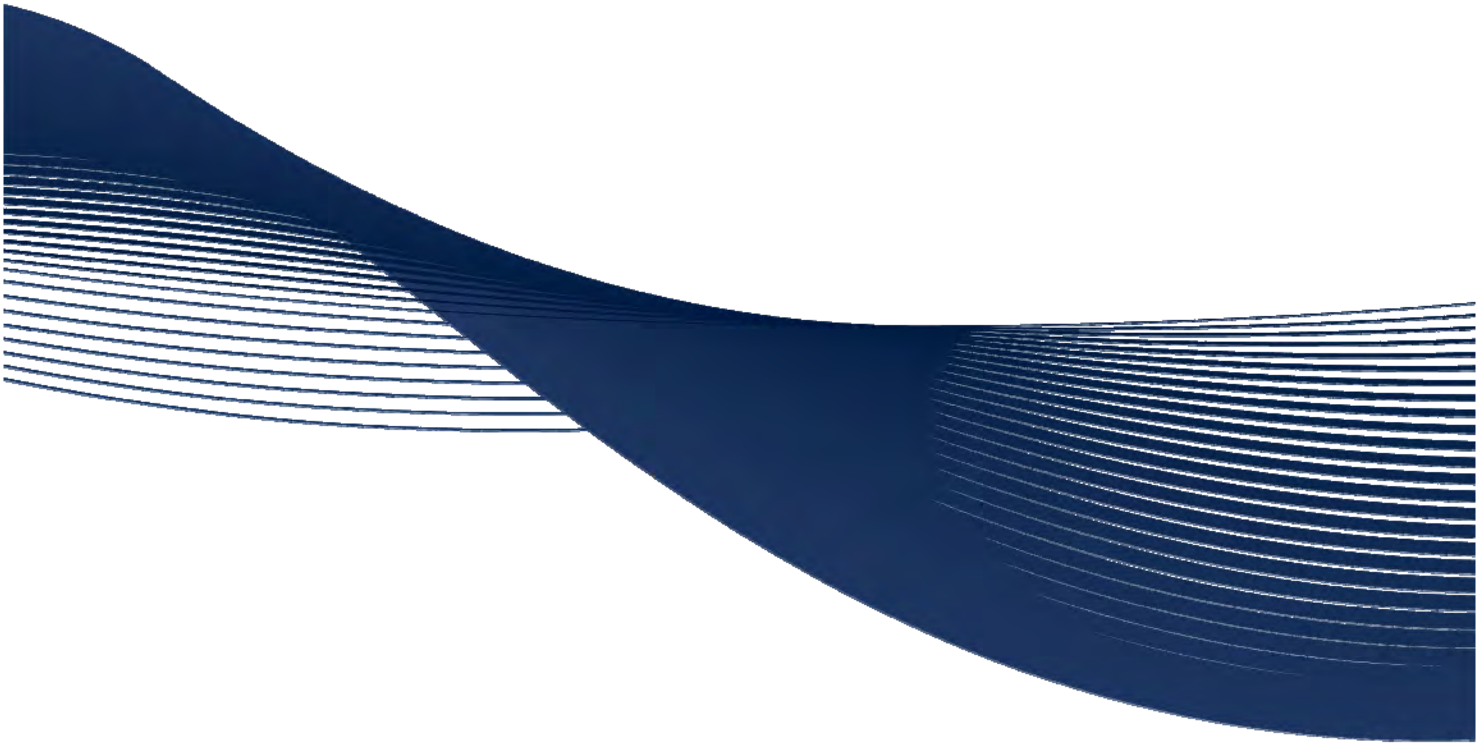
EcoSuperior Environmental Programs

SEDIMENT MANAGEMENT OPTIONS EVALUATION – FINAL REPORT

Thunder Bay North Harbour, City of Thunder Bay

WR13-0704



COLE ENGINEERING GROUP LTD.

HEAD OFFICE
70 Valleywood Drive
Markham, ON CANADA L3R 4T5
T. 905.940.6161 | 416.987.6161
F. 905.940.2064 | www.ColeEngineering.ca

GTA WEST OFFICE
150 Courtneypark Drive West, Unit C100
Mississauga, ON CANADA L5W 1Y6
T. 905.364.6161
F. 905.364.6162

AUGUST 2014

COLE
ENGINEERING

Experience Enhancing Excellence

August 12, 2014
Our Ref: WR13-0704

EcoSuperior Environmental Programs
562 Red River Road
Thunder Bay, ON P7B 1H3

Attention: **Jamie Saunders, BSc. (Env. Eng.)**
Program Coordinator

Dear Mr. Saunders,

Re: **Sediment Management Options Evaluation - FINAL REPORT**
Thunder Bay North Harbour
Thunder Bay, Ontario

We are pleased to provide you with our final Sediment Management Options and Evaluation report. The report has been prepared as per our proposal, considering the input of the stakeholder committee, to address the requirements of project.

Please contact the undersigned should you have any questions or comments on this report.

Yours truly,

COLE ENGINEERING GROUP LTD.

LICENSED PROFESSIONAL ENGINEER
M. F BASSINGTHWAITE
100106723
08/12/2014
PROVINCE OF ONTARIO

Mark Bassingthwaite, P.Eng.
Project Manager

MFB:mfb

c.: Gord Wichert, SLR Consulting

S:\2013 Projects\WR\WR13-0704 EcoSuperior_SedMgmtOp_TB\300-Design-Engineering\312-Deliverables\Project Deliverables\Final Report\WR13-0704 Final Report 08 12 2014.doc

COLE ENGINEERING GROUP LTD.

HEAD OFFICE
70 Valleywood Drive
Markham, ON CANADA
L3R 4T5

T. 905.940.6161 | 416.987.6161
F. 905.940.2064
www.ColeEngineering.ca

THIS PAGE LEFT INTENTIONALLY BLANK

Issues and Revisions Registry

Identification	Date	Description of issued and/or revision
Draft Report	Feb 24, 2014	For client review
Draft Final Report	Apr 30, 2014	For client review
Draft Final Report	May 13, 2014	For client review
Final Report	May 30, 2014	For issue
Final Report	August 12, 2014	For issue

Statement of Conditions

This Report / Study (the “Work”) has been prepared at the request of, and for the exclusive use of, the Owner / Client, and its affiliates (the “Intended User”). No one other than the Intended User has the right to use and rely on the Work without first obtaining the written authorization of Cole Engineering Group Ltd. and its Owner. Cole Engineering expressly excludes liability to any party except the intended User for any use of, and/or reliance upon, the work.

Neither possession of the Work, nor a copy of it, carries the right of publication. All copyright in the Work is reserved to Cole Engineering. The Work shall not be disclosed, produced or reproduced, quoted from, or referred to, in whole or in part, or published in any manner, without the express written consent of Cole Engineering and the Owner.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

APPENDICES

Appendix A – Background Information

Appendix B – Aerial Photography

Appendix C – Select Test Pit Photos from Sediment Management Options Study Field Sampling Report, DST Consulting Engineers Inc. (November 2013)

Appendix D – Site Visit Photographs

Appendix E – Decision Software and Alternative Scoring

Appendix F – SMO Cost Estimates

Appendix G – Public Consultation Materials

Appendix H – Figure 2 Ownership History 1900 to Present, Thunder Bay North Harbour Land Ownership History Report, Author Unknown

1.0 Introduction

Cole Engineering Group Ltd. (Cole Engineering), together with SLR Consulting (Canada) Ltd. (SLR) (collectively referred to as the Study Team), was retained by EcoSuperior Environmental Programs (EcoSuperior, the Client) to complete a Sediment Management Options (SMO) and recommendations report regarding Enriched Organic Sediments (EOS) present in a portion of the Thunder Bay North Harbour (TNBH) Sediment Management Unit (SMU). The study area, including the location of the SMU and the approximate extents of the EOS, is shown on **Figure 1** following the report.

Cole Engineering's direct client is EcoSuperior, who is leading a stakeholder committee composed of:

- Ministry of Environment (MOE);
- Environment Canada (EC);
- Cascades Inc. (Cascades); and,
- Thunder Bay Port Authority (TBPA).

1.1. Study Objectives and Methodology

In 1985, the International Joint Commission identified Areas of Concern (AOCs) across the Great Lakes, where environmental quality has been degraded and beneficial uses of the aquatic ecosystem have been impaired. Thunder Bay was identified as one (1) such AOC, and beneficial use impairments were identified related to contaminated sediments. The Remedial Action Plan (RAP) Public Advisory Committee (PAC) has identified a need to address mercury and organic contaminants in the TBNH area.

Over the years, numerous studies have been conducted by a variety of consultants and researchers on behalf of different stakeholders. The objectives of these studies have generally been to characterize the EOS and assess potential methods to address contaminants in the area, in support of removing the beneficial use impairment related to the sediment and ultimately delisting the Thunder Bay AOC. The purpose of the current project is to bring the analysis phase to a conclusion and to make concrete recommendations to move forward with a recommended SMO within a relatively short timeframe. To satisfy the project objectives, the Study Team has:

- Reviewed background information (refer to **Section 2.0**);
- Undertaken a site visit and contacted local contractors and suppliers to update costing information from previous studies (refer to **Section 3.0**);
- Defined the remedial action objective that the SMO must address (refer to **Section 4.0**);
- Developed an approach to selecting the recommended SMO and discussed previously identified data gaps (refer to **Section 5.0**);
- Defined SMOs (refer to **Section 6.0**);
- Developed weighted evaluation criteria with concurrence of stakeholders (refer to **Section 7.0**);
- Evaluated the SMOs and selected a recommended SMO (refer to **Section 8.0**);
- Further described the recommended SMO and identified potential project risks (refer to **Section 9.0**); and,
- Identified the next steps required to implement the project (refer to **Section 10.0**).

2.0 Background Information

As noted above, the EOS present in the North Harbour has been studied extensively through previous projects. Additional background information related to other key aspects of the study have been provided and reviewed. A complete list of the information received and reviewed during preparation of this report is provided in **Appendix A**, along with a DVD which contains all background information. Aerial photography of the study area, from 1977 to the present time, is included in **Appendix B**.

Several of the background documents reviewed were considered significant to the preparation of this report. Summaries of key information from these documents are provided in the subsequent sections.

2.1. Review of Feasibility Study – Phase II

In January 2011, AMEC Americas, Ltd. (AMEC), on behalf of Confederation College, completed the *Draft Feasibility Study – Phase II* (Phase 2 Study) in support of the evaluation of SMOs considered for the study area. The Phase 2 Study expanded on the *Feasibility Study – Phase I* (Phase 1 Study), which was completed by AMEC in 2010. The Phase 2 Study served to collect additional data to characterize the EOS and advance the understanding of the conceptual SMOs outlined in the Phase 1 Study. Both the Phase 1 Study and the Phase 2 Study included review of previous investigations by others. The AMEC reports and previous investigations identified that there were several contaminants present within the EOS; however the Phase 1 and Phase 2 Studies focused on mercury and methylmercury as contaminants of concern (COC).

In addition to assessing SMOs, the Phase 2 Study included the following data:

- Geotechnical investigation utilizing cone penetrometer testing (CPT) and other methods to obtain in situ geotechnical parameters for the EOS;
- Confirmation of the thickness of the EOS within the Sediment Management Unit (SMU);
- EOS dewatering study; and,
- Sampling and analysis of native sediment (i.e. below the EOS) to assess the vertical extent of mercury within the SMU.

2.1.1. SMOs Assessed

The Phase 2 Study discussed the advantages, disadvantages and costs of each potential SMO. The SMOs evaluated as part of the Phase 2 Study were:

- Monitored natural attenuation (MNA);
- Construction of an isolation cap (capping);
- Construction of a new Confined Disposal Facility (CDF) within the SMU, and dredging the EOS into the CDF;
- Dredging the EOS within the SMU and placing the dredged material into the Mission Bay CDF, owned by the TBPA; and,
- Dredging the EOS within the SMU and placing the dredged material in an upland disposal facility.

2.1.2. Summary of Conclusions

Based on an evaluation of SMOs using available information, the Phase 2 Study recommended that a sediment cap be considered for final design. Its main advantages were that it was considered technically feasible, protected human health and the environment, and it was considered cost effective. The Phase 2 Study further recommended that a reactive core cap be considered to inhibit the diffusion of mercury and other constituents into the water column.

The Phase 2 Study recommended that pilot studies for the recommended SMO be undertaken. While the Phase 2 Study concluded that the placement of a liner and sand cap may be implementable, it was recommended that a capping pilot study be undertaken to reduce uncertainties.

2.2. Review of Feasibility Study – Phase II Peer Review

In June 2011, Anchor QEA, LLC (Anchor), on behalf of Confederation College, completed *the Feasibility Study – Phase II Peer Review* (Phase 2 Peer Review). This report was a peer review of the Phase 2 Study completed in January 2011 by AMEC and included:

- Assessment of field work completed and data collected;
- Verification of assumptions and evaluation of findings and conclusions;
- Review of the methodologies used in preparation of the Phase 2 Study, and comparison to standard engineering practices; and,
- Provision of additional advice on the study findings, including estimates and design considerations.

The Phase 2 Peer Review also examined the potential to either reconfigure or recombine SMOs proposed in the Phase 2 Study and generated and assessed potential SMOs that were not included in the Phase 2 Study. The potential reconfigured or recombined options proposed in the Phase 2 Peer Review included:

- Combined smaller CDF / sediment cap;
- Dredging and use of former mills facilities for on-site landfill disposal; and,
- Alternative methods of CDF containment construction.

The Phase 2 Peer review indicated that the above potential reconfigurations should be further evaluated as there may be potential cost savings.

2.2.1. Identified Data Gaps

As part of the Phase 2 Peer Review, each SMO was reviewed, and a list of key data gaps was identified for each SMO. These data gaps, along with recommendations for resolution are noted in **Table 2-1** below.

Table 2-1: Identified Data Gaps from Feasibility Study – Phase II Peer Review

SMO	Data Gaps	Recommendation
MNA	▪ MNA SMO was not re-evaluated in the Phase 2 Study. ▪ Costs of this SMO should be better documented.	▪ Update evaluation of this SMO. ▪ Document costs for MNA.
Capping	▪ Cap constructability not adequately addressed. ▪ Effectiveness of the isolation cap for chemical sequestration not fully detailed. ▪ Design elements that have significant cost implications not fully addressed, including destabilization of soft EOS and underlying sediment, sourcing of cap materials.	▪ Collect additional geotechnical information. ▪ Perform re-analysis of isolation cap modelling. ▪ Further analyze the SMO.
Dredging with disposal in New Onsite CDF	▪ Proposed CDF structure complex and expensive. Additional information and analysis required to develop a feasible conceptual design for the CDF. ▪ Insufficient analysis to evaluate containment isolation by the CDF. If the proposed design is insufficient, additional costs may be incurred. ▪ More detailed analysis of EOS properties should have been completed to analyze potential releases during dredging. Conceptual design should better refine overdredge allowance and dredge material volume accuracy. ▪ Did not include detailed provision of dredging controls to a level that allows for evaluation of potential performance and cost.	▪ Collect and analyze additional geotechnical information in support of CDF design. ▪ Further evaluate contaminant transport and define isolation requirements to refine cost. ▪ Undertake more detailed analysis of EOS properties. ▪ Utilize available information to better consider controls.
Dredging with disposal in Existing CDF	▪ More detailed analysis of EOS properties should have been completed to analyze potential releases during dredging. Conceptual design should better refine overdredge allowance and dredge material volume accuracy. ▪ Did not include detailed provision of dredging controls to a level that allows for evaluation of potential performance and cost. ▪ Contaminant fate and transport should have been addressed. Filter / reactive layers not included and should be tested against the estimated cost range, based on statement that TBPA CDF berms were likely not designed to contain subject contaminants. ▪ Costs seem inconsistent with on-site CDF disposal. Dredging and barging costs seem high. CDF disposal fee not documented.	▪ Undertake more detailed analysis of EOS properties. ▪ Utilize available information to better consider controls. ▪ Consider cost of filter / reactive layers. ▪ Revisit costs.

SMO	Data Gaps	Recommendation
Dredging and Upland Disposal	▪ More detailed analysis of EOS properties should have been completed to analyze potential releases during dredging. Conceptual design should better refine overdredge allowance and dredge material volume accuracy. ▪ Did not include detailed provision of dredging controls to a level that allows for evaluation of potential performance and cost. ▪ Dewatering system should have been documented and detailed. There is potential for significant cost implications related to the dewatering process and treatment of effluent. ▪ No discussion that the material would comply with landfill requirements.	▪ Undertake more detailed analysis of EOS properties. ▪ Utilize available information to better consider controls. ▪ Provide additional details of dewatering system and effluent treatment requirements. ▪ Assess EOS characteristics versus landfill requirements.

2.2.2. Summary of Conclusions and Recommendations

The Phase 2 Peer Review recommended that the following next steps be undertaken:

- Evaluation criteria should be more fully described and the weighting of evaluation criteria be agreed upon;
- Remedial objectives should be further clarified to better define sediment cleanup objectives and criteria;
- Additional design to refine cost estimates, including:
  - Define containment requirements and cap construction method;
  - Refining sediment / dredge volumes;
  - Assess dredging methods and required environmental controls; and,
  - Identify CDF containment structure type and construction method.
- Further evaluate recombined / reconfigured options.

The Phase 2 Peer Review recommended that additional data be collected and the analysis revisited in order to recommend an SMO and establish a cost estimate to within a 20% accuracy range.

2.3. Review of Site Specific Risk Assessment

In February 2013, Franz Environmental Inc. (Franz), on behalf of Environment Canada, completed the *Thunder Bay North Harbour Site Specific Risk Assessment with Sediment Management Strategy and NCSCS Classification* (SSRA). This report presented an assessment of potential risk to ecological and human receptors related to contaminants present in the EOS. The risk assessment was completed to support the development of a sediment management strategy for the SMU. The analysis utilized data available from the past 20 years, and utilized surficial sediment data (collected from 0 to 10 cm depth) in the risk assessment, as it was assumed that receptors would be more likely to contact surficial layers than deeper sediments.

The SSRA divided the Site into two (2) areas, known as the nearfield area and the farfield area. The limits of the two (2) areas are provided in **Figure 1** following the report. The nearfield and farfield terms have been used by previous studies, but the terms were used in the SSRA to describe slightly different boundaries. The nearfield area is more contaminated while the farfield is considered less contaminated, with concentrations similar to industrial background levels. The nearfield is in close proximity to the effluent discharge point of the former mill, where the highest mercury concentrations were observed, while the farfield area is located further away from the former mill site. Within the farfield area, observed mercury concentrations are considered similar to or marginally elevated above local reference levels.

To develop the sediment management strategy, the risk assessment identified which sediment contaminants could be present in concentrations that present unacceptable levels of risk to human and/or ecological receptors and developed risk-based target levels for clean-up of the EOS on a site specific basis.

2.3.1. Contaminants of Concern

Food web modelling and human exposure modelling indicated that, based on available data, the primary COC is mercury. The SSRA indicated that as methylmercury is the most toxic form of mercury found in the environment, and that it biomagnifies with increasing trophic levels in the food web, it was selected as the primary COC for the purposes of modelling, exposure and risk calculations for ecological receptors.

2.3.2. Human Health and Ecological Risk Assessment

An assessment of the risk associated with the EOS in its current condition was completed using a hazard / risk quotient approach. Hazard and risk quotients are the ratio of estimated exposure of a receptor at a particular site to an acceptable exposure as developed by reputable agencies. For an ecological risk assessment, hazard or risk quotients greater than one (1) indicate that a potential for unacceptable risk is present, whereas quotients less than one (1) indicate that the assessed risk is acceptable. For human health risk assessments, calculated hazard quotients greater than 0.2 for individual pathways or greater than one (1) for all pathways combined are considered as potentially unacceptable levels of risk to human receptors.

To complete the ecological risk assessment, a quantitative assessment of risk to primary producers, benthic invertebrates, fish, birds and mammals was completed. It was determined that hazard and risk quotients for each receptor group ranged from <1 to 7.2 for kingfishers exposed to methylmercury and 12 for sediment dwelling biota exposed to total resin acids.

The human health risk assessment indicated that the unacceptable risks related to consuming recreationally caught fish were present for recreational user / subsistence fishers, with calculated hazard quotients exceeding the target for individual pathways. The greatest potential risk for direct contact with contaminated sediment was for industrial or construction workers, with a hazard quotient of 6.3 for those individuals exposed to mercury in sediments. Additional potential unacceptable risks from direct contact with sediments were identified for recreational users / subsistence fishers.

2.3.3. Sediment Management Strategy

The objective of the sediment management strategy is to determine an area for sediment management activity that provides an adequate level of protection while minimizing the area required for management. Spatially Weighted Average Concentrations (SWAC), representing the average contaminant concentration in the biologically active portion of sediment, were utilized to determine appropriate management areas. Concentrations listed are for the top 10 cm of material below the interface with the water. SWACs were calculated using Thiessen polygons, which define the area of influence around each data point. The use of SWACs is considered appropriate as potential exposure is averaged over the site, and using SWACs can remove bias from isolated anomalies. SWACs were calculated for the nearfield and farfield areas for both total mercury and methylmercury under current conditions, and are presented in **Table 2-2** below.

Table 2-2: Calculated Spatially Weighted Averages with No Management[1]

Parameter	SWAC – Nearfield (µg/g)	SWAC – Farfield (µg/g)
Methylmercury	0.016	0.0031
Total Mercury	5.9	0.55

The SSRA determined that the risk levels in the farfield for the belted kingfisher are in excess of the acceptable level. It would not be feasible to remediate the nearfield to a point where the target risk level (as stated in **Section 2.3.2**) could be achieved, as the target risk level is below background risk levels in the farfield. Therefore, the objective of the sediment management strategy was to reduce concentrations and associated risk levels in the nearfield to achieve concentrations and associated risk equivalent to that in the farfield / industrial background.

Risk based sediment management areas were developed considering a combination of active and passive management options. Examples of active options are dredging and disposal, and examples of passive management options are thin layer capping or monitored / enhanced natural recovery. Active and passive management areas are shown on Figure 17 of the SSRA and **Figure 1** following this report. It was determined within the SSRA that if works undertaken within active and passive management areas achieve 100% effectiveness, the SWAC and corresponding risk levels associated with methylmercury in the nearfield are reduced to a level marginally below the levels in the farfield. Reduced effectiveness within the passive management area was also considered as being 95%, 90% or 85% effective at reducing concentrations of methylmercury, but it was found that reduced effectiveness would result in SWAC and residual risks approximately 1.1, 1.2 and 1.3 times the SWAC and risk levels in the farfield area.

The extent of the determined risk based management area is approximately the same as the extent of the EOS. The SSRA concluded that management of the EOS would effectively reduce spatially weight average total mercury and methylmercury at the Site to levels below the risk based human health target concentration while removing the physical impacts and toxicity associated with the EOS.

---

[1] Source: Table 6-3, Thunder Bay North Harbour Site Specific Risk Assessment with Sediment Management Strategy and NCSC Classification, Franz Environmental Inc., June 2013

2.4. Review of DST Investigation

In November 2013, DST Consulting Engineers Inc. (DST), on behalf of EcoSuperior, completed the *Sediment Management Options Study Field Sampling* report (Sampling Report). The investigations summarized within the Sampling Report were undertaken to provide additional information to assist in the assessment of SMOs being considered to mitigate contaminated sediments within the SMU. The scope of the investigations and reporting included:

- Sampling in 21 locations with water depths between 1.0 and 4.7 m;
- Advancing 10 testpits within the area of study;
- Collecting grab samples (125 L) at two (2) locations;
- Carrying out testing including pocket penetrometer tests, in situ vane tests, water depth measurements, cone penetration tests (CPS) and torvane tests at boreholes locations; and,
- Providing a factual report of findings arising from the investigation.

2.4.1. Test Pit Results

The results of the test pit investigation were summarized within the Sampling Report. It was observed that the EOS was inconsistent, but that generally wood chips were present on the surface of the EOS, underlain by soft and white EOS, also described as fibrous pulp. In addition, eight (8) out of 10 test pits encountered logs of 100 mm in diameter or larger, with five (5) logs present in one (1) recovery at TP4.

The Study Team reviewed the test pit videos and pictures. Selected key pictures are provided within **Appendix C**.

2.4.2. Geotechnical Testing Results

The Sampling Report provided several geotechnical test results, summarized in **Table 2-3** below:

Table 2-3: Sampling Report – Geotechnical Testing Results[2]

Parameter	Results
Specific Gravity	0.5 to 0.94 for EOS 2.79 for native clayey soils
Bulk Density	1047 to 1096 kg/m^3
Organic Content	1.2 to 82.4%
Moisture Content	30 and 1457%

The Sampling Report noted that while the measured specific gravity of the EOS was less than one (1), depending on the ability of the material to absorb water and time to absorb water, the EOS will become submerged.

---

[2] Source: Section 6.1, Sediment Management Options Study Field Sampling, DST Consulting Engineers Inc., November 2013

Various geotechnical laboratory tests were performed, including Grain Size Analysis, 1-Dimension Consolidation, Seepage Induced Consolidation, and Settling Column Tests. The conclusion of the geotechnical testing was that the EOS is extremely soft with very low strength and effective stress. The Sampling Report advised that the EOS would not be able to carry the stress of 10 to 15 kPa likely to be imposed by the placement of a 1.0 to 1.5 m thick cap, and that special placement methods would be required to minimize lateral displacement and failure.

The Sampling Report advised that the re-handling of sediments under water would re-suspend the sediments. Suspended sediments would take a long time to resettle due to the nature of the particles, and some form of barricade such as a silt curtain or temporary vertical wall may be required to prevent migration of suspended solids. Monitoring for Total Suspended Solids (TSS) and other appropriate water quality parameters would be required during dredging activities.

2.4.3. Environmental Testing Results

Environmental testing was conducted on samples collected during the field investigation. The range of test results is provided in **Table 2-4** below.

Table 2-4: Sampling Report – Environmental Testing Results

Parameter	Results
Mercury (Hg) at native soil	<0.05 to 0.60 µg/g
pH	3.91 to 7.07
Methylmercury (MeHg)	5.7×10^{-5} to 0.323 µg/g
Copper (Cu)	17 to 120 µg/g
Mercury (Hg) in the EOS	0.21 to 41 µg/g
Total Organic Carbon	2×10^{3} to 4.2×10^{5} µg/g

The results of the environmental testing undertaken during preparation of the Sampling Report are considered consistent with the results of previous investigations. The data within the Sampling Report is considered sufficient to move forward with evaluating and recommending SMOs.

3.0 Local Fact Finding

3.1. Site Visit

On December 11, 2013, the project team visited the site to undertake local fact finding. Accompanied by Jamie Saunders of EcoSuperior, the Study Team members in attendance for the site visit were:

- Mark Bassingthwaite, Project Manager;
- Dr. Tom Patterson, Remedial Works Specialist; and,
- Jim Juliani, Senior Engineer.

Weather at the time of the site visit was sunny and -25°C, and significant snow cover was present. It was therefore difficult to ascertain ground conditions. It was noted that the former mill operation was undergoing demolition. At the time of inspection, it was noted that the two (2) clarifiers present north of the former mill were intact. The former wastewater lagoons were still present, however the status of any treatment equipment within the lagoons could not be observed due to snow and ice cover.

Select photos taken during the site visit are included as **Appendix D**.

3.2. Meeting with Thunder Bay Port Authority

On December 10, 2013 Mark Bassingthwaite, Project Manager, and Jamie Saunders of EcoSuperior met with Guy Jarvis of the TBPA. At that meeting information was provided regarding the Mission Bay CDF. The TBPA indicated that Mission Bay CDF Cells 1 to 3 were full, and that there was approximately 300,000 m^3 capacity within Cell 4 and approximately 1,200,000 m^3 capacity within the reservoir cell. The reservoir cell was dredged in 2001, and a small dredging project was completed by the TBPA in 2007.

The Phase 2 Study had utilized a tipping fee of $11 per m^3 for disposal of EOS at the Mission Bay CDF. This rate was provided by the TBPA based on typical fees associated with disposal of material generated by normal navigational dredging operations. Typical navigational dredging is completed on an infrequent basis, and quantities generated by navigational dredging are small compared to the potential scale of the TBNH EOS volume. In addition, the characteristics of the EOS are different than those of material generated by navigational dredging. Therefore, the previously used tipping fee of $11 per m^3 may not be an appropriate value for the disposal of EOS at Mission Bay CDF. An appropriate fee would need to be generated based on potential long-term costs and would ultimately be confirmed by the TBPA board.

3.3. Discussions with Local Suppliers and Contractors

To confirm and update unit construction costs used in the Phase 2 Study, Cole Engineering contacted three (3) established local contractors specializing in general civil works, as well as other two (2) other non-local contractors specializing in dredging and dewatering.

It was established that unit costs for construction materials and typical construction methods used in the Phase 2 Study were generally reasonable, and updated costs were established for use in the development of SMO cost estimates (refer to **Section 7.0**). It was also confirmed that local aggregate producers are capable of providing the quantities of materials required for the project within a relatively short time frame.

4.0 Remedial Action Objective

In order to assess and compare potential SMOs a clear remedial action objective was required. Significant background information had been collected since previous feasibility studies were completed, notably the Sampling Report and the SSRA. The SSRA quantified the potential risks associated with the EOS in its current condition, and developed a sediment management strategy that would reduce risks associated with the EOS within the nearfield area to at or below risks within the farfield area, which was considered as a local background condition. During development of the sediment management strategy, the physical limits of the SMU requiring management was defined as the outer limit of the passive management area.

The SSRA identified total mercury as the key COC in terms of human risk, and methylmercury as the key contaminant of concern in terms of ecological risk. Methylmercury is generated from inorganic mercury through a process of methylation, carried out by anaerobic organisms in the natural aquatic environment. Therefore, it would be hypothetically possible to mitigate methylmercury in the short term, only to have methylmercury re-occur due to generation by methylation from inorganic mercury.

Section 6.6.1 of the SSRA indicated that "…high total mercury and methylmercury concentrations generally correlate to locations with thicker EOS, while areas with little to no EOS generally correlate to lower total mercury and methylmercury concentrations. As such, management of the EOS and risks associated with total mercury and methylmercury can be completed concurrently."

The solid phase mercury that is present in the EOS acts as a significant reservoir of mercury that can be slowly released into the water column. Management of the mercury during implementation will require consideration during the design phase to develop appropriate monitoring and control protocols. Effluent from sediment dewatering processes (if required) will also require management and could require water treatment. However, SMOs which include containment of the EOS in a properly designed and constructed disposal facility would greatly slow the migration of mercury into the water column and mitigate long-term environmental impacts.

To simplify the remedial action objective, and allow for more clear verification monitoring, it was therefore determined that total mercury would be the focus of the SMO. As supported by Section 6.6.1 of the SSRA, if the risks associated with total mercury were successfully managed, it would be considered that risk associated with methylmercury would be similarly managed. The remedial action objective was therefore defined as:

To bring the spatially weighted average concentration (SWAC) of Total Mercury in the nearfield to at or below 0.55 mg/kg.

In addition, satisfying the remedial action objective at the SMU should not simply move the problem elsewhere, and there should be no legacy issues generated by the project.

5.0 Approach to SMO Selection

In order to select an SMO that is technically sound, cost effective and which will allow the Stakeholder Committee to make progress towards implementation with confidence, the Study Team performed a wide ranging, systematic and comprehensive re-evaluation of the SMOs previously proposed as well as several variants. In doing so, the concerns raised in the review of the prior studies were addressed, and data generated subsequent to the earlier SMO analyses was incorporated.

Gaps Identified in Phase 2 Peer Review

The recommendations contained in Section 2.2.1 of the Phase 2 Peer Review were addressed as follows:

- **Capping:** The Phase 2 Peer Review recommended additional geotechnical data and performance modelling for the capping SMO. The Sampling Report, completed by DST, provided additional geotechnical information which was used in preparation of the current study. In addition, the practical experience of the Study Team with capping was utilized to account for known potential performance issues with capping during the analysis of SMOs, which was far more comprehensive than the prior assessments, as described in **Section 7.0** below.
- **Dredging / New Onsite CDF:** The recommendations included further analysis, collection of additional geotechnical CDF Design data, further contaminant transport evaluations, and better information on EOS properties. These gaps were dealt with by doing a more comprehensive analysis of SMOs, using the Study Team's experience with marine construction and the observations of the existing successful dyke constructed in the harbour and at the existing CDF. Information generated by the risk assessments was used to develop a mercury fate and transport conceptual model that allowed the team to determine if the proposed CDF construction details would be adequately protective.
- **Dredging / Existing CDF:** The recommendations included using the available information better, revising costs, and a more detailed analysis of the filter / reactive layers that may be required. These were again dealt with by a more comprehensive analysis, providing for reasonable filters and layers within the cost estimate, and recognizing that further details are not needed for the SMO selection process and can be developed during the design process.
- **Dredging / Upland Disposal:** The recommendations included obtaining more data on EOS properties, providing additional details on dewatering, and characterizing the suitability of the EOS for landfilling. These were dealt with by using the data in the risk assessment, assuming a reasonable dewatering scenario used at other sites by the Study Team. It is noted that the Phase 2 Study indicated that the results of testing of the dewatered sediment does not exceed Schedule 4 limits for constituents analyzed and it is assumed by the Study Team that the EOS could be landfilled since it does not contain any significant metal or organic concentrations. The potential of creating a new landfill on the former mill property was considered during this study, but was screened out from further analysis as it would be considered very difficult to implement, given land ownership and approvals issues, and would offer limited potential for cost savings.

The Phase 2 Peer Review included the following general conclusions and recommendations:

- **Evaluation criteria should be more fully described and agreed upon.** This has been achieved by the process described below.
- **Remedial Objectives should be better clarified.** This has been done in **Section 4.0** above.
- Additional design work should be performed on:
  - **Containment aspects of a cap.** These were addressed as described above.

- **Refinement of dredge volumes.** This was done to the extent required for the analyses of the SMOs. The Sampling Report included tables with thicknesses of the EOS at various sampling points. Using those sampling points and thicknesses, the Study Team created a surface using ArcGIS software, and estimated the volume of EOS within the polygons from the SSRA to be 386,000 m^3. The volume calculated by the Study Team compares well to the volume estimated in the Sampling Report of 389,000 m^3. Based on the experience of the Study Team, estimates for this report include a 20% overdredge allowance.
- **Dredging methods and controls.** The Study Team used its experience at other sites to develop a reasonable scenario for purposes of SMO analysis. Further details can be established during the design process.
- **CDF containment structure.** The Study Team used the as-built information observed at the existing structures and added an allowance for additional engineered layers within the cost estimate.

5.1. SMO Selection Steps

The approach the Study Team used to select a recommended SMO involved a series of steps to arrive at a defendable decision and provided a systematic analysis with input of all the relevant technical and cost issues as well as the knowledge and goals of the various Stakeholder Committee members. After further consultation, this approach can be readily extended to incorporate input from local communities, First Nations and Metis Nations to incorporate their preferences and to assess if and how those would potentially change the recommended SMO.

The methodology utilized is summarized below:

- All feasible technologies that could be considered as part of a remedial SMO were selected based on the Study Team's experience, available background data and prior reports.
- These technologies were then evaluated for their applicability to the Site, and those found not to be implementable, effective or cost effective were ruled out as described in **Section 6.2** below.
- A systematic approach was then used to assemble a set of potential viable SMOs using the technologies that passed the screening; i.e. were considered applicable to the Site. This is described in **Section 6.3** below.
- The selected SMOs are described in **Sections 6.3.1** to **6.3.9** below.
- A decision analysis framework was established and reviewed with the Stakeholder Committee. This framework (as discussed in **Section 7.1** below) includes a range of major parameters, such as effectiveness in addressing the remedial action objective, short term impacts, implementability, etc., that need to be considered when selecting a recommended SMO. These major parameters were subdivided into a larger number of secondary parameters and then the framework was refined with input from the Stakeholder Committee and agreed upon.
- Each of the above decision parameters was assigned weights (levels of importance) again with input and agreement from the Stakeholder Committee.
- The Study Team assigned scoring charts for each of the secondary parameters that allowed them to score each of the selected SMOs against each individual parameter (**Section 7.2**).

- Commercially available software (Criterion DecisionPlus™) was used to assemble total scores based on the above weights and individual parameter scores in order to establish a ranking of the SMOs. The results of this ranking are described in **Section 8.0** below.

6.0 Sediment Management Options

6.1. SMO Generation Process

In this section, the SMOs for evaluation are developed. In general, the development of SMOs is based primarily on previous work performed by AMEC in the Phase 1 Study and the Phase 2 Study and Anchor QEA in the Phase 2 Peer Review. However, to be thorough, a screening of technologies was performed, and the technologies assembled into SMOs which were then screened to develop a focused set of SMOs.

6.2. Technology Review

Remedial technologies were selected to address containment of the EOS, removal of EOS, treatment of the EOS (to reduce toxicity and/or volume), disposal of the EOS, and water treatment. A range of technologies was identified and technologies were screened based on effectiveness, cost, and implementability to select technologies that would be retained as process options for development of SMOs. The technology screening results are summarized in **Table 6-1** below.

Containment Technologies

Capping SMOs, with a barrier layer for containment, are rejected based on low implementability. Placement of an effective underwater barrier layer like a membrane or reactive mat would be very difficult to construct. A membrane or reactive mat is manufactured in large sheets (typically 5 to 7 meters wide by 150 to 200 m long) which must be bonded to each other during placement to form an effective barrier. Bonding the sheets (for example by plastic welding) above the water and then sinking them in place with some sort of overburden pressure is a complex operation. Some types of membranes can be bonded underwater (i.e., bituminous membranes) or require no bonding (like geosynthetic clay liners), but installation is no less complex as placement of the large membrane sheets underwater requires a means to keep the material lying flat and positioned with sufficient overlap to form an effective barrier and to not move prior to bonding and covering with a material that keeps them in place. Further, placement of a cap over areas of thicker EOS would increase the pore pressure of water within the EOS which may cause migration of the poor quality pore water and trapped gases out of the EOS, potentially resulting in short and long term impacts to local water quality.

Capping with a sand layer is retained, although placement of the sand would also cause the increase in pore pressure described above which could result in pore water and gas currently in the EOS penetrating into the cap material, with likely release into the water column. Pore water and trapped gas within the cap material releasing to the water column may result in environmental conditions that are worse than the current conditions for a period of months to years. A sand cap over the entire near-field area is considered as one (1) of the SMOs in the following section, and this potential release of water is considered in the evaluation of effectiveness. However, capping thinner areas of EOS or covering areas where EOS has been removed with a thin layer of sand would be effective, easy to implement, relatively low cost and is not likely to result in release of pore water.

Removal Technologies

Using the results of the Sampling Report and local input, technologies for removal of the EOS were screened in consideration of the extensive presence of sunken logs. The North Harbour area was used for a long period of time for staging of large log rafts and test pits, undertaken during preparation of the Sampling Report, showed numerous logs. The physical properties of the EOS (low density, high water content, fibrous, etc.), as shown in the Sampling Report, were also considered when screening technologies.

Construction of a temporary coffer dam using sheet piling then dewatering the interior area to allow removal of the logs and EOS using conventional upland excavation equipment was retained for further consideration. The cost of this technology is relatively high as the underlying sediments are soft and may not support excavation equipment, and water within the coffer dam area must be managed. The water overlying the EOS within the coffer dam area may be able to be removed and discharged without treatment. However, continued dewatering during excavation (coffer dams leak) and the water released from the EOS during removal may require water treatment. On the other hand, an advantage of this technology would be that upland excavation methods simplify the removal of the sunken logs separate from the EOS, and allows direct observation of the removal conditions (i.e., the EOS to be excavated can be visually discerned from native sediment that remains in place). Residuals (i.e., the material that becomes suspended during dredging and then settles to the bottom in areas that have been dredged) are also eliminated.

Mechanical dredging with a clamshell bucket was retained over the option of using a suction dredge or hydraulic dredge due to the amount of water entrained with the latter two (2) methods and the difficulty of treating or otherwise managing that water. A clamshell bucket is also better able to deal with the sunken logs. Based on current information, a clamshell is viewed as preferable over a backhoe dredge. However, test dredging and value engineering during detailed design may indicate that a backhoe dredge has an advantage. In any case, the choice of a clamshell or a backhoe dredge has no effect on the results of the present evaluation, and the exact mechanical dredging method may not even be specified within the detailed design.

Conditioning / Dewatering Technologies

Conditioning technologies that were considered include in situ as well as ex situ approaches. In situ technologies are used to immobilize the sediments. Injecting the EOS with a solidification agent would be very difficult and because of the nature of the EOS it is unclear if such technologies could be effective. In situ solidification would involve injection of grout or cement or some polymeric agent within the EOS to mix with it and form a massive block or solid. Because of the near-neutral density of the EOS, the lack of inherent cohesion and gases trapped within the EOS, it is probably impossible to perform in situ solidification without re-suspending a considerable amount of EOS, greatly reducing effectiveness of this technology. Therefore, in situ conditioning is rejected.

Ex-situ conditioning technologies include dewatering technologies as well as chemical stabilization. These technologies are only used for the options that include removal of the sediment. As with the in situ conditioning, ex situ conditioning for chemical stabilization (such as addition of cement) may not be effective because of the nature of the EOS. In addition, chemical stabilization would likely result in a greater disposal volume / mass that would be more costly to handle and dispose. Also, based on the composition of the EOS, it is unlikely that chemical stabilization prior to disposal would provide any benefit. Therefore, because of increased cost and uncertain effectiveness, chemical stabilization is rejected.

Dewatering is performed to reduce the water content, volume and mass of dredged sediments prior to upland disposal. Given the nature of the EOS, dewatering would be required to ensure that the material would pass a slump test to be classified as a solid waste under Ontario Regulation 347. As shown in **Table 6-1** below, pressure filtration, such as with a plate and frame filter press, is retained. Belt filtration may be used as a pre-treatment step for pressure filtration if value engineering or design evaluations determine that this approach provides a cost or production advantage. Vacuum filtration is rejected as pressure filtration achieves a higher degree of dewatering and it costs about the same.

Gravity filtration is where the dredged material drains in an upland area or CDF under its own weight. It is not expected to achieve a high degree of dewatering or volume reduction because of the physical properties of the EOS. However, gravity filtration is retained for options involving disposal in a CDF where the degree of dewatering is not so important.

Water Quality Management

Control and management of water quality is a common element of sediment remediation projects. SMOs that involve dredging of the EOS would cause water quality impacts within the water column that result from disturbance and removal of the EOS. The water associated with the sediments that are removed typically also needs to be managed to prevent water quality impacts.

To control water quality impacts that may result from dredging, containment technologies are typically used. Containment is provided by silt curtains or other temporary barriers, water quality monitoring, reconnaissance (for removal of floating debris), and booms. The water quality within the dredging area is essentially impossible to control during dredging, so the emphasis is to limit the area that is being temporarily impacted and prevent migration out of the area.

Management of the water associated with the sediments that are removed is used to address a variety of potential water quality impacts. Water draining from the sediments, for example on a barge, is typically returned directly to the contained area where dredging is occurring. Filtration, using geotextile fabric or hay bales or wattles, is often used as a best management practice to help control water quality impacts.

For all SMOs involving dredging and also those involving CDF disposal, containment of water within the dredge area and filtration have been retained as the water quality management technology.

Management of excess water in a CDF is typically treated by filtration, for example through a geotextile filter fabric on the wall of the CDF. This is also common practice on the basis that the migration of water out of the CDF is slow and most of the contaminants are associated with the solid phase (soluble contaminants have been removed through prolonged contact with water).

For SMOs where the sediments are dewatered prior to disposal, for example using filter or belt presses, the water can also be returned to the area being dredged without treatment if such management options are permissible according to logistics, regulation, and location. However, it is more common that such water is managed separately and may require treatment prior to discharge to meet effluent and receiving water quality requirements. Disposal of such water by discharge to a publicly owned treatment works (for example the sanitary sewer system leading to the sewage treatment plant operated by the City of Thunder Bay) may also require treatment in order to meet their influent requirements or to avoid excessive surcharges.

For this project, available data to assess whether treatment would be required are measurements of pore water chemistry performed as part of the Phase 2 Study. These data are limited to a few general parameters including biological oxygen demand, pH, volatile organic compounds, total suspended solids, phosphorus, total mercury, and phenolics. If dewatering of the EOS is required with discharge of the water to the sewer or back to Lake Superior, additional testing of water quality and also of treatment technologies would be required. However, for the present study, conservative assumptions have been made to allow for treatment as further described below.

Based on the pore water chemistry data presented in the Phase 2 Study, water from dewatering would need to be treated by filtration, pH adjustment, standard biological treatment, and a carbon polish (which also removes mercury and methylmercury) prior to discharge to Lake Superior. Such a discharge would require special discharge approvals with monitoring and reporting. Based on our comparison of pore water analysis in the Phase 2 Study to the City's Sewer Use By-law (included in **Appendix A**) discharge to the City's sanitary sewer system would only require pH adjustment and some clarification / filtration to reduce biochemical oxygen demand (BOD), total suspended solids (TSS) and some total mercury. A discharge permit from the City may be required, and there would be analysis, monitoring, and discharge fees. Based on the City's current sanitary sewer network, a forcemain connection is available near the adjacent Shipyards property.

Based on the lower degree of treatment required and simplicity, discharge to the City's wastewater treatment plant after pH adjustment and clarification / filtration is retained as the water treatment and disposal technology for SMOs that involve dewatering. Testing would be required during design to determine the actual processing required.

Disposal of Dredged Material

The technologies retained for disposal of the dredged EOS are the same as those selected by AMEC in the Phase 2 Study. These are listed in **Table 6-1** below. Disposal in an on-site upland landfill (i.e., on the property of the former paper mill) was also considered, but was screened out based on project-specific complexities, which include the significant difficulties associated with acquiring approvals to establish a new landfill, and private land ownership issues.

Table 6-1: Summary of Technology Review

Technology	Process Option	Effectiveness	Cost	Implementability	Screening Result
Capping – impervious	Bituminous and sand	High	Moderate	Low	Reject
	FML and sand	High	Moderate	Low	Reject
Capping – pervious	Geotextile and sand	Moderate	Moderate	Low	Reject
	Reactive mat and sand	Moderate-High	Moderate	Low	Reject
	Thick layer of sand	Moderate	Moderate-Low	High	Retain
	Thin layer of sand	Low	Low	High	Retain, must be used in conjunction with other technologies.
Removal – dry excavation	Coffer dams, draining, excavation	High	High	Moderate	Retain
Removal – dredging	Suction dredge	High	Low	Low	Reject
	Clamshell	Moderate	Moderate	Moderate	Retain
	Backhoe	Moderate	High	Moderate	Reject in favor of clamshell, but detailed design may indicate this method is preferable.
Conditioning - exsitu	Pressure filtration	Moderate	High	Moderate	Retain
	Vacuum Filtration	Moderate	Moderate-High	Low-Moderate	Reject in favor of pressure filtration.
	Belt filtration	Low-Moderate	Moderate	Low	Retain if needed to support other technologies.
	Gravity dewatering	Moderate	Low	High	Retain if needed to support other technologies.
	Chemical stabilization, for example with pozzolan	High	High	Low	Reject
Conditioning - insitu	Stabilization	Low	Very High	Low	Reject
Disposal	Upland landfill	High	Moderate	High	Retain
	Upland fill area – offsite	High	Moderate	High	Retain
	Upland fill area – onsite	High	Moderate	Low	Reject
	CDF – offsite	High	Moderate	Moderate	Retain

Technology	Process Option	Effectiveness	Cost	Implementability	Screening Result
	CDF – onsite	High	Low	Moderate	Retain
Water Management	Discharge to lake water	Moderate	Low	Moderate	Reject
	Seepage to lake water	Moderate	Low	Moderate-High	Retain for options involving CDF and for barge drainage into the lake.
	Discharge to City WTP	High	High	Low-Moderate	Retain
	Treat in package unit and discharge to lake (Hg, phosphates, pH, BOD, etc.) Technology: pH adjustment, filtration, biological treatment, carbon polish	High	High	Moderate	Reject
	Treat in package unit and discharge to City WTP .Technology: pH adjustment	High	High	Moderate-High	Retain

6.3. Sediment Management Option Development

The technologies that passed initial screening were assembled into a range of logical SMOs for comparative analysis in **Sections 7.0** through **8.0** below. The SMOs developed are summarized in **Table 6-2** below. A discussion of each is provided in the following subsections.

Table 6-2: Description of SMOs

SMO	Description	Comments / details
1	▪ Cap EOS within SMU with a sand cap.	▪ Geotextile foundation underlies sand cap to distribute the weight of the sand. ▪ Sand cap is nominal 1 m thick.
2	▪ Construction of a coffer dam. ▪ Dewater the SMU. ▪ Excavate EOS and woody debris. ▪ Disposal in Upland Landfill.	▪ Surficial water within the coffer dam discharged directly to the lake. ▪ Sediments dewatered using filter press. ▪ Water from sediments and ongoing dewatering within the coffer dam is treated and discharged to the City Sewer.
3	▪ Dredge EOS and woody debris. ▪ Disposal in Upland Landfill.	▪ Sediments dewatered using filter press. ▪ Water from sediments is treated and discharged to the City Sewer.
4A	▪ Construction of an on-site CDF within the SMU. ▪ Dredge EOS and woody debris outside the CDF and dispose directly in CDF.	▪ Final grade of the CDF is above lake level. ▪ After a period of time for consolidation, a cover is placed on the CDF to isolate the sediments.
4B	▪ Same as 4A, except the area of the existing water treatment ponds is used as part of the disposal area within the CDF.	▪ Requires closure of water treatment ponds prior to implementation.
5	▪ Dredge EOS and woody debris. ▪ Disposal in Existing CDF owned by the Port Authority.	▪ May require some environmental permitting to allow disposal of the EOS in the existing CDF. ▪ Woody debris disposal in upland landfill.
6	▪ Dredge EOS and woody debris to maximum water depth of 3.5m. ▪ Cap the remaining areas of EOS with a sand cap. ▪ Disposal in Upland Landfill.	▪ No geotextile foundation necessary to distribute the weight of the sand. ▪ Sand cap is nominal 1 m thick.
7	▪ Same as SMO 6 except the EOS is disposed at the Port Authority's existing CDF as in SMO 5.	▪ See SMOs 5 and 6.
8	▪ Same as SMO 6 except the EOS is disposed in an on-site CDF as in SMO 4A.	▪ See SMOs 4A and 6.

Total net present value costs for each SMO were estimated and are discussed in **Section 7.2** below with the evaluation of SMOs. Capital costs and operations, monitoring and maintenance (OM&M) costs have been estimated based on the remedial elements, the estimated dimensions and volumes, and typical unit costs. These estimates should be considered conceptual and to have a +/- 30% variance.[3] Net present value costs are based on the capital costs, estimates of annual OM&M, and a three percent discount rate.[4] The duration of the annual cost elements range from a few years for active remediation to 30 years for monitoring and maintenance.

---

[3] The U.S. Army Corps of Engineers proposes a -30%/+50% level estimate (EPA, 2000).

[4] The discount rate is used to convert future annual costs to a total present value in 2014. It is approximately equal to the difference between the long term average U.S. Treasury rate, which reflects the cost of money, and the average annual construction inflation rate. Note that EPA typically uses this rate for its feasibility studies.

Note that after the evaluation process was completed and a recommended SMO was selected, a more detailed cost estimate was prepared for the recommended SMO. The cost estimate for the recommended SMO is presented in **Section 9.5**.

Value Engineering Items

The purpose of this evaluation is to select a recommended SMO for the EOS based on currently available information. As such, there are several general assumptions, based on the Study Team's experience, that have been made that, during the evaluation of SMOs, were determined to not have an effect on the selection of the recommended approach but could result in significant cost savings or scheduling and implementation. These elements are expected to be sorted out as part of a routine design process. The elements we have identified during the performance of this work include the following:

- Method of dredging (i.e., clamshell versus backhoe dredge, or a specialized combination dredge);
- Method of removal and disposal of the sunken logs and other woody debris;
- Thickness, gradation, grading and placement method of a sand cap to cover residuals;
- Barge water management;
- Performance / confirmation monitoring and other long term monitoring; and,
- General environmental management plans including assessment of air quality, odour and noise controls that may be required.

6.3.1. SMO 1 – Capping

SMO 1 consists of the placement of a cap over the extent of the near-field area and is shown conceptually in **Figures 2, 3 and 4** following the report. The cap would consist of a nominal 1 m thick sand layer underlain by a geotextile fabric. The geotextile fabric layer is a barrier to the movement of the EOS and is included to provide a base to distribute the weight of the sand to prevent the sand from sinking into the EOS and sunken logs. There is anchor rock placed at the limits of the cap to reduce the impacts from waves and to anchor the geotextile layer.

The 1 m thickness of the sand cap is based on the alternatives developed in the Phase 2 Feasibility Study and the concurrence by the Study Team that a 1 m thickness provides isolation of the underlying material from flora and fauna that live within sediments and also in consideration of potential physical forces which could cause movement of the cap material (e.g., waves and prop-wash). The actual thickness of the cap and its composition / gradation would be determined as part of detailed design, but use of 1 m for a feasibility study is considered representative based on experience.

Installation of the cap could cause an increase in pore pressure within the EOS which could result in pore water penetrating into the cap material, with potential release into the water column. Pore water within the cap material and release to the water column may result in environmental conditions that are worse than the current conditions for a period of months to years.

Field observation also indicates that there is a considerable amount of gas within the EOS. Adding the surcharge pressure of the cap material would also cause ebullition of the trapped gas through the geotextile and cap material, which would also enhance the transport of the pore water and possibly some gas-borne constituents through the cap and into the water column. Trapping of the gas bubbles under the cap could also be a problem that must be addressed as part of design.

Monitoring would be conducted for a period of time to ensure the cap is performing as intended. Monitoring periods associated with a cap would be longer than those associated with SMOs involving removal. An allowance has been included in the cost estimate to provide for local enhancements to the initially placed cap, should monitoring indicate that this is necessary.

6.3.2. SMO 2 – Excavate and Upland Disposal

SMO 2 consists of excavation with upland disposal. A sheet pile coffer dam would be constructed around the area shown in **Figure 5**, following the report, and the area dewatered by pumping into Lake Superior. After removal of the water, the EOS and woody debris would be removed by low ground pressure excavation equipment including loaders, backhoes, and haul trucks. The trucks would move the excavated material to a dewatering area.

Figure 6, following the report, shows the location where the dredged material would be dewatered using plate and frame filter presses and a water treatment area where the filtrate and water seeping into the containment area would be treated before discharge. A temporary above-ground pipeline would be constructed to convey the treated effluent to a connection with the City sewer.

The dewatered sediments and woody debris would be placed in a covered storage area also shown in **Figure 6**. This covered storage would be necessary due to odours from the EOS material. On-highway trucks would be used to haul the dewatered sediment to a municipal landfill, as well as the woody debris. The cost estimate includes the $43 per tonne tipping fee from AMEC (January 2011) for disposal at the landfill.

Confirmatory testing would be performed to assure that all the EOS had been removed and to confirm cleanup objectives have been met, then the sheet pile coffer dam removed. Long term monitoring of the SMU would not be required.

6.3.3. SMO 3 – Dredge and Upland Disposal

SMO 3 is configured much like SMO 2 except that the EOS and woody debris would be removed using a mechanical clamshell dredge on a barge. The dredged material would be placed in a barge and moved to a dredge storage area (see **Figure 6** following the report) where it can be moved using upland equipment to the dewatering plant. For this SMO, the location of sediment dewatering and storage plant is flexible but ideally would be located as shown on **Figure 6**. The water treatment and disposal of the sediment and debris is the same as in SMO 2. Confirmatory testing would be performed to assure that all the EOS had been removed, and to confirm cleanup objectives have been met. Long term monitoring of the SMU would not be required.

6.3.4. SMO 4A – Dredge and New On-Site CDF Disposal

SMO 4A consists of construction of a new on-site CDF in a portion of the water area of the North Harbour. A conceptual layout for the CDF is shown in **Figure 7** following the report. EOS and woody debris would be removed from the alignment of the containment barrier to allow construction, and the removed material would be placed in the northeast corner of the CDF area. The containment barrier may be constructed of rock and gravel, or may be constructed of sheet pile. A geotextile would be placed on the inward face of the new barrier, along the face of the existing seawall that forms one side of the new CDF, and along the existing shoreline for the extent of the CDF. The geotextile would allow water removed with the dredge material to flow through, and acts as a filter.

Once constructed, EOS and woody debris would be removed from outside the CDF and placed within the containment area. The CDF would be designed with a minimal area, and would be designed to have a final grade of nominally 1 m above the lake level when full. The material in the CDF would be allowed to settle and consolidate for several years, and then an earthen cover would be placed to allow revegetation or future use (e.g., as a storage area, park, or parking lot).

Odours during consolidation may be an issue, however prevailing winds primarily blow off-shore across the lake. If odour becomes an issue, mitigation measures that can be taken include application of a deodorizer over the material in the CDF and early placement of a temporary cover (like other dredged material) on the material disposed in the CDF.

Confirmatory testing would be performed in the area of dredging to assure removal of the contaminated sediment. Monitoring of water quality would be performed during and after the CDF is filled (assumed as five (5) years after completion of cover construction for the purpose of cost estimation) to assure that there are no long term water quality impacts. Inspection and maintenance of the CDF would be performed for a longer period (assumed as 30 years for the purpose of cost estimation).

6.3.5. SMO 4B – Dredge and Use Existing Lagoons as CDF Disposal

SMO 4B is the same as SMO 4A except that the existing settling ponds associated with the former paper mill operations would be used as part of the disposal area. This would move the containment area to the north somewhat. However, use of the ponds for disposal could cause a delay in schedule as the ponds must be clean-closed by the current owner prior to their use as part of the CDF. In addition, ownership of the lands would need to be conveyed to the proponents of the SMO in order to complete the work. The existing ponds may be at least partially lined with polyethylene, but the integrity of the lining and the structural integrity of the berms are not known at this time. Enhancements to the existing ponds would likely be required.

Confirmatory testing, monitoring, and inspection and maintenance for SMO 4B are the same as for SMO 4A above.

6.3.6. SMO 5 – Dredge and Off-site CDF Disposal

SMO 5 consists of removing the EOS and woody debris using a clamshell dredge on a barge. The majority of the woody debris would be removed separately from the EOS and disposed of in an upland landfill. Confirmatory testing of the dredged area would be performed to verify that all the EOS has been removed. Long term monitoring of the SMU would not be required. The dredged material would be placed in a barge and towed by tug to the existing Mission Bay CDF owned and operated by the TBPA approximately 12 km to the south (see **Figure 8** following the report). Sediments would be offloaded from the barge and placed in either Cell 4 or the south end of the reservoir cell.

At this time, it has not been verified that disposing of the EOS within the CDF would result in containment of contaminants within the CDF; therefore there may be some evaluation and permitting required to verify that disposal in the CDF is acceptable. The CDF was constructed between 1977 and 1979, and final design drawings or reports are not available for review. Based on information provided by the TBPA, the CDF berms are in good condition and therefore do not likely require structural reinforcement. However, without further design considerations beyond the scope of this study, it cannot be confirmed that the CDF is suitable for containment of contaminants associated with the EOS.

For the purposes of evaluating SMOs, the Study Team has included potential enhancements to the existing CDF within the cost estimate, as shown on **Figure 8** after the report. The potential enhancements are based on the new CDF configuration proposed by the Phase 2 Study, and are provided within this report as examples of appropriate enhancements for this project, and may include:

- Enhancement of the interior face of the existing perimeter dyke to include filtration comprised of geotubes filled with clean sand containing >1% organic carbon and overlying rip rap cover material;
- Construction of a new containment dyke constructed with quarry run material within the reservoir cell, including geotubes for filtration and rip rap for armouring;
- Capping and vegetating the new containment cell after adequate consolidation of placed material; and,
- Provision of net present value of 25 years of monitoring at the CDF as a capital cost.

Based on the consulting team's experience, the enhancements noted above would be appropriate containment enhancements to the existing CDF to retain the solid phase of mercury. As discussed with the stakeholder committee, the capital cost of enhancements to the CDF and net present value of monitoring has been assumed to replace the \$11 per m^3 disposal fee previously used in the Phase 2 Study.

6.3.7. SMO 6 – Dredge, Cap and Upland Disposal

SMO 6 is configured to remove the thickest portions of the EOS and woody debris and to maximize the water area for future use as a harbour. The sediments are dredged and managed using the same methods described above for SMO 3. However, the EOS and woody debris are removed to a native sediment or a maximum water depth of 3.5 m (whichever is less) and the residual material is covered with a thin (0.5m) layer of sand as a cap as described in **Figure 9** after the report. As shown in the Phase 2 Study, the EOS is generally thin (less than 1 m thick) at where the existing water depth is >3.5 m, so there is no need for the geotextile support layer. The selected water depth for dredging was selected based on providing adequate draft for recreational sailboats which were identified by local landowners as potential future uses of the area.

Confirmatory testing would be the same as for SMO 3. However, because some material would be left in place, long term monitoring and maintenance as described for SMO 1 (capping) has also been assumed.

6.3.8. SMO 7 – Dredge, Cap and Off-site CDF Disposal

SMO 7 is the same as SMO 6, except the dredged material is barged to the Port Authority CDF as in SMO 5. Confirmatory testing, long term monitoring and maintenance are assumed to be the same as for SMO 6.

6.3.9. SMO 8 – Dredge, Cap and On-site CDF Disposal

SMO 8 is the same as SMO 6, except the dredged material is disposed in a CDF constructed on-site as in SMO 4A. Confirmatory testing and monitoring are assumed to be the same as for SMO 6 except with the long term monitoring and maintenance of the CDF as in SMO 4A.

7.0 Sediment Management Option Analysis

7.1. Approach

A comparative analysis of the nine (9) SMOs identified in **Section 6.3** was conducted to identify the most appropriate SMO. In performing this analysis the Study Team identified the decision parameters that need to be considered, determined the relative importance, or weighting factors for each these parameters, and then finally scored each of the SMOs against each of the selected decision parameters. The stakeholder committee was consulted and had opportunities for input throughout this process, and ultimately reviewed and agreed to the final list of parameters and the weighting factors. The decision parameters and weighting factors are summarized in **Table 7-1** below.

One (1) of the more important parameters that are to be taken into account in the comparative analysis is input from the local communities, First Nations and Metis Nations. Since it is important to share the technical information contained in this report with these groups, so they can provide sound commentary, a preliminary comparative analysis has been completed without their input. Once consultation with these groups has been completed the comparative analysis will be re-visited incorporating their input. The information described in **Table 7-1** below shows how their input could be incorporated at a later date.

Table 7-1: First Tier Evaluation Criteria

First Tier Parameter	Weight[5]	Description
Environmental effectiveness and permanence	Critical (100)	This is a critically important parameter as it allows for the comparison of SMOs considering their effectiveness in addressing the remedial action objective, in protecting the environment and human health, and in the long term durability of the remedial construction.
Short term impacts	Moderately Important (50)	This is a less important parameter that allows for comparison based on the duration of the disturbance created during the implementation / construction of each SMO and the associated environmental impacts that occur during construction.
Implementability	Important (75)	This allows for the comparison of SMOs based on the relative ease with which they can be permitted and constructed.
Community support	Moderately Important (50)	This is an important parameter which is ultimately going to be incorporated into the comparative analysis. Community support is not taken into account in this preliminary analysis since the local communities, First Nations and Metis Nations still need to be consulted in order to obtain their input into the decision making process.
Land use benefits	Moderately Important (50)	This parameter evaluates the effect each SMO has on land use potential and property values in the area.
Sustainability	Minimally Important (25)	This parameter considers the effect of each SMO on the longevity of local resources such as aggregate and landfill capacity.
Costs	Critical (100)	Costs, expressed as the net present value of capital plus operations, monitoring, and maintenance, are considered to be of critical importance. The net present value is equal to the capital (implementation / construction) cost of each SMO plus lump sum equivalent of the long term monitoring and maintenance costs using a net financial discounting factor of 3% (5% return minus 2% inflation).

Each of the above first tier parameters, with the exception of costs, were subdivided into a number of second tier parameters to facilitate a more detailed evaluation as presented in **Table 7-2** below. Typically, the first tier parameter for cost would require second tier parameters for separate capital and ongoing costs; however this is not required for this analysis as the first tier cost parameter is expressed as net present value.

---

[5] The relative weights are both verbally described and also assigned a numerical value which is used in the comparative analysis.

Table 7-2: Second Tier Evaluation Criteria

Second Tier Parameter	Weight	Description
Tier 1: Environmental Effectiveness and Performance		
Prevent human health risk from fish ingestion	Critical (100)	This is a critical parameter since it is one of the main objectives of the Project.
Minimize ecological risks to identified receptors	Critical (100)	This is also one of the major objectives of the Project.
Durability and monitoring and maintenance requirement	Critical (100)	It is critical that SMOs are durable and require a minimum amount of long term monitoring and maintenance.
Requirements for managing residuals	Important (100)	This parameter addresses the need to provide for the long term management of any constituents of concern that remain on-site after the SMO is implemented, e.g. a cap which requires maintenance in the long term, since residual constituents remain under the cap.
Technology reliability	Important (75)	This parameter addresses the reliability of the technologies incorporated in each of the SMOs.
Tier 1: Short Term Impacts		
Project duration	Minimally Important (25)	The length of time it takes to implement an SMO is considered to be minimally important.
Un-mitigatable environmental impacts	Moderately Important (50)	The amount of environmental impact that occurs during the construction of an SMO that cannot be effectively mitigated is considered to be moderately important.
Tier 1: Implementability		
Regulatory requirements	Minimally Important (25)	These are considered minimally important since applicable regulations will need to be complied within any event. The parameter considers the level of effort to meet the requirements.
Implementation uncertainty	Moderately Important (50)	The uncertainty associated with actually getting an SMO implemented is considered moderately important.
Constructability	Critical (100)	The constructability of each SMO reflects the ease with which it can be constructed and is considered critical.
Adaptability to modify / update	Moderately Important (50)	This parameter reflects the ease with which the SMO can be modified during construction to better fit unexpected field conditions.
Effectiveness of verification monitoring	Important (75)	This parameter describes and reflects how effective monitoring will be after construction to verity the SMOs goals have been met.
Tier 1: Community Support		
Community support	Important (75)	Input from the community on the different SMOs is considered important.
First Nations and Metis Nations support	Important (75)	Input from First Nations and Metis Nations is considered important.

Second Tier Parameter	Weight	Description
Tier 1: Land Use Benefits		
Added upland developed area	Minimally Important 25)	Considered minimally important since there is a significant amount of upland area already available.
Effect adjacent property Values	Important (75)	This is considered to be an important parameter for the local residents.
Harbour potential	Important (75)	Creating additional useful harbour space is considered important.
Aquatic habitat creation	Moderately Important (50)	This is considered moderately important since it is not a critical habitat area.
Open water inside the breakwater	Minimally Important (25)	Increasing the amount of open water behind the breakwater is considered to be minimally important.
Tier 1: Sustainability		
Depletion of local landfill or CDF disposal capacity	Important (75)	This parameter is considered important, as capacity is finite and creating additional space requires effort and involves costs.
Depletion of local aggregate sources	Moderately Important (50)	Aggregate sources are considered moderately important since additional sources can be established with some effort.

7.2. Comparative Analysis of Sediment Management Options

Using the above set of parameters, the Study Team performed a comparative analysis and ranking of the SMOs. Information used in this analysis included basic information on the site and the SMOs; knowledge of permitting and approval processes as well as physical and chemical processes that would occur when the remedies are put in place. It also includes the professional experience and judgment of the Study Team. The analysis was accomplished by scoring each of the SMOs individually against each of the Tier 2 Parameters and then using a numeral technique to establish a total relative score for each SMO. The highest scoring SMO is considered the recommended SMO.

Appendix E describes the computer software that was used to facilitate the ranking process, while **Table 7-3** below describes the scoring scales that were used and scores selected by the Study Team for each of the SMOs. In each case a score range of 0 to 10 was used. **Appendix E** also contains a detailed printout of the scores for each SMO. This software merely provides an efficient means of integrating the large amount of information described above in the SMO ranking process.

Table 7-3: Criteria Scoring Table

Parameter	Verbal Scoring Scale (Numeric scale is 0 to 10 in each case)	Basis for Scoring
Prevent human health risks from fish ingestion	From a very low to a very high level of protection against risk. (Represent a low score to a high score)	This scoring was accomplished by considering the level of water quality protection provided by each SMO. The dredge and CDF disposal SMOs are considered to have a higher score than the capping SMOs since the EOS in these SMOs is permanently removed from the aquatic habitat. The partial capping and dredging SMOs are scored in between these extremes. The score magnitudes are based on knowledge of site conditions and tempered by professional judgment.
Minimize ecologic risks to identified receptors	Same as the above scale.	The scores were assigned on a similar basis to those above for the prevention of human health risks. A further refinement is included to distinguish between SMOs involving an off-site CDF, which are scored higher than those involving an on-site CDF or an upland landfill. The off-site CDF is considered to pose a lower risk since it is in an isolated area that is already associated with dredge spoil disposal. The score magnitudes are based on knowledge of site conditions tempered by professional judgment.
Durability and monitoring and maintenance requirements	Categories include: Prone to failure, susceptibility to failure, moderately robust, very robust.	The CDF SMOs are considered to be very robust since the EOS is contained and covered and its integrity can be observed and repaired in the event any damage occurred that exposed the EOS material. The SMOs involving capping are scored slightly lower as robust, since the cap is exposed to storm wave action and its integrity cannot be readily observed. The score magnitudes are based on knowledge of site conditions and knowledge of basic physical processes.
Requirements for managing residuals	Considerable concern, moderate concern, some concern, and no concern.	There is no concern associated with upland disposal since that is a maintained facility. There is some concern with an on- or off-site CDF since provisions would need to be put in place to prevent disturbance to the CDF covers in the future. There is a moderate level of concern associated with capping since this would be more susceptible to damage in the long term. The score magnitudes are based on knowledge of site conditions and of basic physical processes.
Technology reliability	Very low to a very high probability of meeting the objectives of the project.	Upland and CDF disposal are considered to have a very high probability of meeting the objectives. SMOs involving capping are considered to have a high probability of meeting objectives; slightly lower since it is more difficult to verify adequate cap construction under water. The score magnitudes are based on knowledge of site conditions and experience in constructing land- and water-based caps and covers.
Project duration	Durations ranging from one to over 10 years.	The scoring is based on the construction schedules, which in turn are based on the amount of construction work needed for each SMO.

Parameter	Verbal Scoring Scale (Numeric scale is 0 to 10 in each case)	Basis for Scoring
Unmitigatable impacts (during Construction)	Significant, some, minimal and no impacts.	Dredging and disposal in an on-site or off-site CDF are considered to have minimal environmental impacts during construction. Some impacts are expected from the other SMOs since they involve upland disposal with the associated truck traffic or capping which again requires trucks to bring in the cap material. The score magnitudes are based on knowledge of site conditions and of basic physical processes
Regulatory requirements	Extremely complex, complex, moderately easy and minimal effort.	Capping and dredging with either upland disposal or disposal in the existing off-site CDF are considered to be moderately easy and score the highest. SMOs including the onsite CDF are considered complex and score lower since they involve a new CDF. The SMO involving use of the existing ponds for disposal is considered extremely complex and scores the lowest since it involves private property.
Implementation uncertainty	Very high to none.	The SMOs involving dredging or excavation and upland disposal are considered to have a very low implementation uncertainty and score the highest. Capping and dredging with disposal in an onsite CDF have a low uncertainty, while dredging and the combination of both capping and CDF disposal are considered to have a moderate uncertainty since there are more activities to undertake. Dredging and disposal in an on-site CDF and the existing ponds scores the lowest as it involves dealing with private property.
Constructability	Most complex to the most straightforward of the SMOs.	SMOs involving dredging and upland and off-site CDF disposal are considered the least complex and score the highest. The SMOs involving both capping and dredging are considered the most complex and score the lowest.
Adaptability to modify / update	Least adaptable to very adaptable.	The SMOs involving capping and dredging and upland disposal are considered the most adaptable to change and score the highest, since it is straightforward to increase the size and thickness of the cap or increase the amount of dredging since the upland disposal area has more than adequate capacity. The least adaptable SMOs are those that involve excavation of the EOS since that would occur within sheet pile constructed areas which would be difficult to modify.
Effectiveness of verification monitoring	Minimally effective to very effective.	Generally, SMOs involving capping are more difficult to verify and score the lowest, since visual observation of the caps surface is not possible underwater and spot probes of the cap need to be relied upon.
Community support	Least preferable to most preferable.	The SMOs were not scored for this parameter. Scoring will be done after the public consultation process.
First Nations and Metis Nations support	Least preferable to most preferable.	The SMOs were not scored for this parameter. Scoring will be done after the public consultation process.

Parameter	Verbal Scoring Scale (Numeric scale is 0 to 10 in each case)	Basis for Scoring
Added upland development area	Lowest to highest new land area created for the range of SMOs.	Scores were based on estimates of the increased upland area (overlying the onsite CDF) that would be created by each of the SMOs.
Effect adjacent property values	Significant decreases; decreases, no change; increases, and significant increases.	Use of an on-site CDF and the existing ponds is considered to result in a significant increase in property values since this would remove blight (the ponds) and create usable land area adjacent to the water. SMOs involving dredging and excavation and CDF disposal are considered to result in increases in property value since the EOS is removed and contained and harbor depth is maintained. SMOs involving capping are considered to result no change to a decrease in property value since the EOS would still be present in the harbour.
Harbour potential	Harbour depth and quay length reduction; depth or quay reduction; neither; quay increase; depth increase and depth and quay increases.	The scores for the SMOs are quantitatively-based on estimates of increased harbour area and depth.
Aquatic habitat creation	No change; added aquatic habitat; added benthic (sediment) habitat, and added aquatic and benthic habitat.	Scores are quantitatively-based on estimates of the additional amount of aquatic and benthic habitat that is created by the various SMOs.
Open water inside breakwater	Very high to no reduction.	Scores are quantitatively-based on the extent to which navigable open water is created.
Depletion of local landfill / CDF capacity	Moderate to none.	SMOs involving upland disposal score lower since they result in a reduction in landfill capacity.
Depletion of local aggregate resources	As above.	SMOs involving capping score lower since they require more gravel from local gravel pits.
Costs	From 0 to over $90 million in $10 million incrementally; i.e. $0 to $10 million, $10 to $20 million, etc. For the purposes of this comparative analysis the net present value (NPV)	Scores are quantitatively-based on the estimated costs.

For the purposes of this comparative analysis the net present value (NPV) costs were developed from the available cost estimates in the Phase 2 Study. Certain unit prices were adjusted and combinations of different estimates were used to establish the following cost ranges, and summaries of the estimates are provided in **Appendix F**. Net present value cost (in 2014 dollars) for each of the SMOs is presented in **Table 7-4**.

Table 7-4: Sediment Management Option Net Present Value Costs

SMO #	SMO	NPV Cost Range ($ Million)
1	Capping	$30 to $40
2	Excavate and Upland Disposal	> $90
3	Dredge and Upland Disposal	> $90
4A	Dredge and New On-Site CDF Disposal	$40 to $50
4B	Dredge and Use Existing Lagoons as CDF Disposal	$40 to $50
5	Dredge and Off-site CDF Disposal	$40 to $50
6	Dredge, Cap and Upland Disposal	> $90
7	Dredge, Cap and Off-site CDF Disposal	$40 to $50
8	Dredge, Cap and On-site CDF Disposal	$40 to $50

The results of the numeric analyses and scores are discussed in **Section 8.0**.

8.0 Results of Comparative Analysis

8.1. Overall Scores

The overall results, expressed as numerical scores, derived from the comparative analysis are presented in **Table 8-1**:

Table 8-1: Sediment Management Option Scoring

Rank	SMO	Score
1	5. Dredge and Off-Site CDF Disposal	0.722
2	4A. Dredge and New On-Site CDF Disposal	0.694
3	4B. Dredge and Use Existing Lagoons as CDF Disposal	0.664
4	8 Dredge, Cap and On-Site CDF Disposal	0.575
5	1. Capping	0.570
6	7. Dredge, Cap and Off-Site CDF Disposal	0.566
7	3. Dredge and Upland Disposal	0.548
8	2. Excavate and Upland Disposal	0.531
9	6. Dredge, Cap and Upland Disposal	0.408

The reasons SMO 5 ranks the highest are as follows:

- It ranks second in cost as it is in the second lowest cost range of the SMOs considered;
- It ranks as high as the highest of any of the other SMOs for the following parameters:
  - Prevent human health risks from fish ingestion;
  - Minimize ecological risks;
  - Durability and monitoring and maintenance requirements;
  - Un-mitigatable environmental impacts (during construction);
  - Constructability;
  - Effectiveness in verification modelling;
  - Technology reliability;
  - Implementation uncertainty;
  - Depletion of local aggregate resources;
  - Open water inside breakwater; and,
  - Regulatory requirements.

The details of the scoring by parameters are provided in **Appendix E**.

8.2. Sensitivity Analyses

Sensitivity analyses were completed to establish how much various parameter weights would have to change in order to alter the above ranking. The relevant results (i.e., those that change the recommended SMO) are presented in **Table 8-2**.

Table 8-2: Sensitivity Analysis

In The Event	Highest Ranking SMO
Sustainability is considered important (instead of minimally important)	SMO 4A
Implementability is considered minimally important (instead of important)	SMO 4A or 4B
Land use benefits is considered critical (instead of minimally important)	SMO 4A

8.3. Recommended Sediment Management Option

At the time of this draft report, subject to consultation on the various SMOs with the local communities including First Nations and Metis Nations, SMO 5: “Dredge and Offsite CDF Disposal” is the recommended SMO.

9.0 Description of Recommended Sediment Management Option

The recommended SMO is removal of the EOS and woody debris by dredging with disposal in the existing CDF owned and operated by the Port Authority. In this section, details of the conceptual design and conceptual implementation plan are presented.

9.1. Design and Permitting

The first step for implementation is design and permitting. This will likely require approximately two (2) years including procurement. The design and the permitting would be performed in parallel as these activities are typically interrelated. Major permitting activities include definition and approval of water quality controls and monitoring that will be implemented during dredging and disposal, development of a confirmatory monitoring program to verify that cleanup objectives within the SMU / near-field area have been achieved, and working with the Port Authority to acceptance of the proposed disposal plan within the Mission Bay CDF.

In addition the approvals process will include project review by several agencies due to the potential environmental impact and to comply with all applicable acts and regulations. A list of required agency approvals is provided in **Section 10.1** below.

Dredging
There are several studies that should be performed during the detailed design phase. Currently the recommended design studies include a test dredge to establish the best equipment for dredging and to establish material handling characteristics, a survey for the locations of submerged logs and woody debris, exploration of methods to remove the logs and woody debris, dredge elutriate testing (DRET) and pore water testing to aid in permitting water management operations during implementation.

During the investigation undertaken for the Sampling Report, video was taken of bulk sampling using a backhoe and the video indicated that:

- There is a lot of woody debris in the EOS;
- There are trapped gases in the EOS that are released when the material is disturbed;
- The EOS releases a lot of water while it is draining under its own weight; and,
- The EOS does not settle from the water column as well as “normal” sediments.

These features have been considered in developing the cost estimate for the removal of the EOS and woody debris.

Of particular consideration is the presence of the City’s Bare Point Municipal Water Intake, located approximately 2.5 km north of the SMU. Using MIKE3 modelling software, MOE has completed the *Assessment of Impacts from Potential Releases of Materials from the Thunder Bay Harbour SMU upon the Bare Pt. Municipal Intake* (Preliminary Report, January 21, 2014). This report assessed the potential for both short-term releases (1 metric tonne over one (1) hour into the surface water layer) and long-term releases (1 kg of material per hour for a seven month period from April 1 to November 1) of various materials from the SMU. Materials assessed included:

- Water (via loss of pore water);
- Clay / very fine silt;
- Fine / medium silt; and,
- Coarse silt.

The report determined that there is a large degree of mixing that would occur with any plume that may travel from the SMU to the Bare Point intake. The smallest dilution factor from short-term releases for any material was approximately 70 million and the smallest dilution factor from long-term releases for any material was approximately 450 million. The report concluded that only a large scale release of material from the SMU could produce contaminant levels of concern at the intake. Therefore, the potential for dredging within the SMU undertaken with appropriate controls to affect the Bare Point intake is limited.

Based on the limited potential for impacts to the City's water intake, the design of environmental controls would focus on protection of local water quality, wildlife and human health. For the present conceptual design, it has been assumed that the water quality controls will be typical of remediation dredging projects; i.e., a silt curtain extending to near the lake bottom will surround the work area, drainage from the barge during loading will be directed through the barge scuppers (covered with geotextile to provide some filtration) back into the work area, containment booms will be used to control floating debris, and continuous monitoring and reconnaissance from a work boat will be performed to prevent release of contaminated water and floating debris. Water quality criteria for dredging would need to be established during detailed design, and contingency measures evaluated. Relatively simply additional environmental controls would include an additional silt curtain system or a more robust silt curtain. As an alternative to the silt curtain and boom system, consideration could be given to using steel sheet pile to isolate the dredge area. Steel sheet piles could be installed in advance of each dredging season, then pulled and re-used for the subsequent dredge season. However, in the opinion of the Study Team, and for the purposes of the cost estimate, at this time it is anticipated that silt curtains will provide sufficient restriction of turbid water.

It is also assumed that a majority of the logs will be removed onto a barge prior to a dredging crew coming through to remove the EOS. Mapping the locations of woody debris is recommended as part of the design. The logs and woody debris would not be disposed of in the CDF. Removal of the majority of the woody debris prior to dredging is anticipated to improve the efficiency and performance of dredging and the water quality controls.

For the present conceptual design, the extent of dredging is assumed to be the Sediment Management Unit (SMU) boundary defined in the AMEC feasibility studies. This SMU boundary is approximately the same as the outer limits of the passive management area defined in the SSRA. The neat lines and thicknesses defined in the AMEC feasibility studies are also used herein, which represents a total estimated dredge volume of 465,000 cubic metres, allowing for a 20% overdredge on a neat volume of 386,000 m^3.

Disposal within Mission Bay CDF

Based on information provided by the TBPA, the CDF berms are in good condition and therefore do not likely require structural reinforcement. However, at this time it is not known if the existing configuration of the CDF would adequately contain contaminants present within the EOS. As noted in **Section 6.3.6**, the CDF was constructed between 1977 and 1979, and final design drawings or reports are not available for review.

Therefore, the Study Team has included potential enhancements to the existing CDF within the cost estimate, as shown on **Figure 8** after the report. The potential enhancements to the CDF are based on the new CDF configuration proposed by the Phase 2 Study, and include:

- Enhancement of the interior face of the existing perimeter dyke to include filtration comprised of geotubes filled with clean sand containing >1% organic carbon and overlying rip rap cover material;
- Construction of a new containment dyke constructed with quarry run material within the reservoir cell, including geotubes for filtration and rip rap for armouring;
- Capping and vegetating the new containment cell after adequate consolidation of placed material; and,
- Provision of net present value of 25 years of monitoring at the CDF as a capital cost.

During the detailed design phase, the potential CDF enhancements would be determined as part of the development of a disposal plan for EOS within the CDF. While the conceptual enhancements outlined above represent a conservative cost for estimate purposes, other value engineering items related to disposal within the CDF to be examined during design would include:

- Potential for disposal of dredged EOS within the current Cell 4 to the maximum extent possible, with the remainder of the dredged EOS disposed of within the reservoir cell;
- Determining the most efficient method of dredge material disposal in the reservoir cell;
- Determining the alignments of any new containment cells, based on refined disposal area requirements;
- Undertaking contaminant transport modelling to establish the most efficient methods for filtration or containment; and,
- Determining final monitoring requirements.

9.2. Construction

Construction is anticipated to require three (3) dredging seasons of seven (7) months each year (May through November. This will require an extension or exemption from the Ministry of Natural Resources of their in-water activity window of June 15 through August 31. The extension or exemption seems justified as the goal of the remediation project is to provide a better habitat for aquatic life, which is similar to the goal of the in-water activity window.

The construction schedule is assumed to require three (3) mobilizations and demobilizations. Dredging is assumed to occur six (6) days per week and 10 hours per day with a 90% availability of the dredge / transport crews and equipment. A nearby area with berthing would be used for laydown, offices, logistics, and maintenance.

Several spring spawning species likely spawn in vegetated parts of the near field portion of Thunder Bay Harbour. Based on a spring spawning period, in-water activity is typically restricted from April 1st until June 15th. Inferred use of main habitat types indicate little to no potential spawning within the SMU where pulp is >1m. Yellow Perch and Sticklebacks, species with adhesive eggs, may spawn over areas of submergent vegetation within the SMU where the pulp is <1 m and submergent vegetation occurs. Yellow Perch and Sticklebacks typically spawn from April to June. Suitable spawning habitat for these species occurs outside the SMU. According to the Thunder Bay North Harbour Fish Community and Habitat Synthesis, by Northern Bioscience (2012), no suitable habitat for fall spawning species occurs within the SMU. Given the low suitability of spawning habitat within the SMU, and suitable spawning habitat adjacent, species within the SMU can move to more suitable spawning locations and construction activities within the SMU will not likely affect overall spawning success of Yellow Perch and Sticklebacks that may have previously spawned within the SMU. Based on this information, we recommend discussion with DFO to extend the in water work window to include April to June to reduce the overall duration for dredging.

Log removal occurs during the first half of the first season. The log removal would be performed using equipment such as grappling hooks and a backhoe with a claw. The logs would be loaded onto a barge and taken to a transloading area where they are loaded onto trucks. It is assumed that the woody debris that is unsuitable for re-use is taken to the Johns Street landfill, although there may be some other appropriate disposal for this material. The current conceptual design assumes that the net cost for disposal of any old growth logs that cannot be recycled is the same as landfill disposal.

During the first construction season, the enhancements to the Mission Bay CDF (if necessary) would be constructed. It is assumed that the new containment dyke would be left open to permit barge access to the newly created disposal cell.

Dredging would be performed with a clamshell dredge on a barge. Most modern dredging equipment is equipped with a GPS-controlled bucket. This allows more precise dredging and minimizes overdredge while assuring that all the EOS within the SMU is removed. The dredged material will be loaded onto a barge which, when full and sufficiently drained, is pulled by tugboat to the CDF. The barge would be offloaded by a second clamshell bucket directly into the disposal cell of the CDF.

Management of residuals (the material that became suspended during dredging and settles back to the lake bottom in areas already dredged) is always an issue in environmental dredging. It is strongly recommended to have an approved approach for both water quality monitoring and action levels during dredging and management of residuals after dredging prior to initiating the dredging project. It is assumed for this conceptual design that residual material would be managed by placement of a thin gravelly sand cap (nominally 15 cm) at the end of the last season of dredging. The cap would be placed by spreading with the clamshell dredge and, in addition to managing residuals, would have an added benefit of providing increased aquatic habitat. Confirmatory testing is performed during and after placement of the gravelly sand cap to assure that the cap covers the residual material and to confirm that the surface of the cap meets the cleanup objective.

9.3. Project Closeout

During the end of the last season of dredging, there is a final demobilization and confirmation with the contractors that all the project objectives have been met. A construction completion report is prepared that contains all records of the areas dredged, the final depths achieved, the confirmatory data demonstrating that cleanup objectives have been met, and the amount of material removed and placed in either the landfill (for the woody debris) or the CDF.

9.4. Post-Construction Monitoring and CDF Capping

For the purpose of conceptual design and cost estimation, the Study Team has assumed that separate monitoring programs would be required at the SMU and at the CDF. The exact details of the monitoring programs would be confirmed during the design and permitting phase of the project, but a preliminary monitoring program has been developed for the purposes of developing a cost estimate.

Confirmatory testing would be performed to assure that all the EOS had been removed. While this should be sufficient to confirm that cleanup objectives have been met, the conceptual design has made provision for two (2) years of semi-annual monitoring followed by eight (8) years of annual verification monitoring at the SMU. This monitoring is to verify that the overall project objectives have been met. Habitat monitoring may be considered also or as an alternative, but is not included in the present assumptions.

This conceptual design also includes long term monitoring at the CDF to verify containment. At this time, it is anticipated that the program would include five (5) years of semi-annual monitoring followed by 25 years of annual monitoring. Costs for the CDF monitoring program have been estimated, and have been included in the net present value estimate.

It is noted that Environment Canada is developing a long-term monitoring program for the Thunder Bay Harbour that includes installation of tree swallow boxes and analysis of tree swallow eggs to monitor contaminant levels. This data may be useful to demonstrate long-term reduction in bioaccumulation.

After a material placed in the CDF is consolidated sufficiently, it would be capped with approximately 500 mm of clean cover material over geotextile, and then seeded with a suitable native species mix. The net present value cost estimate includes this work as a capital cost, as the exact timing for capping would not be known until after construction.

9.5. Cost Estimate

A more detailed cost estimate has been prepared for the recommended SMO as per the scope of work for the present evaluation. The detailed cost estimate is presented in **Appendix F**, and the total net present value cost in 2014 dollars is $44.4 million. This cost includes a 15% recommended contingency (primarily to address additional details that are currently unknown and variations in quantities and/or unit prices used in the estimate). The cost also includes allowances for permitting, procurement, engineering, project administration, and construction management. The estimate should be considered a Class 4 Estimate with an expected accuracy range of +30% to -15% as defined by AACE International Recommended Practice No. 18R-97.

As the project will not commence construction until 2017 and is to be constructed over three (3) years (refer to **Section 10.0**), inflationary costs have been calculated assuming a 3% annual inflation rate. For the purposes of this calculation it has been assumed that 100% of the project cost will experience inflation between 2014 and tender in 2017. In addition, 40% of the project value will experience inflation during construction between the tender and completion of construction. Including these inflationary costs, the project cost rises to $50.3 million at time of tender in 2017.

9.6. Environmental Impact

Potential Environmental Impacts

Potential environmental impacts from the projects are primarily short term environmental impacts during implementation. These include water quality impacts during dredging (turbidity, mercury, pH, and dissolved oxygen), disturbance of habitat, possible fish deaths, noise and odour. Long term environmental impacts in the North Harbour area would be an alteration of habitat resulting from deepening the area of the SMU. After capping of dredged sediments, no long term environmental impacts in the area of the CDF are expected.

Mitigation Measures

Mitigation measures must be implemented during construction to address the potential short term environmental impacts. The water quality controls and monitoring discussed in **Section 9.1** are meant to confine the water quality and ecological impacts limited to the work area. If the controls prove to be insufficient, the water quality controls and monitoring could be altered, for example by changing the configuration of the sediment curtain and containment booms, or curtailing work during certain conditions such as high winds or storms.

As per the SSRA, the SMU likely provides some spawning opportunities in vegetated areas for Yellow Perch and other small-bodied fish species that have adhesive eggs and spawn over submergent vegetation. The SMU also appears to provide nursery habitat for young-of-year (YOY) Longnose Sucker, White Sucker and Walleye that spawn in the Current River nearby (Franz 2013). Each of these species spawns in the spring. DFO guidelines restrict in-water activity from April 1st until June 15th to protect reproductive activities of spring spawning species. Implementation of in-water work restrictions should be confirmed with DFO, however dredging activities will disrupt the spawning locations and therefore the in-water work restriction is likely not required.

Noise is unlikely to be a significant adverse impact as land use in the North Harbour area is industrial, being located right next to a shipyard and a float plane station. Further, the level of noise that is expected is likely commensurate with or less than the baseline from the adjacent facilities and operations.

Odour could be an issue under certain conditions (i.e., onshore or along-shore winds) as the EOS has a strong odour. However, prevailing winds during the dredging season primarily blow off-shore across the lake. Therefore, odour from the dredging, transport and disposal operations is not expected to be an issue. If odour becomes an issue, mitigation measures that can be taken include curtailing work under certain conditions (i.e., when the wind is not blowing off-shore), covering the disposal barges during transport, or spraying a deodorizer over the EOS on the barge and within the work area.

Early placement of an odour mitigation cover (such as straw) on the material disposed in the CDF may also be required to mitigate odours prior to final capping.

Net Environmental Impact

The net environmental impact of the project will be positive. The existing SMU includes poor fish habitat and provides limited opportunities for juveniles and adults of a subset of fish species found in Thunder Bay Harbour and nearby locales. The deepening of the SMU and placement of gravels and cobbles in appropriate locations may improve the near shore and littoral habitat as well as provide suitable spawning habitat for fish that spawn over a range of substrates in spring and fall seasons. These species may include Walleye, Northern Pike, Whitefish, Lake Trout and others. The aquatic habitat in the vicinity of the North Harbour will be more diverse, providing spawning and growth opportunities for numerous species and water quality conditions will also be improved. It is anticipated that the project will also result in lower mercury concentrations in fish tissue, which reduces human health and ecological risks.

9.7. Project Risk

At the time of this report, there has been limited community, First Nations and Metis Nations consultation regarding the proposed SMOs. The SMO analysis to date has not included community input, and it is critical to the project to obtain input from all stakeholders, and particularly the Fort William First Nation whose lands are located near the Mission Bay CDF.

Use of the upland area of the site as a staging or laydown area could represent a potential implementation risk, as the former mill site is under private ownership. However, an advantage of the recommended SMO is that the only shore-based facilities and elements are limited to berthing, offices, lay-down area, and maintenance. Because of the lack of nearby berthing, it may actually be preferable to locate the shore-based facilities at a somewhat remote location, such as the inactive grain elevator facility approximately 3 km to the southwest. Otherwise, and depending on schedule, the former paper mill site could be used or perhaps an agreement with other landowners adjacent to the site could be developed.

The presence of the logs and woody debris represent a constructability risk. This risk can be mitigated through design studies such as the test dredge and through discussion with contractors during design. In addition it is recommended that, during the tendering phase, contractors be shown videos of the test pits completed during the Sampling Report at a mandatory bidders meeting so it can be made clear to potential bidders that there are many logs present in the EOS and that the logs need to be taken into consideration when developing a bid for the work.

After implementation, there is also a risk that the long term monitoring in the North Harbour area may show that conditions have not improved sufficiently to meet cleanup objectives. As the North Harbour area is a low energy area of deposition, there will likely be natural recovery from natural sediment deposition. This natural recovery could be enhanced by covering with additional sand. Institutional controls may also be considered to prevent disturbance of the bottom, such as preventing anchorage in the SMU area or limiting the speed and size of vessels.

10.0 Implementation

The next steps to implement the project are outlined in **Table 10-1** below, along with approximate potential project timelines. The values included in parenthesis assume that an SMO is recommended from a technical perspective in August 2014 and is confirmed in May 2015.

Table 10-1: Implementation Steps and Timelines

Milestone	Activity Duration	Potential Completion Date
Complete Sediment Management Options and Recommendations Report and Select Recommended SMO.	-	August 2014
Consultation Regarding Recommended SMO and Selection of Preferred SMO.	0.75 Years	May 2015
Design and Permitting Land Acquisition	Two (2) Years	May 2017
Tender	0.25 Years	Summer 2017
Construction	Three (3) Years	Fall 2020
Project Verification and Close-out	0.25 Years	End of 2020

10.1. Consultation

During the evaluation process described in this report, SMOs were technically evaluated based on concepts with available local and background information. Initial community consultations have been held as described below; however further community consultation, including First Nations and Metis Nations, will be undertaken prior to final selection of a preferred SMO which will then proceed to the design and permitting phase.

As part of the current project, the Study Team, together with EcoSuperior and the Stakeholder Committee, undertook local community consultation in March, 2014. Two (2) separate events were held on consecutive evenings, as described below:

1. On March 19, 2014, the Study Team made a presentation to the Thunder Bay AOC Public Advisory Committee (PAC) at Lakehead University. The presentation materials are included in **Appendix G**. A total of 54 attendees were present at that meeting.
2. On March 20, 2014, the Study Team convened a drop-in style open house, with two (2) presentations, at the Prince Arthur Hotel. The presentation materials are included in **Appendix G**. There were 29 attendees at the open house.

Groups represented at the consultations included:

- Remedial Action Plan Public Advisory Committee;
- Lakehead University;
- Wilderness North;
- Richardson International;

- Council of Canadians;
- Gravel & Lakes;
- Thunder Bay Tug Services;
- Lakehead Region Conservation Authority;
- City of Thunder Bay;
- Confederation College; and,
- Local media sources.

Comment forms received at both events were reviewed and summarized. General questions received and responses from the Study Team are provided in **Table 10-2** below.

Table 10-2: General Public Inquiries Received

Inquiry	Study Team Response
More pricing details	▪ Cost estimates for each alternative are provided in **Appendix F**.#
More technical details	▪ Further technical details have been provided in this report. ▪ Additional technical details would be generated through the design and permitting phase.
Why aren't the adjacent lands being considered?	▪ Disposal in an on-site upland landfill (i.e., on the property of the former paper mill) was also considered, but was screened out based on project-specific complexities, which include the significant difficulties associating with acquiring approvals to establish a new landfill or expanding an existing landfill, and private land ownership and long term liability issues. ▪ Alternative 4B would enhance and utilize the existing lagoons as part of a CDF.
Impact of flooding and storm events on the material	▪ The material has accumulated and remained in this area over the years, and volumes have not decreased since studies began. ▪ During design and permitting phases, details related to potential impacts to the material during and after construction would be evaluated.
Flow and current patterns in the TBNH	▪ The material has accumulated and remained in this area over the years, and volumes have not decreased since studies began. ▪ Using MIKE3 modelling software, MOE has completed the "Assessment of Impacts from Potential Releases of Materials from the Thunder Bay Harbour SMU upon the Bare Pt. Municipal Intake" (Preliminary Report, January 21, 2014). ▪ During the design and permitting phases, environmental controls and water quality criteria would be established.
Is incineration an option?	▪ Incineration / thermal treatment was considered in the Phase 2 Peer Review and rejected as these technologies require a low moisture content which may not be achievable. In addition, incineration is generally not recommended for wastes containing mercury. ▪ The Study Team agreed with this finding of the Phase 2 Peer Review and also notes that incineration would have high capital cost associated with the construction of an incinerator.
Is using a microbial solution an option?	▪ The Study Team is not aware of any microbial solutions that can destroy elemental mercury without result to the environment.
Examine beneficial uses of the material	▪ Beneficial uses of the material are limited due to contaminants, inconsistencies in the material and difficulties collecting and dewatering the material.
More data on the material and its waste classification	▪ Additional data was collected in the Sampling Report, which is available in **Appendix A**.

Based on consultation undertaken to date, scores can not be assigned to the Community Support criterion (refer to **Section 7.1**). Further consultation with the community, First Nations and Metis Nations is currently being undertaken. Once sufficient consultation is completed, scoring can be assigned for each SMO and the recommended SMO may be confirmed.

10.2. Permits and Approvals

The Study Team has compiled a list of permits and approvals required, which are presented in **Table 10-3** below.

Table 10-3: Summary of Potential Approvals to Support Proposed Activities

Approval Agency and Legislation	Proposed Activity Requiring Approval
Department of Fisheries and Oceans *Fisheries Act (R.S.C., 1985) last amended 25 November 2013*	▪ In water work resulting in potential harm to fish and fish habitat.# ▪ Temporary disruption of fish habitat by disturbing substrates. ▪ Potential release of sediment or sediment-laden water.#
Environment Canada *Species at Risk Act, 2002*	▪ No species at risk identified in or near project area.
Transport Canada *Navigation Protection Act, 2013*	▪ A work for the purpose of the Navigable Waters Protection Act includes the dumping of fill and the excavation of materials from the bed of any navigable water. ▪ Lake Superior is listed as a Scheduled Navigable Water and therefore works will require a permit under the Navigable Waters Protection Act.
Ministry of Environment *Ontario Water Resources Act, Section 34* *O. Reg. 387/04 (Water Taking)*	▪ A permit to take water is required if water taking greater than 50,000 litres of water per day is planned. ▪ Water taking exceeding 50,000 litres per day is not currently anticipated, but should be evaluated during the design phase.
Ministry of Natural Resources *Lakes and Rivers Improvement Act (R.S.0 1990) last amended 2012*	▪ MNR does not usually review projects under the Lakes and Rivers Improvement Act where a Conservation Authority is in place, unless a dam is proposed.
Lakehead Region Conservation Authority *O. Reg. 180/06 Development, Interference with Wetlands and Alterations to Shorelines and Watercourses*	*Regulated Areas* ▪ 15 metres landward and 1 kilometre lakeward from the 100 year flood level of Lake Superior. ▪ All watercourses including streams, rivers and creeks and area adjacent. *Regulated Activities* ▪ Alteration of river banks and lake shores. ▪ The construction, reconstruction, erection or placing of a structure of any kind. ▪ The temporary or permanent placing, dumping or removal of any material, originating on the site or elsewhere.
Ministry of Natural Resources *Endangered Species Act (ESA) 2007 (Ontario)*	▪ No aquatic species at risk identified in or near project area.

At the time of this report, approvals requirements for potential modifications to the Mission Bay CDF are not clear. Once the requirements for, and the extents of, modifications are confirmed, potential approval agencies should be consulted directly. As a minimum, the stakeholder committee should consider potential approvals requirements from the agencies listed in **Table 10-3** above, and also consider the Crown's duty to consult First Nations and Metis Nations when contemplated work that might adversely impact potential or established First Nations, Metis Nations or Treaty rights. At this time, the Study Team does not know if the potential modifications to the Mission Bay CDF would impact potential or established First Nations or Metis Nations Treaty rights, and it is recommended that consultations with the Fort William First Nation be undertaken directly, in addition to consulting all other First Nations and Metis Nations in the area.

10.3. Land Acquisition / Easements

Works to be undertaken will require access to privately owned lands. Property boundaries in the vicinity of the SMU have been confirmed through a title search completed by Environment Canada, which is included within **Appendix A**. For ease of reference, "Figure 2 Ownership History 1900 to Present", is included as **Appendix G**. In order to implement the preferred SMO, permission to enter agreements, easements or ownership for the following lands will be required:

- PIN 62262-0029, currently owned by Wilderness North Management Services;
- PIN 62262-0026, currently owned by Superior Fine Papers; and,
- PIN 62262-0030, currently owned by Lakehead Marine and Industrial.

In addition to the above private properties, permission to carry out dredging will be required from the TBPA who, on behalf of Transport Canada, controls the Port of Thunder Bay.

A suitable site for a laydown, berthing and staging area should be selected somewhere in the Thunder Bay Harbour. It is assumed that the TBPA could provide a suitable site, but it may be necessary to acquire land or easements over other properties.

Additionally, a title search should be completed in the area of the Mission Bay CDF to confirm property boundaries and ownership. At a minimum, permission from the TBPA will be required to work near the Mission Bay CDF.

11.0 Conclusions

The Sediment Management Options and Recommendations Study has served to bring the analysis phase to a conclusion and has made concrete recommendations to move forward with a recommended SMO. The recommended SMO is to dredge the EOS and dispose of dredged materials in the Mission Bay CDF. During the process of selecting the recommended SMO, the Study Team has:

- Reviewed background information (refer to **Section 2.0**);
- Undertaken a site visit, contacted local contractors and suppliers to updated and costing information from previous studies (refer to **Section 3.0**);
- Defined the remedial action objective that the SMO must address (refer to **Section 4.0**);

- Developed an approach to selecting the recommended SMO and discussed previously identified data gaps (refer to **Section 5.0**);
- Defined SMOs (refer to **Section 6.0**);
- Developed weighted evaluation criteria with concurrence of stakeholders (refer to **Section 7.0**);
- Evaluated the defined SMOs and selected a recommended SMO (refer to **Section 8.0**);
- Further described the recommended SMO and identified potential project risks (refer to **Section 9.0**); and,
- Identified the next steps required to implement the project (refer to **Section 10.0**).

The estimated net present value of the recommended SMO is $44.4 million in 2014 dollars. Taking inflation before tender and during construction into account, the estimated cost at time of tender (assumed in 2017) will be $50.3 million. Some modifications to the Mission Bay CDF may be required in order to effectively contain the dredged material. The Study Team has made assumptions regarding the CDF modifications required, and has included the cost of these modifications, along with long-term monitoring costs, with the net present value cost estimate for the recommended SMO.

It is noted that the options were technically evaluated as concepts with local and background information where available, in order to determine a recommended SMO from a technical perspective. After completion of further consultations with property owners, community, First Nations and Metis Nations, scoring for each SMO under the Community Support criterion can be generated and the recommended SMO can be confirmed. The next steps to implement the project are design and permitting, to be undertaken concurrently. During this phase, land for a staging / laydown / berthing area should be secured, and permission to complete the work acquired from private property owners and the TBPA. Based on the preliminary schedule, the project could be completed in approximately six (6) and a half years after finalization of this report.