/2 Normal**		**DL/2 Log-Transformed**	

Mean in Original Scale	108.8	Mean in Log Scale	4.109
SD in Original Scale	132.7	SD in Log Scale	1.03
95% t UCL (Assumes normality)	142.4	95% H-Stat UCL	150.9
DL/2 is not a recommended method, provided for comparisons and historical reasons			
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution at 5% Significance Level			
Suggested UCL to Use			
95% KM (Chebyshev) UCL	204		
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
Recommendations are based upon data size, data distribution, and skewness.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
Manganese			
General Statistics			
Total Number of Observations	44	Number of Distinct Observations	25
		Number of Missing Observations	0
Minimum	3	Mean	22.05
Maximum	177	Median	11
SD	35.5	Std. Error of Mean	5.352
Coefficient of Variation	1.61	Skewness	3.646
Normal GOF Test			
Shapiro Wilk Test Statistic	0.504	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.944	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.307	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.132	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	31.04	95% Adjusted-CLT UCL (Chen-1995)	33.99
		95% Modified-t UCL (Johnson-1978)	31.53
Gamma GOF Test			
A-D Test Statistic	2.612	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.777	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.212	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.137	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0.999	k star (bias corrected MLE)	0.946
Theta hat (MLE)	22.07	Theta star (bias corrected MLE)	23.3
nu hat (MLE)	87.9	nu star (bias corrected)	83.24
MLE Mean (bias corrected)	22.05	MLE Sd (bias corrected)	22.67
		Approximate Chi Square Value (0.05)	63.22

	A–E	F	G–K	L
157	Adjusted Level of Significance	0.0445	Adjusted Chi Square Value	62.63
158				
159	**Assuming Gamma Distribution**			
160	95% Approximate Gamma UCL (use when n>=50))	29.03	95% Adjusted Gamma UCL (use when n<50)	29.3
161				
162	**Lognormal GOF Test**			
163	Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk Lognormal GOF Test**	
164	5% Shapiro Wilk Critical Value	0.944	Data Not Lognormal at 5% Significance Level	
165	Lilliefors Test Statistic	0.12	**Lilliefors Lognormal GOF Test**	
166	5% Lilliefors Critical Value	0.132	Data appear Lognormal at 5% Significance Level	
167	**Data appear Approximate Lognormal at 5% Significance Level**			
168				
169	**Lognormal Statistics**			
170	Minimum of Logged Data	1.099	Mean of logged Data	2.515
171	Maximum of Logged Data	5.176	SD of logged Data	0.956
172				
173	**Assuming Lognormal Distribution**			
174	95% H-UCL	27.38	90% Chebyshev (MVUE) UCL	28.88
175	95% Chebyshev (MVUE) UCL	33.24	97.5% Chebyshev (MVUE) UCL	39.3
176	99% Chebyshev (MVUE) UCL	51.2		
177				
178	**Nonparametric Distribution Free UCL Statistics**			
179	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
180				
181	**Nonparametric Distribution Free UCLs**			
182	95% CLT UCL	30.85	95% Jackknife UCL	31.04
183	95% Standard Bootstrap UCL	30.79	95% Bootstrap-t UCL	44.71
184	95% Hall's Bootstrap UCL	74.4	95% Percentile Bootstrap UCL	31.5
185	95% BCA Bootstrap UCL	34.93		
186	90% Chebyshev(Mean, Sd) UCL	38.1	95% Chebyshev(Mean, Sd) UCL	45.37
187	97.5% Chebyshev(Mean, Sd) UCL	55.47	99% Chebyshev(Mean, Sd) UCL	75.29
188				
189	**Suggested UCL to Use**			
190	95% H-UCL	27.38		
191				
192	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
193	Recommendations are based upon data size, data distribution, and skewness.			
194	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
195	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
196				
197	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
198	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
199	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
200	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
201				

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2021 10:52:05 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Iron-Site(BHSL)

Sample 2 Data: Iron-Backgrond

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	22	11
Number of Distinct Observations	20	10
Minimum	3000	13000
Maximum	39000	30000
Mean	22350	22273
Median	24500	22000
SD	10614	5658
SE of Mean	2263	1706

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	384.5
WMW U-Stat	131.5
Standardized WMW U-Stat	0.401
Mean (U)	121
SD(U) - Adj ties	26.17
Lower Approximate U-Stat Critical Value (0.025)	-1.96
Upper Approximate U-Stat Critical Value (0.975)	1.96
P-Value (Adjusted for Ties)	0.688

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2021 10:59:32 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Iron-Site(NS)

Sample 2 Data: Iron-Backgrond

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	2	5
Number of Distinct Observations	2	5
Minimum	6700	3400
Maximum	8000	6400
Mean	7350	4940
Median	7350	4700
SD	919.2	1155
SE of Mean	650	516.3

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	13
WMW U-Stat	10
Mean (U)	5
SD(U) - Adj ties	2.582
Lower U-Stat Critical Value (0.025)	0
Upper U-Stat Critical Value (0.975)	10
Standardized WMW U-Stat	1.743
Approximate P-Value	0.0814

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2021 10:53:40 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Manganese-Site(BHSL)

Sample 2 Data: Manganese-Backgrond

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	22	11
Number of Distinct Observations	22	9
Minimum	45	810
Maximum	3700	4300
Mean	1027	1636
Median	770	1300
SD	965.3	970.8
SE of Mean	205.8	292.7

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	312
WMW U-Stat	59
Standardized WMW U-Stat	-2.369
Mean (U)	121
SD(U) - Adj ties	26.17
Lower Approximate U-Stat Critical Value (0.025)	-1.96
Upper Approximate U-Stat Critical Value (0.975)	1.96
P-Value (Adjusted for Ties)	0.0178

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2021 10:54:14 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median >= Sample 2 Mean/Median (Form 2)
Alternative Hypothesis	Sample 1 Mean/Median < Sample 2 Mean/Median

Sample 1 Data: Manganese-Site(BHSL)

Sample 2 Data: Manganese-Backgrond

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	22	11
Number of Distinct Observations	22	9
Minimum	45	810
Maximum	3700	4300
Mean	1027	1636
Median	770	1300
SD	965.3	970.8
SE of Mean	205.8	292.7

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 >= Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	312
Standardized WMW U-Stat	-2.388
Mean (U)	121
SD(U) - Adj ties	26.17
Approximate U-Stat Critical Value (0.05)	-1.645
P-Value (Adjusted for Ties)	0.00846

Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 < Sample 2

P-Value < alpha (0.05)

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2021 10:58:07 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Manganese-Site(NS)

Sample 2 Data: Manganese-Backgrond

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	2	5
Number of Distinct Observations	2	4
Minimum	300	110
Maximum	440	180
Mean	370	142
Median	370	130
SD	98.99	27.75
SE of Mean	70	12.41

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	13
WMW U-Stat	10
Mean (U)	5
SD(U) - Adj ties	2.582
Lower U-Stat Critical Value (0.025)	0
Upper U-Stat Critical Value (0.975)	10
Standardized WMW U-Stat	1.954
Approximate P-Value	0.0507

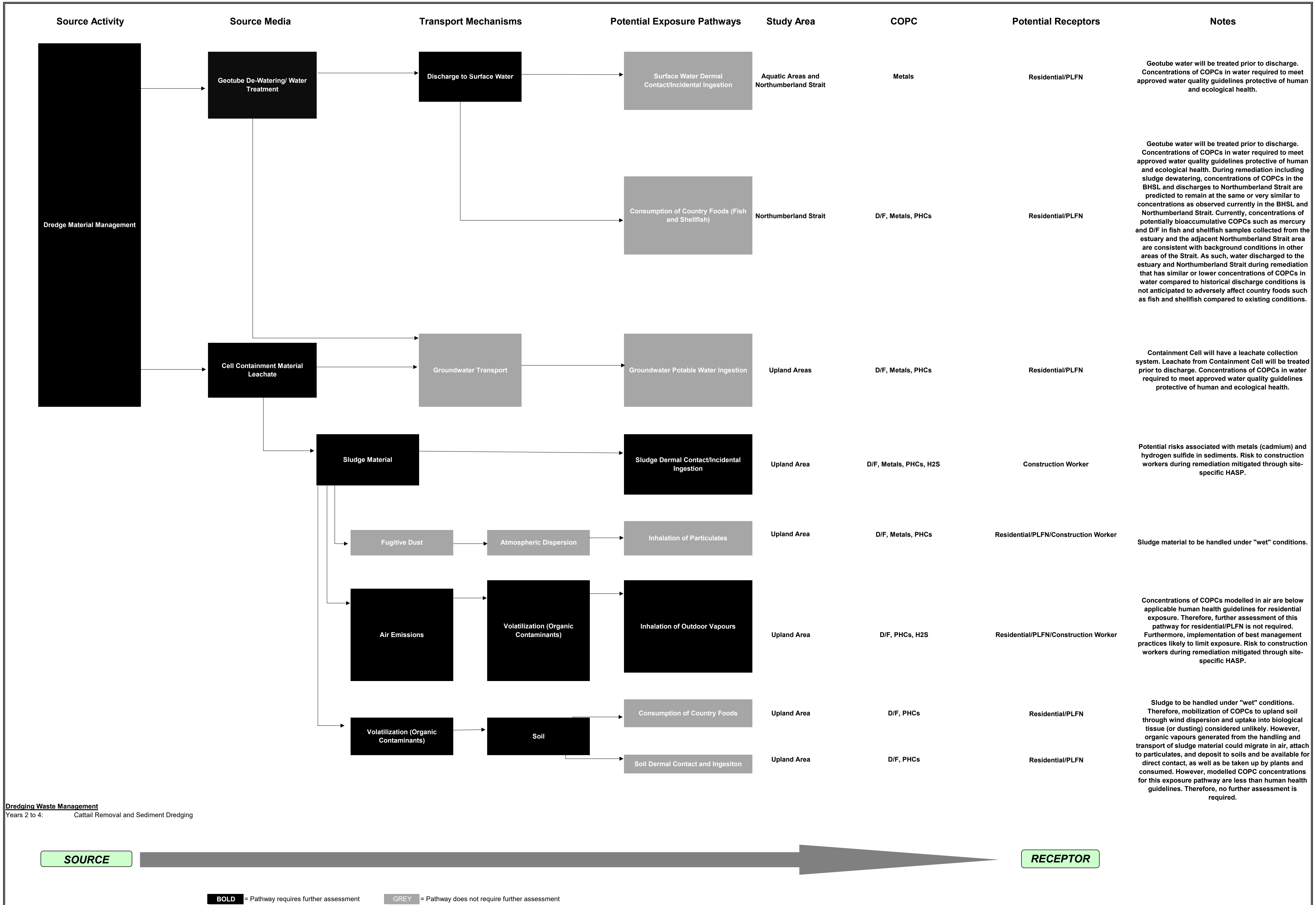
Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

Appendix D

Supporting Information for IAAC-42 and IAAC-43

D.1 - Figure 3.4: Conceptual Site Model for Human Receptors - Waste Management - Boat Harbour Effluent Treatment Facility



Memorandum

December 9, 2021

To	Angela Swaine, NS Lands		
Copy to	Christine Skirth		
From	Chris Everest, Troy Small/vl/096	**Tel**	+1 613 297 7687
Subject	Establishment of Water Treatment Compliance Criteria (Updated from Memorandum 57) Boat Harbour Remediation Planning and Design	**Project no.**	11148275

1. Introduction

This memorandum outlines the proposed water discharge criteria and sampling approach for water discharged during the Boat Harbour Remediation Project (BHRP). The proposed water discharge criteria will govern the release of water to the estuary from the Boat Harbour Stabilization Lagoon (BHSL) during active remediation of the Boat Harbour Effluent Treatment Facility (BHETF) and the Temporary Leachate Treatment System (TLTS). The TLTS will commence operation once the BHSL is remediated and will continue until the final cover is placed on the Containment Cell and the quantity of leachate generated is suitable to be managed through long-term leachate management (i.e., off-site disposal).

The memorandum has been updated to include additional data collected from the BHETF in 2020-2021. The initial memorandum outlining the proposed water discharge criteria (GHD, Memo-057 dated October 2020) included data collected up to July 2019.

The water treatment strategy for active remediation is attenuation through physical separation of suspended solids using a series of double silt curtains, chemical and physical treatment in the Geotubes® and attenuation from surface water and groundwater inflow to the BHETF. Once the waste is in the Containment Cell and the cell is completed with interim cover, a TLTS will be added to the treatment process before the effluent collected in the containment cell is discharged to the estuary. The TLTS will mirror the approach executed during pilot remediation activities (refer to GHD Pilot Water Treatment Summary Technical Memorandum No. 035 provided in Appendix F of the Pilot Scale Testing Report [GHD Report 19]). This approach includes flow equalization, pH adjustment, coagulation/flocculation, sedimentation, filtration, and adsorption.

Implementation of the treatment strategies as well as lowering of the BHSL normal operating level will provide multiple levels of protection during remediation efforts ensuring that the quality of water discharging from the BHSL is compliant with the discharge criteria.

Active remediation includes implementation of remedial activities (such as dredging and other improvements) to address areas that have been impacted from the long-term operation of the BHETF. The core activities of the proposed remediation effort that will generate wastewater include facility cleaning, removal and dewatering of impacted sludge/sediment, bulk water management, and leachate management from the new dewatered Containment Cell. During active remediation it is expected that continuous (or nearly continuous) discharge from the BHETF to the estuary will occur. Discharge from the TLTS will be on a continuous or intermittent basis as required.

The approach for development of the water discharge criteria included the following components:

1. Identification of the final effluent release point where the criteria will apply.

2. Identification of the contaminants and/or physical stressors which will require discharge limits.
3. Identification and harmonization, where appropriate, with existing federal, provincial/territorial, and municipal requirements.
4. Review of historical surface water quality as part of the discharge criteria development.
5. Establishment of risk-based (protection of aquatic life) water treatment discharge criteria.
6. Establishment of limit of technology-based water treatment discharge criteria.
7. Establishment of the proposed sampling methodology to demonstrate compliance with the proposed discharge criteria.

2. Identification of Final Release Point and Point of Application of Water Discharge Criteria

During active remediation of the BHETF water utilized or recirculated as part of remediation activities will be discharged within the BHETF at a location downstream of the active work area, eventually flowing to the estuary leading to the Northumberland Strait via the existing BHSL outlet structure (i.e., existing dam).

Within the BHSL, the final release of water (retaining or releasing at the proposed temporary water level control structure upstream of the causeway) will provide a means to hold bulk water in the event of an upset condition. Water recirculated as part of the active remediation will be monitored and operations will cease if upset or adverse conditions are detected.

Based on input from Nova Scotia Department of Environment and Climate Change (NSECC), a mixing zone-based approach is not likely permissible. As such, the discharge criteria would apply at the overflow point (i.e., existing dam until dam is removed), and at the end of pipe (EOP) for discharge from the TLTS.

3. Identification of Contaminants and/or Physical Stressors which will Require Discharge Limits

The discharge limits will apply for the duration of BHRP and will apply to bulk water during active remediation (i.e., water within the BHSL) and effluent from the TLTS. Contaminants of concern and physical stressors were identified through completion of the BHRP Environmental Site Assessments (ESAs), the Remedial Option Decision Document (RODD), and subsequent treatability testing (bench and pilot scale testing). The primary driver for the development of the list of contaminants and/or physical stressors which will require discharge limits, was consideration for the protection of aquatic (marine) life, given that discharges will be released to the estuary and ultimately the Northumberland Strait.

Provincial (Tier 1 Environmental Quality Standards, Surface Water) and federal (Canadian Council of Ministers of the Environment [CCME]) Water Quality Guidelines for the Protection of Aquatic Life were considered in the development of contaminants of concern as detailed in Table 1 (attached).

4. Identification and Harmonization, where Appropriate with Existing Federal, Provincial/Territorial and Municipal Requirements

The BHRP is subject to environmental approvals (e.g., Industrial Approval) as required by NSECC – i.e., provincial jurisdiction. As previously noted, to support the development of the contaminants/physical stressors and associated discharge limits, federal guidelines for protection of aquatic life (CCME) were also considered. Lacking guidelines or standards for select contaminants/stressors, standards from other jurisdictions (other provinces) were also considered. Consideration for the discharge of a "non-deleterious" discharge from the BHRP (as mandated per Fisheries and Oceans Canada) was also considered. Criteria typically associated with municipal wastewater treatment applications were not considered except for biochemical oxygen demand (BOD).

5. Surface Water Quality Discharge Criteria Development

In the development of the discharge criteria, historical surface water quality along with risk-based criteria and limit of technology-based criteria were reviewed and assessed as detailed in Sections 5.1 to 5.3. Following the review and assessment, proposed consolidated discharge limits are presented in Section 5.4. The proposed limits detailed in Section 5.4 are based on the possible limits discussed in the following sections.

5.1 Establishment of Historical Boat Harbour Surface Water Quality

Since the construction of the BHETF in the late 1960s, water has discharged to the Northumberland Strait via the estuary. On this basis, BHETF historical precedent (2017-2019) surface water quality within the stabilization lagoon was reviewed in consideration of the development of the proposed discharge criteria. As noted in Section 5.4, the proposed discharge criteria are primarily established using risk based values for the protection of aquatic life with the historical and predicted future water quality within the stabilization lagoon of the BHETF provided for context purposes. Table 2 (attached) summarizes concentrations of constituents of potential concern (COPCs) in surface water samples collected from the stabilization lagoon of the BHETF from 2017 to 2019. Table 5.1 (below) summarizes the BHSL precedent based water quality values.

Table 5.1 Boat Harbour Surface Water Quality Precedent

Parameter	Units	Value	Rationale
General Chemistry			
pH	S.U.	6-9	Ensure discharging treated water is approximately neutral in pH
Metals			
Total Mercury (Hg)	µg/L	0.03	Based on historical water quality
Total Aluminum (Al)	µg/L	2,000	Based on historical water quality
Total Barium (Ba)	µg/L	500	Based on historical water quality
Total Cadmium (Cd)	µg/L	2	Based on historical water quality
Total Chromium (Cr)	µg/L	4	Based on historical water quality
Total Copper (Cu)	µg/L	7	Based on historical water quality
Total Iron (Fe)	µg/L	1,000	Based on historical water quality
Total Lead (Pb)	µg/L	3	Based on historical water quality
Total Zinc (Zn)	µg/L	200	Based on historical water quality
Petroleum Hydrocarbons			
C6-C10 (less BTEX)- GAS	mg/L	0.1	Based on historical water quality
>C10-C16 Hydrocarbons- FUEL	mg/L	0.2	Based on historical water quality
>C16-C21 Hydrocarbons- FUEL	mg/L	0.5	Based on historical water quality
>C21-<C32 Hydrocarbons- LUBE	mg/L	0.5	Based on historical water quality
Modified TPH (Tier 1) GAS/FUEL/LUBE	mg/L	Per Above	Based on historical water quality

Table 5.1 Boat Harbour Surface Water Quality Precedent

Parameter	Units	Value	Rationale
Dioxins and Furans			
Total Toxic Equivalency (TEQ)	pg/L	5	Based on historical water quality
Toxicity			
Rainbow Trout (Acute)	Pass/ Fail	Pass	To Demonstrate Effluent is not deleterious
Notes: µg/L = microgram/litre mg/L =milligram/litre pg/L = picogram/litre			

The values detailed in Table 5.1 are based on observed maximum concentrations with margins for BHSL water quality variability. All parameters (detailed in Section 3 and Table 1, attached) that have not been identified in Table 5.1 (i.e., select metals, speciated dioxin and furans, select polycyclic aromatic hydrocarbons – refer to Table 5.2 for these constituents) would be routinely monitored to confirm concentrations are non-detect or at acceptable levels. Despite a historical precedent for discharges from the BHSL consistent with the historical BHETF Industrial Approval (IA) and Pulp and Paper Effluent Regulations (PPER), deleterious effects to aquatic species have been documented in the estuary of Boat Harbour. For this reason, utilizing historical BHSL water quality as a basis for discharges during the BHRP may not be sufficiently protective of the receiving environment.

Currently, the BHSL receives discharge from the aerated stabilization basin (ASB) of the BHETF at existing compliance Point C as well as surface water contributions (direct precipitation and drainage from the Boat Harbour catchment area) and groundwater contributions (from the perimeter of the BHSL). Historically, approximately 67,000 cubic metres/day (m^3/day) of effluent was discharged to the BHSL via Point C. The BHSL also receives an average of 16,000 m^3/day of surface water flow and 12,000 m^3/day of groundwater infiltration. The distribution of historical flows to the BHSL is shown in Figure 1.

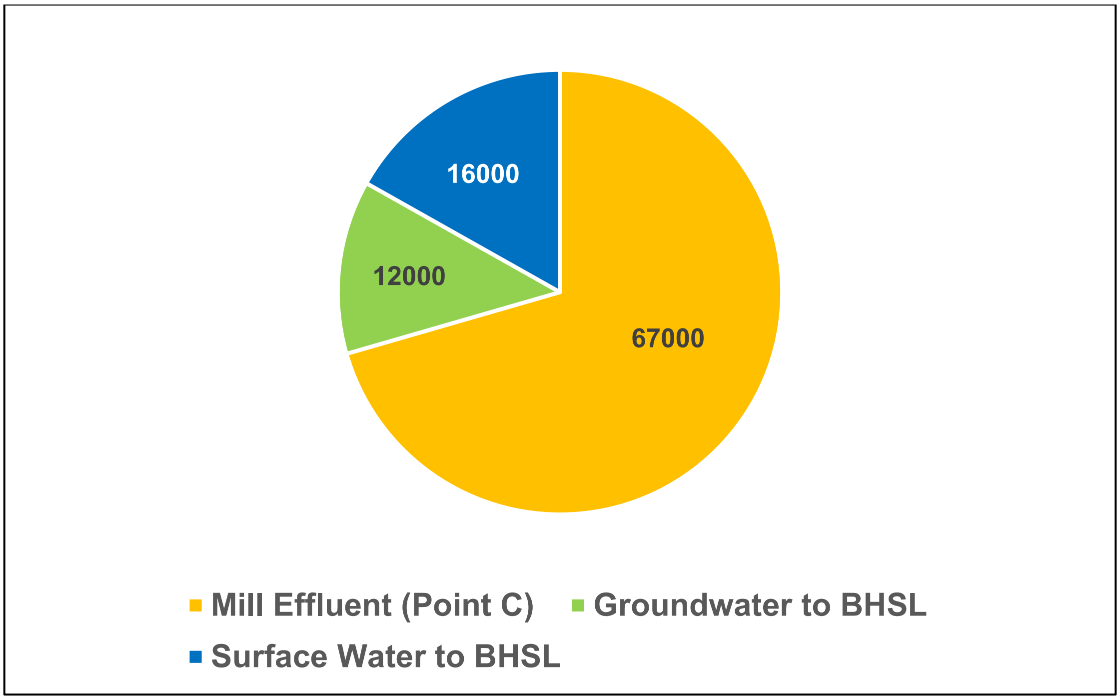


Figure 1 Historical Flow into BHSL (based on Northern Pulp flow data 2011-2017, flows in m^3/day)

As can be seen from Figure 1, when the BHETF was accepting effluent from the mill (i.e., before January 31, 2020) the majority of flow through the BHSL was effluent from the mill.

Following the cessation of production activities at the mill, the majority of flow through the BHSL became natural water sources (i.e., surface water and groundwater). During the BHRP, the BHSL will receive Geotube® dewatering effluent in addition to the natural water sources. The Geotube® effluent is the water released following the dredging, coagulation, and flocculant addition, and dewatering within the Containment Cell. The estimated average daily Geotube® effluent flow to the BHSL is 12,000 m^3/day. The influent flow distribution of the BHSL during the active remediation phase is shown in Figure 2.

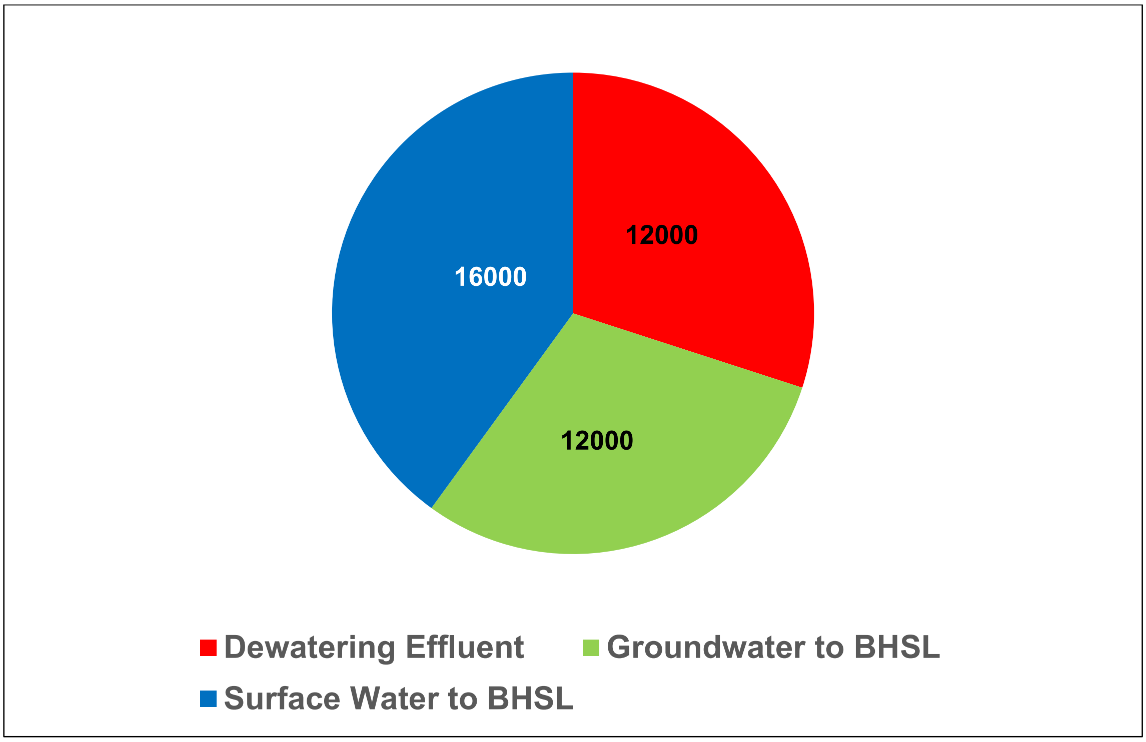


Figure 2 Flow into BHSL during Active Remediation (flows in m^3/day))

Due to the high contributing fraction of natural water sources (i.e., groundwater, surface water) to the BHSL during active remediation, the quality of water within the BHSL is expected to progressively improve and approach quality consistent with the contributing surface water and groundwater sources. A water/mass balance assessment was completed to estimate the bulk water concentration in the BHSL during the remediation period. The initial mass balance has been further refined/updated based on water quality data collected from the BHETF during a 2020 and 2021 field program completed following cessation of the mill effluent. The 2020-2021 field program was designed to confirm the quality of contributing streams to the BHETF (i.e., groundwater/surface water) as well as flow through the BHETF as discussed below (i.e., confirmation of the natural occurring groundwater and surface contributions).

The following key assumptions were made as part of the water/mass balance assessment:

- Influent to the BHSL includes surface water drainage from the BHSL collection area, groundwater infiltration from the surrounding area, and effluent from the sludge dewatering process (i.e., Geotube® effluent). A dredging rate of 12,000 m^3/day (average dredged slurry volume) was applied.
- All contributing inputs are fully mixed within the BHSL (i.e., average water quality within the BHSL is equal to discharge at the dam).
- Groundwater and surface water entering the BHSL is equal to quality of samples collected during execution of the Phase 2 ESA studies as well as supplemental field data collected during 2020-2021 field program. Groundwater quality was considered to be the average of approximately 30 groundwater samples collected from monitoring wells around the BHETF.
- Average of surface water and groundwater samples was considered without consideration of proportional contribution for specific groundwater or surface water sources (i.e., all source samples considered to have equal impact).
- The dredging operation (within the BHSL) will have no impact on overall bulk water quality (i.e., disturbed sludge/sediment will not have an impact on bulk water quality/discharge concentration

at Point D). Mitigation measures (e.g., silt curtains) will be in place to prevent migration of suspended solids during dredging operations.

- No natural attenuation of COPCs.
- Surface water flows to be equal to historical surface water drainage into the BHSL as per data provided by Northern Pulp (approximately 16,000 m^3/day).
- Groundwater influent (flow) to be equal to base groundwater flow per 2016 AECOM hydrogeological report and GHD's hydrologic model (approximately 12,000 m^3/day).
- GHD's 2020 and 2021 field program further corroborated the above surface water and groundwater flow values.
- BHSL volume was considered to be approximately 2.6 million cubic metres with the operating water levels lowered by 0.5 metres (m) (i.e., 3.0 m above mean sea level [masl]).
- The mass balance does not account for any temperature or pH related effects within the BHETF.

Utilizing this data and assumptions, the bulk water concentration of COPCs were derived within the BHSL for the five-year period following cessation of mill effluent discharge to the BHETF (i.e., commencing in February 2020) and dewatering effluent contribution commencing in Year 1. Results are presented in Table 5.2 below. For comparison purposes, Nova Scotia Environmental Quality Standards for marine waters (NS Tier 1 EQS; NSECC, 2021) or CCME Surface Water Guidelines (Marine) have also been provided as assessment criteria.

Table 5.2 Mass Balance Projections of BHSL Water Quality during Remediation

Parameter	Assessment Criteria[3]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Metals (µg/L)							
Total Mercury (Hg)	0.016	0.025	0.015	0.015	0.015	0.015	0.015
Total Aluminum (Al)	-	1455	674.00	671.14	671.13	671.13	671.13
Total Arsenic (Ar)	12.5	1.35	0.81	0.81	0.81	0.81	0.81
Total Barium (Ba)	500	224.0	138.226	137.912	137.911	137.911	137.911
Total Cadmium (Cd)	0.12	0.86	0.098	0.095	0.095	0.095	0.095
Total Chromium (Cr)	1.5	2.46	0.96	0.96	0.96	0.96	0.96
Hexavalent Chromium (Cr VI)	1.5	0.00	0.198	0.199	0.199	0.199	0.199
Total Copper (Cu)	2	5.00	3.597	3.592	3.592	3.592	3.592
Total Iron (Fe)	-	596.0	325.96	324.98	324.97	324.97	324.97
Total Lead (Pb)	2	2.00	0.836	0.832	0.832	0.832	0.832
Manganese (Mn)	-	2100.0	623.440	618.036	618.016	618.016	618.016
Total Nickel (Ni)	8.3	2.7	1.63	1.63	1.63	1.63	1.63
Total Silver (Ag)	1.5	0.22	0.06	0.06	0.06	0.06	0.06
Total Thallium (Tl)	**0.3**	**0.00**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**
Total Uranium (U)	8.5	0.85	0.20	0.20	0.20	0.20	0.20
Total Vanadium (V)	5	3.60	1.77	1.76	1.76	1.76	1.76
Total Zinc (Zn)	10	82.80	11.846	11.586	11.585	11.585	11.585
Total Cyanide (µg/L)							
Strong Acid Dissoc. Cyanide (CN)	1	ND (0.5)	0.64	0.64	0.64	0.64	0.64
Total Petroleum Hydrocarbons (mg/L)							
Benzene	2.1	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)

Table 5.2 Mass Balance Projections of BHSL Water Quality during Remediation

Parameter	Assessment Criteria[3]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Toluene	0.770	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Ethylbenzene	0.320	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Xylene	0.330	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)	ND (0.002)
>C10-C16 Hydrocarbons- FUEL	1.5	0.13	0.03	0.03	0.03	0.03	0.03
>C16-C21 Hydrocarbons- FUEL	0.1	0.16	0.05	0.05	0.05	0.05	0.05
>C21-<C32 Hydrocarbons- LUBE	0.1	0.24	0.13	0.13	0.13	0.13	0.13
Modified TPH (Tier 1) GAS/FUEL/LUBE	Per Above	0.53	0.19	0.19	0.19	0.19	0.19
Dioxins and Furans (pg/L)							
2,3,7,8-Tetra CDD *	-	0.55	0.003	0.001	0.001	0.001	0.001
1,2,3,7,8-Penta CDD *	-	0.5	0.111	0.109	0.109	0.109	0.109
1,2,3,4,7,8-Hexa CDD *	-	0.55	0.034	0.032	0.032	0.032	0.032
1,2,3,6,7,8-Hexa CDD *	-	0.5	0.084	0.082	0.082	0.082	0.082
1,2,3,7,8,9-Hexa CDD *	-	0.5	0.051	0.049	0.049	0.049	0.049
1,2,3,4,6,7,8-Hepta CDD *	-	0.70	0.44	0.44	0.44	0.44	0.44
Octa CDD *	-	19.30	18.59	18.59	18.59	18.59	18.59
Total Tetra CDD*	-	9.075	0.034	0.001	0.001	0.001	0.001
Total Penta CDD*	-	0.5	0.111	0.109	0.109	0.109	0.109
Total Hexa CDD*	-	0.5	0.174	0.173	0.173	0.173	0.173
Total Hepta CDD *	-	1.05	0.59	0.59	0.59	0.59	0.59
2,3,7,8-Tetra CDF **	**-**	**5.275**	**9.901**	**9.918**	**9.918**	**9.918**	**9.918**
1,2,3,7,8-Penta CDF **	-	0.55	0.021	0.019	0.019	0.019	0.019
2,3,4,7,8-Penta CDF **	-	0.55	0.147	0.146	0.146	0.146	0.146
1,2,3,4,7,8-Hexa CDF **	-	0.55	0.002	0.000	0.000	0.000	0.000
1,2,3,6,7,8-Hexa CDF **	-	0.5	0.092	0.090	0.090	0.090	0.090
2,3,4,6,7,8-Hexa CDF **	-	0.6	0.059	0.057	0.057	0.057	0.057
1,2,3,7,8,9-Hexa CDF **	-	0.65	0.067	0.065	0.065	0.065	0.065
1,2,3,4,6,7,8-Hepta CDF **	-	0.45	0.002	0.000	0.000	0.000	0.000
1,2,3,4,7,8,9-Hepta CDF **	-	0.65	0.0023	0.0000	0.0000	0.0000	0.0000

Table 5.2 Mass Balance Projections of BHSL Water Quality during Remediation

Parameter	Assessment Criteria[3]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Octa CDF **	-	0.65	0.002	0.000	0.000	0.000	0.000
TEQ	-	2.61	1.224	1.220	1.220	1.220	1.220
Polycyclic Aromatic Hydrocarbons (µg/L)							
1-Methylnaphthalene	1	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
2-Methylnaphthalene	1	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Acenaphthene	6	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Acenaphthylene	-	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Benzo(a)pyrene	0.01	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Chrysene	0.1	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Fluorene	12	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Naphthalene	1.4	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)
Pyrene	0.02	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Quinoline	-	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Fluoranthene	0.2	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)
Phenanthrene	0.3	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.01)

Notes:

1. For the purposes of the mass balance, when dioxins and furans were measured to be below the detection limit, half of the estimated detection limit concentration was assumed.
2. A select few constituents increase in concentration over time per the mass balance. This result is due to higher concentrations of these parameters in the influent streams than in the bulk water within the BHSL. **These constituents are shown in bold**.
3. Presented assessment criteria are based on either Federal (CCME) or Provincial (NS Tier 1 EQS) water quality standards for marine waters.
4. ND (detection limit): non-detectable in any surface water, groundwater or Geotube® effluent.

As shown in Table 5.2, the average water quality in the BHSL (and thus discharge over the dam) stabilizes after approximately two years. For most constituents, predicted concentrations within the BHSL drop sharply following the first year due to the effects caused by high groundwater and surface water flow into the BHSL. The trends in decreasing water concentrations were corroborated through the 2020-2021 field program. During remediation some constituents (e.g., copper) increase slightly over time due to higher concentrations in the groundwater/surface water/Geotube® effluent entering the BHSL; however, the overall increase in concentration associated with each year is extremely low. The general trend of expected water quality within the BHSL is illustrated by the example of predicted zinc concentrations below along with the actual results for the samples collected in June 2020, which demonstrates actual concentration below the predicted concentration for the specific period.

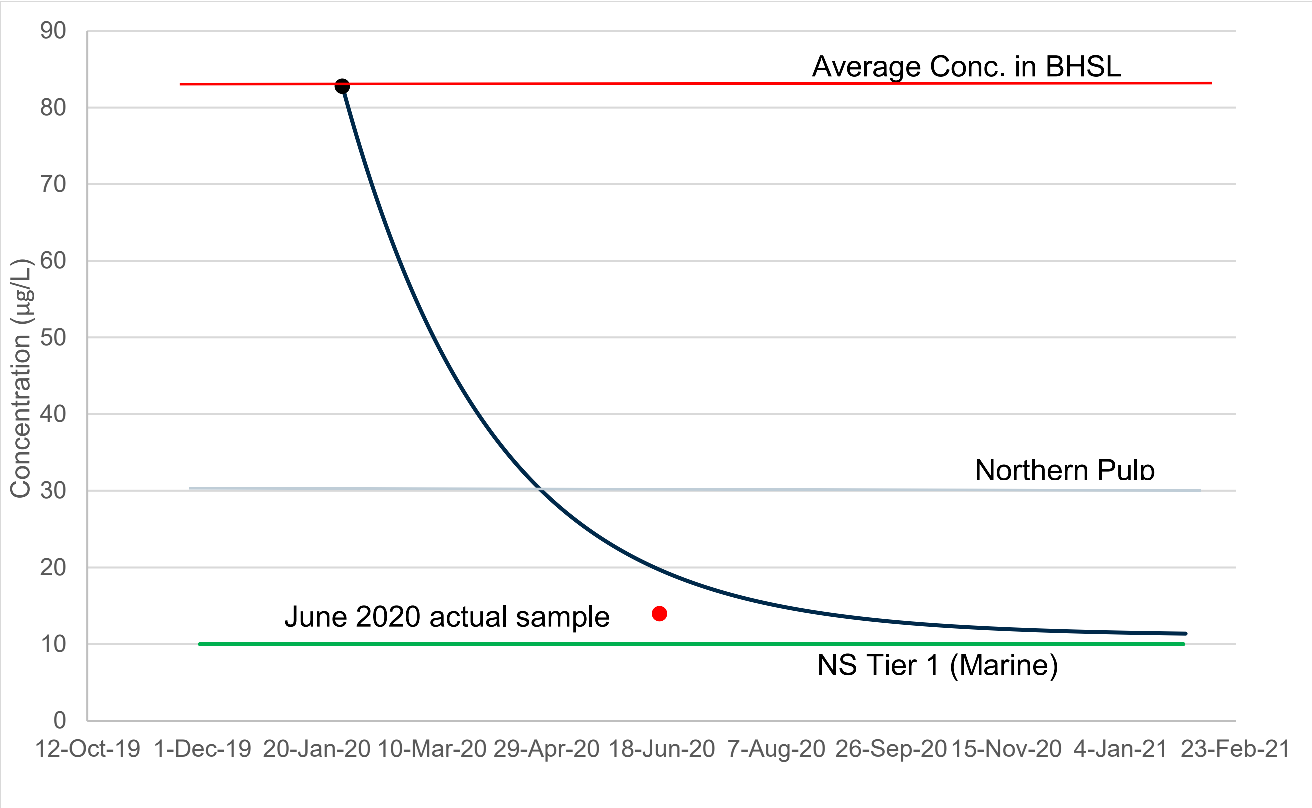


Figure 3 ***Predicted Concentration of Total Zinc in the BHSL***

These results suggest that with sediment control during sludge/sediment dredging (e.g., use of silt curtains, Geotubes®, and naturally occurring attenuation) the overall quality of water within the BHSL will improve over time and be maintained during the BHRP.

5.2 Establishment of Risk Based (Protection of Aquatic Life) Discharge Criteria

The Quantitative Human Health and Ecological Risk Assessment (HHERA) conducted for the BHETF areas including associated wetlands and estuary identified a number of chemical constituents as potentially posing risk to ecological receptors. This assessment was utilized as a basis for identifying the COPCs associated with a risk-based water discharge approach.

NSECC has identified environmental quality standards for freshwater and marine waters in Nova Scotia (NSECC, 2021). The majority of the standards are those identified by the CCME and British Columbia Ministry of the Environment and Climate Change Strategy (BCMOECCS). The NSECC standards for BTEX (benzene, toluene, ethylbenzene, and xylenes) and petroleum hydrocarbons (PHCs) are those identified by the Atlantic Partnership in RBCA (risk-based corrective action).

The NSECC standards are screening values used to identify constituents that require further evaluation of risk to ecological receptors. As such, they are intentionally conservative to minimize the potential for incorrectly dismissing risk in the screening phase of an ecological risk assessment. Because the standards are generic, as well as conservative, they may not be applicable to the discharge of dewatering effluent (i.e., Geotube® filtrate) into the BHSL and discharge of bulk water from the BHSL into the estuary contributing to the Northumberland Strait. Exposure to COPC concentrations in the effluent will be short-term (acute) rather than long-term (chronic) as fate processes, such as volatilization and mixing with the surface water within the BHSL, will result in relatively rapid reduction in concentrations (refer to mass balance projections of the BHSL in Section 5.1). Note that the mass balance evaluations within the BHSL result in concentrations lower than the identified risk-based criteria. While mixing of the BHSL discharges in the estuary have not been considered in this analysis, it is important to note that mixing within the estuary will occur and reduce salinity shock to organisms within the estuary exposed to freshwater discharges from the BHSL. Exposure of aquatic life in the estuary to the low salinity and concentrations of COPCs in the effluent will be short-term given the small volume of water being discharged relative to the volume of water in the estuary and tide cycles. Mass balance projections demonstrate a progressive shift towards natural contributing stream COPC concentrations during the remediation program. Following remediation, it is expected that discharges from the BHSL will be equal to contributing drainage stream quality.

To identify site-specific, risk-based discharge limits for the constituents identified above, the source document for each standard, if available, was reviewed to determine the basis of the standard. If appropriate, the standard was modified to be applicable to effluent discharge from the BHSL. A discussion of the standard for each constituent and rationale for modification, are presented in the following sections. As effluent will be discharged into the estuary downstream of the BHSL, standards for marine waters are evaluated.

Table 5.3 identifies the NSECC standards for each constituent, source of the standard, risk-based discharge limit, and rationale for the discharge limit.

5.2.1 Metals

Aluminum

NSECC does not identify a standard for aluminum in marine waters. The NSECC standard for freshwater is 5 micrograms per litre (µg/L) for waters with a pH less than 6.5. The cited source is CCME. The CCME website cites the source of the freshwater standard as the Ontario Ministry of the Environment. Region 4 of the United States Environmental Protection Agency (USEPA) identifies a chronic screening value of 1,500 µg/L for saltwater. The source of this value is Chapter 62-302 of the Florida surface water standards. Neither British Columbia nor any other Canadian jurisdiction identifies a marine standard for aluminum. Australia/New Zealand, which is a source for many of the British Columbia standards, also does not identify a standard for marine water.

The risk-based discharge limit for aluminum is the USEPA Region 4 screening value/Florida chronic standard of 1,500 µg/L. USEPA Region 4 does not identify an acute screening value.

Arsenic

NSECC identifies a standard of 12.5 µg/L for arsenic in marine waters. The cited source is CCME. The basis of this value is discussed in the fact sheet for arsenic (CCME, 2001). The value is a chronic lowest effect concentration (LOEC) for the diatom *Skeletonemia costatum*, the most sensitive species organism to arsenic in a dataset of 33, with a safety factor of 10 applied. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 125 µg/L for arsenic. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Barium

NSECC identifies a standard of 500 µg/L for barium in marine waters. The cited source is British Columbia Contaminated Sites Regulation Schedule 3.2 for Aquatic Life (BC CSR Schedule 3.2), which was last amended March 11, 2021. The generic numerical water standard (GNWS) for marine and estuarine life is 5,000 µg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 500 µg/L. As exposure to effluent discharged from BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 5,000 µg/L for barium.

Cadmium

NSECC identifies a standard of 0.12 µg/L for cadmium in marine waters. The cited source is CCME. The fact sheet for cadmium (CCME, 2014) identifies 0.12 µg/L as the guideline for long-term exposure, but does not address the basis for this value. The basis for the guideline of 0.12 µg/L can be found in the Canadian Water Quality Guidelines electronically published in November 2008. The value is a 20 day lowest observed adverse effect level (LOAEL) for increased mortality in the mysid shrimp, *Mysidopsis bahia*, the most sensitive marine organism identified in the literature at the time the guideline was developed with a safety factor of 10 applied. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit of 1.2 µg/L. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Chromium, Total

NSECC identifies a standard of 56 µg/L for total chromium in marine waters. The cited source is CCME. The CCME fact sheet for chromium (CCME, 1999a) identifies an interim water quality guideline of 56 µg/L for trivalent chromium, which is expected to be the dominant form of chromium in the effluent. This value is chronic LOEC for the marine invertebrate *Tisbe battagliai* with a safety factor of 10 applied. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit of 560 µg/L for total chromium. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Chromium, Hexavalent

NSECC identifies a standard of 1.5 µg/L for hexavalent chromium in marine waters. The cited source is CCME. The CCME fact sheet for chromium (CCME, 1999a) identifies 1.5 µg/L as the chronic half maximal inhibitory concentration (IC_{50}) for the invasive and potentially toxic dinoflagellate *Prorocentrum mariae-lebouriae* with a safety factor of 10 applied. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 15 µg/L for hexavalent chromium. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Copper

NSECC identifies a standard of 2.0 µg/L for copper in marine waters. The cited source is BCMOECCS 2019 - Approved. This value is the long-term chronic water quality guideline for total copper. USEPA, Region 4 identifies an acute saltwater screening value of 4.8 µg/L for dissolved copper. The source of this value is Chapter 62-302 of the Florida surface water standards. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for copper is the USEPA, Region 4 screening value/Florida acute standard of 4.8 µg/L.

Lead

NSECC identifies a standard of 2.0 µg/L for lead in marine waters. The cited source is BCMOECCS 2019 - Approved. This value is the long-term chronic water quality guideline. The BCMOEECCS (2019) short-term acute water quality guideline is 140 µg/L. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for lead is the BCMOECCS short-term acute water quality guideline of 140 µg/L.

Mercury, Total

NSECC identifies a standard of 0.016 µg/L for total mercury in marine waters. The cited source is CCME (2007). The CCME fact sheet for mercury identifies 0.016 µg/L as an interim value based on the chronic LOAEL for the algae *Emiliania huxleyi* with a safety factor of 10 applied (CCME, 2003). As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 0.16 µg/L for total mercury. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Methylmercury

NSECC identifies a standard of 0.004 µg/L for methylmercury in marine waters. The cited source is CCME. The NSECC standard appears to be a guideline for freshwater as the CCME fact sheet for mercury (CCME, 2003) states there is no recommended guideline (NRG) for methylmercury in marine waters. Therefore, the Nova Scotia value of 0.004 µg/L cannot be verified.

The only other standard for protection of aquatic life in marine waters is the Dutch maximum permissible concentration (MPC) of 0.013 µg/L (Crommentuijn et al., 1997). As this is the only verifiable standard, the risk-based discharge limit for methylmercury is the Dutch MPC of 0.013 µg/L.

Nickel

NSECC identifies a standard of 8.3 μg/L for nickel in marine waters. The cited source is BC CSR Schedule 3.2. The GNWS for marine and estuarine life is 83 μg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 8.3 μg/L. NSECC notes that 8.3 μg/L is a four day average and that British Columbia identifies a one hour average of 75 μg/L. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit is 75 μg/L for nickel.

Silver

NSECC identifies a standard of 1.5 μg/L for silver in marine waters. The cited source is BCMOECCS 2019 - Approved. This value is the long-term chronic water quality guideline. The BCMOECCS 2019 - Approved short-term acute water quality guideline is 3.0 μg/L. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for silver is the BCMOECCS short-term acute water quality guideline of 3.0 μg/L.

Thallium

NSECC identifies a standard of 0.3 μg/L for thallium in marine waters. The cited source is BC CSR Schedule 3.2. The GNWS for marine and estuarine life is 3 μg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 0.3 μg/L. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 3 μg/L for thallium.

Uranium

NSECC identifies a standard of 8.5 μg/L for uranium in marine waters. The cited source is BC CSR Schedule 3.2. The GNWS for marine and estuarine life is 85 μg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 8.5 μg/L. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 85 μg/L for uranium.

Vanadium

NSECC identifies a standard of 5 μg/L for vanadium in marine waters. The cited source is the Federal Environmental Quality Guideline (FEQG) developed by Environment and Climate Change Canada (ECCC, 2016). The FEQG is based on the lowest acute endpoint of 50 μg/L (48-hour LOEC for oyster larvae with a safety factor of 10 applied). As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit of 50 μg/L. This risk-based discharge limit would also be protective of acute toxicity to organisms evaluated as part of the ECCC guideline derivation.

Zinc

NSECC identifies a standard of 10 μg/L for zinc in marine waters. The cited source is BCMOECCS 2019 -Approved. This value is the long-term chronic water quality guideline. The BCMOECCS 2019 -Approved short-term acute water quality guideline is 55 μg/L. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for zinc is the BCMOECCS short-term acute water quality guideline of 55 μg/L.

5.2.2 Polycyclic Aromatic Hydrocarbons

1-Methylnaphthalene

NSECC identifies a standard of 1.0 μg/L for 1-methylnaphthalene (methylate naphthalene) in marine waters. The cited source is BCMOECCS 2019 - Approved. Whereas the BC Ministry of Environment (BCMOE) Technical Report (BCMOE, 1993), which is the source of the standard, discusses the toxicity of naphthalenes to aquatic organisms, the specifics for derivation of the guideline of 1.0 μg/L are not clearly identified. It appears to be the lowest chronic value of 10 μg/L with a safety factor of 10 applied. In addition, BCMOE (1993) identifies 1.0 μg/L as a value for chronic exposure. As exposure to effluent discharged from the BHRP will be acute, a conversion factor of 10 is applied to produce a risk-based discharge limit of 10 μg/L.

2-Methylnaphthalene

NSECC identifies a standard of 1.0 µg/L for 2-methylnaphthalene in marine waters. The cited source is BCMOECCS 2019 - Approved. Whereas the Technical Report (BCMOE, 1993), which is the source of the standard, discusses the toxicity of naphthalenes to aquatic organisms, the specifics for derivation of the guideline of 1.0 µg/L are not clearly identified. As for 1-methylnaphthalene, this value appears to be the lowest chronic value of 10 µg/L with a safety factor of 10 applied. In addition, BCMOE (1993) identifies 1.0 µg/L as a value for chronic exposure. As exposure to effluent discharged from the BHRP will be acute, a conversion factor of 10 is applied to produce a risk-based discharge limit of 10 µg/L. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Acenaphthene

NSECC identifies a standard of 6.0 µg/L for acenaphthene in marine waters. The cited source is BCMOECCS 2019 - Approved. The specifics for derivation of the guideline of 6.0 µg/L is not clearly presented in BCMOE (1993), which is the source of the standard. BCMOE (1993) identifies 6.0 µg/L as a value for chronic exposure. As exposure to effluent discharged from the BHRP will be acute, a conversion factor of 10 is applied to produce a risk-based discharge limit of 60 µg/L. This risk based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Acenaphthylene

NSECC does not identify a standard for acenaphthylene in marine waters freshwaters. BCMOECCS and BC CSR Schedule 3.2 also do not identify a standard for acenaphthylene.

USEPA Region 4 identifies chronic and acute saltwater screening values of 28 and 291 µg/L, respectively. Both screening values were calculated using USEPA's ECOSAR model. As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for acenaphthylene is the USEPA Region 4 saltwater acute screening value of 291 µg/L.

Benzo(a)pyrene

NSECC identifies a standard of 0.01 µg/L for benzo(a)pyrene in marine waters. The cited source is BCMOECCS 2019 - Approved. The specifics for derivation of the guideline of 0.01 µg/L is not clearly presented in BCMOE (1993), which is the source of the standard. BCMOE (1993) identifies 0.01 µg/L as a value for chronic exposure. As exposure to effluent discharged from the BHRP will be acute, a conversion factor of 10 is applied to produce a risk-based discharge limit of 0.1 µg/L.

Chrysene

NSECC identifies a standard of 0.1 µg/L for chrysene in marine waters. The cited source is BCMOECCS 2019 - Approved. The specifics for derivation of the guideline of 0.1 µg/L is not clearly presented in BCMOE (1993), which is the source of the standard. It appears to be a chronic value of 1.0 µg/L for increases in incidence of molt in pink shrimp (*Panaeus duorarum*) with a safety factor of 10 applied. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit of 1.0 µg/L. This risk-based discharge limit would also be protective of acute toxicity to vertebrate and invertebrate organisms evaluated as part of the CCME guideline derivation.

Fluorene

NSECC identifies a standard of 12 µg/L for fluorene in marine waters. The cited source is BCMOECCS 2019 - Approved. The specifics for derivation of the guideline of 12 µg/L is not clearly presented in BCMOE (1993), which is the source of the standard. BCMOE (1993) identifies 12 µg/L as a value for chronic exposure. As exposure to effluent discharged from the BHRP will be acute, a conversion factor of 10 is applied to produce a risk-based discharge limit of 120 µg/L.

Naphthalene

NSECC identifies a standard of 1.42 µg/L for naphthalene in marine waters. The cited source is CCME. This interim value is a lowest chronic value for *Eurotemora affinis*, a calanoid copepod, with a safety factor of 10 applied (CCME, 1999b). As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 14.2 µg/L for naphthalene.

Phenanthrene

NSECC identifies a standard of 0.3 µg/L for phenanthrene in marine waters. The cited source is BC CSR Schedule 3.2. The GNWS for marine and estuarine life is 3 µg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 0.3 µg/L. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 3 µg/L for phenanthrene.

Pyrene

NSECC identifies a standard of 0.02 µg/L for pyrene in marine waters. The cited source is BC CSR Schedule 3.2. The GNWS for marine and estuarine life is 0.2 µg/L. NSECC appears to have applied a safety factor of 10 to derive the standard of 0.02 µg/L. As exposure to effluent discharged from the BHRP will be acute, the safety factor of 10 is removed to produce a risk-based discharge limit 0.2 µg/L for pyrene.

Quinoline

NSECC does not identify a standard for quinoline. BCMOECCS Working Water Quality Guidelines (BCMOECCS, 2021) identifies a standard of 3.4 µg/L for freshwater. BC CSR Schedule 3.2 identifies a standard of 34 µg/L for marine and freshwater life. The risk based discharge limit for quinoline is the BC CSR Schedule 3.2 standard of 34 µg/L.

5.2.3 BTEX

Benzene

NSECC identifies a standard of 2,100 µg/L for benzene in marine waters. The cited source is the Atlantic Risk-Based Corrective Action (ARBCA, 2021). The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model developed by Redman et al., 2012. The benchmark is based on protection of the 5th percentile of chronic no observed effect levels (NOELs) of 42 aquatic species. The species at the 5th percentile of the species sensitivity distribution (SSD) is the algae *Chlamydomonas reihardtii*.

ARBCA, 2021 also identifies an acute aquatic toxicity benchmark of 17,500 µg/L, which is based on the LC_{50} (lethal concentration for 50 percent of test organisms) for rainbow trout (*Oncorhynchus mykiss*), which is in the lower 20th percentile of the SSD. Although rainbow trout is a freshwater species, toxicity of benzene is similar in both freshwater and marine environments.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for benzene is the ARBCA, 2021 acute benchmark of 17,500 µg/L.

Toluene

NSECC identifies a standard of 770 µg/L for toluene in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. ARBCA, 2021 also identifies an acute aquatic toxicity benchmark of 6,400 µg/L, which is based on the LC_{50} for *O. mykiss*.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for toluene is the ARBCA, 2021 acute benchmark of 6,400 µg/L.

Ethylbenzene

NSECC identifies a standard of 320 µg/L for ethylbenzene in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. APIRI also identifies an acute aquatic toxicity benchmark of 2,700 µg/L, which is based on the LC_{50} for *O. mykiss*.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for ethylbenzene is the ARBCA, 2021 acute benchmark of 2,700 µg/L.

Xylenes, Total

NSECC identifies a standard of 330 µg/L for xylenes in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. RBCA, 2021 also identifies an acute aquatic toxicity benchmark of 2,750 µg/L, which is based on the LC_{50} for *O. mykiss*.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for xylenes is the ARBCA, 2021 acute benchmark of 2,750 µg/L.

5.2.4 Petroleum Hydrocarbons

Modified TPH (Gas)

NSECC identifies a standard of 1,500 µg/L for modified TPH (gas) in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. APIRI, 2012 also identifies an acute aquatic toxicity benchmark of 12,520 µg/L, which is based on the LC_{50} for *O. mykiss*.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for modified TPH (gas) is the ARBCA, 2021 acute benchmark of 12,520 µg/L.

Modified TPH (Fuel)

NSECC identifies a standard of 100 µg/L for modified TPH (fuel) in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. ARBCA, 2021 also identifies an acute aquatic toxicity benchmark of 840 µg/L, which is based on the LC_{50} for *O. mykiss*.

The benchmarks for several of the aliphatic and aromatic fractions generated by the PETROTOX model and used to development the benchmark for modified TPH (fuel) exceeded the solubility of aliphatic hydrocarbons with 12 or more carbons and aromatic hydrocarbons with 16 or more carbons. Toxicity is due to exposure to dissolved concentrations in water, those fractions with calculated benchmarks greater than their solubility have a limited potential to be toxic to aquatic organisms. Approximately 73 percent of the aliphatic and aromatic fractions in TPH (fuel) are likely not toxic. Consequently, both the chronic and acute benchmarks overestimate risk.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for modified TPH (fuel) is the ARBCA, 2021 acute benchmark of 840 µg/L.

Modified TPH (Lube)

NSECC identifies a standard of 100 µg/L for modified TPH (lube) in marine waters. The cited source is ARBCA, 2021. The standard is the chronic aquatic toxicity benchmark generated using the PETROTOX model (Redman et al., 2012). The benchmark is based on protection of the 5th percentile of chronic NOELs. The species at the 5th percentile of the SSD is *C. reihardtii*. APIRI, 2012 also identifies an acute aquatic toxicity benchmark of 480 µg/L, which is based on the LC_{50} for *O. mykiss*.

The benchmarks for several of the aliphatic and aromatic fractions generated by the PETROTOX model and used to development the benchmark for modified TPH (lube) exceeded the solubility of aliphatic hydrocarbons with 12 or more carbons and aromatic hydrocarbons with 16 or more carbons. Approximately 95 percent of the aliphatic and aromatic fractions in TPH (lube) have a high number of carbons and are likely not toxic. Consequently, both the chronic and acute benchmarks overestimate risk.

As exposure to effluent discharged from the BHRP will be acute, the risk-based discharge limit for modified TPH (lube) is the ARBCA, 2021 acute benchmark of 480 µg/L.

5.2.5 Dioxins and Furans

NSECC does not identify a standard for dioxins and furans in marine waters, either as individual constituents or toxic equivalency (TEQ). Standards or guidelines were not identified in CCME or other sources consulted. USEPA Region 4 does identify a freshwater screening value of 0.0031 picograms per litre (pg/L) for 2,3,7,8-tetrachloro-p-dibenzo-dioxin (TCDD). However, this screening value is for protection of wildlife that consume aquatic organisms, not for organisms that live in the water column.

The absence of standards or guidelines for protection of aquatic life is likely due to the high hydrophobicity of dioxins and furans and the affinity to bind to sediment and organic matter in the water column and sediment. NSECC states that dioxins and furans "*do not partition to water to any significant extent*". Consequently, the presence of dioxins and furans in the dissolved phase is at best short-term.

To identify a benchmark for dioxins and furans, the USEPA Knowledgebase was consulted (https://cfpub.epa.gov/ecotox/). Three studies were identified that evaluated sub-lethal toxic effects of 2,3,7,8-TCDD, the most toxic of the dioxins and furans, in marine waters. Two of the three studies are in peer-reviewed journals. The third is a PhD dissertation. The most applicable study is a chronic 16-day test for early live stage effects (i.e., growth) to the sea urchin (*Psammechinus miliaris*) published by (Aselmo et al., 2012). The reported endpoint is a LOEC of 965,924 pg/L. This chronic value is selected as the risk-based discharge limit for 2,3,7,8-TCDD as an indicator of dioxins and furans in the discharge of water from the BHRP.

5.2.6 General Chemistry

pH

NSECC identifies a standard of 7.0 to 8.7 for pH in marine water. The cited source is CCME. The CCME fact sheet for pH (CCME, 1999c) has a narrative water quality guideline stating the pH of marine waters should fall within the range of 7.0 to 8.7 unless it can be demonstrated that a pH value outside of this range is a result of natural processes. As such, pH values should not vary by more than ±0.2 standard units from background values. Background refers to the quality of water in the ultimate receiver – in this case the estuary discharging to the Northumberland Strait. The pH of waters within the BHETF will be primarily affected by natural drainage (freshwater) and groundwater. For this reason, a discharge range of pH 6-9 is proposed to be consistent with CCME guidelines for freshwater.

Cyanide

NSECC identifies a standard of 1 µg/L for cyanide in marine waters. The cited source is BCMOECCS 2019 - Approved. This value is the maximum concentration of weak acid dissociable cyanide at any time for protection of marine and estuarine aquatic life. This value (1 µg/L) is selected as the risk-based discharge limit for cyanide.

Toxicity

To demonstrate that the effluent discharging from the BHRP during the active remediation period is not deleterious to aquatic life, it is proposed that whole effluent toxicity testing (Trout, mortality percentage, single concentration) be executed. The assessment criteria for this test will be a Pass result.

Biochemical Oxygen Demand (BOD)

Collaborative studies executed by Canadian Universities (University of Prince Edward Island, Wilfred Laurier University, University of Guelph) as well as Environment and Climate Change Canada (Martel, et. al., 2017) have identified that the probability of deleterious associated with organic loading (discharges) from pulp and paper mill effluent mills in Canada were lowest when the discharges from the mills contained concentrations of BOD less than 20 milligrams/litres (mg/l). These conclusions were obtained from the result of analysis of 81 effluents from 20 mills across Canada. The study suggested that higher levels of BOD removal can be achieved through the use of biological treatment systems such as the aerated stabilization basins currently employed as part of the BHETF. As effluent toxicity testing as well as the setting of limits on individual organic compounds (e.g., TPHs, PAHs) contributing to BOD through a risk-based approach have been proposed, a limit on BOD is not suggested. This constituent will however be monitored over the remediation period.

A complete summary of the considered contaminants and associated criteria is presented in Table 3. Table 5.3 below summarizes the proposed risk based discharge criteria.

Table 5.3 Risk Based (Protection of Aquatic Life) Discharge Criteria

Parameter	Units	Value	Source/Rationale
General Chemistry			
Strong Acid Dissoc. Cyanide (CN)	µg/L	1	BCMOECCS 2019 - Approved
pH	S.U.	6-9	CCME, 1999
Metals			
Total Mercury (Hg)	µg/L	0.16	CCME, 2003
Methylmercury	µg/L	0.013	Dutch maximum permissible concentration
Total Aluminum	µg/L	1,500	USEPA Region 4 screening value
Total Arsenic (As)	µg/L	125	CCME, 2001
Total Barium (Ba)	µg/L	5,000	BC CSR Schedule 3.2
Total Cadmium (Cd)	µg/L	1.2	CCME, 2014
Total Chromium (Cr)	µg/L	560	CCME, 1999a
Total Copper (Cu)	µg/L	4.8	USEPA Region 4 chronic saltwater screening value/Florida water quality standard
Total Lead (Pb)	µg/L	140	BCMOECCS 2019 - Approved
Total Nickel (Ni)	µg/L	75	BC CSR Schedule 3.2
Total Silver (Ag)	µg/L	3	BCMOECCS 2019 - Approved
Total Thallium (Ti)	µg/L	3	BC CSR Schedule 3.2
Total Uranium (U)	µg/L	85	BC CSR Schedule 3.2
Total Vanadium (V)	µg/L	50	ECCC, 2016
Total Zinc (Zn)	µg/L	55	BCMOECCS 2019 - Approved
Hexavalent Chromium (Cr VI)	µg/L	15	CCME, 1999a
Petroleum Hydrocarbons			
Benzene	mg/L	17.5	ARBCA, 2021 acute aquatic toxicity benchmark
Toluene	mg/L	6.4	ARBCA, 2021 acute aquatic toxicity benchmark
Ethylbenzene	mg/L	2.7	ARBCA, 2021 acute aquatic toxicity benchmark

Table 5.3 Risk Based (Protection of Aquatic Life) Discharge Criteria

Parameter	Units	Value	Source/Rationale
Total Xylenes	mg/L	2.75	ARBCA, 2021 acute aquatic toxicity benchmark
C6 - C10 (less BTEX)- GAS	mg/L	12.52	ARBCA, 2021 acute aquatic toxicity benchmark
>C10-C16 Hydrocarbons- FUEL	mg/L	0.840	ARBCA, 2021 acute aquatic toxicity benchmark
>C16-C21 Hydrocarbons- FUEL	mg/L	0.840	ARBCA, 2021 acute aquatic toxicity benchmark
>C21-<C32 Hydrocarbons- LUBE	mg/L	0.480	ARBCA, 2021 acute aquatic toxicity benchmark
Modified TPH (Tier 1) GAS/FUEL/LUBE	mg/L	Per Above	ARBCA, 2021 acute aquatic toxicity benchmark
Dioxins and Furans			
2,3,7,8 -TCDD	pg/L	965,924	Aselmo et al. 2012
Polyaromatic Hydrocarbons			
1-Methylnaphthalene	µg/L	10	BCMOECCS 2019 - Approved
2-Methylnaphthalene	µg/L	10	BCMOECCS 2019 - Approved
Acenaphthene	µg/L	60	BCMOECCS 2019 - Approved
Acenaphthylene	µg/L	291	USEPA Region 4 screening value
Benzo(a)pyrene	µg/L	0.1	BCMOECCS 2019 - Approved
Chrysene	µg/L	1.0	BCMOECCS 2019 - Approved
Fluorene	µg/L	120	BCMOECCS 2019 - Approved
Naphthalene	µg/L	14.2	CCME, 1999b
Phenanthrene	µg/L	3.0	BC CSR Schedule 3.2
Pyrene	µg/L	0.2	BC CSR Schedule 3.2
Quinoline	µg/L	34	BC CSR Schedule 3.2
Toxicity			
Rainbow Trout (Acute)	Pass/Fail	Pass	-

All parameters (detailed in Section 3 and Table 1 [attached]) that have not been identified in Table 5.3 (i.e., select metals, speciated dioxin and furans, select polyaromatic hydrocarbons) will be routinely monitored to confirm concentrations.

5.3 Establishment of Limit of Technology Based Discharge Criteria

For establishment of limit of technology-based discharge criteria, composite effluent samples from the pilot water treatment system operated during the pilot scale testing were considered (refer to GHD Memorandum No. 035). The water treatment process consisted of flow equalization, pH adjustment, coagulation/flocculation, sedimentation, filtration, and adsorption. A summary of the pilot water treatment composite effluent samples is provided in Table 4 (attached). Table 5.4 below summarizes the proposed limit of technology-based discharge criteria.

Table 5.4 Limit of Technology Based Discharge Criteria

Parameter	Units	Value	Rationale
General Chemistry			

Table 5.4 Limit of Technology Based Discharge Criteria

Parameter	Units	Value	Rationale
pH	S.U.	6-9	Ensure discharging treated water is approximately neutral in pH
Metals			
Total Mercury (Hg)	µg/L	0.013	Based on pilot treatment system performance
Total Aluminum (Al)	µg/L	500	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Arsenic (As)	µg/L	5	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Barium (Ba)	µg/L	200	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Cadmium (Cd)	µg/L	0.2	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Chromium (Cr)	µg/L	2	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Copper (Cu)	µg/L	3	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Lead (Pb)	µg/L	2	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Nickel (Ni)	µg/L	5	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Zinc (Zn)	µg/L	10	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Petroleum Hydrocarbons			
Benzene	mg/L	1.00	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Toluene	mg/L	0.80	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Ethylbenzene	mg/L	0.32	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Xylene	mg/L	0.33	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
C6 - C10 (less BTEX)- GAS	mg/L	1.5	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
>C10-C16 Hydrocarbons- FUEL	mg/L	0.1	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
>C16-C21 Hydrocarbons- FUEL	mg/L	0.1	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
>C21-<C32 Hydrocarbons- LUBE	mg/L	0.1	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Modified TPH (Tier 1) GAS/FUEL/LUBE	mg/L	Per Above	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Dioxins and Furans			
Total Toxic Equivalency (TEQ)	pg/L	5	Based on pilot treatment system effluent quality with some allowance for treatment system performance variation
Toxicity			
Rainbow Trout (Acute)	Pass/Fail	Pass	To Demonstrate Effluent is not deleterious

All parameters (detailed in Section 3 and Table 1) that have not be identified in Table 5.4 (i.e., select metals, speciated dioxin and furans, select polyaromatic hydrocarbons) will be routinely monitored to confirm concentrations.

5.4 Proposed Discharge Criteria

A summary of BHSL water quality precedent review, risk-based criteria, and limit of technology based criteria is provided in Table 4 (attached). A consolidated list of criteria is presented in Table 5.5 below.

Based on consideration of historical precedent-based water quality, risk-based criteria, and limit of technology based criteria, the following consolidated discharge limits are proposed. These criteria will apply to all water discharges from the BHRP.

Table 5.5 Boat Harbour Remediation Project Discharge Criteria

Parameter	Units	Value	Rationale
General Chemistry			
Strong Acid Dissoc. Cyanide (CN)	µg/L	1	Per risk based approach
pH	S.U.	6-9	Ensure discharging treated water is approximately neutral in pH, typical for surface water discharges
Metals			
Total Mercury (Hg)	µg/L	0.16	Per risk based approach
Methylmercury	µg/L	0.013	Per risk based approach
Total Aluminum (Al)	µg/L	1,500	Per risk based approach
Total Arsenic (As)	µg/L	125	Per risk based approach
Total Barium (Ba)	µg/L	5,000	Per risk based approach
Total Cadmium (Cd)	µg/L	1.2	Per risk based approach
Total Chromium (Cr)	µg/L	560	Per risk based approach
Total Copper (Cu)	µg/L	4.8	Per risk based approach
Total Lead (Pb)	µg/L	140	Per risk based approach
Total Nickel (Ni)	µg/L	75	Per risk based approach
Total Silver (Ag)	µg/L	3	Per risk based approach
Total Thallium (Ti)	µg/L	3	Per risk based approach
Total Uranium (U)	µg/L	85	Per risk based approach
Total Vanadium (V)	µg/L	50	Per risk based approach
Total Zinc (Zn)	µg/L	55	Per risk based approach
Hexavalent Chromium (Cr VI)	µg/L	15	Per risk based approach
Petroleum Hydrocarbons			
Benzene	mg/L	17.5	Per risk based approach
Toluene	mg/L	6.4	Per risk based approach
Ethylbenzene	mg/L	2.7	Per risk based approach
Total Xylenes	mg/L	2.75	Per risk based approach
C6 - C10 (less BTEX)- GAS	mg/L	12.5	Per risk based approach
>C10-C16 Hydrocarbons- FUEL	mg/L	0.840	Per risk based approach

Table 5.5 Boat Harbour Remediation Project Discharge Criteria

Parameter	Units	Value	Rationale
>C16-C21 Hydrocarbons- FUEL	mg/L	0.840	Per risk based approach
>C21-<C32 Hydrocarbons- LUBE	mg/L	0.480	Per risk based approach
Modified TPH (Tier 1) GAS/FUEL/LUBE	mg/L	Per Above	Per risk based approach
Dioxins and Furans			
2,3,7,8-TCDD	pg/L	965,924	Per risk based approach
Polyaromatic Hydrocarbons			
1-Methylnaphthalene	µg/L	10	Per risk based approach
2-Methylnaphthalene	µg/L	10	Per risk based approach
Acenaphthene	µg/L	60	Per risk based approach
Acenaphthylene	µg/L	291	Per risk based approach
Benzo(a)pyrene	µg/L	0.1	Per risk based approach
Chrysene	µg/L	1.0	Per risk based approach
Fluorene	µg/L	120	Per risk based approach
Naphthalene	µg/L	14.2	Per risk based approach
Phenanthrene	µg/L	3.0	Per risk based approach
Pyrene	µg/L	0.2	Per risk based approach
Quinoline	µg/L	34	Per risk based approach
Toxicity			
Rainbow Trout (Acute)	Pass/ Fail	Pass	To Demonstrate Effluent is not deleterious

The proposed criteria and discharge limits will be confirmed via the sampling approach detailed in Section 6. All other criteria detailed in Section 3 (Table 1, attached) will be routinely monitored to confirm effluent concentrations.

6. Proposed Effluent Sampling Approach

Water management during the BHRP will be implemented in three key phases: initial and final lowering of the operating water level in the BHSL, during active remediation, and during operation of the TLTS. To demonstrate compliance with the discharge criteria, the following sampling regime is proposed:

Table 6.1 Proposed Effluent Sampling Program

Remediation Phase	Sample Location	Sample Frequency	Sample Type
Initial/Final Water Level Lowering(1)	Discharge from BHSL at Point D	Weekly	Composite; 24 hr
During Active Remediation (1)	Discharge from BHSL at Point D Dewatering effluent from the Containment Cell	Weekly	Composite; 24 hr
Monitored Parameters (no discharge limit)(2)	Discharge from BHSL at Point D	Quarterly	Composite; 24 hr

Bulk Water in BHSL(3)	Northeast portion of BHSL	Weekly	Grab
During operation of the TLTS(1)	End of Pipe for the TLTS(4)	Weekly	Composite; 24 hr
Notes: (1) Analyzed for all parameters with proposed discharge limits. (2) Analyzed for parameters that are "monitor only" refer to Section 3 and Table 1 (attached). (3) Analyzed for all parameter as outlined in Section 3. (4) Discharge from leachate discharge forcemain at Point D.			

Effluent samples will be collected as detailed in Table 6.1 to ensure compliance with the discharge criteria. Samples will be collected (with NSECC) in an agreed timeframe to ensure discharge compliance from the BHSL and to monitor parameters not identified as having discharge criteria (refer to Section 3 and Table 1, attached). During the BHRP, multiple levels of protection will be integrated to ensure that the quality of water discharging to the estuary meets the proposed discharge criteria. As previously discussed, these protection measures include the use of multiple silt curtains to contain suspended sediments during dredging, dewatering of sediment through the Geotubes® and lowering of the water level in the BHSL during dredging. A lower operating level in the BHSL will provide time to allow for corrective action (by raising the discharge weir) should a silt curtain fail or water quality within the BHSL be identified as non-compliant.

Intermediate sampling (between treatment steps within the TLTS) will be completed on an as needed basis to support operating decisions to bypass select treatment steps and allow for the implementation of corrective action (e.g., replacement of adsorption media) should treated effluent be non-compliant.

7. Conclusion

As detailed in this technical memorandum, GHD has assessed various approaches for the development of water discharge criteria for the BHRP including historical surface water quality along with risk-based criteria and limit of technology-based criteria. The proposed water discharge criteria will govern the release of water to the estuary from the BHSL during active remediation of the BHETF and the TLTS operation. Implementation of the treatment strategies during active remediation (e.g. physical separation using double silt curtains and chemical/physical treatment in Geotubes®) as well as lowering of the BHSL normal operating level will provide multiple levels of protection during remediation efforts ensuring that the quality of water discharging from the BHSL is compliant with the discharge criteria. In addition, GHD assessed the natural processes (surface water and groundwater inputs) contributing to the BHSL water quality and anticipated quality of discharging water through the development and summary of flows in the BHSL during the remediation program.

Confirmation of water discharge criteria from Point D to the estuary/Northumberland Strait is necessary for the finalization of water management strategies for the remediation of the BHETF and surrounding areas. The finalized water discharge criteria will significantly impact the volumes of water and level of treatment to be provided. This in turn will have major impact on:

- Water treatment/management equipment (procurement/rental) costs.
- Operating costs (treatment chemicals, adsorption materials, electricity, etc.).
- Residuals generation (chemical sludge, backwash water).
- The space required for the water management systems will also be indirectly dictated by the finalized water management criteria.

For the above reasons, it is GHD's professional opinion that the proposed water discharge criteria (Table 5.5 – established primarily from risk-based criteria) are reasonable from an environmental risk perspective in that they will ensure discharges at Point D are unlikely to adversely affect aquatic biota and will be of equal or higher quality than historical precedent. This risk-based approach is also consistent with the approach used in the HHERA to develop the remedial target levels for the BHRP which was included in Appendix A of the Environmental Impact Statement (EIS). The proposed criteria are considered reasonable as well as being protective of the environment and will reduce the volumes of water to be treated during active remediation and thus result in lower quantity of residuals to be managed.

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Regards

Chris Everest Senior Wastewater Engineer	**Troy Small** Business Group Leader – Impact Assessment

Table 1

List of Contaminants and Physical Stressors
Boat Harbour Remediation Planning and Design

General Chemisytry
Hardness (CaCO3)
Nitrate (N)
Biochemical Oxygen Demand
Carbonaceous BOD
Total Chemical Oxygen Demand (COD)
Dissolved Chlorate (ClO3-)
Dissolved Chlorite (CLO2-)
Colour
Nitrate + Nitrite (N)
Nitrite (N)
Dissolved Organic Carbon (C)
pH
Total Suspended Solids
Strong Acid Dissoc. Cyanide (CN)

Metals
Total Mercury (Hg)
Methylmercury
Total Aluminum (Al)
Total Antimony (Sb)
Total Arsenic (As)
Total Barium (Ba)
Total Beryllium (Be)
Total Bismuth (Bi)
Total Boron (B)
Total Cadmium (Cd)
Total Calcium (Ca)
Total Chromium (Cr)
Total Cobalt (Co)
Total Copper (Cu)
Total Iron (Fe)
Total Lead (Pb)
Total Magnesium (Mg)
Total Manganese (Mn)
Total Molybdenum (Mo)
Total Nickel (Ni)
Total Phosphorus (P)
Total Potassium (K)
Total Selenium (Se)
Total Silver (Ag)
Total Sodium (Na)
Total Strontium (Sr)
Total Thallium (Tl)
Total Tin (Sn)
Total Titanium (Ti)
Total Uranium (U)
Total Vanadium (V)
Total Zinc (Zn)
Chromium (VI)

Petroleum Hydrocarbons
Benzene
Toluene
Ethylbenzene
Total Xylenes
C6 - C10 (less BTEX)- GAS
>C10-C16 Hydrocarbons- FUEL
>C16-C21 Hydrocarbons- FUEL
>C21-<C32 Hydrocarbons- LUBE
Modified TPH (Tier1) GAS/FUEL/LUBE

Dioxins & Furans
2,3,7,8-Tetra CDD
1,2,3,7,8-Penta CDD
1,2,3,4,7,8-Hexa CDD
1,2,3,6,7,8-Hexa CDD
1,2,3,7,8,9-Hexa CDD
1,2,3,4,6,7,8-Hepta CDD
Octa CDD
Total Tetra CDD
Total Penta CDD
Total Hexa CDD
Total Hepta CDD
2,3,7,8-Tetra CDF
1,2,3,7,8-Penta CDF
2,3,4,7,8-Penta CDF
1,2,3,4,7,8-Hexa CDF
1,2,3,6,7,8-Hexa CDF
2,3,4,6,7,8-Hexa CDF
1,2,3,7,8,9-Hexa CDF
1,2,3,4,6,7,8-Hepta CDF
1,2,3,4,7,8,9-Hepta CDF
Octa CDF
Total Tetra CDF
Total Penta CDF
Total Hexa CDF
Total Hepta CDF
Total Toxic Equivalency

Polyaromatic Hydrocarbons
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(b/j)fluoranthene
Benzo(g,h,i)perylene
Benzo(j)fluoranthene
Benzo(k)fluoranthene
Chrysene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Perylene
Phenanthrene
Pyrene
Quinoline

Fish Toxicity, Rainbow Trout Acute Lethality
-
-
-
-
-
-
-
-

Table 2

Boat Harbour Stabilization Lagoon Precedent Evaluation
Boat Harbour Remediation Planning and Design

Sample ID:		BHSL-SW-1	WG-11148275-BH	BH-DEC03-BULK SURFACE	Raw Bulk-Point C	Surface Water Quality Precedent Criteria	Rationale
Description:		Untreated Bulk Water	Untreated Bulk Water	Untreated Bulk Water - Point C	Untreated Bulk Water - Point C		
Sample Date:		11/2/2017	11/29/2017	12/3/2018	5/4/2019		
Parameters	**Units**						
General Chemisytry							
Hardness (CaCO3)	mg/L	110	-	-	110	Monitor	
Nitrate (N)	mg/L	0.04	-	-	<0.050	Monitor	
Biochemical Oxygen Demand	mg/L	-	-	-	10	Monitor	
Carbonaceous BOD	mg/L	-	-	-	26	Monitor	
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	550	Monitor	
Dissolved Chlorate (ClO3-)	mg/L	ND(0.1)	-	-	<1.0	Monitor	
Dissolved Chlorite (CLO2-)	mg/L	ND(0.1)	-	-	2.5	Monitor	
Colour	TCU	900	-	-	860	Monitor	
Nitrate + Nitrite (N)	mg/L	ND(0.05)	-	-	<0.050	Monitor	
Nitrite (N)	mg/L	0.04	-	-	<0.010	Monitor	
Dissolved Organic Carbon (C)	mg/L	-	-	-	140 (2)	Monitor	
pH	S.U.	7.99	7.19	7.68	7.61	**6-9**	Ensure discharging treated water is approximately neutral in pH
Total Suspended Solids	mg/L	-	-	-	44	Monitor	
Strong Acid Dissoc. Cyanide (CN)	mg/L	0.0018	**0.021**	<0.0020	<0.0050	Monitor	
Metals							
Total Mercury (Hg)	µg/L	0.028	ND(0.2)	**0.027**	**0.02**	**0.03**	Based on historical water quality precedent with some allowance for treatment system performance variation
Methylmercury	ng/L	-	-	0.24	0.06	Monitor	
Total Aluminum (Al)	µg/L	1300	1,220	**1,900**	**1,400**	**2,000**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Antimony (Sb)	µg/L	ND(1.0)	ND(50)	<1.0	<1.0	Monitor	
Total Arsenic (As)	µg/L	1.2	ND(50)	1.5	<1.0	Monitor	
Total Barium (Ba)	µg/L	240	208	**250**	**400**	**500**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Beryllium (Be)	µg/L	ND(1.0)	ND(25)	<1.0	<1.0	Monitor	
Total Bismuth (Bi)	µg/L	ND(2.0)	-	<2.0	<2.0	Monitor	
Total Boron (B)	µg/L	85	-	95	67	Monitor	
Total Cadmium (Cd)	µg/L	0.64	ND(25)	**0.84**	**1.1**	**2**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Calcium (Ca)	µg/L	36000	29800	33000	37000	Monitor	
Total Chromium (Cr)	µg/L	1.8	ND(25)	**1.8**	**3.8**	**4**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Cobalt (Co)	µg/L	0.49	ND(50)	0.67	0.52	Monitor	
Total Copper (Cu)	µg/L	3.7	ND(50)	**4.7**	**6.6**	**7**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Iron (Fe)	µg/L	370	395	**920**	**500**	**1,000**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Lead (Pb)	µg/L	1.4	ND(50)	**2.5**	**2.2**	**3**	Based on historical water quality precedent with some allowance for treatment system performance variation
Total Magnesium (Mg)	µg/L	5200	5240	15000	5100	Monitor	
Total Manganese (Mn)	µg/L	1800	1480	2100	2600	Monitor	
Total Molybdenum (Mo)	µg/L	ND(2.0)	-	2.1	<2.0	Monitor	
Total Nickel (Ni)	µg/L	2	ND(50)	2.7	3.6	Monitor	
Total Phosphorus (P)	µg/L	1100	-	1000	1500	Monitor	
Total Potassium (K)	µg/L	15000	22600	17000	16000	Monitor	
Total Selenium (Se)	µg/L	ND(1.0)	ND(100)	<1.0	<1.0	Monitor	
Total Silver (Ag)	µg/L	0.18	ND(50)	0.23	0.24	Monitor	
Total Sodium (Na)	µg/L	310000	312000	310000	320000	Monitor	
Total Strontium (Sr)	µg/L	140	-	170	150	Monitor	
Total Thallium (Tl)	µg/L	ND(0.1)	ND(100)	<0.10	<0.10	Monitor	

Table 2

Boat Harbour Stabilization Lagoon Precedent Evaluation
Boat Harbour Remediation Planning and Design

Sample ID:		BHSL-SW-1	WG-11148275-BH	BH-DEC03-BULK SURFACE	Raw Bulk-Point C	Surface Water Quality Precedent Criteria	Rationale
Description:		Untreated Bulk Water	Untreated Bulk Water	Untreated Bulk Water - Point C	Untreated Bulk Water - Point C		
Sample Date:		11/2/2017	11/29/2017	12/3/2018	5/4/2019		
Parameters	**Units**						
Total Tin (Sn)	µg/L	ND(2.0)	-	<2.0	<2.0	Monitor	
Total Titanium (Ti)	µg/L	12	-	12	13	Monitor	
Total Uranium (U)	µg/L	0.67	-	0.85	0.32	Monitor	
Total Vanadium (V)	µg/L	3.9	ND(50)	4.1	2.8	Monitor	
Total Zinc (Zn)	µg/L	64	**64.4**	**89**	**120**	**200**	Based on historical water quality precedent with some allowance for treatment system performance variation
Chromium (VI)	µg/L	-	-	<0.50	<2.50 (9)	Monitor	
Petroleum Hydrocarbons							
Benzene	mg/L	ND(0.001)	ND(0.002)	<0.0010	<0.0010	Monitor	
Toluene	mg/L	ND(0.001)	ND(0.002)	<0.0010	<0.0010	Monitor	
Ethylbenzene	mg/L	ND(0.001)	ND(0.002)	<0.0010	<0.0010	Monitor	
Total Xylenes	mg/L	ND(0.001)	ND(0.002)	<0.0020	<0.0020	Monitor	
C6 - C10 (less BTEX)- GAS	mg/L	ND(0.01)	<0.010	<0.010	<0.010	**0.1**	Based on historical water quality precedent with some allowance for treatment system performance variation
>C10-C16 Hydrocarbons- FUEL	mg/L	ND(0.05)	<0.02	0.17	0.095	**0.2**	Based on historical water quality precedent with some allowance for treatment system performance variation
>C16-C21 Hydrocarbons- FUEL	mg/L	ND(0.05)	0.046	0.34	0.091	**0.5**	Based on historical water quality precedent with some allowance for treatment system performance variation
>C21-<C32 Hydrocarbons- LUBE	mg/L	130	0.288	0.43	0.12	**0.5**	Based on historical water quality precedent with some allowance for treatment system performance variation
Modified TPH (Tier1) GAS/FUEL/LUBE[2a]	mg/L	0.13	**0.335**	**0.94**	**0.30**	**1.5**	Based on historical water quality precedent with some allowance for treatment system performance variation
Dioxins & Furans							
2,3,7,8-Tetra CDD *	pg/L	-	ND(9.5)	<1.1	<1.03	Monitor	
1,2,3,7,8-Penta CDD *	pg/L	-	ND(48)	<1.0	<1.09	Monitor	
1,2,3,4,7,8-Hexa CDD *	pg/L	-	ND(48)	<1.1	<1.33	Monitor	
1,2,3,6,7,8-Hexa CDD *	pg/L	-	ND(48)	<1.0	<1.15	Monitor	
1,2,3,7,8,9-Hexa CDD *	pg/L	-	ND(48)	<1.0	<1.12	Monitor	
1,2,3,4,6,7,8-Hepta CDD *	pg/L	-	ND(48)	<1.4	**3.01**	Monitor	
Octa CDD *	pg/L	-	30	16	11.9	Monitor	
Total Tetra CDD *	pg/L	-	-	<1.1	<1.03	Monitor	
Total Penta CDD *	pg/L	-	-	<1.0	<1.09	Monitor	
Total Hexa CDD *	pg/L	-	-	<1.0	<1.19	Monitor	
Total Hepta CDD *	pg/L	-	-	<2.1	3.01	Monitor	
2,3,7,8-Tetra CDF **	pg/L	-	ND(11)	**8.5**	**2.05**	Monitor	
1,2,3,7,8-Penta CDF **	pg/L	-	ND(48)	<1.1	<1.32	Monitor	
2,3,4,7,8-Penta CDF **	pg/L	-	ND(48)	<1.1	<1.33	Monitor	
1,2,3,4,7,8-Hexa CDF **	pg/L	-	ND(48)	<1.1	<1.16	Monitor	
1,2,3,6,7,8-Hexa CDF **	pg/L	-	ND(48)	<1.0	<0.971	Monitor	
2,3,4,6,7,8-Hexa CDF **	pg/L	-	ND(48)	<1.2	<1.10	Monitor	
1,2,3,7,8,9-Hexa CDF **	pg/L	-	ND(48)	<1.3	<1.22	Monitor	
1,2,3,4,6,7,8-Hepta CDF **	pg/L	-	25	<0.9	<1.10	Monitor	
1,2,3,4,7,8,9-Hepta CDF **	pg/L	-	ND948)	<1.3	<1.25	Monitor	
Octa CDF **	pg/L	-	39	<1	<1.14	Monitor	
Total Tetra CDF **	pg/L	-	-	14.8	3.35	Monitor	
Total Penta CDF **	pg/L	-	-	<1.1	<1.32	Monitor	
Total Hexa CDF **	pg/L	-	-	<1.1	<1.10	Monitor	
Total Hepta CDF **	pg/L	-	-	<1.1	<1.17	Monitor	
Total Toxic Equivalency	pg/L	-	0.2569	2.61	1.84	**5**	Based on historical water quality precedent with some allowance for treatment system performance variation

Table 2

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Boat Harbour Remediation Planning and Design

Sample ID:		BHSL-SW-1	WG-11148275-BH	BH-DEC03-BULK SURFACE	Raw Bulk-Point C	Surface Water Quality Precedent Criteria	Rationale
Description:		**Untreated Bulk Water**	**Untreated Bulk Water**	**Untreated Bulk Water - Point C**	**Untreated Bulk Water - Point C**		
Sample Date:		**11/2/2017**	**11/29/2017**	**12/3/2018**	**5/4/2019**		
Parameters	**Units**						
Polyaromatic Hydrocarbons							
1-Methylnaphthalene[2a]	µg/L	ND(0.05)	ND(2)	<0.080	<0.050	Monitor	Precedent for Non-detect Levels in BH
2-Methylnaphthalene[2a]	µg/L	ND(0.05)	ND(2)	<0.080	<0.050	Monitor	Precedent for Non-detect Levels in BH
Acenaphthene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Acenaphthylene[2b]	µg/L	0.015	ND(2)	<0.040	<0.030	Monitor	Precedent for Non-detect Levels in BH
Acridine[2b]	µg/L	ND(0.05)		<0.080	<0.050	Monitor	Precedent for Non-detect Levels in BH
Anthracene[2b]	µg/L	ND(0.010)	ND(2)	0.065	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(a)anthracene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(a)pyrene[2a]	µg/L	ND(0.010)	ND(2)	<0.030	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(b)fluoranthene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(b/j)fluoranthene[2b]	µg/L	-	ND(2)	<0.040	<0.020	Monitor	Precedent for Non-detect Levels in BH
Benzo(g,h,i)perylene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(j)fluoranthene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Benzo(k)fluoranthene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Chrysene	µg/L	ND(0.010)	ND(2)	<0.030	<0.010	Monitor	Precedent for Non-detect Levels in BH
Dibenz(a,h)anthracene[2b]	µg/L	ND(0.010)	ND(2)	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Fluoranthene[2b]	µg/L	0.022	ND(2)	0.095	<0.040	Monitor	Precedent for Non-detect Levels in BH
Fluorene[2b]	µg/L	0.039	ND(2)	<0.20	<0.070	Monitor	Precedent for Non-detect Levels in BH
Indeno(1,2,3-cd)pyrene[2b]	µg/L	ND(0.010)	ND(2)	<0.030	<0.010	Monitor	Precedent for Non-detect Levels in BH
Naphthalene[2a]	µg/L	ND(0.2)	ND(2)	<0.30	<0.20	Monitor	Precedent for Non-detect Levels in BH
Perylene[2b]	µg/L	ND(0.01)	-	<0.020	<0.010	Monitor	Precedent for Non-detect Levels in BH
Phenanthrene	µg/L	0.017	ND(2)	0.059	<0.040	Monitor	Precedent for Non-detect Levels in BH
Pyrene	µg/L	0.012	ND(2)	<0.030	<0.020	Monitor	Precedent for Non-detect Levels in BH
Quinoline[2b]	µg/L	-	-	<0.080	<0.050	Monitor	Precedent for Non-detect Levels in BH
Fish Toxicity, Rainbow Trout Acute Lethality	(Pass/Fail)	-	-	Pass	Pass	**Pass**	To Demonstrate Effluent is not deliterious

Table 3

Risk Based Criteria
Boat Harbour Remediation Planning and Design

Parameters	Units	Nova Scotia Guideline Value	Nova Scotia Guideline Source	Risk Based Discharge Limit	Rationale
Inorganics					
Hardness (CaCO3)	mg/L	-	-	Monitor	
Nitrate (N)	mg/L	200	-	Monitor	
Biochemical Oxygen Demand	mg/L	-	-	Monitor	
Carbonaceous BOD	mg/L	-	-	Monitor	
Total Chemical Oxygen Demand (COD)	mg/L	-	-	Monitor	
Dissolved Chlorate (ClO3-)	mg/L	-	-	Monitor	
Dissolved Chlorite (CLO2-)	mg/L	-	-	Monitor	
Colour	TCU	-	-	Monitor	
Nitrate + Nitrite (N)	mg/L	-	-	Monitor	
Nitrite (N)	mg/L	-	-	Monitor	
Dissolved Organic Carbon (C)	mg/L	-	-	Monitor	
Strong Acid Dissoc. Cyanide (CN)	µg/L	1	BCMOECCS 2019 - Approved	1	Not Modified
Total Suspended Solids	mg/L	-	-	Monitor	
pH	S.U.	NG	CCME	6–9	i
Metals					
Total Mercury (Hg)	µg/L	0.016	CCME 2007	0.16	b
Methylmercury	ng/L	0.004 *	CCME 2007	0.013	e
Total Aluminum (Al)	µg/L	5 *	CCME 2007	1,500	a
Total Antimony (Sb)	µg/L	-	-	Monitor	
Total Arsenic (As)	µg/L	12.5	CCME 2007	125	b
Total Barium (Ba)	µg/L	500	BC CSR Schedule 3.2	5000	c
Total Beryllium (Be)	µg/L	-	-	Monitor	
Total Bismuth (Bi)	µg/L	-	-	Monitor	
Total Boron (B)	µg/L	-	-	Monitor	
Total Cadmium (Cd)	µg/L	0.12	CCME 2007	1.2	b
Total Calcium (Ca)	µg/L	-	-	Monitor	
Total Chromium (Cr)	µg/L	-	-	560	b
Total Cobalt (Co)	µg/L	-	-	Monitor	
Total Copper (Cu)	µg/L	2.0	BCMOECCS 2019 - Approved	4.8	a
Total Iron (Fe)	µg/L	-	-	Monitor	
Total Lead (Pb)	µg/L	2.0	BCMOECCS 2019 - Approved	140	d
Total Magnesium (Mg)	µg/L	-	-	Monitor	
Total Manganese (Mn)	µg/L	-	-	Monitor	
Total Molybdenum (Mo)	µg/L	-	-	Monitor	
Total Nickel (Ni)	µg/L	8.3	BC CSR Schedule 3.2	75	c
Total Phosphorus (P)	µg/L	-	-	Monitor	
Total Potassium (K)	µg/L	-	-	Monitor	
Total Selenium (Se)	µg/L	-	-	Monitor	
Total Silver (Ag)	µg/L	1.5	BCMOE 1996	3.0	d
Total Sodium (Na)	µg/L	-	-	Monitor	
Total Strontium (Sr)	µg/L	-	-	Monitor	
Total Thallium (Tl)	µg/L	0.3	BC CSR Schedule 3.2	3	c

Table 3

Risk Based Criteria
Boat Harbour Remediation Planning and Design

Parameters	Units	Nova Scotia Guideline Value	Nova Scotia Guideline Source	Risk Based Discharge Limit	Rationale
Total Tin (Sn)	µg/L	-	-	Monitor	
Total Titanium (Ti)	µg/L	-	-	Monitor	
Total Uranium (U)	µg/L	8.5	BC CSR Schedule 3.2	85	c
Total Vanadium (V)	µg/L	5	ECCC 2016	50	b
Total Zinc (Zn)	µg/L	10	BCMOECCS 2019 - Approved	55	d
Chromium (VI)	µg/L	1.5	CCME 2007	15	b
Petroleum Hydrocarbons					
Benzene	µg/L	2,100	ARBCA 2021	17,500	g
Toluene	µg/L	770	ARBCA 2021	6,400	g
Ethylbenzene	µg/L	320	ARBCA 2021	2,700	g
Total Xylenes	µg/L	330	ARBCA 2021	2,750	g
C6 - C10 (less BTEX)- GAS	µg/L	1,500	ARBCA 2021	12,520	g
>C10-C16 Hydrocarbons- FUEL	µg/L	100	ARBCA 2021	840	g
>C16-C21 Hydrocarbons- FUEL	µg/L	100	ARBCA 2021	840	g
>C21-<C32 Hydrocarbons- LUBE	µg/L	100	ARBCA 2021	480	g
Modified TPH (Tier1) GAS/FUEL/LUBE	µg/L	-	1.5/0.1/0.1	Monitor	Per Above
Dioxins & Furans					
2,3,7,8-Tetra CDD *	pg/L	NG	---	965,924	h
1,2,3,7,8-Penta CDD *	pg/L	-	-	Monitor	
1,2,3,4,7,8-Hexa CDD *	pg/L	-	-	Monitor	
1,2,3,6,7,8-Hexa CDD *	pg/L	-	-	Monitor	
1,2,3,7,8,9-Hexa CDD *	pg/L	-	-	Monitor	
1,2,3,4,6,7,8-Hepta CDD *	pg/L	-	-	Monitor	
Octa CDD *	pg/L	-	-	Monitor	
Total Tetra CDD *	pg/L	-	-	Monitor	
Total Penta CDD *	pg/L	-	-	Monitor	
Total Hexa CDD *	pg/L	-	-	Monitor	
Total Hepta CDD *	pg/L	-	-	Monitor	
2,3,7,8-Tetra CDF **	pg/L	-	-	Monitor	
1,2,3,7,8-Penta CDF **	pg/L	-	-	Monitor	
2,3,4,7,8-Penta CDF **	pg/L	-	-	Monitor	
1,2,3,4,7,8-Hexa CDF **	pg/L	-	-	Monitor	
1,2,3,6,7,8-Hexa CDF **	pg/L	-	-	Monitor	
2,3,4,6,7,8-Hexa CDF **	pg/L	-	-	Monitor	
1,2,3,7,8,9-Hexa CDF **	pg/L	-	-	Monitor	
1,2,3,4,6,7,8-Hepta CDF **	pg/L	-	-	Monitor	
1,2,3,4,7,8,9-Hepta CDF **	pg/L	-	-	Monitor	
Octa CDF **	pg/L	-	-	Monitor	
Total Tetra CDF **	pg/L	-	-	Monitor	
Total Penta CDF **	pg/L	-	-	Monitor	
Total Hexa CDF **	pg/L	-	-	Monitor	
Total Hepta CDF **	pg/L	-	-	Monitor	
TOTAL TOXIC EQUIVALENCY[7]	pg/L	-	-	Monitor	

Table 3

Risk Based Criteria
Boat Harbour Remediation Planning and Design

Parameters	Units	Nova Scotia Guideline Value	Nova Scotia Guideline Source	Risk Based Discharge Limit	Rationale
Polyaromatic Hydrocarbons					
1-Methylnaphthalene	µg/L	1	BCMOECCS 2019 - Approved	10	d
2-Methylnaphthalene	µg/L	1	BCMOECCS 2019 - Approved	10	d
Acenaphthene	µg/L	6	BCMOECCS 2019 - Approved	60	d
Acenaphthylene	µg/L	NG	-	291	f
Acridine	µg/L	-	-	Monitor	
Anthracene	µg/L	-	-	Monitor	
Benzo(a)anthracene	µg/L	-	-	Monitor	
Benzo(a)pyrene	µg/L	0.01	BCMOECCS 2019 - Approved	0.1	d
Benzo(b)fluoranthene	µg/L	-	-	Monitor	
Benzo(b/j)fluoranthene	µg/L	-	-	Monitor	
Benzo(g,h,i)perylene	µg/L	-	-	Monitor	
Benzo(j)fluoranthene	µg/L	-	-	Monitor	
Benzo(k)fluoranthene	µg/L	-	-	Monitor	
Chrysene	µg/L	0.1	BCMOECCS 2019 - Approved	1	d
Dibenz(a,h)anthracene	µg/L	-	-	Monitor	
Fluoranthene	µg/L	-	-	Monitor	
Fluorene	µg/L	12	BCMOECCS 2019 - Approved	120	d
Indeno(1,2,3-cd)pyrene	µg/L	-	-	Monitor	
Naphthalene	µg/L	1.4	CCME 1999	14.2	b
Perylene	µg/L	-	-	Monitor	
Phenanthrene	µg/L	0.3	BC CCSR Schedule 3.2	3	c
Pyrene	µg/L	0.02	BC CCSR Schedule 3.2	0.2	c
Quinoline	µg/L	NG	BC CCSR Schedule 3.2	34	c
Fish Toxicity, Rainbow Trout Acute Lethality	(Pass/Fail)	-	-	**Pass**	To Demonstrate Effluent is not deliterious

Notes to follow on next page.

Table 3

Risk Based Criteria
Boat Harbour Remediation Planning and Design

Notes:
* Freshwater value
ARBCA - Atlantic Risk Based Corrective Action
BC CSR - British Columbia Contaminated Sites Regulation
BCMOECCS - British Columbia Ministry of the Environment and Climate Change Strategy
BG - Background
CCME - Canadian Council of Ministers of the Environment
ECCC - Environment and Climate Change Canada
NG - No Guideline
NI - Risk-based guideline not identified
TCDD - Tertrachlorodibenzodioxin
TPH - Total Petroleum Hydrocarbons
Modification Codes
a - USEPA Region 4 chronic saltwater screening value/Florida water quality standard
b - Chronic LOEC/IC50/LOAEL for sensitive species. Safety factor of 10 has been removed
c - British Columbia Contaminated Sites Regulation Schedule 3.2 generic numerical water standard
d - BCMOECCS short-term acute water quality guideline
e - Dutch maximum permissible concentration
f - USEPA Region 4 acute saltwater screening value
g - ARBCA acute aquatic toxicity benchmark
h - USEPA ECOTOX Knowledgebase
i- CCME 1999

Table 4

Limit of Technology Based Criteria
Boat Harbour Remediation Planning and Design

Sample ID:		BH - NOV19 - COMPOSITE 2	BH - NOV 26 - COMPOSITE 3	COMPOSITE 4	COMPOSITE 5	COMPOSITE 6	COMPOSITE 7	COMPOSITE 8	COMPOSITE 9	Composite 10	Composite 11	Proposed Water Treatment Criteria	Rationale
Description:		Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Dry- WWTF effluent	Dry- WWTF effluent		
Sample Date:		11/19/2018	11/24/2018	12/3/2018	12/4/2018	12/10/2018	12/13/2018	5/4/2019	5/9/2019	6/17/2019	6/21/2019		
Parameters	**Units**												
General Chemisytry													
Hardness (CaCO3)	mg/L	-	-	-	-	-	-	120	130	180	220	Monitor	
	mg/L	-	-	-	-	-	-	0.088	<0.050	0.52	0.11	Monitor	
Biochemical Oxygen Demand	mg/L	-	-	-	-	-	-	<2.0	<2.0	17	<5.0	Monitor	
Carbonaceous BOD	mg/L	-	-	-	-	-	-	<5.0	<5.0	-	-	Monitor	
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	-	-	-	33	45	<20	<20	Monitor	
Dissolved Chlorate (ClO3-)	mg/L	-	-	-	-	-	-	<0.10	<0.10	<0.1	<0.1	Monitor	
Dissolved Chlorite (CLO2-)	mg/L	-	-	-	-	-	-	1.8	2.0	<0.1	<0.1	Monitor	
Colour	TCU	-	-	-	-	-	-	16	28	<5	<5	Monitor	
Nitrate + Nitrite (N)	mg/L	-	-	-	-	-	-	0.088	<0.050	0.56	0.16	Monitor	
Nitrite (N)	mg/L	-	-	-	-	-	-	<0.010	<0.010	0.044	0.054	Monitor	
Dissolved Organic Carbon (C)	mg/L	-	-	-	-	-	-	7.3	8.9	0.66	0.55	Monitor	
pH	S.U.	7.59	8.13	7.95	7.84	7.41	7.85	8.56	8.18	8.01	7.85	**6-9**	Ensure discharging treated water is approximately neutral in pH
Total Suspended Solids	mg/L	-	-	-	-	-	-	2.0	2.2	3.2	<1.0	Monitor	
Strong Acid Dissoc. Cyanide (CN)	mg/L	<0.0010	<0.0040	<0.0020	<0.0020	<0.0020	<0.0050	<0.0050	<0.0050	<0.005	<0.0005	Monitor	
Metals													
Total Mercury (Hg)	µg/L	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	0.0037	<0.002	**0.013**	Based on low-tech pilot treatment system performance
Methylmercury	ng/L	0	0	0	0	0.01	0.01	0	0	0.016	<0.0035	Monitor	
Total Aluminum (Al)	µg/L	14	12	18	21	130	160	160	230	240	220	**500**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Antimony (Sb)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	1.7	1	Monitor	
Total Arsenic (As)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1	1.1	**5**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Barium (Ba)	µg/L	57	58	72	73	19	37	78	110	120	180	**200**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Beryllium (Be)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	Monitor	
Total Bismuth (Bi)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	Monitor	
Total Boron (B)	µg/L	<50	<50	80	69	<50	<50	<50	<50	230	210	Monitor	
Total Cadmium (Cd)	µg/L	<0.010	<0.010	<0.010	0.013	<0.010	0.011	0.029	0.032	0.098	<0.010	**0.2**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Calcium (Ca)	µg/L	30000	30000	29000	28000	31000	33000	39000	41000	52000	60000	Monitor	
Total Chromium (Cr)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**2**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Cobalt (Co)	µg/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.44	<0.40	<0.40	Monitor	
Total Copper (Cu)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.52	0.72	0.99	<0.50	**3**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Iron (Fe)	µg/L	<50	<50	<50	<50	<50	170	<50	63	64	<50	Monitor	
Total Lead (Pb)	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.6	<0.50	<0.50	<0.50	<0.50	**2**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Magnesium (Mg)	µg/L	8500	8800	8400	9200	15000	22000	6300	6000	13000	17000	Monitor	
Total Manganese (Mn)	µg/L	16	13	7	6	190	140	820	790	120	170	Monitor	
Total Molybdenum (Mo)	µg/L	2.9	4.0	4.3	4.2	2.6	2.7	<2.0	<2.0	14	11	Monitor	
Total Nickel (Ni)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	**5**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Phosphorus (P)	µg/L	130	<100	<100	<100	140	150	110	130	<100	100	Monitor	
Total Potassium (K)	µg/L	9600	5500	4700	4900	27000	37,000	19000	16000	5800	8300	Monitor	
Total Selenium (Se)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	Monitor	
Total Silver (Ag)	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	Monitor	
Total Sodium (Na)	µg/L	77000	72000	61000	66000	300000	370,000	290000	280000	67000	120000	Monitor	
Total Strontium (Sr)	µg/L	84	85	78	76	130	140	140	140	250	320	Monitor	
Total Thallium (Tl)	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	Monitor	
Total Tin (Sn)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	Monitor	
Total Titanium (Ti)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	Monitor	
Total Uranium (U)	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.45	0.37	Monitor	
Total Vanadium (V)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	6.5	7	Monitor	
Total Zinc (Zn)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	6.8	5.1	5.5	5.3	<5.0	**10**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Chromium (VI)	µg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<5.0	Monitor	

Table 4

Limit of Technology Based Criteria
Boat Harbour Remediation Planning and Design

Sample ID:		BH - NOV19 - COMPOSITE 2	BH - NOV 26 - COMPOSITE 3	COMPOSITE 4	COMPOSITE 5	COMPOSITE 6	COMPOSITE 7	COMPOSITE 8	COMPOSITE 9	Composite 10	Composite 11	Proposed Water Treatment Criteria	Rationale
Description:		Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Dry- WWTF effluent	Dry- WWTF effluent		
Sample Date:		11/19/2018	11/24/2018	12/3/2018	12/4/2018	12/10/2018	12/13/2018	5/4/2019	5/9/2019	6/17/2019	6/21/2019		
Petroleum Hydrocarbons													
Benzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**1.00**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Toluene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.80**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Ethylbenzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.32**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Total Xylenes	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	**0.33**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
C6 - C10 (less BTEX)- GAS	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.011	<0.010	<0.010	<0.10	<0.10	**1.50**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
>C10-C16 Hydrocarbons-FUEL	mg/L	<0.050	<0.050	<0.050	<0.050	0.12	0.1	0.10	0.13	0.085	0.086	**0.10**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
>C16-C21 Hydrocarbons-FUEL	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.053	<0.050	<0.050	**0.10**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
>C21-<C32 Hydrocarbons-LUBE	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.11	<0.10	<0.10	**0.10**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation
Modified TPH (Tier1) GAS/FUEL/LUBE[2a]	mg/L	<0.10	<0.10	<0.10	<0.10	0.12	0.1	0.10	0.13	<0.10	<0.10	Monitor	
Dioxins & Furans													
2,3,7,8-Tetra CDD *	pg/L	<1.08	<1.02	<0.82	<0.88	<1.34	<0.793	<1.14	<1.20	<1.09	<1.10	Monitor	
1,2,3,7,8-Penta CDD *	pg/L	<1.21	<0.944	<1.18	<0.81	<1.24	<0.840	<1.11	<1.25	<1.15	<1.17	Monitor	
1,2,3,4,7,8-Hexa CDD *	pg/L	<1.03	<1.13	<1.10	<1.04	<1.38	<1.19	<1.12	<1.46	<1.09	<1.15	Monitor	
1,2,3,6,7,8-Hexa CDD *	pg/L	<1.06	<0.982	<0.96	<0.91	<1.21	<1.13	<0.969	<1.27	<0.972	<1.03	Monitor	
1,2,3,7,8,9-Hexa CDD *	pg/L	<0.996	<0.986	<0.97	<0.91	<1.21	<1.08	<0.942	<1.24	<1.02	<1.08	Monitor	
1,2,3,4,6,7,8-Hepta CDD *	pg/L	<1.25	<0.945	<0.98	<1.04	<1.25	<0.922	<0.980	<1.22	**2.54**	<1.17	Monitor	
Octa CDD *	pg/L	<1.46	<1.91	2.9	<3.3	<1.1	1.19	<1.93	<1.13	22.1	10.3	Monitor	
Total Tetra CDD *	pg/L	<1.04	<1.02	<0.82	<0.88	<1.34	<0.793	<1.14	<1.20	<1.09	<1.10	Monitor	
Total Penta CDD *	pg/L	<1.16	<0.944	<1.18	<0.81	<1.24	<0.840	<1.11	<1.25	<1.15	<1.17	Monitor	
Total Hexa CDD *	pg/L	<0.990	<1.03	<1.01	<0.95	<1.26	<1.14	<1.00	<1.32	<1.03	<1.08	Monitor	
Total Hepta CDD *	pg/L	<1.21	<0.945	<0.98	<1.04	<1.25	<0.922	<0.980	<1.22	2.54	<1.17	Monitor	
2,3,7,8-Tetra CDF **	pg/L	<1.10	<1.01	<0.99	<1.06	<1.40	<0.876	<1.04	<1.21	**2.73**	<1.15	Monitor	
1,2,3,7,8-Penta CDF **	pg/L	<1.43	<0.967	<1.11	<1.06	<1.35	<1.15	<1.12	<1.31	<1.03	<1.13	Monitor	
2,3,4,7,8-Penta CDF **	pg/L	<1.44	<0.986	<1.13	<1.08	<1.38	<1.13	<1.12	<1.31	<1.06	<1.16	Monitor	
1,2,3,4,7,8-Hexa CDF **	pg/L	<0.707	<0.990	<0.92	<0.85	<1.17	<0.866	<1.06	<1.34	<1.10	<1.06	Monitor	
1,2,3,6,7,8-Hexa CDF **	pg/L	<0.713	<0.896	<0.84	<0.77	<1.06	<0.825	<0.880	<1.12	<1.02	<0.990	Monitor	
2,3,4,6,7,8-Hexa CDF **	pg/L	<0.806	<1.07	<1.00	<0.91	<1.26	<0.958	<0.996	<1.26	<1.25	<1.21	Monitor	
1,2,3,7,8,9-Hexa CDF **	pg/L	<0.826	<1.20	<1.12	<1.03	<1.42	<1.00	<1.10	<1.40	<1.42	<1.37	Monitor	
1,2,3,4,6,7,8-Hepta CDF **	pg/L	<0.839	<0.875	<0.83	<0.81	<1.08	<0.918	<1.06	<1.03	<1.01	<0.880	Monitor	
1,2,3,4,7,8,9-Hepta CDF **	pg/L	<1.08	<1.23	<1.17	<1.14	<1.53	<1.13	<1.21	<1.17	<1.36	<1.19	Monitor	
Octa CDF **	pg/L	<1.30	<1.15	<1.3	<1.3	<1.1	<0.828	<1.07	<1.06	14.7	<2.40	Monitor	
Total Tetra CDF **	pg/L	<1.05	<1.01	<0.99	<1.06	<1.40	<0.876	<1.04	<1.21	2.73	<1.15	Monitor	
Total Penta CDF **	pg/L	<1.38	<0.976	<1.12	<1.07	<1.37	<1.14	<1.12	<1.31	<1.05	<1.14	Monitor	
Total Hexa CDF **	pg/L	<0.730	<1.03	<0.96	<0.88	<1.21	<0.908	<1.00	<1.27	<1.18	<1.14	Monitor	
Total Hepta CDF **	pg/L	<0.907	<1.02	<0.97	<0.95	<1.27	<1.01	<1.13	<1.10	4.45	<1.89	Monitor	
Total Toxic Equivalency	pg/L	1.92	1.68	1.72	1.53	2.19	1.54	1.86	2.12	1.86	1.92	**5**	Based on low tech pilot treatment system effluent quality with some allowance for treatment system performance variation

Table 4

Limit of Technology Based Criteria
Boat Harbour Remediation Planning and Design

Sample ID:		BH - NOV19 - COMPOSITE 2	BH - NOV 26 - COMPOSITE 3	COMPOSITE 4	COMPOSITE 5	COMPOSITE 6	COMPOSITE 7	COMPOSITE 8	COMPOSITE 9	Composite 10	Composite 11	Proposed Water Treatment Criteria	Rationale
Description:		Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Sediment Removal in Wet - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Buk Water Treatment - WWTF Effluent	Dry- WWTF effluent	Dry- WWTF effluent		
Sample Date:		11/19/2018	11/24/2018	12/3/2018	12/4/2018	12/10/2018	12/13/2018	5/4/2019	5/9/2019	6/17/2019	6/21/2019		
Polyaromatic Hydrocarbons													
1-Methylnaphthalene[2a]	µg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	Monitor	
2-Methylnaphthalene[2a]	µg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	Monitor	
Acenaphthene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Acenaphthylene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Acridine[2b]	µg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	Monitor	
Anthracene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(a)anthracene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(a)pyrene[2a]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(b)fluoranthene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(b/j)fluoranthene[2b]	µg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	Monitor	
Benzo(g,h,i)perylene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(j)fluoranthene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Benzo(k)fluoranthene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Chrysene	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Dibenz(a,h)anthracene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Fluoranthene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Fluorene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Indeno(1,2,3-cd)pyrene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Naphthalene[2a]	µg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	Monitor	
Perylene[2b]	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Phenanthrene	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Pyrene	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	Monitor	
Quinoline[2b]	µg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	Monitor	
Fish Toxicity, Rainbow Trout Acute Lethality	(Pass/Fail)	Pass	Pass	Pass	Pass	Pass	Pass	Pass	-	Pass	Pass	**Pass**	Based on low tech pilot treatment system effluent quality

Appendix E

Supporting Information for IAAC-44 and IAAC-45

Table E.1

Environmental Sound Level Measurements, LEQ - Validated Background Measurements
GSC Boat Harbour Remediation
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Day Time Hours
Evening Time Hours
Night Time Hours
Missing Data

Date	Time	Leq (dBA) [2], [3] Station 1	Station 2	Station 3	Station 4	Station 5	Wind Spd (km/h) [1]	Temperature (°C)	Wind Speed	Precipitation	Comments
2017-11-22	13:00:00	45	52	33	36	48	11	13.8			
2017-11-22	14:00:00	**40**	52	**31**	**35**	47	9	14.2			
2017-11-22	15:00:00	46	**50**	33	36	**46**	1	14.1			
2017-11-22	16:00:00	44	53	36	40	46	15	8.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	17:00:00	44	52	36	42	45	16	9.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	18:00:00	45	51	37	40	43	18	10.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	19:00:00	44	51	36	39	44	28	11.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	20:00:00	44	52	39	44	46	32	11.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	21:00:00	45	52	46	54	47	32	12.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-22	22:00:00	44	52	43	49	44	26	12	Wind Speed >= 14 km/hr	0.6 mm	Invalidated Due to Inclement Weather
2017-11-22	23:00:00	46	52	46	51	48	24	11.7	Wind Speed >= 14 km/hr	0.3 mm	Invalidated Due to Inclement Weather
2017-11-23	00:00:00	51	56	51	56	52	33	12	Wind Speed >= 14 km/hr	0.9 mm	Invalidated Due to Inclement Weather
2017-11-23	01:00:00	53	59	55	60	56	36	12.3	Wind Speed >= 14 km/hr	1.7 mm	Invalidated Due to Inclement Weather
2017-11-23	02:00:00	51	53	52	56	51	48	12.5	Wind Speed >= 14 km/hr	2.9 mm	Invalidated Due to Inclement Weather
2017-11-23	03:00:00	49	54	49	53	49	36	10	Wind Speed >= 14 km/hr	3.0 mm	Invalidated Due to Inclement Weather
2017-11-23	04:00:00	54	60	52	57	54	29	12.8	Wind Speed >= 14 km/hr	1.0 mm	Invalidated Due to Inclement Weather
2017-11-23	05:00:00	60	63	59	60	56	37	6.8	Wind Speed >= 14 km/hr	0.6 mm	Invalidated Due to Inclement Weather
2017-11-23	06:00:00	62	66	59	61	57	85	5.5	Wind Speed >= 14 km/hr	1.8 mm	Invalidated Due to Inclement Weather
2017-11-23	07:00:00	58	62	55	56	53	61	2.5	Wind Speed >= 14 km/hr	1.0 mm	Invalidated Due to Inclement Weather
2017-11-23	08:00:00	53	56	52	52	51	61	2.8	Wind Speed >= 14 km/hr	1.1 mm	Invalidated Due to Inclement Weather
2017-11-23	09:00:00	51	56	52	50	49	63	3.7	Wind Speed >= 14 km/hr	0.3 mm	Invalidated Due to Inclement Weather
2017-11-23	10:00:00	49	55	48	46	47	61	3.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	11:00:00	48	53	45	43	45	37	2.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	12:00:00	47	53	44	43	45	39	3.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	13:00:00	45	53	41	38	43	42	3.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	14:00:00	46	52	39	38	44	43	3.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	15:00:00	39	52	38	38	45	39	3.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	16:00:00	39	53	36	35	44	42	3.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	17:00:00	41	54	36	36	45	38	3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	18:00:00	39	53	37	36	43	26	2.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	19:00:00	38	54	38	36	42	18	0.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	20:00:00	38	53	37	35	42	18	-0.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	21:00:00	37	53	35	33	42	19	-0.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	22:00:00	36	52	35	34	41	18	-0.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-23	23:00:00	37	52	34	33	39	15	-1.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-24	00:00:00	37	53	33	33	34	15	-2.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-24	01:00:00	35	51	28	32	33	15	-1.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-24	02:00:00	**36**	**49**	**25**	**32**	34	13	-2.1			
2017-11-24	03:00:00	**36**	50	29	33	**33**	11	-2.2			
2017-11-24	04:00:00	36	51	31	33	33	15	-2	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather

Table E.1

Environmental Sound Level Measurements, LEQ - Validated Background Measurements
GSC Boat Harbour Remediation
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Day Time Hours
Evening Time Hours
Night Time Hours
Missing Data

Date	Time	Leq (dBA) [2], [3] Station 1	Station 2	Station 3	Station 4	Station 5	Wind Spd (km/h) [1]	Temperature (°C)	Wind Speed	Precipitation	Comments
2017-11-28	13:00:00	51	51	53	34	42	27	-1.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	14:00:00	48	51	38	35	44	25	-1.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	15:00:00	39	51	35	34	43	23	-1.2	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	16:00:00	38	51	32	33	45	17	-2.2	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	17:00:00	**37**	51	35	32	44	12	-2.7			
2017-11-28	18:00:00	39	52	**29**	**30**	44	8	-3.3			
2017-11-28	19:00:00	40	**49**	**29**	33	**43**	6	-3.3			
2017-11-28	20:00:00	39	48	30	34	44	14	-3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	21:00:00	41	48	36	35	39	14	-3.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	22:00:00	42	48	36	35	42	17	-3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-28	23:00:00	42	49	38	40	41	17	-2.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	00:00:00	43	51	38	43	45	16	-2.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	01:00:00	44	53	40	45	46	13	-0.7			
2017-11-29	02:00:00	44	**51**	**37**	41	43	13	0.5			
2017-11-29	03:00:00	**40**	**51**	**37**	**40**	**41**	9	0.6			
2017-11-29	04:00:00	46	55	42	46	47	12	2.4			
2017-11-29	05:00:00	50	56	47	47	49	16	4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	06:00:00	50	60	48	52	53	18	4.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	07:00:00	52	58	46	52	55	22	5.4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	08:00:00	53	59	48	53	56	23	6.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	09:00:00	49	56	45	46	49	26	7.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	10:00:00	47	56	44	44	47	24	8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	11:00:00	48	55	43	43	48	19	9.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	12:00:00	45	54	38	45	46	22	9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	13:00:00	45	**53**	38	41	**46**	13	8.4			
2017-11-29	14:00:00	44	**53**	**37**	**40**	47	10	8.3			
2017-11-29	15:00:00	**41**	**53**	39	42	47	11	8.8			
2017-11-29	16:00:00	40		38	37	45	11	6.8		0.6 mm	Invalidated Due to Inclement Weather
2017-11-29	17:00:00	40		39	38	45	24	6.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	18:00:00	39		39	36	44	35	6.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	19:00:00	40		38	36	45	28	5.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	20:00:00	41		43	42	43	33	5.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	21:00:00	42		46	47	45	38	4.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	22:00:00	45		48	49	47	49	3.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-29	23:00:00	44		50	52	47	44	2.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-30	00:00:00	45		49	50	48	49	1.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-30	01:00:00	42		44	44	44	51	1.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-30	02:00:00	40					45	1.4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-30	03:00:00	39					41	1.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-11-30	04:00:00	39					38	1.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather

Table E.1

Environmental Sound Level Measurements, LEQ - Validated Background Measurements
GSC Boat Harbour Remediation
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Day Time Hours
Evening Time Hours
Night Time Hours
Missing Data

Date	Time	Leq (dBA) [2], [3] Station 1	Station 2	Station 3	Station 4	Station 5	Wind Spd (km/h) [1]	Temperature (°C)	Wind Speed	Precipitation	Comments
2017-12-07	13:00:00		59		38	45	13	6.3			
2017-12-07	14:00:00	52	51	56	**34**	42	12	5.9			
2017-12-07	15:00:00	45	50	34	35	45	18	5.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-07	16:00:00	40	51	34	36	44	6	4.2			
2017-12-07	17:00:00	41	50	36	38	42	5	2.9			
2017-12-07	18:00:00	40	50	34	35	42	6	3			
2017-12-07	19:00:00	40	50	36	37	41	8	2.9			
2017-12-07	20:00:00	41	50	34	36	42	13	3.2			
2017-12-07	21:00:00	40	50	35	36	**40**	11	2.8			
2017-12-07	22:00:00	**38**	**49**	**32**	36	**40**	10	2.7			
2017-12-07	23:00:00	**38**	**49**	32	**33**	39	10	2.4			
2017-12-08	00:00:00	**38**	**49**	**29**	**33**	34	9	2.1			
2017-12-08	01:00:00	39	50	31	35	36	6	2			
2017-12-08	02:00:00	39	**49**	31	35	39	7	1.7			
2017-12-08	03:00:00	39	**49**	31	35	33	6	1.6			
2017-12-08	04:00:00	39	50	32	35	**31**	7	1.3			
2017-12-08	05:00:00	**38**	**49**	32	35	**31**	9	1.2			
2017-12-08	06:00:00	41	**49**	32	34	34	11	1.1			
2017-12-08	07:00:00	44	**49**	37	36	40	11	0.6			
2017-12-08	08:00:00	43	**49**	36	37	41	11	0.2			
2017-12-08	09:00:00	44	50	34	36	44	11	1.6			
2017-12-08	10:00:00	43	51	36	36	43	15	2.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-08	11:00:00	50	51	32	35	44	24	3.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-08	12:00:00	46	52	35	34	43	22	3.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-08	13:00:00	46	52	35	37	45	18	2.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-08	14:00:00	43	52	33	35	44	6	3.4			
2017-12-08	15:00:00	46	51	34	37	44	4	3.1			
2017-12-08	16:00:00	53	51	33	34	**40**	8	3.4			
2017-12-08	17:00:00	**39**	51	33	35	41	9	2.9			
2017-12-08	18:00:00	45	51	35	36	44	8	3			
2017-12-08	19:00:00	65	50	35	36	44	6	2.9			
2017-12-08	20:00:00	39	51	33	35	42	9	2.4			
2017-12-08	21:00:00	**39**	50	**31**	**33**	43	6	2.4			
2017-12-08	22:00:00	45	**49**	38	**33**	**40**	7	2.5			
2017-12-08	23:00:00	**39**	52	**30**	32	37	8	2.3			
2017-12-09	00:00:00	52	53	35	31	41	13	2.3			
2017-12-09	01:00:00	47	**51**	33	31	40	11	2.6			
2017-12-09	02:00:00			34	29	37	2	1.7			
2017-12-09	03:00:00			34	**23**	32	3	1.4			
2017-12-09	04:00:00			34	26	**29**	10	2.3			

Table E.1

Environmental Sound Level Measurements, LEQ - Validated Background Measurements
GSC Boat Harbour Remediation
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Day Time Hours
Evening Time Hours
Night Time Hours
Missing Data

Date	Time	Leq (dBA) [2], [3] Station 1	Station 2	Station 3	Station 4	Station 5	Wind Spd (km/h) [1]	Temperature (°C)	Wind Speed	Precipitation	Comments
2017-12-14	13:00:00	54	58	56	49	50	26	-0.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	14:00:00	44	54	37	41	48	21	-0.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	15:00:00	46	52	34	38	46	23	-1.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	16:00:00	43	51	31	37	48	20	-1.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	17:00:00	**40**	**52**	**29**	**36**	**44**	13	-1.9			
2017-12-14	18:00:00	39	51	28	35	43	18	-1.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	19:00:00	39	51	32	37	40	19	-3.4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	20:00:00	44	52	37	42	46	19	-5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	21:00:00	43	51	38	41	41	21	-6.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	22:00:00	43	53	37	42	42	22	-7.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-14	23:00:00	41	53	32	40	42	22	-8.4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	00:00:00	43	53	32	41	41	22	-8.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	01:00:00	43	53	30	41	41	29	-8.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	02:00:00	44	54	33	42	41	26	-9.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	03:00:00	45	53	34	39	40	20	-9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	04:00:00	42	53	32	38	41	23	-8.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	05:00:00	45	55	36	43	44	18	-8.7	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	06:00:00	49	57	38	47	47	19	-8.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	07:00:00	49	57	36	47	49	23	-8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	08:00:00	51	58	38	49	49	21	-7.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	09:00:00	49	57	37	47	51	24	-6.8	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	10:00:00	51	59	42	50	56	26	-6.5	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	11:00:00	51	59	41	51	51	33	-5.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	12:00:00	54	60	43	50	50	31	-4.2	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	13:00:00	53	60	43	51	51	32	-4.3	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	14:00:00	51	58	39	47	48	30	-3.9	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	15:00:00	49	55	35	47	48	26	-3.6	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	16:00:00	45	52	33	39	46	23	-4.1	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	17:00:00	42	51	33	41	45	13	-4.4			
2017-12-15	18:00:00	40	50	28	35	45	16	-4	Wind Speed >= 14 km/hr		Invalidated Due to Inclement Weather
2017-12-15	19:00:00	**39**	49	29	35	45	12	-4.4			
2017-12-15	20:00:00	40	49	29	35	45	4	-5.6			
2017-12-15	21:00:00	**39**	49	28	34	**41**	4	-7			
2017-12-15	22:00:00	**39**	**48**	**26**	**33**	43	7	-6.9			
2017-12-15	23:00:00	39	**47**	25	33	33	9	-6.9			

Table E.1

Environmental Sound Level Measurements, LEQ - Validated Background Measurements
GSC Boat Harbour Remediation
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Day Time Hours
Evening Time Hours
Night Time Hours
Missing Data

Date	Time	Leq (dBA) [(2), (3)] Station 1	Station 2	Station 3	Station 4	Station 5	Wind Spd (km/h) [(1)]	Temperature (°C)	Wind Speed	Precipitation	Comments
2017-12-16	00:00:00	39	49	26	33	37	6	-7.7			
2017-12-16	01:00:00	39	48	26	32	**30**	8	-6.8			
2017-12-16	02:00:00	38	48	28	32	36	3	-7.1			
2017-12-16	03:00:00	37	50	25	29	**30**	3	-7.4			
2017-12-16	04:00:00	**36**	49	**22**	**28**	**30**	11	-7.3			

		Station 1 (POR1,2,3)	Station 2	Station 3 (POR7,8)	Station 4 (POR4&5,9)	Station 5 (POR6)
16 hour daytime LD	2017-11-22	44.1	51.1	32.5	36.0	47.0
	2017-11-28	38.8	50.7	32.1	31.6	43.9
	2017-11-29	43.7	53.1	37.9	41.3	46.7
	2017-12-07	44.6	52.8	47.2	36.4	42.4
	2017-12-08	54.8	50.5	34.7	35.4	42.4
	2017-12-14	39.9	51.6	28.7	36.3	43.6
	2017-12-15	40.2	49.2	29.5	36.8	44.0
Total LD Log Average		47.7	51.5	39.8	37.1	44.7
8 hour nighttime LN	2017-11-23	36.0	49.4	27.7	32.3	33.3
	2017-11-28	44.1	54.7	43.1	45.9	47.5
	2017-12-07	39.0	49.4	31.4	34.3	35.7
	2017-12-08	48.3	52.1	33.5	29.7	37.8
	2017-12-15	38.1	48.7	25.6	31.3	33.7
Total LN Log Average		43.5	51.5	37.0	39.6	41.5

Notes:

(1) Weather data provided by Environment Canada's Caibou Point and Debert, Nova Scotia Climate Stations.
(2) Measurements recorded during inclement weather (winds speeds greater than 14 km/h and/or rain) were disregarded.
(3) Bolded data represents the lowest measured Leq during the respective monitoring time period.

Table E.2

Point of Reception Partial Level Noise Impact Summary
Boat Harbour Remediation and Planning Design
Nova Scotia Lands

Cadna A ID	Source Description	POR1 Distance (m)	POR1 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR1 Evening 7pm–11pm	POR1 Night 11pm–7am	POR2 Distance (m)	POR2 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR2 Evening 7pm–11pm	POR2 Night 11pm–7am	POR3 Distance (m)	POR3 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR3 Evening 7pm–11pm	POR3 Night 11pm–7am
Construction, Remediation, Demolition Noise Impact													
s-Bull Dozer	Bulldozer	1047	41.5	34.3	—	949	42.3	33.0	—	1092	40.5	30.1	—
s-Dredge1	Dredging Area 1	1554	33.8	33.8	33.8	1476	34.6	34.6	34.6	1489	33.9	33.9	33.9
s-Dredge2	Dredging Area 2	1013	38.8	38.8	38.8	1138	37.6	37.6	37.6	1593	33.2	33.2	33.2
s-Dredge3	Dredging Area 3	1518	34.8	34.8	34.8	1591	34.7	34.7	34.7	1872	32.7	32.7	32.7
s-Dredge4	Dredging Area 4	2637	29.9	29.9	29.9	2630	29.9	29.9	29.9	2642	29.2	29.2	29.2
s-Pile Driver	Impact Pile Driver	3807	37.3	37.3	—	3795	36.9	36.9	—	3730	36.5	36.5	—
s-TR1	Construction On-Site Haul Route	37	52.2	52.2	—	191	42.3	42.3	—	838	31.6	31.6	—
s-TR2	Dam Construction On-Site Haul Route	35	46.5	46.5	—	156	39.9	39.9	—	361	34.6	34.6	—
s-ex	Excavator	1005	30.2	30.2	—	891	30.7	30.7	—	1034	29.1	29.1	—
Total Facility Sound Level (1-hour Leq):			**53.9**	**53.7**	**41.5**		**48.0**	**46.8**	**41.0**		**44.5**	**42.5**	**38.6**
Operational Noise Impact													
i-TR2	Operation On-Site Haul Route	41	45.7	45.7	45.7	182	36.6	36.6	36.6	830	26.3	26.3	26.3
s-Bull Dozer	Bulldozer	1047	41.5	34.1	—	949	42.3	32.7	—	1092	40.4	29.6	—
s-Dredge1	Dredging Area 1	1554	33.8	33.8	33.8	1476	34.6	34.6	34.6	1489	33.9	33.9	33.9
s-Dredge2	Dredging Area 2	1013	38.8	38.8	38.8	1138	37.6	37.6	37.6	1593	33.2	33.2	33.2
s-Dredge3	Dredging Area 3	1518	34.8	34.8	34.8	1591	34.7	34.7	34.7	1872	32.7	32.7	32.7
s-Dredge4	Dredging Area 4	2637	29.9	29.9	29.9	2630	29.9	29.9	29.9	2642	29.2	29.2	29.2
s-ex	Excavator	1005	30.1	30.1	—	891	30.7	30.7	—	1034	29.0	29.0	—
Total Facility Sound Level (1-hour Leq):			**48.2**	**47.4**	**47.1**		**45.5**	**43.1**	**42.4**		**42.9**	**39.7**	**38.9**

Cadna A ID	Source Description	POR4 Distance (m)	POR4 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR4 Evening 7pm–11pm	POR4 Night 11pm–7am	POR5 Distance (m)	POR5 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR5 Evening 7pm–11pm	POR5 Night 11pm–7am	POR6 Distance (m)	POR6 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR6 Evening 7pm–11pm	POR6 Night 11pm–7am
Construction, Remediation, Demolition Noise Impact													
s-Bull Dozer	Bulldozer	1380	37.3	30.4	—	1262	40.0	38.6	—	503	47.3	47.3	—
s-Dredge1	Dredging Area 1	1336	34.4	34.4	34.4	1298	36.0	36.0	36.0	2137	28.9	28.9	28.9
s-Dredge2	Dredging Area 2	1970	30.1	30.1	30.1	2039	30.1	30.1	30.1	2783	25.5	25.5	25.5
s-Dredge3	Dredging Area 3	1921	32.0	32.0	32.0	1584	36.8	36.8	36.8	2269	31.7	31.7	31.7
s-Dredge4	Dredging Area 4	2100	32.2	32.2	32.2	782	44.4	44.4	44.4	1199	39.7	39.7	39.7
s-Pile Driver	Impact Pile Driver	2954	39.6	39.6	—	1247	50.4	50.4	—	487	60.0	60.0	—
s-TR1	Construction On-Site Haul Route	1532	26.8	26.8	—	1330	26.7	26.7	—	2031	21.6	21.6	—
s-TR2	Dam Construction On-Site Haul Route	194	37.0	37.0	—	369	32.9	32.9	—	125	39.2	39.2	—
s-ex	Excavator	1370	26.2	26.2	—	1241	28.9	28.9	—	481	35.8	35.8	—
Total Facility Sound Level (1-hour Leq):			**44.4**	**43.6**	**38.5**		**52.0**	**52.0**	**45.7**		**60.3**	**60.3**	**40.8**
Operational Noise Impact													
i-TR2	Operation On-Site Haul Route	1509	21.8	21.8	21.8	1570	21.9	21.9	21.9	2189	17.3	17.3	17.3
s-Bull Dozer	Bulldozer	1380	37.1	29.3	—	1878	37.4	34.5	—	2417	32.1	29.6	—
s-Dredge1	Dredging Area 1	1336	34.4	34.4	34.4	1298	36.0	36.0	36.0	2137	28.9	28.9	28.9
s-Dredge2	Dredging Area 2	1970	30.1	30.1	30.1	2039	30.1	30.1	30.1	2783	25.5	25.5	25.5
s-Dredge3	Dredging Area 3	1921	32.0	32.0	32.0	1584	36.8	36.8	36.8	2269	31.7	31.7	31.7
s-Dredge4	Dredging Area 4	2100	32.2	32.2	32.2	782	44.4	44.4	44.4	1199	39.7	39.7	39.7
s-ex	Excavator	1370	25.9	25.9	—	1860	26.6	26.6	—	2425	22.5	22.5	—
Total Facility Sound Level (1-hour Leq):			**41.0**	**39.3**	**38.6**		**46.4**	**46.1**	**45.7**		**41.4**	**41.2**	**40.8**

Cadna A ID	Source Description	POR7 Distance (m)	POR7 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR7 Evening 7pm–11pm	POR7 Night 11pm–7am	POR8 Distance (m)	POR8 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR8 Evening 7pm–11pm	POR8 Night 11pm–7am	POR9 Distance (m)	POR9 Partial Sound Levels¹ (dBA) Day 7am–7pm	POR9 Evening 7pm–11pm	POR9 Night 11pm–7am
Construction, Remediation, Demolition Noise Impact													
s-Bull Dozer	Bulldozer	1890	33.9	33.4	—	1597	38.2	35.2	—	991	40.6	40.1	—
s-Dredge1	Dredging Area 1	3088	23.8	23.8	23.8	2026	30.0	30.0	30.0	1744	31.8	31.8	31.8
s-Dredge2	Dredging Area 2	3134	23.0	23.0	23.0	1238	35.9	35.9	35.9	2470	27.3	27.3	27.3
s-Dredge3	Dredging Area 3	2694	29.1	29.1	29.1	1707	32.9	32.9	32.9	1995	33.3	33.3	33.3
s-Dredge4	Dredging Area 4	2185	32.3	32.3	32.3	2845	28.6	28.6	28.6	1135	39.3	39.3	39.3
s-Pile Driver	Impact Pile Driver	1902	45.4	45.4	—	3959	36.2	36.2	—	975	53.0	53.0	—
s-TR1	Construction On-Site Haul Route	2619	19.0	19.0	—	54	49.9	49.9	—	1745	23.6	23.6	—
s-TR2	Dam Construction On-Site Haul Route	1823	16.7	16.7	—	956	25.1	25.1	—	22	48.4	48.4	—
s-ex	Excavator	1906	23.6	23.6	—	1575	27.6	27.6	—	968	29.4	29.4	—
Total Facility Sound Level (1-hour Leq):			**46.1**	**46.0**	**34.7**		**50.7**	**50.6**	**38.8**		**54.7**	**54.7**	**41.1**
Operational Noise Impact													
i-TR2	Operation On-Site Haul Route	2338	14.1	14.1	14.1	48	44.5	44.5	44.5	1964	18.9	18.9	18.9
s-Bull Dozer	Bulldozer	2352	30.7	29.5	—	1597	38.1	35.1	—	2244	33.9	31.0	—
s-Dredge1	Dredging Area 1	3088	23.8	23.8	23.8	2026	30.0	30.0	30.0	1744	31.8	31.8	31.8
s-Dredge2	Dredging Area 2	3134	23.0	23.0	23.0	1238	35.9	35.9	35.9	2470	27.3	27.3	27.3
s-Dredge3	Dredging Area 3	2694	29.1	29.1	29.1	1707	32.9	32.9	32.9	1995	33.3	33.3	33.3
s-Dredge4	Dredging Area 4	2185	32.3	32.3	32.3	2845	28.6	28.6	28.6	1135	39.3	39.3	39.3
s-ex	Excavator	2388	21.2	21.2	—	1575	27.5	27.5	—	2244	23.7	23.7	—
Total Facility Sound Level (1-hour Leq):			**36.3**	**36.0**	**34.7**		**46.3**	**46.0**	**45.6**		**41.9**	**41.6**	**41.1**

Note:

¹ Sound level at the receptor was calculated using Cadna A acoustical modelling software.

Appendix F

Supporting Information for IAAC-13, 42, 43

Table 2.19

Forecasted Leachate Quality
(Updated in response to IAAC-13)
Boat Harbour Remediation Planning and Design
Nova Scotia Lands

Parameters	Units	Canadian Council of Ministers of the Environment (CCME) Marine Discharge a	Nova Scotia Env Tier 1 Table 3 Environmental Quality Standards (EQS) SW and GW Discharge to SW <10m from SW Body, Marine Marine Discharge b	Nova Scotia Env Tier 2 Table 3 GW Discharge to SW > 10m from SW Body, Marine Marine Discharge c	Risk Based Discharge Criteria Protection of Aquatic Life d	Pilot Testing Geotube Effluent (Grab) Max	Pilot Testing Geotube Effluent (Grab) Average	Pilot Testing Geotube Effluent (Comp) Max	Pilot Testing Geotube Effluent (Comp) Average	Pilot Testing Dewatered Sludge SPLP Max	Pilot Testing Dewatered Sludge SPLP Average	Forecasted Leachate Basis of Design - Cell and TLTS Maximum - Worst Case	Forecasted Leachate Typical Average Quality
General Chemistry													
Cyanide	µg/L	-	-	10	1	1.1[d]	1.1[d]	1.3[d]	1.2[d]			1.3[d]	1.2[d]
Metals													
Mercury	µg/L	0.016	0.016	0.16	0.16	0.025[a,b]	0.025[a,b]	0.058[a,b]	0.04[a,b]	<0.0020	<0.0020	0.058[a,b]	0.033[a,b]
Methyl mercury	µg/L	-	0.004	0.04	0.013	<0.004	<0.004	0.027[d]	0.016[d]			0.027[d]	0.016[d]
Aluminum	µg/L	-	-	-	-	12000	5019	4400	2063	100	80	12000	2387
Arsenic	µg/L	12.5	12.5	125	125	2.9	1.8	1.4	1.4	<2	<2	2.9	1.6
Barium	µg/L	-	500	5,000	5,000	170	109	130	116	170	165	170	130
Cadmium	µg/L	0.12	0.12	1.2	1.2	0.33[a,b]	0.12	0.5[a,b]	0.225[a,b]	<0.30	<0.30	0.5[a,b]	0.175[a,b]
Chromium	µg/L	-	1.5	15	560	2.5[b]	1.75[b]	3.8[b]	2.5[b]	<2	<2	3.8[b]	2.13[b]
Copper	µg/L	-	2	20	4.8	3.1[b]	3.1[b]	11[b,d]	11[b,d]	<2	<2	11[b,d]	7.05[b,d]
Lead	µg/L	-	2	20	140	2.9[b]	2.0	3.3[b]	2.15[b]	<0.50	<0.50	3.3[b]	2.075[b]
Nickel	µg/L	-	8.3	83	75	2.5	2.5	3.1	3.1	<2	<2	3.1	2.8
Silver	µg/L	-	1.5	15	3	0.11	0.11	0.14	0.14	<0.50	<0.50	0.14	0.13
Thallium	µg/L	-	21.3	213	3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0	0
Uranium	µg/L	-	100	1,000	85	0.30	0.23	0.17	0.17	<0.10	<0.10	0.30	0.20
Vanadium	µg/L	-	50	500	50	6.5	4.8	6.7	4.4	3.2	3.1	6.7	4.1
Zinc	µg/L	-	10	100	55	28[b]	16.3[b]	39[b]	29[b]	6.2	5.8	39[b]	17[b]
Chromium VI (hexavalent)	µg/L	1.5	-	-	15	<0.5	<0.5	<0.5	<0.5			0	0
Petroleum Products													
Methyl tert butyl ether (MTBE)	µg/L	5,000	5,000	50,000	-	<10	<10					0	0
Benzene	µg/L	110	2,100	4,600	17,500	<1	<1	<1	<1			0	0
Toluene	µg/L	215	770	4,200	6,400.0	<1	<1	<1	<1			0	0
Ethylbenzene	µg/L	25	320	3,200	2,700.0	<1	<1	<1	<1			0	0
Xylenes (total)	µg/L	-	330	2,800	2,750.0	<2	<2	<2	<2			0	0
Total Petroleum Hydrocarbons (C6-C10) Less BTEX - Gas	µg/L	-	see Modified TPH	13,000	12,520	10	10	<10	<10			10	10
Petroleum hydrocarbons F2 (C10-C16) - Fuel	µg/L	-	see Modified TPH	840	840.0	720	690	86	74	<20	<20	720	382
Total Petroleum Hydrocarbons (>C16-C21) - Fuel	µg/L	-	see Modified TPH	840	840.0	530	400	180	137	<20	<20	530	269
Total Petroleum Hydrocarbons (C21-C32) - Lube	µg/L	-	see Modified TPH	100	480.0	1500[c,d]	1070[c,d]	590[c,d]	360[c]	<50	<50	1500[c,d]	715[c,d]
Total Petroleum Hydrocarbons - Modified - Tier 1 - Gas/Fuel/Lube	µg/L	-	1500/100/100	-	-	2700	2150	850	570	<50	<50	2700	1360
Dioxins & Furans													
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/L	-	-	-	965,924			<1.14	<1.14			0	0
TOTAL TOXIC EQUIVALENCY	pg/L	-	120	120	-			3.01	2.53			3.01	2.5
SVOAs													
1-Methylnaphthalene	µg/L	-	1	10	10			<0.05	<0.05	0.052	0.052	0.052	0.052
2-Methylnaphthalene	µg/L	-	2	20	10			<0.05	<0.05	0.081	0.070	0.081	0.070
Acenaphthene	µg/L	-	6	60	60			<0.02	<0.02	0.043	0.032	0.043	0.032
Acenaphthylene	µg/L	-	6	60	291			<0.01	<0.01	<0.01	<0.01	0	0
Benzo(a)pyrene	µg/L	-	0.01	0.1	0.1			0.015[b]	0.015[b]	<0.01	<0.01	0.015[b]	0.015[b]
Chrysene	µg/L	-	0.1	1	1			<0.03	<0.03	<0.01	<0.01	0	0
Fluoranthene	µg/L	-	11	110	-			0.035	0.028	0.017	0.015	0.035	0.021
Fluorene	µg/L	-	12	120	120			0.029	0.025	0.047	0.042	0.047	0.033
Naphthalene	µg/L	-	1.4	14	14.2			<0.2	<0.2	0.26	0.26	0.26	0.260
Phenanthrene	µg/L	-	4.6	46	3.0			0.037	0.023	0.045	0.040	0.045	0.031
Pyrene	µg/L	-	0.02	0.2	0.2			0.053	0.034	<0.01	<0.01	0.053[b]	0.034[b]
Fish Toxicity, Rainbow Trout Acute Lethality	(Pass/Fail)	-	-	-	Pass			Pass	Pass			Pass	Pass

Appendix G

Supporting Information for IAAC-54b, 56, 58

Memorandum

June 20, 2022

To	Angela Swaine, NS Lands		
Copy to	Gord Reusing, Tom Ferrara		
From	Paul Van Kerkhove/Troy Small	**Tel**	716-213-3395/ 613-297-7687
Subject	Boat Harbour Remediation Project – Supplemental Air Quality Modelling Update	**Project no.**	12572494

1. Introduction

1.1 Purpose

This memorandum provides an update to modelling outlined in Memorandum-88 *Supplemental Air Quality Modelling*. The purpose of the updated modelling was to address regulatory comments on the control efficiency factor used for twice-daily watering of site roads for the project. The changes to the assumptions for the modelling are listed below:

– Decrease in control efficiency factor of twice-daily watering of unpaved roads to control fugitive dust emissions from 80 percent to 55 percent.
  - The initial modelling had utilized a control efficiency of 80 percent consistent with the United States Protection Agency's (USEPA's) AP-42 Section 13.2.2 – Unpaved Roads.
  - The updated modelling utilizes a control efficiency of 55 percent referenced by Environment Canada in *Road Dust Emissions from Unpaved Surfaces: Guide to Reporting*.

– The modelled periods with truck emissions changed from 24 hours per day to 12 hours per day.
  - The maximum hourly 1-hour emission rates used in the original modelling continued to be used based on the truck traffic for short-term modelling (e.g., 1-hour and/or 24-hour averaging periods).
  - The 12-hour modelling period much more closely aligns with the expected daily period of truck traffic.

As with the initial modelling, the short-term modelling is based on truck operation during dry conditions, but with twice-daily watering of the paved and unpaved sections of the site road. The watering is only performed on days without sufficient precipitation to provide natural mitigation conditions (i.e., wet, snow covered, and/or frozen roads).

The control efficiency of twice-daily watering of unpaved roads is discussed above. The control efficiency of twice-daily watering of paved roads is based on procedures outlined in USEPA's AP-42 Section 13.2.1 - Paved Roads, which result in a control efficiency of approximately 48 percent. During the project, the site access road will be watered as often as it is required to suppress dust generation. The assumption of twice-daily watering was used for this modelling analysis.

Finally, the modelling was expanded to include particulate matter with aerodynamic diameters less than or equal to 2.5 micrometres ($PM_{2.5}$) even though concentrations of this parameter were previously identified to be below applicable guidelines (Project criteria) in the initial modelling (see Section 1.2 below).

1.2 Background

An Air Quality Impact Analysis (AQIA) Technical Report (GHD Report 35) was prepared and included in Appendix U of the Environmental Impact Statement (EIS), Boat Harbour Remediation Project, Pictou Landing, Nova Scotia for the remediation of the Boat Harbour Effluent Treatment Facility (BHETF) and associated properties located in Pictou Landing, Nova Scotia (the Project). The AQIA report summarized the methods used to estimate emissions and run the dispersion models to assess the air quality impacts from Project activities. The AQIA report described that particulate matter emissions from final capping and seeding of the containment cell (Scenario 7) are predicted to exceed total suspended particulate (TSP) and particulate matter with aerodynamic diameters less than or equal to 10 micrometres (PM_{10}) ambient air criteria as outlined below in Table 1.

Table 1 Summary of Air Quality Results for TSP, PM10, and PM2.5 with 0.15 km of Paved Road

Air Pollutant	Averaging Period	Modelled Maximum ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Maximum Impact ($\mu g/m^3$)	Project Criteria ($\mu g/m^3$)
TSP	24-hour	394	39	433	120
	Annual	80	11	91	70
PM_{10}	24-hour	82	14	96	50
$PM_{2.5}$	24-hour	8	11	19	27
	Annual	1.7	3.4	5.1	8.8

Reference: Table 6.1 of AQIA Technical Report (GHD Report 35)

The exceedances are the result of over 100 trucks per day travelling on the gravel access road and due to the proximity of portions of the access road to the Site boundary. The areas of particulate matter exceedances were modelled to be within approximately 100 metres (m) of the Site boundary; and occur in forested land extending from the paved section at the Site entrance for several 100 m into the Project Site. The edge of the impact area abuts three residential properties. Modelling also suggests an exceedance of the TSP ambient criteria during access road improvements (Scenario 1). The potential exceedances under this scenario would occur in the same location as Scenario 7 (isolated area near the access road) but would be lower and over a smaller area.

During discussions with Nova Scotia Environment and Climate Change (NSECC), NSECC stated that mitigative measures will need to be modelled to demonstrate that Project criteria compliance can be achieved along the Site boundary and be available to be implemented based on performance monitoring results during Project implementation. NSECC states that modelling and mitigation measures would be determined and submitted in support of any future industrial approvals along with a performance monitoring program.

This memorandum provides an assessment of mitigation measures and updated modelling to demonstrate compliance with the Project criteria for projected worst case estimated exceedances of the TSP and PM_{10} Project criteria.

2. Updated Assessment and Modelling Results

An evaluation of the modelling results identified fugitive dust generated from truck traffic on the unpaved sections of the access road as the most likely major contributor to the particulate matter exceedances. The initial modelling included a watering program to mitigate fugitive dust emissions from the unpaved road sections. As such, modelling was conducted to assess how paving portions of the Site access road would affect particulate matter impacts.

By examining access road configuration, it was estimated that increasing the paved portion of the access road from the Site entrance to 1.07 kilometres (km) from the entrance would result in the fugitive dust emissions from paved roads becoming the dominant influence on the receptors where particulate matter exceedances were estimated to occur. The increased paved road section is illustrated in Figure 1.

Using the new access road configuration and construction materials (paving 1.07 km from site entrance), new modelling runs were conducted for TSP and PM_{10}. The modelling assumed that for 24-hour impacts, the fugitive dust emissions rates used in the modelling are based on dry roads with no rain for at least 2 days.

An analysis of the results indicated that though the maximum modelling impacts were greatly reduced, there were still some exceedances of the 24-hour TSP Project criteria at receptors near the Site entrance (abutting residential properties) and other locations near the access road. Given the distance from the receptors of concern to unpaved road sections, it is assumed the fugitive dust generated from paved road sections are the major influence on particulate matter impacts and additional paving near the Settling Basins or Aeration Stabilization Lagoon (ASB) would only have very minor changes to modelled impacts.

Therefore, to further mitigate potential impacts and ensure compliance at the Site boundary, further modelling runs were conducted that incorporated the twice-daily watering of paved sections of the access road on days without rain in addition to watering of the unpaved sections of the road. The results of the modelling runs are summarized in Table 2.

Table 2 Summary of Revised Air Quality Modelling Results for TSP and PM_{10} with 1.07 km of Paved Road and Watering

Air Pollutant	Averaging Period	Modelled Maximum ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Maximum Impact ($\mu g/m^3$)	Project Criteria ($\mu g/m^3$)
TSP	24-hour	70	39	109	120
	Annual	0.7	11	11.7	70
PM_{10}	24-hour	15	14	29	50
$PM_{2.5}$	24-hour	2	11	13	27
	Annual	0.03	3.4	3.4	8.8

Based on updated modelling, expansion of paving to 1.07 km of access road and twice-daily watering of paved and unpaved sections of the access road on days without rain would eliminate modelled exceedances of TSP and PM_{10} Project criteria. Revised air modelling result figures for TSP and PM_{10} are included in Attachment 1 (Figures E-1 to E-3). These figures are based on the modelling results summarized in Table 2 which include additional paved road and up to twice daily watering when needed as discussed above.

Due to the planned mitigation measures of paving sections of the site access road and as-needed watering of all portions of the site access road, the generation of fugitive road dust will be minimized and is not anticipated to be an issue for the project.

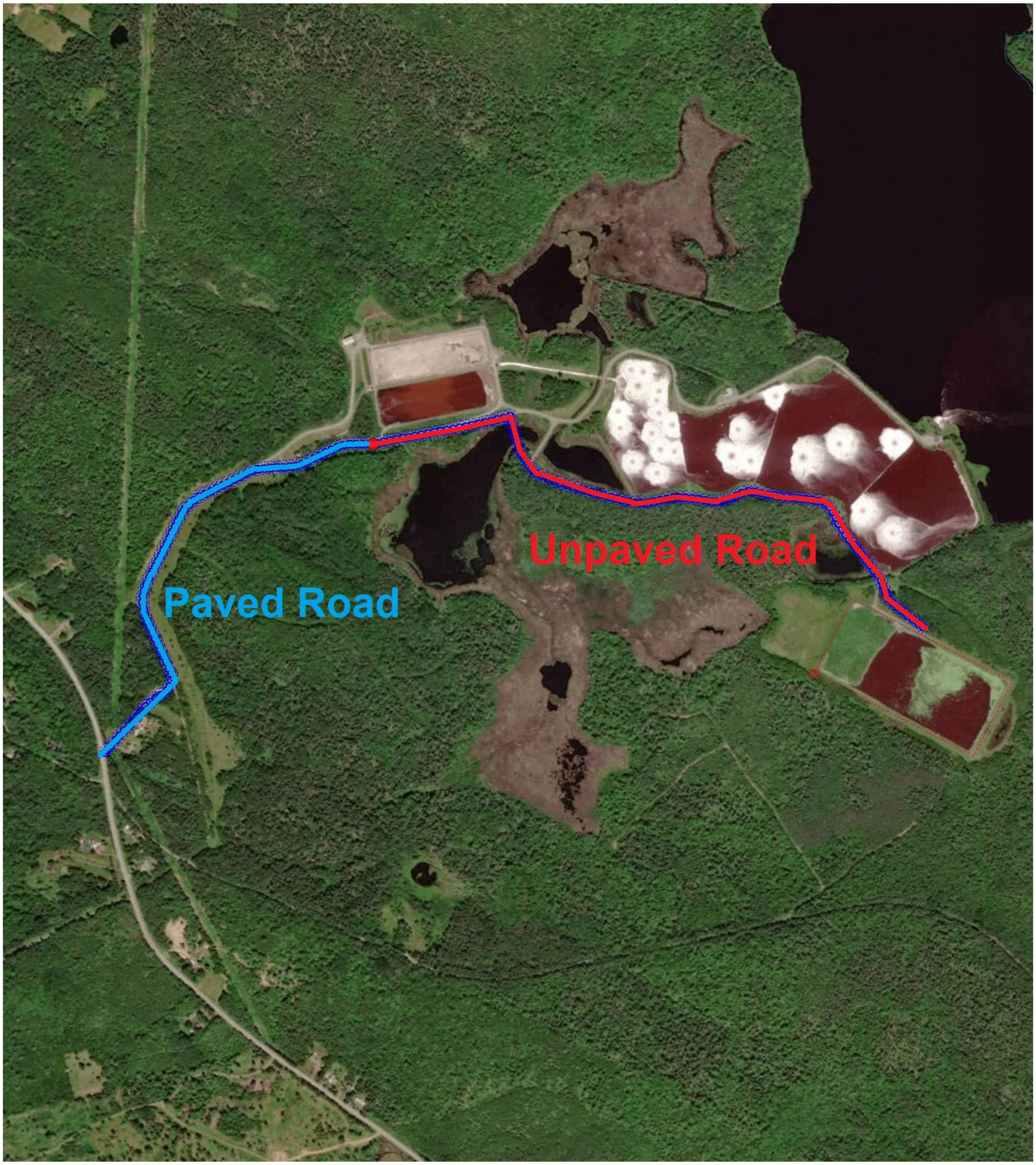


Figure 1 ***Illustration of Paved and Unpaved Road Sections (with 1.07 km of Paved Roads)***

Regards

Troy Small
Project Manager

Paul Van Kerkhove
Senior Air Compliance Engineer

Encl

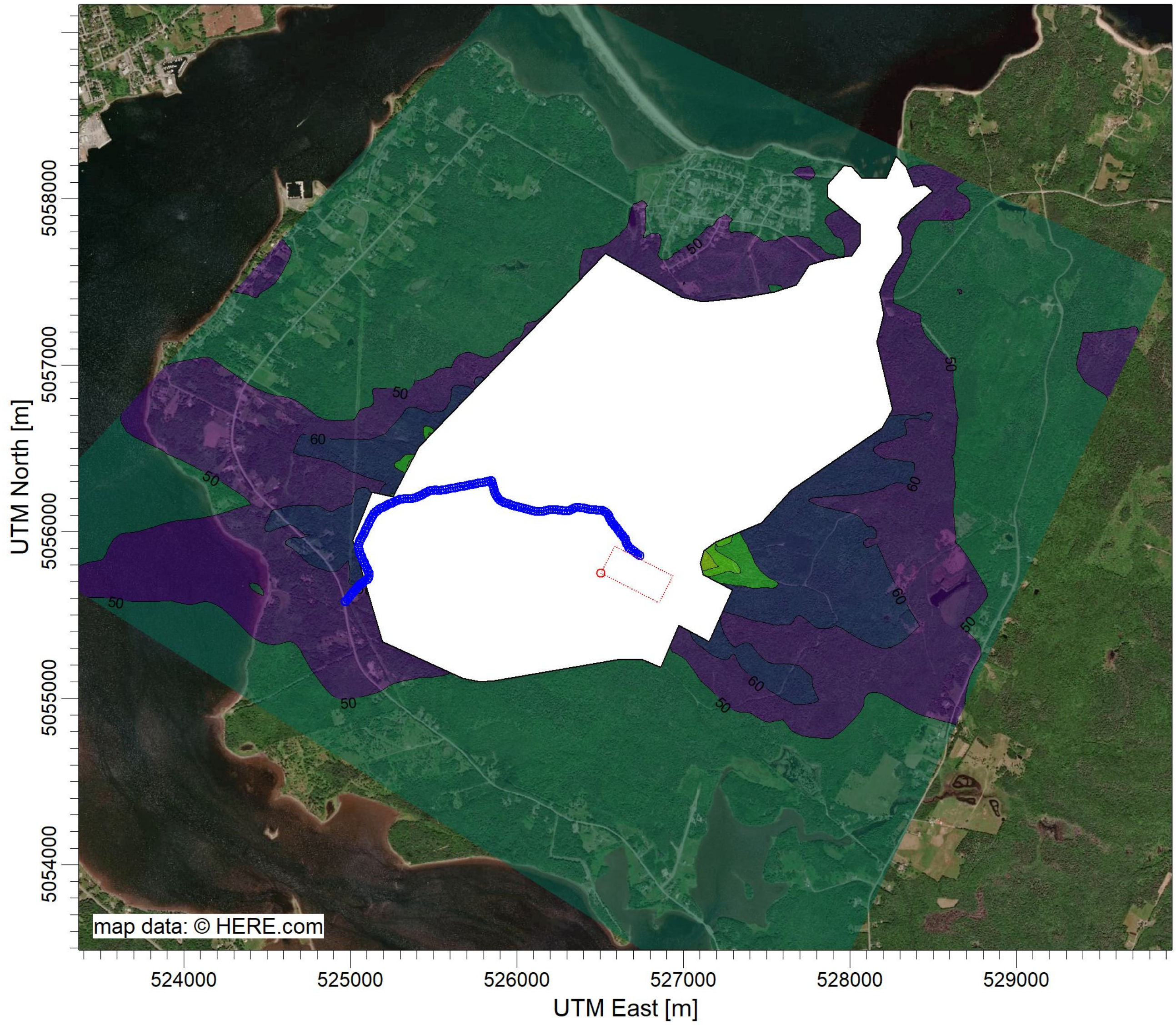
Attachments

Attachment 1

Revised Air Modelling Result Figures

PROJECT TITLE:

Figure E-1: TSP, 24-Hour
Scenario 7 - Containment Cell Final Capping and Grading



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ug/m^3

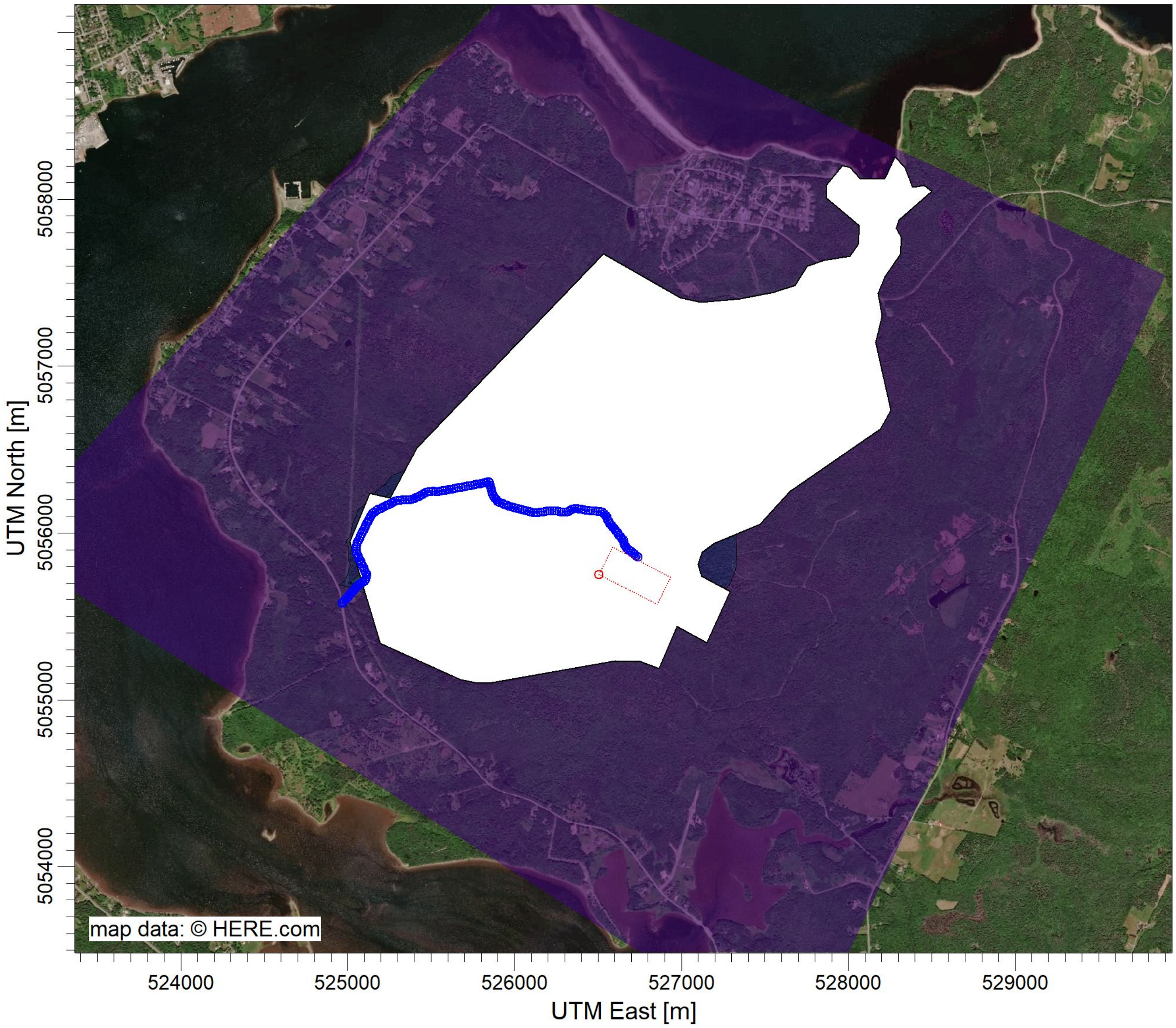
Max: 109 [ug/m^3] at (527112.99, 5055847.95)

40 50 60 80 90 100 110 120

COMMENTS: TSP 24-Hour Criteria = 120 ug/m3 TSP 24-Hour Background = 39 ug/m3 Concentrations include modeled impacts (from site emissions) plus background. Up to twice daily watering when needed for access road; 1.44 km unpaved and 1.07 km paved.	SOURCES: **3**	COMPANY NAME:	
	RECEPTORS: **1427**	MODELER: **GHD**	GHD
	OUTPUT TYPE: **Concentration**	SCALE: 1:41,297 0 — 1 km	
	MAX: **109 ug/m^3**	DATE: **5/24/2022**	PROJECT NO.: **11148275**

PROJECT TITLE:

Figure E-2: TSP, Annual
Scenario 7 - Containment Cell Final Capping and Grading



PLOT FILE OF ANNUAL VALUES AVERAGED ACROSS 5 YEARS FOR SOURCE GROUP: ALL ug/m^3

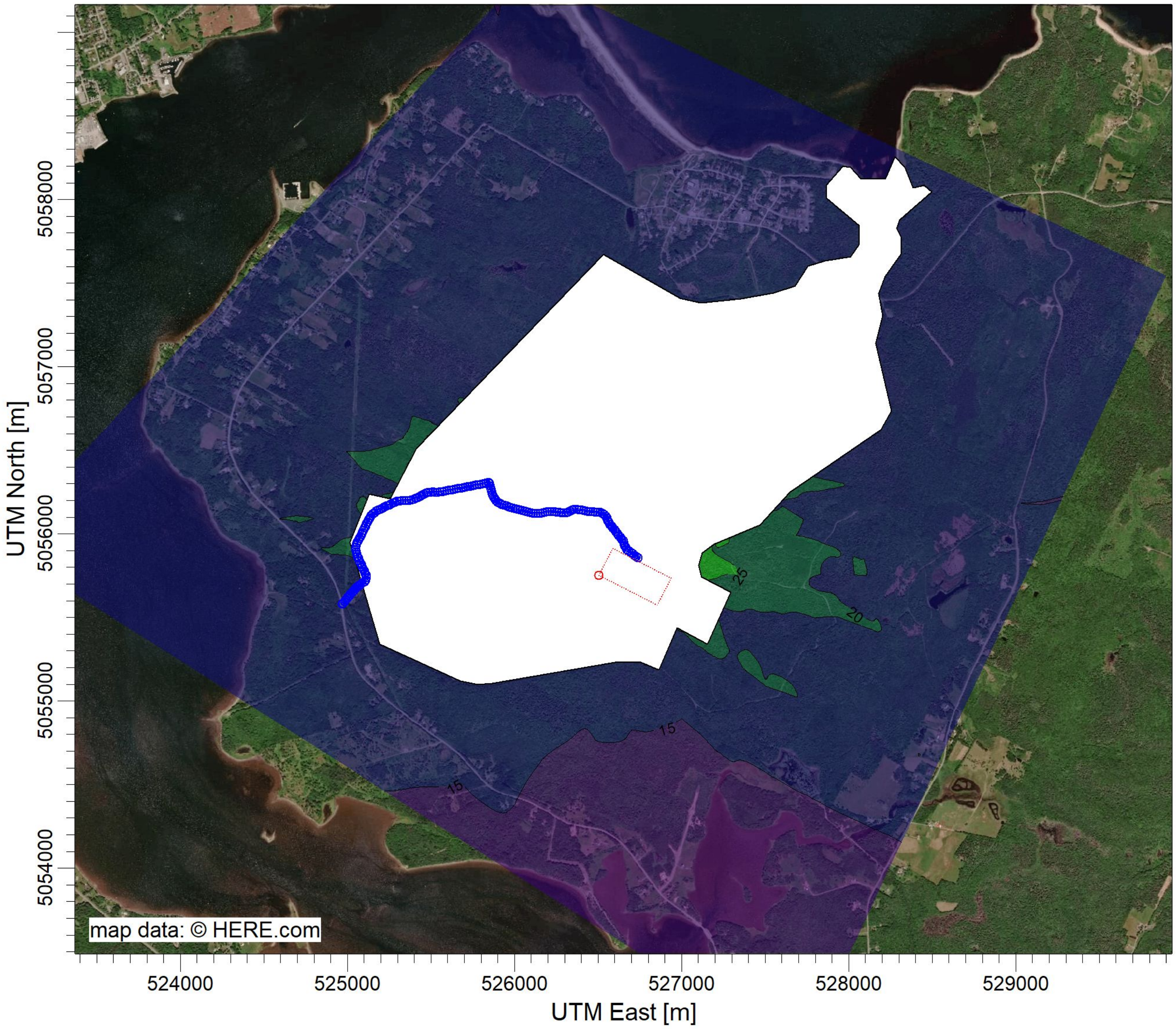
Max: 11.7 [ug/m^3] at (525083.85, 5055714.29)

11.0 11.2 11.4 11.6 11.8 12.0 12.2 12.4 12.6 12.8

COMMENTS: TSP Annual Criteria = 70 ug/m3 TSP Annual Background = 11 ug/m3 Concentrations include modeled impacts (from site emissions) plus background. Up to twice daily watering when needed for access road; 1.44 km unpaved and 1.07 km paved.	SOURCES: **3**	COMPANY NAME:	
	RECEPTORS: **1427**	MODELER: **GHD**	GHD
	OUTPUT TYPE: **Concentration**	SCALE: 1:41,352 0 1 km	
	MAX: **11.7 ug/m^3**	DATE: **5/24/2022**	PROJECT NO.: **11148275**

PROJECT TITLE:

Figure E-3: PM10, 24-Hour
Scenario 7 - Containment Cell Final Capping and Grading



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ug/m^3

Max: 29 [ug/m^3] at (527112.99, 5055847.95)

COMMENTS:	SOURCES:	COMPANY NAME:	
TSP 24-Hour Criteria = 50 ug/m3 TSP 24-Hour Background = 14 ug/m3 Concentrations include modeled impacts (from site emissions) plus background. Up to twice daily watering when needed for access road; 1.44 km unpaved and 1.07 km paved.	**3**		
	RECEPTORS: **1427**	MODELER: **GHD**	GHD
	OUTPUT TYPE: **Concentration**	SCALE: 1:41,297 0 — 1 km	
	MAX: **29 ug/m^3**	DATE: **5/24/2022**	PROJECT NO.: **11148275**

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