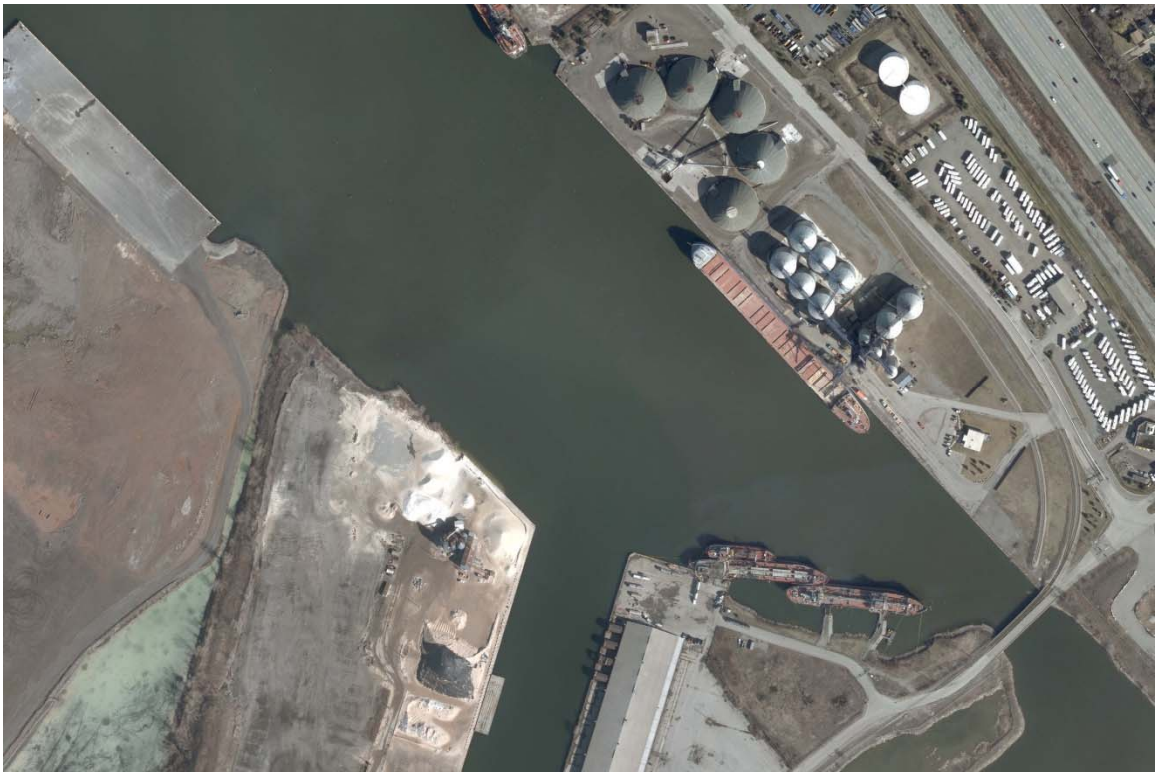
FINAL REPORT

HAMILTON - OSHAWA PORT AUTHORITY

Pier 25 Maintenance Dredging Dredgeate Disposal Feasibility Study



prepared by

Shoreplan Engineering Limited

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SHOREPLAN

Pier 25 Maintenance Dredging Dredgeate Disposal Feasibility Study

Prepared for

Hamilton - Oshawa Port Authority

by

SHOREPLAN ENGINEERING LIMITED

VERSION	DATE	STATUS	COMMENTS
01	2019-10-15	preliminary draft	for discussion
02	2019-12-16	Final Draft	for review
03	2020-03-23	City Comments	for review
04	2020-06-15	Final Report	

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1 INTRODUCTION

Hamilton - Oshawa Port Authority (HOPA) and the City of Hamilton (City) are preparing for the next maintenance dredge of an area offshore of Pier 25. Pier 25 is located along the east shore of Hamilton Harbour near Strathearne Channel. The City is responsible for dredging this area to maintain Seaway draft at Pier 25. The last maintenance dredges were in 2016 and 2010. HOPA carried out this work on behalf of the City. It is anticipated that the next dredge will occur in 2022.

HOPA retained Shoreplan Engineering Limited to carry out a dredgeate disposal feasibility study. This report describes the dredging operation and management of excess material both solid and liquid. The report is organized in six sections with figures and tables provided at the end of each section in which they are referenced. Section 2 provides a general overview of the dredging operation and description of the sediment quality from the sample testing carried out in 2016 prior to the previous dredge at Pier 25. Dredgeate disposal sites, which include two City sites, two HOPA properties and two local landfills, are discussed in Section 3. Section 4 describes the management of excess liquid or water that is generated from the dredging operation and entrained in the dredge material. It also provides a general overview of methods to dry the material for transfer to a local landfill. Approvals and permits required to dredge Pier 25 are provided in Section 5. A summary of the disposal options and costs are provided in Section 6 along with our recommendations.

2 DREDGE METHODS AND SEDIMENT QUALITY

Pier 25 is located at the east end of Hamilton Harbour where the harbour narrows at Windermere Basin/ Red Hill Creek. Several port users use Pier 25 to load and unload large shipping vessels which require Seaway draft (8.2m depth below chart datum (74.0m, IGLD 1985). This area experiences ongoing siltation which requires maintenance dredging. The area is historically dredged to 9.0m below chart datum every 6 years. Figure 2.1 shows the location of Pier 25 and the dredge area.

HOPA recently completed a sounding survey of the area. Figure 2.2 shows the depths soundings. The estimated dredge volume to establish a navigation depth of 9m below chart datum is currently 15,000m^3. It is estimated that by summer 2022 this volume will increase to approximately 30,000m^3.

2.1 Dredging Methods

Dredging methodology depends on the equipment, materials and labour available to the contractor at the time of the project. The following provides a possible methodology based on experience on similar projects in Southern Ontario.

Dredging may be carried out using mechanical or hydraulic equipment. It is anticipated the dredging operation will be carried out using a mechanical marine-based dredging plant with tugboat and scows. Mechanical dredging plant equipment will consist of a crane or long reach excavator fitted with a bucket. The type of bucket used depends on the quality of the material. An open bucket can be used where material is not contaminated. It allows water to drain maximizing the quantity of material lifted off the bottom with each bucket and placed in a scow. A closed bucket or environmental bucket is used when there is a potential for contaminated dredge material or in areas sensitive to turbidity. This bucket seals tight once it is closed around the material preventing loss of dredge material through the water column as the bucket travels to the surface. Water does not escape from the bucket until it is opened over the scow.

Hydraulic dredging equipment uses suction to lift material off the bottom. Depending on the material being dredged, the head of the suction pipe is fitted with a cutter head to help loosen the material on the bottom. A slurry of dredgeate travels along the pipeline to a scow. Hydraulic dredging contains a higher percentage of water compared to mechanical dredging.

Once a scow is full, a tugboat maneuvers the scow to a dock where it is unloaded using an excavator or pumped to a temporary staging area. From shore it can be loaded into trucks and transported to a disposal site. Depending on the quality of the material (e.g., slump, water content) the material may need to be temporarily stored so that it can be decanted/dried and/or tested before being transported to a disposal site. The disposal sites available depend on the sediment quality.

Dredging 30,000m^3 of material is estimated to be completed in approximately 8 to 10 weeks, depending on weather conditions. Construction timing of the work will be restricted by the fisheries in-water work window. Construction of the facilities to support the dredge operation, dewatering

and management of the material on land will depend on the dredge material qualities and disposal site selected.

The work will need to be carried out within a turbidity curtain. Additional measures may be required depending on the dredging method employed and the quality of the material.

2.2 Sediment Quality

Prior to the next maintenance dredge, sediment samples will be collected and tested according to Ministry of Environment Conservation and Parks (MECP) guidelines. These guidelines/ regulatory documents include:

- Rules for Soil Management and Excess Soil Quality Standards (MECP, 2019) which provides guidance on the management of excess material and has been adopted as Ontario Regulation 406/19 (On-Site and Excess Soil Management);
- Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario (MECP, 2011) for disposal near or in the water; and
- Soil Ground Water and Sediment Standards for Use Under XV.1 of the Environmental Protection Act (MECP, April 2011) for on land disposal.

MECP (2019) specifies criteria for reuse of soil on land, while MECP (2011) provides guidance on in-water disposal. Hamilton is a federal port and shipping and navigation are federally regulated activities. This dredge project is required to maintain navigation within the Port. The project is under federal jurisdiction and is not required to meet provincial regulations. However, meeting the intent of the provincial regulations is considered a best practice by HOPA.

MECP (2019) consists of two parts: Part I: Rules for Soils management and Part II: Excess Soil Quality Standards. Part I addresses requirements for planning and management including an assessment of past uses, a sampling and analysis plan, a soil characterization report, an excess soil destination assessment report and requirements of a tracking system. It also includes direction on soil processing and storage, waste transfer sites, and reuse sites. It addresses specific rules for reuse sites in relation to specific types of soil and types of reuse sites, the use of the Beneficial Reuse Assessment Tool (BRAT) and risk assessments. Part II provides direction on determining the applicable generic excess soil quality standards. This section provides tables of generic excess soil quality standards. Prior to this regulation change, the soil would be compared to Soil Ground Water and Sediment Standards for Use Under XV.1 of the Environmental Protection Act (MECP, April 2011) for on land disposal and Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario (MECP, 2011) for disposal near or in the water.

In 2016, Peto MacCallum Limited (PML) carried out sediment sampling and testing of the area offshore of Pier 25 in order to characterize the material for land disposal and management during completion of the previous dredging project. Their report, titled Pier 25 Pre-Dredge Sediment Sampling and Chemical Testing Program Pier 25 Hamilton Ontario for Hamilton Port Authority dated April 2016 provides details of their sampling and testing procedure. Sixteen samples (fourteen grab and two composite) were tested. The sediment testing results were compared to

Table 9 - Generic Site Condition Standard for Use within 30 m of a Water Body in a Non-Potable Groundwater Condition and Table 3 – Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition (MECP, April 2011) for on land disposal.

PML found that the samples tested did not meet Table 9 criteria. They also found that the sediment quality did not meet Table 3 criteria for several metals and inorganics parameters and acid/base/neutral compounds.

The Fill Quality Guide (MECP, 2011) states that contaminated fill should not be placed in the water or along the shore or bank adjacent to the water or along the shore or bank. Materials placed behind an impermeable barrier on the shore or bank that can withstand a one in 100 year storm are not subject to the Fill Quality Guide. If the material meets the guidelines for unconfined fill (Table C-2) it may be placed in or near the water. If the material meets the guidelines for Confined Fill (Table C-1), the material may be placed within the confines of a structure that is capable of withstanding the 100 year storm and prevents it from coming in contact with open water and being washed away. The 2016 sediment sample test results indicate that the material does not meet the criteria for either unconfined fill or confined fill. Prior to the next dredge harbour bottom sediments should be sampled and tested. If the sediment meets the standards provided in the Fill Quality Guide for Shore Infilling, more beneficial reuse options for material management are available.

The sediment samples were also compared to O. Reg. 347 as amended by O. Reg. 558/00 for disposal at a landfill. The sediment quality met O. Reg. 347 as amended by O. Reg. 558/00 Schedule 4 Criteria. The material can be classified as non-hazardous waste for landfill disposal. PML provided a list of guidelines for off-site and on-land disposal of the material. In particular, they state that the dredgeate cannot be taken to a property for which a Record of Site Condition (RSC) has been previously filed unless the sediment meets the Site Condition Standard (SCS) contained in the RSC.

For this feasibility study, a comparison of the PML sample test results to Table 3.1 (Full Depth Excess Soil Quality Standards in Non-Potable Ground Water Condition) and Table 9.1 (Full Depth Excess Soil Quality Standards for use within 30 metres of a Water Body in a Non-Potable Water Condition) of MECP (2019) was carried out. It was found that the sediment sample qualities did not meet Table 3.1 or Table 9.1 standards. Table 1 presents a summary of the contaminants tested by AGAT Laboratories and provided in the PML report that exceeded Table 3.1 standards. The contaminants presented have at least one sample of the 16 samples tested that exceeded the standard for either disposal location (i.e., Residential/Parkland/Institutional or Industrial/Commercial/Community). The average concentration of the 16 samples is also presented. Where an average exceeded Residential/ Parkland/Institutional standards the value is blue text. Where the average exceeded the Industrial/ Commercial/Community standard the value is red text and where the average did not exceed either standard the value is black text. Overall the contaminate levels were found to be consistent across the site.

Table 2.1 - Contaminant Exceedances

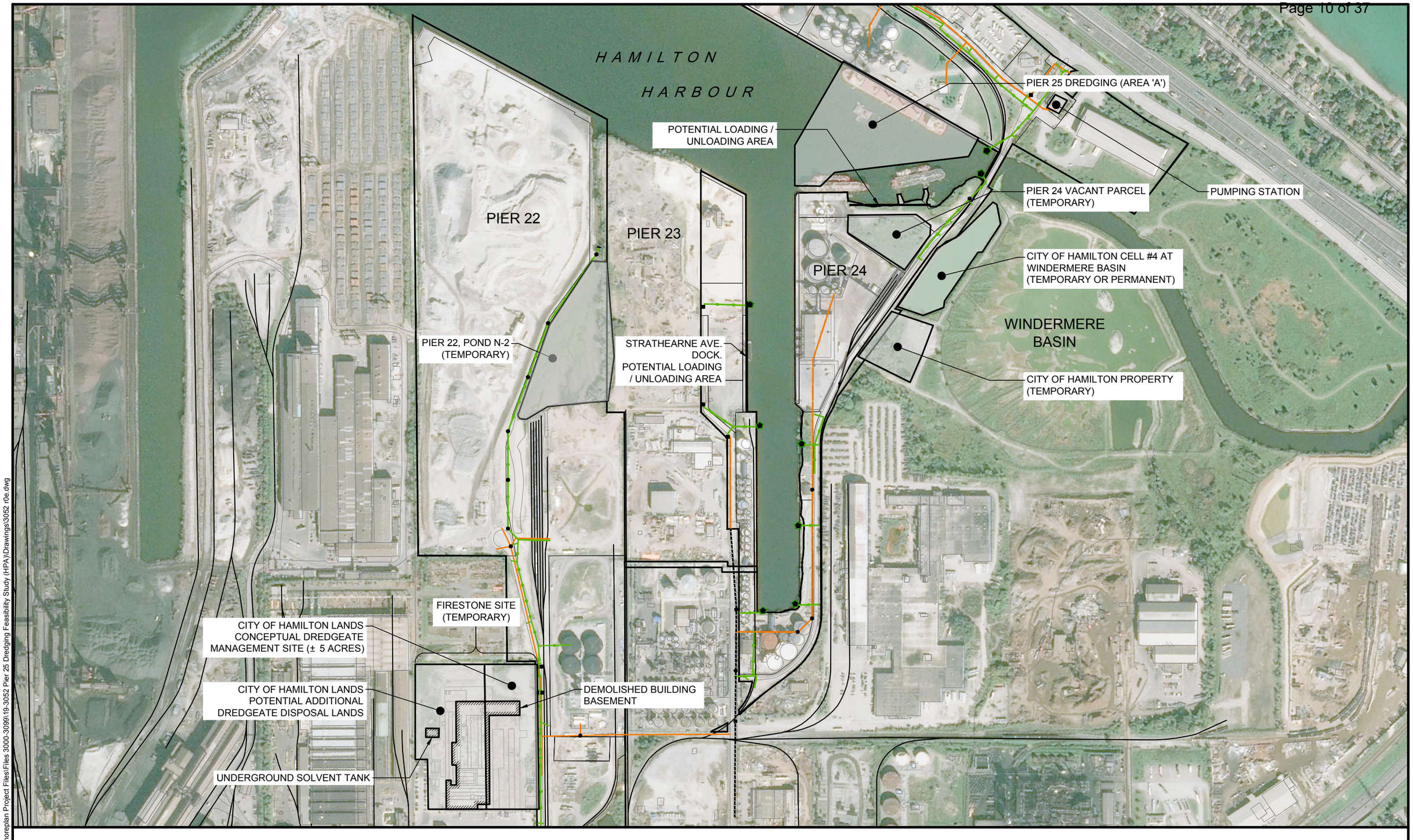
	Table 3.1(MECP 2019) Soil Standard (ug/g)		Average of 16 samples (µg/g)
	Residential/ Parkland/ Institutional	Industrial/ Commercial/ Community	
Parameter	**Any exceedance is coloured by category**		
Acenaphthylene	0.093	0.093	0.074
Anthracene	0.16	0.16	0.17
Benz(a)anthracene	0.5	1	0.38
Benzo(a) pyrene	0.57	0.7	0.91
Bis(2-Ethlhexyl)Phthalate	5	28	4.1
Boron (hot water soluble)	1.5	2	1.86
Cadmium	1.2	1.9	1.46
Copper	140	230	159
Fluoranthene	0.69	70	2.15
Indeno(1,2,3-cd)pyrene	0.38	0.76	0.4
Mercury	0.27	0.27	0.28
Petroleum Hydrocarbons F2	10	26	>30
Petroleum Hydrocarbons F3	300	1700	609
Polycholrinate Biphenyls	0.35	0.78	0.57
Selenium	2.4	5.5	3.9
Toluene	0.99	7.8	1.31
Zinc	340	340	720.9
Electrical Conductivity	0.7	1.4	1.46

Legend
Blue text parameter concentration exceeds MECP (2019) Table 3.1 Residential/Parkland/ Institutional
Red Text parameter concentration exceeds MECP (2019) Table 3.1 Industrial/Commercial/Community

Table 9.1 of the Excess Soil Quality Standards (MECP 2019) provides standards for contaminant for use within 30 metres of a water body. These levels are equivalent or more stringent than the levels set out in Table 3.1 (MECP 2019) which the currently available samples exceed. Figure 2.3 Decision Tree for Disposal Options

provides a decision tree for determining the disposal options based on the sediment quality.

Development of a site-specific excess soil quality standard may be possible using the Beneficial Reuse Assessment Tool (BRAT) or carrying out a site-specific risk assessment. These assessments must be carried out by a Qualified Person as set out in section 5 or section 6 of O.Reg.153/04. MECP (2019) also has special considerations for soil that have been solidified using certain additives which may restrict the reuse site to being 30 metres way from a water body.



Project: 19-3052
Scale 1:600
SHOREPLAN

Figure 2.1
Pier 25 Dredging Feasibility Study
Study Limits and Existing Sanitary and Storm Sewers

Drawing Location: S:\Shoreplan Project Files\Files 3000-3099\19-3052 Pier 25 Dredging Feasibility Study (HPA)\Drawings\3052 -0e.dwg

EASTPORT BLVD

PIER 25

AGRICO

RICHARDSON

HAMILTON RESCUE

HAMILTON ENERGY

PROVMAR

PIER 24

McASPHALT

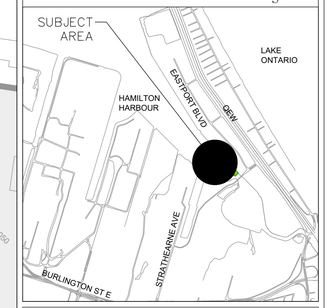
PIER 23

LAKESHORE SANDS

STRATHEARNE AVENUE SLIP

KEY PLAN

SCALE: N.T.S.



GENERAL NOTES:

1. All soundings are shown in metres below International Great Lakes Datum 1985 for Lake Ontario which is 74.2m above sea level.
2. Horizontal Coordinates are referenced to NAD1983, UTM Zone 17.
3. Soundings were taken on Aug. 23, 2019 by S.P. using Single Beam Teledyne Odom Echotrac CVM Surveying Sounder interfaced with SX Blue II DGPS
4. Water level at the time of survey was 1.33m above datum as measured at the Canadian Hydrographic Services Gauge in Burlington.

REVISIONS:

No.	COMMENTS	INITIALS

LEGEND

PORT PROPERTY LIMITS

×9.0 SOUNDING 9.0m DEPTH BELOW CHART DATUM

25 0 Meters 25 50

1:1000

KEY TO DRAWING LOCATION:

NMBR / LCTN DRAWING NUMBER
SHEET NUMBER

DREDGE LIMITS

POINT	NORTHING	EASTING
1	4791605.8	598690.0
2	4791408.7	598874.6
3	4791384.3	598848.5
4	4791426.0	598620.4
5	4791412.0	598589.8
6	4791425.1	598547.6
7	4791491.6	598568.1

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NOTE:
These soundings are **NOT FOR NAVIGATION**. They are for planning purposes only, and only reflect conditions at the time of the survey. It is the responsibility of the vessel operator to use updated hydrographic charts for navigation of their vessel in the ordinary practice of good seamanship.

PROJECT:	**PIER 25 SOUNDINGS**
DWG. TITLE:	**BATHYMETRIC SOUNDING SURVEY**
SCALE:	**1 : 1,000**
DATE:	**SEPTEMBER 2019**
DRAWN BY:	**S.P.**
CHECKED BY:	**NONE**
DWG. No:	**M-01**
LOCATION:	**s/engineering/civil 3d projects/p25 soundings/p25 facewall soundings_aug 2019.dwg**

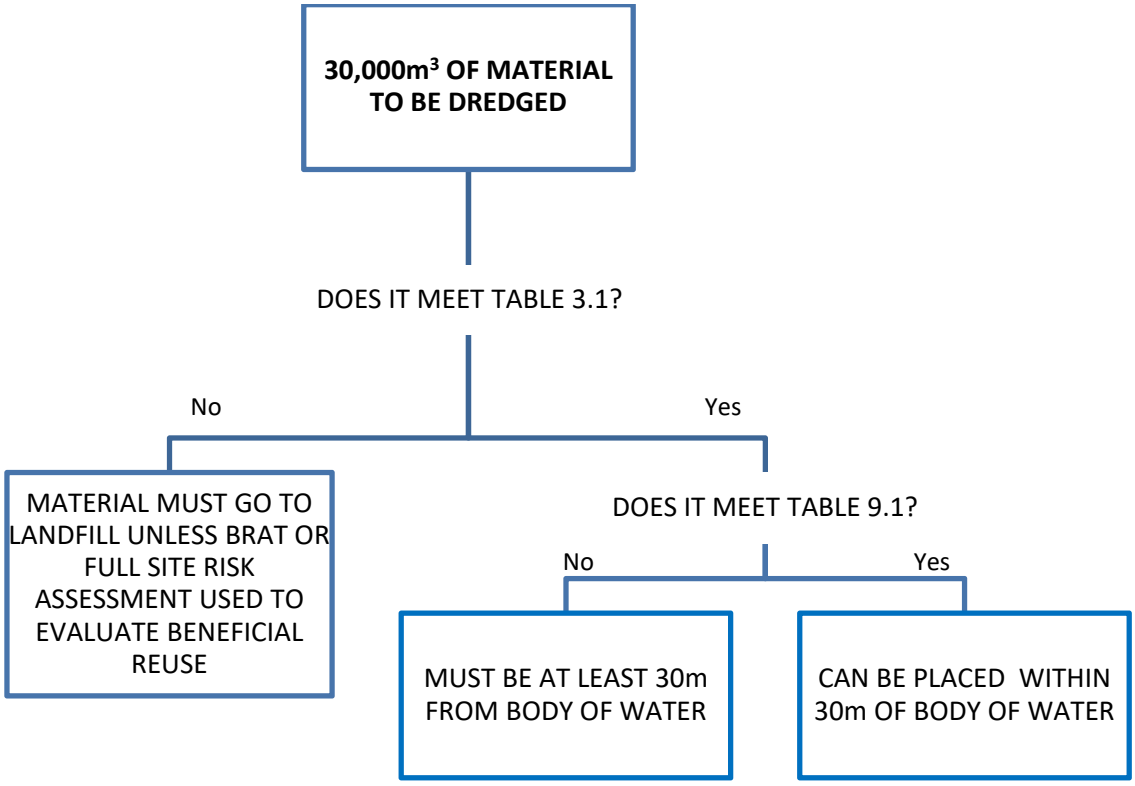

Figure 2.3 Decision Tree for Disposal Options

3 DISPOSAL OPTIONS

Disposal options for the dredgeate depend on the sediment quality and slump. The results of the 2016 sediment sample testing found that the material could be disposed of as non-hazardous waste at a landfill. The material exceeded some of the parameters in Table 3, Full depth generic site condition standards in a non-potable ground water site condition (MECP 2011) and exceeds the new standards set out in Table 3.1, Full Depth Excess Soil Quality Standards in a Non-Potable Ground Water Condition (MECP 2019). We understand that the previous excess material from dredging Pier 25 was placed at Pier 22, a HOPA property.

Sediment testing of the dredge material for the current project should be carried out to assess disposal options. If the testing shows that the dredgeate samples meet Table 3.1 standards, i.e., it can be placed on land at a location 30 m away from the water, City owned disposal sites could be utilized to permanently store the material. City owned disposal sites considered in this investigation are described in Section 3.1. Other City owned or privately owned sites not reviewed in this report may be available. The City's by-law (Fill by-law 03-126) restrictions and any possible exemptions would need to be considered when assessing these other disposal sites.

If the material does not meet Table 3.1 standards, beneficial re-use options should be assessed using BRAT or a full risk assessment could be carried out to modify the standards. These assessments must be carried out by a Qualified Person (as per O.Reg.153/04). Treatment or conditioning options may also be available including the addition of polymers to the dredge material. The viability of treatment or conditioning of the material is highly dependent on contaminants present in the dredgeate determined through testing. These options will also need to be assessed and reviewed by a Qualified Person. Treatment or conditioning will result in additional disposal costs that can only be assessed once testing is completed.

If these other options are not viable, the material it will need to be disposed of at a landfill. Landfill options are discussed in Section 3.2. Other options for disposal are available if the testing shows that the quality of the material has improved significantly. These options include disposing the material closer to the water as confined fill or in the water as unconfined fill.

3.1 Disposal Sites

HOPA has identified several areas at Piers 22 to 25 for dredge material disposal. These sites are being considered for either temporary management of material or permanent disposal.

The sites available as identified by HOPA include:

1. Cell #4 at Windermere Basin
2. Pier 24 Vacant Parcel
3. Former Firestone Site
4. Filled Pond N-2 at Pier 22

Figure 2.1shows the location of each site. The following sub-sections describe the features of each site and its potential for use as a disposal site. Methods for unloading and transporting the

material are discussed. Decanting/drying the material is discussed separately in Section 4. Table 3.1 at the end of this section summarizes the options for permanent storage at each location.

3.1.1 Cell #4 at Windermere Basin

Cell #4 is located to the northwest of Windermere Basin between the basin and the rail line and along the roadway known as Pier 24 Gateway. It was previously evaluated to be used as a temporary storage area for Pier 25 dredge material by Baird (2010). The sediment management plan presented in that report stated that Pier 25 would be dredged using mechanical equipment. The dredgeate would be trucked to Cell 4 where it would be dewatered. Once dewatered, it would be trucked to an appropriate landfill for disposal. Baird proposed expediting dewatering by use of a centrifuge. Odour, dust and noise were identified as potential concerns.

Capacity

HOPA indicated that the expected capacity of this pond is 26,000m^3. This volume was based on information provided by the City indicating that the design volume was noted as 21,000m^3 and that the cell has been dredged an additional 5,000m^3 as proposed in Baird (2010). Subsequently, the City and Hamilton Conservation noted that the cell had not been dredged again. They also advised that the cell could only be filled to an elevation of 75.0m, matching existing grades at the site, because it is in the flood plain. With an estimated area of approximately 12,000m^2 this would indicate that average depth of the material placed at the site could be just over 1.5m for a total volume available of 18,000m^3. During detailed design, a topographic and bathymetric survey to confirm the actual capacity of Cell #4 should be carried out.

Temporary Storage Site

If Cell #4 is considered for a temporary storage site, it is expected that the cell would be filled completely to the existing grade (elevation 75.0m) resulting in a disposal of approximately 18,000m^3. The material will require dewatering before transporting off the site. MECP (2019) provides requirements for soil management that may need to be considered during detailed design.

Permanent Disposal Site

If Cell #4 is considered for permanent disposal, capping is required which will decrease its capacity. If a 0.5m cap layer is assumed, the estimated remaining capacity to store dredge material is less than 12,000 m^3. If the dredge material is contaminated to a degree that the cell would need to be isolated from the water, its capacity is further reduced to levels that do not make this site viable. Additional storage capacity will be needed elsewhere to accommodate the estimated 30,000m^3 dredge material in 2022.

Disposal at Cell #4 requires management of both existing pond water and the excess water from the dredge material. Management of the excess water is described in Section 4.

Loading/Unloading

Cell #4 is located close to the dredge area. Off-loading options for Cell #4 depend on the dredge method used (i.e., mechanical or hydraulic). Two shore connected dolphins on the south side of the dredge area at Pier 24 and near Cell #4 are currently being used for berthing vessels. The shore connections are not adequate for loading trucks. However, they could be utilized for mooring scows and pumping dredgeate across to Cell #4. Additional temporary dolphins may be required depending on the contractor's equipment. A hydraulic pump and pipeline system could be used to transfer the material from the scow to Cell #4. One of the challenges of constructing a pipeline would be crossing the road and railway tracks. This may be overcome by raising the pipeline over the road and railway track. The contractor would need to design and build modifications to the dock, and pipeline and pump system as part of their contract because the design requirements would be based on their equipment. Given the small dredgeate storage volume these structures would support, it is likely that this option is cost prohibitive unless they could be utilized for offloading the remaining dredge material for transport to other locations or used for future dredge operations.

Offloading the material into trucks is another option. A dock for unloading the dredge material could be provided by constructing a temporary dock southwest of the dredge area near Pier 24. Travel required from the potential unloading area to Cell 4 disposal area is less than 200m. Alternatively the existing dock at the north end of Strathearne Ave could be used to could be utilized. The travel distance increases significantly to approximately 1.5km. For disposal at Cell #4, the material would be loaded into watertight trucks and transported to the disposal site. A temporary watertight container located at the dock would likely be required to store a small quantity of material to manage trucking and dredging timing.

3.1.2 Pier 24 Vacant Parcel

This vacant parcel of land is located on the west side of Pier 24 Gateway across the road from Cell #4. This HOPA property is adjacent to Pier 24 which is currently leased to McAsphalt. An access road to Pier 24 runs along the north side of the property.

Capacity

The available property area is approximately 8,900m^2 and well vegetated. Dredgeate could be placed on the portion of the property that is 30 m away from the water which reduces the footprint available for placing material. Given the relatively flat angle of repose of dredge material, the volume of material that can be stored at this site is reduced. Perimeter retaining walls could be constructed around the property to increase the storage volume. The estimated remaining storage area is approximately 7000m^2 with a capacity to store approximately 8400m^3 of material if the walls are designed to retain material 1.2m high. Higher walls could be constructed to increase capacity.

Excess water will need to be managed at the site. The volume of water to be managed will depend on the dredge method. Management of the excess water is described in Section 4.

Temporary Storage Site

We understand that due to HOPA's lease obligations this site can only be used as a temporary handling or storage site. If the dredgeate meets Table 3.1 standards (MECP 2019) the material can be stored on the site. If the material does not meet Table 3.1 standards, an impermeable storage facility could be constructed to store and dewater the material until it is transferred to a permanent disposal site. Its close proximity to the work area makes this site ideal for temporary storage. Creating an impermeable storage facility would reduce the storage capacity of the site.

Loading/Unloading

This location directly south of the dredge area is ideal if off-loading activities can be accommodated along the shoreline. The same off-loading facilities described in Section 3.1.1 for Cell #4 would apply here for both hydraulic and mechanical dredging. An access road to Pier 24 runs along the north side of the property. Therefore the material would need to be either pumped or trucked across the road from the dock. If off-loading activities are restricted to the pier at the north end of Strathearne Ave., the travel distance increases significantly to just over 1.5km.

3.1.3 Former Firestone Site

The former Firestone property is located on the west side of Hobson Road north of the City resource recovery station. The land at the Firestone site previously held a building which was demolished to ground level. The foundation, basement and ground floor slab of the building remain. The basement of the building is outlined on Figure 2.1. A site visit revealed holes cored in the slab and open areas such as stair wells covered with steel plates.

Permanent Disposal Site

Using the basement of this site as a permanent disposal site has been rejected by the City's Legal, Real Estate and Waste divisions. We agree with this decision at this time on the basis that the contents of the basement are unknown. We understand that water has filled the basement to the level of the harbour. Care would need to be taken to ensure water from dredgeate run off and potentially contaminated materials did not mix with the water in the basement which could contain contaminants from the equipment and materials stored in the basement of the building.

Additionally if dredge material were permanently placed at this site it may restrict future use of the site. With additional planning the site could be remediated, removing the concrete cover on the basement, clearing the area and treating any contaminated water that is found in the basement. Once cleared, this site could be used to store future dredgeate. Future dredging projects will need to reassess this option with the relevant City stakeholders.

Temporary Storage Site

Currently, the best use of this site is for temporary handling or storage of the material in the area outside the basement. However, we understand that currently this option has also been rejected

by the City. If revisited, the area in the southeast corner that sits outside the basement is approximately 8,000m^3 and provides an area that could be used to dry approximately 8,000-10,000m^3 of dredge material for offsite disposal. Currently this site is being leased to HOPA by the City. We understand that if the City were to use this site for temporary storage of dredge material, the City's Real Estate department would need to approve the proposed use as there are environmental implications for this site.

Loading/Unloading

Access to the site would need to be provided from the Strathearne Ave. slip where loading and initial decanting would occur. Temporary handling would most likely require a dedicated area for managing excess water from the dredge material which is described in Section 4.

3.1.4 Filled Pond N-2 at Pier 22

Pond N-2 is located on the west side of Pier 22 approximately 250m west of the dock wall. The pond was previously used to store dredge material and capped. HOPA indicated that the cap is a 2m thick layer of clean fill material. The pond area is approximately 16,000m^2.

Capacity

The cap material would need to be removed prior to placing material at this site. Up to 32,000m^3 of cap material would need to be excavated to place dredgeate at this site. The excavated cap material could be used to create a perimeter berm and remaining cap material either removed or reused as cap material in the future. It is anticipated that 30,000m^3 of material could be stored at the site.

Temporary Storage Site

This HOPA property site is only available for temporary storage area of the dredge material while it is dewatering. City would need to lease this property from HOPA while the material is drying. The drying or dewatering at this site would be passive. The time to dewater the material will impact the cost of using the site. Expediting this process is possible with treatments (additives) or mechanical dewatering systems (centrifuge). Additives could be used to expedite the process but may increase landfill costs and may eliminate the possibility of beneficial reuse according to MECP (2019). Further discussion of dewatering is discussed in Section 4.

Table 3.1 - Permanent Placement Options

	Permanent Placement			
	City Property		HOPA Property	
	Cell #4	**Firestone Site**	**Pier 24**	**Pond - N2**
Meets Table 9.1	< 12,000m^3 capacity with cap (0.5m min.) ~18,000m^3 to be disposed of elsewhere.	Rejected for any use by Real Estate	Not Available	Not available
Meets Table 3.1	limited capacity (<10,000m3) and requires cap and structures to separate dredgeate from water. ~20,000m^3 to dispose of elsewhere			

Table 3.2 Temporary Storage Site Options

		Temporary Storage for Dewatering			
		City Property		HOPA Property	
		Cell #4	**Firestone Site**	**Pier 24**	**Pond - N2**
	Passive de-watering	Isolation from harbour would allow passive drying. Requires significant infrastructure to create a water tight barrier limiting capacity.	Rejected for any use by Real Estate	Requires construction of walls min.1.2m high. Limited capacity (<10,000 m^3)	Requires removal of cap and construction of 2m high berm to accommodate all dredge material
Active De-watering	Centrifuge	**Not Isolated** This is a flood plain and material will remain wet without isolation. Centrifuges may be used at a high cost for the equipment and a concrete pad and only small quantities would be accommodated.		Could provide space for centrifuge but would require new concrete pad, and potentially permanent lease to operate for small quantities more often.	This would require building a concrete pad on a site that is intended to be returned to HOPA. Significant infrastructure would be built for temporary purposes.
	Additives			Additives would require more space which is already limited	Could use additives to limit dry time. The depth of the area to be filled could be increased to accommodate a larger volume.
		All contaminated material would be sent to a landfill unless a beneficial reuse could be established using BRAT or site specific risk assessment. If the material meets Table 3.1 or 9.1 it could be used by the City.			

3.2 Commercial Landfills

The sediment sample testing from 2016 indicated that the material could be disposed of offsite at a landfill as non-hazardous waste. Disposing of the material at a registered landfill requires that the material also meet slump requirements. The material must have a slump less than 150mm. The dredgeate may require dewatering or drying at a temporary storage or handling area to achieve that slump. Options for dewatering are discussed in Section 4.

In 2015, HOPA reviewed two potential local landfills to dispose of the dredgeate. These sites included Stoney Creek Regional Landfill currently operated by Terrapure Environmental and Niagara Waste Systems Landfill operated by Walker Environmental. At the time, Stoney Creek Landfill was anticipating reaching its capacity and would be unable to accept the material. However, we understand the facility has recently expanded its capacity and may be available for disposal of material when the next dredge at Pier 25 occurs. Niagara Waste Systems Landfill had capacity in 2015 and currently has capacity to accept the material.

4 MANAGEMENT OF EXCESS WATER

The dredge material will contain excess water. Water from the dredging operation will collect in the scow and water will be entrained in the dredge material. It is estimated that mechanical dredging can contain 50 to 60% water. If hydraulic dredging methods are used high volumes of water will need to be managed. The estimated water content for hydraulic dredging is between 65 to 90%. It is anticipated that the dredging will be carried out with mechanical equipment.

Based on the sediment and water sample testing results during detailed design, water collected during the dredging operation may need to be contained, sampled and tested (e.g., quality, total suspended solids). Appropriate management options will be determined by comparing the test results to the Sewer Use by-law and Provincial Water Quality Ontario Standards (PWQO) and if it is determined that the waste water will not be deleterious to fish if the water is being discharged to fish bearing waters. Plans developed to manage the excess liquid will need to be prepared by a Qualified Person. Management options may include discharge to the local sanitary sewer, storm sewer, vacuum truck disposal, and onsite treatment and discharge back to the harbour.

The sewer options depend on disposal or temporary storage location utilized for the project. Figure 2.1 shows the local sanitary and storm sewer lines provided by HOPA. Excess water at Cell#4 could directed to either of City and HOPA sanitary and storm sewers. Excess water at Pier 24 could be directed to either HOPA's storm sewer or the City's sanitary sewer and Pond N-2 water could be directed to HOPA sanitary or storm sewer lines.

Eastport (HC017) Wastewater Pumping Station is in close proximity to Pier 24 and Cell#4. It has an existing MECP ECA which defines and limits pump station capacity. Water directed to HC017 must comply with the MECP ECA for the station and meet the City's Sewer Use by-law. Use of the local pump station is also be dependent on available capacity at the time of dredging. The pumping station has limited capacity during high water level periods on Lake Ontario. It may only be available for use during periods of low precipitation and low lake levels. Discharge to the station during high precipitation events will not be facilitated by Plant Operations.

The remaining fine grained dredge material will have a high water content even after the surface water has been decanted. The material must have a slump less than 150mm in order to be considered as solid waste for transfer to a landfill. If it does not meet this requirement it is considered liquid waste. If the material is being disposed of at a landfill, slump tests will be carried out prior to transport offsite. A temporary storage or handling area will likely be required to dry or condition the material for acceptance at a landfill or for beneficial reuse. Potential temporary handling areas are located at the vacant property at Pier 24 and Pond N-2.

The dredge material will need to be dewatered passively or actively. The following describes methods for passively drying the material or actively drying the material by conditioning, filtering through a membrane, or centrifuge to meet slump requirements.

4.1 Passive Drying

Passive drying of the material primarily relies on evaporation to reduce water content and solidify the material. The dredgeate is spread out over an area for drying. The thicker the layer of material the longer time it will take to dry. The material should be graded such that water flows away from it into an area for collection and removal. Depending on the quality of the water collected, the water may need to be tested and/or treated. Once the excess water meets criteria for disposal, it can be returned to the harbour, local sewers or vacuumed trucked for offsite disposal.

Passive drying can be a slow process taking months to years. The temporary storage areas would be fully utilized over that period of time. If the material is found to exceed Table 3.1 (MECP 2019), an impermeable containment area would need to be constructed to facilitate drying at the temporary storage sites (Cell 4, Pier 24 and Pond N-2). This could consist of placing a clay or bentonite layer on the ground and constructing lined retaining walls to prevent loss of material from the handling area. These measures increase the drying time because water can only evaporate from the surface and cannot be absorbed into ground.

The stock pile should be monitored during the drying process. The upper layer of material will dry faster creating a crust over the lower material. This crust may slow the drying of the bottom material. A drain system could be installed within the handling area to help expedite dewatering from the bottom sediments. This water would need to be managed similar to the other collected water. Alternatively, the upper layer of the stock pile could be taken away to a landfill when it meets the slump criteria. This would allow drying of the bottom sediments through evaporation. Detailed design should consider means to direct water away from the stock pile for treatment and disposal and the need for a layer to prevent infiltration based on the results of the testing and site requirements.

If the material takes longer to dry than anticipated and the extended period has the potential to impact project costs, active drying techniques for a portion of the material may be considered.

4.2 Active Drying

Active drying is another method to remove water or solidify the material resulting in increased slump. Several methods exist including adding commercially available absorbents, adding sand or wood chips, filtering the material through a Geotube or similar product to remove water, or a mechanical centrifuge.

Previous dredge plans considered a centrifuge method as a feasible method to dewater the material. This method was discussed with Terrapure Environmental (Terrapure) who provides both hydraulic dredging and centrifuge drying services to manage dredgeate. While a centrifuge may be used with material dredged with mechanical or hydraulic equipment, Terrapure recommended hydraulic dredging because of the high water content. Using hydraulic dredging equipment, harbour bottom sediments and water are pumped into a scow. The material is then pumped to shore where it is placed in a mixing tank to create a slurry for the centrifuge. The slurry

needs to have a solid content in the order of 5 to 20% which means additional water may need to be added to the dredgeate in the tank. Polymers are also added to the slurry to facilitate flocculation. The flocculated slurry is injected into the centrifuge. Three centrifuges were recommended for the estimated volume of dredge material and production rate of the hydraulic dredge equipment.

Processing this material will require management of a large volume of water. The processing area will need to include a mixing tank, centrifuges, and area to manage the dried material and centrate (by-product water). Treatment facilities for the centrate may also be required depending on the by-product water quality. A centrifuge supplier provided an example of the processing area layout which is shown in Figure 2.1

A centrifuge system can either be supplied and operated by a contractor such as Terrapure or purchased and operated by the City. A preliminary cost estimate for this work is provided in Section 6.3.3. A preliminary cost estimate from a manufacturer for purchasing a centrifuge system including three centrifuges, mixing tank, centrate holding tank, and concrete pad is between $2.M and $2.5M. This does not include site improvements or operating cost which will further increase the cost of the system. The area south of Cell #4 was previously identified as an area to operate a centrifuge system. The site is equipped with electrical service for this operation. However, additional site improvements would need to be constructed in order to operate the centrifuge system at this site.

The current quality of the dredge material and decanted water is not known at this time. The additional volume of water needed to create the slurry increases the volume of water substantially therefore increasing project costs. If the dredge production rate is not matched to the centrifuge production rate, there can be standby time which also increases project costs.

All of the active drying methods need a temporary handling area to manage the material. The space required depends on the method utilized. Each increases the cost of handling by the cost of the added equipment and materials and by increasing the volume of material to be disposed of offsite (except with the centrifuge option). If the material needs to be removed quickly to a landfill these methods should be explored. MECP (2019) has special conditions for dewatered/solidified soil which should be considered when assessing active drying methods which may restrict the reuse site to being 30 metres way from a water body. If time is not critical and the temporary storage areas are not needed for the next dredge or other operations, we recommend passive drying as the preferred alternative.

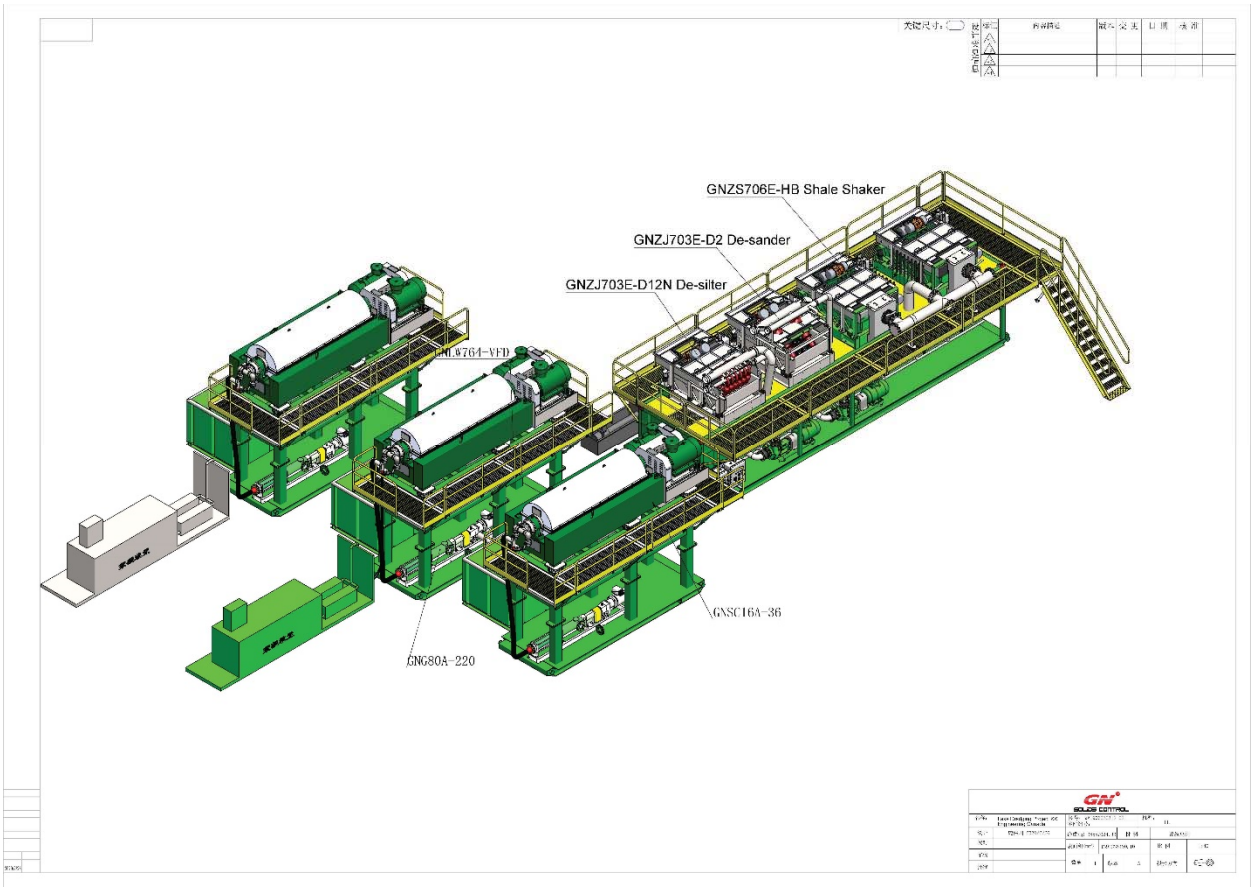

Figure 4.1 Centrifuge System

5 PERMITS AND APPROVALS

Dredging Hamilton Harbour requires the project to be reviewed and/or approved by the following federal agencies:

- Transport Canada (TC)
- Fisheries and Oceans Canada (DFO)
- Hamilton – Oshawa Port Authority (HOPA)

Provincial and Municipal review may include:

- Ministry of Natural Resources and Forestry (MNRF)
- Ministry of Environment Conservation and Parks (MECP)
- Hamilton Region Conservation Authority (HCA)
- City of Hamilton

Organizations to be informed of the project include:

- Hamilton Remedial Action Plan (RAP)

A brief description of each agencies review and/or approval process is provided below.

5.1 Transport Canada

Transport Canada (TC) reviews projects with respect to the Navigation Protection Act. Works that are classed by TC to fall under the “designated works” under the NPA (that is complying with the requirement of the Minor Works Order) may proceed without Notice of the Minister as long as they comply with the legal requirements. Dredging is included under the minor works order if *the works are done in order to maintain the width and depth of the navigable waters; all dredge materials are disposed of above the ordinary high-water mark or in the water where the disposal is authorized by or under an Act of Parliament; the works do not use suction dredging that involves the use of floating or submerged pipes; the works have no cables that cross over or through any portion of the navigable water; and the works do not include blasting*. If any of these conditions cannot be met, the project will need to be reviewed by Transport Canada.

5.2 Fisheries and Oceans Canada

Fisheries and Oceans Canada (DFO) may review the project under the Fisheries Act. The Fisheries Act states that “No person shall carry on any work, undertaking or activity that results in the harmful alteration or disruption, or the destruction, of fish habitat”. In the past maintenance dredging was considered an activity that did not require review if certain conditions could be met. DFO has recently developed an interim code of practice for maintenance dredging which outlines the best practices for routine maintenance dredging. DFO considers routine maintenance dredging to be dredging that “*occurs at least once every 10 years and involves the mechanical removal of accumulated sediment from the bed of a water body with clamshell buckets, draglines or backhoes, suction dredges). Routine dredging helps to maintain the design depths of navigation channels, harbours, marinas, boat launches, docking sites and port facilities that*

contribute to tourism, recreation and the transportation of goods." The project does not require review by DFO if routine maintenance dredging has been completed once in the last 10 years; a test for polychlorinated biphenyls (PCB) content of the substrate to be dredged was completed within the last 5 years and no species at risk (SARA) or critical SARA habitat is found in the area; the material will be disposed and stabilized on land following provincial legislation or disposed of in an approved Marine Disposal and Dumping Site; and all applicable measures in the code of practice and all other measures to protect fish and fish habitat are incorporated in the project.

This project could meet all of these conditions and not require review. Currently, no SARA species are identified in the dredge area. It is anticipated that sediment sampling and testing which includes PCBs will need to be carried out prior to the next dredge to confirm the presence of PCBs.

5.3 Hamilton – Oshawa Port Authority

Any work within the Port will require review by HOPA. The Hamilton Harbour Master will need to be informed of the project timing in order to notify vessels within the port and manage vessel traffic.

5.4 Ministry of Natural Resources and Forestry

The Ministry of Natural Resources and Forestry (MNRF) reviews projects under the Public Lands Act. It is our understanding that the project is within the HOPA's water lot and no Public Lands Act Work Permit is required.

MNRF is also responsible for establishing in-water work construction timing windows. It is our experience that the in-water work window is between July 1 and September 14 in Hamilton Harbour. We recommend contacting MNRF to confirm site specific fisheries timing windows near the time of implementation. The project is within Federal jurisdiction therefore DFO will establish the in-water work windows. It is our past experience that DFO uses the same timing windows as MNRF in this area. This will need to be confirmed during detailed design.

5.5 Ministry of Environment Conservation and Parks

MECP reviews project under the Endangered Species Act. A review of the SARA data base indicates that there is no SARA near the work area. To ensure that the projects does not impact Species at Risk (SARA) we recommend pre-consultation with MECP to determine the possibility of SARAs in the area.

5.6 Hamilton Conservation Authority

Ontario Regulation 161/06 allows the Hamilton Conservation Authority to grant permission for development within the regulated area. Hamilton Harbour is within HOPA's water lot which is under Federal jurisdiction. If the work is carried out by HOPA and the material is disposed of on HOPA property, review by HCA is not required. If the project is completed by the City and/or the material is disposed of on City owned property within HCA regulated area, HCA would review the project and provide a work permit. Preliminary consultation with HCA is recommended prior to

detailed design. HCA also recommends that any fill material be placed outside of the flood and erosion hazards of creeks and harbour.

6 DREDGE AND DISPOSAL MANAGEMENT PLAN

The following outlines options for dredging and disposing of the estimated 2022 dredge volume of 30,000 m^3. Three options for disposal management are presented. The first option assumes that the material meets Table 3.1 Full depth excess soil quality standards in a non-potable ground water condition (MECP 2019) or standards developed using the BRAT tool or a site specific risk assessment. The other two options assume that the material will disposed of at a landfill. The cost of each component of the work is presented for each option and summarized in Tables 6.1 to 6.3. These estimates do not include design including development of site specific standards, contingency allowances or taxes. The estimates are based on the construction costs from recently tendered contracts in the Greater Toronto and Hamilton Area. Recent high water levels on the Great Lakes have increased the cost of marine construction noticeably and may influence the cost of future work.

6.1 Pre- dredging investigations

Prior to commencement of the project, dredge material and water samples from the dredge material and from Cell #4 should be taken and tested to determine the soil and water qualities. MECP (2019) provides direction on sampling and reporting requirements. It also provides direction on documenting the reuse plan. The soil sample qualities will need to be compared to the soil standards in MECP (2019). Water samples will need to be compared to the requirements of the City's Sewer Use By-Law. Results of these tests will determine the appropriate option from those presented in this report.

A topographic and bathymetric survey of Cell #4 should be conducted to determine the actual capacity of the cell should it be found that the dredge material qualities are within the limits appropriate for Cell #4 design. An estimate of the potential volume of water Cell #4 contains should also be carried out in order to estimate the volume of water that will need to be managed. We understand that it may be possible to dispose of the water from Cell #4 by discharging it back to the harbour, however this will need to be confirmed with testing.

If Pier 24 or Pond N-2 are considered as a temporary storage site a topographic survey of the area should be conducted in order to prepare a base plan for the project

A survey of the dredge area should be conducted to confirm the quantity of material to be dredged and to prepare the contract drawings.

6.2 Dredge Operation

Disposal Options 1 and 2 assume that the harbour bottom is mechanically dredged using an excavator or crane operating from a barge to fill scows with dredge material. Open buckets will be used to minimize the volume of water that will need to be managed and the work will need to be carried out within a turbidity curtain. A loading dock area will be needed to load the material from a scow to trucks where it is transported to either a permanent disposal site or temporary storage area. As discussed in Section 3 this could either be at the Strathearne Ave dock or Pier 24. Pier 24 requires construction of mooring dolphins and a dock. The estimated cost of

constructing a temporary dock and other site preparation work for the dock at Pier 24 is $250,000. Site preparation and restoration at Strathearne dock includes constructing a temporary watertight bin to transfer the material from scow to truck. The estimated to cost of site preparation and restoration at Strathearne dock is $60,000. Security may be required during the dredging operation. Its cost is not included in the estimate.

Based on recently tendered projects, the estimated cost of the dredging operation including mobilization, demobilization, turbidity curtains, preparation and restoration of the dock at Strathearne Ave. and lease of the slip from HOPA is approximately $3.2M. This estimate assumes Strathearne Ave. is utilized as the offloading dock for the dredge operation. It would increase to $3.4M if Pier 24 were utilized. Table 6.1 provides a breakdown of the preliminary estimated cost of the dredging operation. Costs associated with decanting the water are not included but are included with the management of the excess material and liquid.

Table 6.1 Dredging Operation Cost Estimate

		Total Quanity	Units	Unit Rate	Units	Strathearne Dock	Pier 24
Mechanical Dredge Operation							
1	Mobilization/ Dembilization	1	L.S.	100,000.00	$/each	$ 100,000.00	$ 100,000.00
2	Turbidity Curtain	1	L.S.	50,000.00	$/each	$ 50,000.00	$ 50,000.00
3	Mechanical Dredging	30000	cu.m	100.00	/ cu.m	$ 3,000,000.00	$ 3,000,000.00
4	Loading/Unloading Area						
a)	Pier 24	1	L.S.	250,000.00	$/each		250,000.00
b)	Strathearne Slip	1	L.S.	60,000.00	$/each	$ 60,000.00	
5	HOPA docking fees (3 months)	0.25	years	10,000.00	$/year	$ 2,500.00	$ 2,500.00
5	HOPA area fees (300m2 for 3 mor	75.00	m2/year	20.00	$/m2/year	$ 1,500.00	$ 1,500.00
				Sub Total (Dredge Operation)		**$ 3,214,000.00**	**$ 3,404,000.00**
				30% Contingency		$ 964,200.00	$ 1,021,200.00
					Total	**$ 4,178,200.00**	**$ 4,425,200.00**

6.3 Disposal Options

Three options for disposal of the material are described below. Options 1 and 2 assume the sediment quality is appropriate for disposal or temporary storage in Cell #4 with minimal modifications to the cell. The first option considers permanent disposal of the material in Cell #4. The second is temporary storage at Pond N-2 and offsite disposal at a landfill. Option 3 utilizes the land south of Cell #4 to operate a centrifuge and direct transport of the material to a landfill.

Temporary storage area could be provided at Pier 24. However, the volume of material that can be stored at this site is less than the dredge quantity. Active drying techniques would need to be used to accelerate the transfer of the material to the land fill. This increases the disposal costs significantly. Use of these properties for temporary storage is not recommended at this time due to cost and no further discussion is provided.

6.3.1 Option 1 – Permanent Disposal at Cell #4

In order to dispose of material at Cell #4, the cell will need to be cleared of vegetation, the existing outlet would need to be closed and the cell dewatered. Our estimate assumes that water in Cell #4 will be transported to and treated at a waste water treatment plant. This will need to be confirmed. Section 4 provides other options that could be considered. Once the site is prepared to accept material, material would be trucked in sealed boxes from Strathearne dock to Cell #4. An excavator will be used to grade and shape the material in the cell.

Cell #4 is estimated to accept 12,000 m^3. This is not enough capacity; the surplus material would need to be taken to a landfill. Currently the unit cost for disposal at a Waste Systems (Walker Environmental) is $50 per tonne. However this rate and the availability at the preferred landfills is not guaranteed and should be confirmed closer to the intended dredge date.

Decanted excess liquid from the dredgeate and water currently in the cell will need to be managed. Our estimate assumes that 100% of the water from the cell and 30% of the volume of dredge material will be water that needs to be managed. This option assumes that excess liquid can be directed and treated at a local waste water treatment plant. The cost associated with treatment is the cost of pumping the liquid across the river to the pumping station. The unit price is estimated to be $0.1 per litre. If testing of the excess liquid finds that it has contaminates or suspended solids that exceed the limits of the City's by-law or if the capacity of the pumping station cannot accept the liquid, the excess liquid will need to be transported by vacuum truck to another facility that will accept this liquid waste. Alternatively the contractor could treat the liquid onsite and return it to the harbour. Vacuum trucking and onsite treatment are considered to have similar costs of $0.6 per litre.

After the material has dried sufficiently to allow access to the disposal area, the site will need to be restored. This will include capping the material and may include seeding or planting other vegetation. The estimate includes an allowance for restoration.

The remaining 18,000m3 of material will be temporarily stored at Pond N-2. The existing cap material will need to be removed and reused for berm material to store the dredge material. The material would be transferred from Strathearn dock to the prepared area and using excavators the material would be placed in berms to facilitate drying. Passive drying is estimated to take 1 year, after which the material would be transported to a landfill for disposal. Pond N-2's cap would be restored. The estimated cost of permanently disposing of the dredgeate at Cell #4 is $5.9M not including a contingency or taxes. Table 6.2 shows a breakdown of the disposal costs for this option. Table 6.1 provides the dredging operation costs. The total estimate cost of the project (dredging and disposal) is $9.1M.

Pond N-2 would be leased from HOPA until the material is dried. Our estimate assumes the whole site is leased. The area required and leasing cost will need to be confirmed at detailed design. We estimate the cost of leasing to be in the order of $320,000 for one year. Alternative methods for drying are discussed in Section 4. During detailed design it may be determined that a larger quantity of material may be stored at Cell #4 and or a beneficial reuse of the material may be possible which could reduce landfill costs.

Table 6.2 Permanent Disposal at Cell #4 and Landfill

		Total Quantity						Unit Rate		Cell 4 Permanent Disposal + Temporary at Pond N-2 + Landfill
Trucking										
a)	Dock to local storage site (Cell 4, Pond N2, Pier 24)									
	Trucks (loading and travel time)	12000	cu.m	8	m3/truck	375	hrs	100	$/hr	$ 37,500.00
	Excavator at Slip (time to load trucks)					375	hrs	200	$/hr	$ 75,000.00
	Trucks (loading and travel time)	18000	cu.m	8	m3/truck	562.5	hrs	100	$/hr	$ 56,250.00
	Excavator at Slip (time to load trucks)					562.5	hrs	200	$/hr	$ 112,500.00
e)	Local storage site to Landfill									
	Trucks (loading and travel time)	18000	cu.m	8	m3/truck	3375	hrs	100	$/hr	$ 337,500.00
	Excavator (time to load trucks)					562.5	hrs	200	$/hr	$ 112,500.00
Permanent Disposal Site (Cell 4)										
1	Site Preparation - vegegation and water	1	LS					50000	$/each	$ 50,000.00
2	Dewater from Cell 4									
	Sewer	12000	cu.m	100	% water	12000000	litres	0.10	$/l	$ 1,200,000.00
3	Decanted Water from Dredgeate									
	Sewer	30000	cu.m	30	% water	9000000	litres	0.10	$/l	$ 900,000.00
4	Cap Material	12000	sq. m	0.5	m	60000	m3	50	$/m3	$ 600,000.00
5	Site Finishing	1	LS					50000	$/each	$ 50,000.00
Temporary Storage Area (Pond N2 + Passive Drying)										
1	Access and Site Preparation	1	LS					25000	$/each	$ 25,000.00
2	Cap Removal, Berm, and Cap Restoration	32000	cu.m					10	$/m3	$ 320,000.00
3	Leasing (1 year)	16000	sq.m					20	$/m2	$ 320,000.00
4	Placement and Management	18000	cu.m					10	$/m3	$ 180,000.00
5	Site Restoration	1	LS					10000	$/each	$ 10,000.00
Landfill - Permanent Disposal										
1	Landfill Tipping Fees (Dry dredge material)	18000	cu.m	1.7	t/m3	30600	tonnes	50	$/tonne	$ 1,530,000.00
					Sub Total (Permanent and Landfill Disposal)					**$ 5,916,250.00**
								30% Contingency		$ 1,774,875.00
									Total	**$ 7,691,125.00**

6.3.2 Option 2 – Temporary Storage at Pond N-2 and Disposal at a Landfill

This option includes transferring all of the material from Strathearne dock to Pond N-2 for temporary storage. The Pond would need to be prepared. The cap on the Pond will need to be removed and used to form a berm. The dredge material would be trucked from Strathearne dock. An excavator would be used to grade and shape the material in order to collect decanted water. No additives or materials are added to the dredgeate to improve slump of the material for faster transport to the landfill. After the material has dried sufficiently (2 years) to meet the slump criteria, it will be transferred to a landfill for permanent disposal. Decanted liquid could be managed the same way as described in Option 1.

Once the material has met the slump criteria, it will be excavated from the pond and transferred by truck to a landfill. Pond N-2 would be restored to a condition agreed to with HOPA.

The estimated cost of this disposal option is $5.8M not including a contingency allowance. Table 6.3 provides a breakdown of the disposal costs for this option. Dredging operation costs are provided in Table 6.1. The total cost of the project (dredging and disposal) is $9M without a contingency allowance. Additional costs would be incurred if the additives, geotubes or bulking materials (sand or wood chips) were added to the dredgeate to accelerate transfer to the landfill.

Pond N-2 would be leased from HOPA until the material is dried. The whole site would be utilized for this work. The area required and leasing cost will need to be confirmed at detailed design. We estimate the cost of leasing to be in the order of $640,000 for two years. Alternative methods for drying are discussed above. Leasing costs should also be considered in detailed design. We also note that following testing a beneficial reuse of the material (MECP 2019) may be possible which could reduce landfill costs.

Table 6.3 Temporary Storage at Pond N-2 and Disposal at a Landfill

		Total Quantity						Unit Rate		Total Cost of Item	Temporary at Pond N-2 + Landfill
Trucking											
a)	Dock to local storage site (Cell 4, Pond N2, Pier 24)										
	Trucks (loading and travel time)	30000	cu.m	8	m3/truck	937.5	hrs	100	$/hr	$ 93,750.00	$ 93,750.00
	Excavator at Slip (time to load trucks)					937.5	hrs	200	$/hr	$ 187,500.00	$ 187,500.00
e)	Local storage site to Landfill										
	Trucks (loading and travel time)	30000	cu.m	8	m3/truck	5625	hrs	100	$/hr	$ 562,500.00	$ 562,500.00
	Excavator (time to load trucks)					937.5	hrs	200	$/hr	$ 187,500.00	$ 187,500.00
Temporary Storage at Pond N-2											
1	Access and Site Preparation	1	LS					25000	$/each	$ 25,000.00	$ 25,000.00
2	Decanted Water from Dredgeate										
	Sewer	30000	cu.m	30	% water	9000000	litres	0.10	$/l	$ 900,000.00	$ 900,000.00
3	Cap Removal, Berm, and Cap Restoration	32000	cu.m					10	$/m3	$ 320,000.00	$ 320,000.00
4	Leasing (2 years)	16000	sq.m	2	years			20	$/m2	$ 640,000.00	$ 640,000.00
5	Placement and Management	30000	cu.m					10	$/m3	$ 300,000.00	$ 300,000.00
6	Site Restoration	1	LS					10000	$/each	$ 10,000.00	$ 10,000.00
Landfill - Permanent Disposal											
1	Landfill Tipping Fees (Dry dredge material)	30000	cu.m	1.7	t/m3	51000	tonnes	50	$/tonne	$ 2,550,000.00	$ 2,550,000.00
					Sub Total (Permanent and Landfill Disposal)						**$ 5,776,250.00**
								30% Contingency			$ 1,732,875.00
									Total		**$ 7,509,125.00**

6.3.3 Option 3 – Centrifuge and Disposal at a Landfill

This option includes hydraulically dredging and transferring of the material to a centrifuge system where it is dried and disposed of at a landfill. The centrifuge system including premixing tanks for flocculation would be temporarily operated on City owned property south of Cell #4. Site preparation would include constructing a concrete pad to set up the centrifuge system. Dried dredge material would be trucked to a landfill immediately after processing. Centrate would be managed the same as the decanted water in Options 1 or 2 by transporting and treating it at a

local treatment plant. The quality of the centrate will need to be determined to see if it meets the City's by-law during detailed design.

The estimated cost of hydraulic dredging is $3.6M and disposal is $7.4M not including a contingency allowances. Table 6.4 shows a breakdown of the dredging and disposal costs for this option. The total cost of the project is $11M without a contingency allowance. The cost estimate assumes that the contractor will provide all equipment materials and labour to carry out the work including operation of the centrifuge. It does not include operational costs such as power consumption, maintenance of equipment or site security. Additional costs would be incurred it were found that the centrate cannot be disposed of in the local sanitary sewer. This cost estimate was prepared with the assistance of Terrapure Environmental. The information they provided included production rates. Downtime for this operation is difficult to estimate because it will depend on the weather, environmental restrictions (in-water work windows) and equipment issues. Our estimate includes 30% downtime.

Table 6.4: Centrifuge and Disposal at a Landfill

			Total Quantity						Unit Rate		Total Cost of Item	Hdyraulic Dredge and Landfill
City Property South of Cell 4												
1	Access and Site Preparation		1	LS					50000	$/each	$ 50,000.00	$ 50,000.00
2	Reinforced Concrete Pad + Base		1000	sq.m	0.2	m	200	m3	1000	$/m3	$ 200,000.00	$ 200,000.00
3	Hydraulic Dredge											
	Mobilization/Demobilization		1	LS					60000	$/each	$ 60,000.00	$ 60,000.00
	Dredge Operation for Centrifuge*		107	days	2	shifts/day			16500	$/shift	$ 3,517,800.00	$ 3,517,800.00
4	Centrifuge											
	Mobilization/Demobilization		1	LS					140000	$/each	$ 140,000.00	$ 140,000.00
	Centrifuge operation*		128	days	2	shifts/day			7700	$/shift	$ 1,969,968.00	$ 1,969,968.00
5	Centrate (Water Management)											
	Sewer		44442	cu.m	65	% water	28887300	litres	0.10	$/l	$ 2,888,730.00	$ 2,888,730.00
Landfill - Permanent Disposal												
1	Landfill Trucking and Tipping (Dry dredge mater		282	DMT/d	82	days	23208.6	tonnes	90	$/tonne	$ 2,088,774.00	$ 2,088,774.00
						Sub Total (Permanent and Landfill Disposal)						**$ 10,915,272.00**
									30% Contingency			$ 3,274,581.60
										Total		**$ 14,189,853.60**

6.4 Comparison of Options

Three options for disposal of the dredge material were developed based on our current understanding of the project. Table 6.5 provides a comparison of the options. All of the options Option 1 utilizes both City and HOPA property to store the material. The City's property is used for permanent filling and HOPA's property is used as a temporary store the excess material to dry the material before transfer to a landfill. Option 2 uses only HOPA property to temporarily store and dry dredgeate until it is transferred to a landfill. Option 3 utilizes City property as a temporary work area to operate a centrifuge and stage the work. HOPA property leasing fees would not be included in the costs if City property were used to store or manage the material. However, only

Option 3 can be carried out without the use of HOPA property. As well, Cell #4 and the area identified south of Cell #4 for the centrifuge operation is in close proximity to Windermere Basin that is a public park. Managing dredge material may not be a compatible activity adjacent to the park.

Table 6.5 Comparison of Options

Option	1	2	3
Disposal Location	Cell 4 (Permanent) + Pond N-2 (Temporary) Landfill	Pond N-2 (Temporary) Landfill	City Property Landfill
Sediment Quality	Meets Table 3.1 (MECP 2019)	Non-Hazardous Waste	Non-Hazardous Waste
Dredge Method	Mechnical Dredging	Mechanical Dredging	Hydraulic Dredging
Loading Dock	Strathearne Dock	Strathearne Dock	n/a
Water Management	City Storm/Sanitary Sewer	City Storm/Sanitary Sewer	City Storm/Sanitary Sewer
Capacity	12,000m^3 - Cell 4 18,000m^3 - Pond N-2/Landfill	30,000m^3 - Pond N-2/Landfill	n/a
Land Ownership	City and Port	Port Only	City Only
Total Costs	**$9.1M + 30% allowance**	**$9M + 30% allowance**	**$11M + 30% allowance**
Dredge	$3.2M *mechanical dredge, dock, turbidity curtain, restoration*	$3.2M *mechanical dredge, dock, turbidity curtain, restoration*	$3.6M *hydraulic dredge, turbidity curtain, pumping to centrifuge*
Disposal	$5.9M *$0.7M - Cell 4* *$0.9M - Pond N-2* *$2.1M - Sewer* *$2.2M - Trucking & Landfill*	$5.8M *$1.3M - Pond N-2* *$0.9M - Sewer* *$3.3M - Trucking and Landfill*	$7.4M $0.3M - Access & Site Prep $2.1M - Centrifuge $2.9M - Sewer $2.1M - Trucking and Landfill
Notes	Potential for larger volume stored at Cell 4, direct water from dredge and Cell 4 to sewers	Direct water to sewer from dredge only	Based on Terrapure Environmental estimate, assumes 30% downtime and sewer treatment, does not include power consumption, and other costs

Option 1 assumes that the material either meets Table 3.1 (MECP 2019) or that only minimal modifications to the cell are required to accept this material. Although it is anticipated that this is the case, there is a risk that the sediment sampling and testing will not support these assumptions.

Permanent disposal at Cell #4 may not be feasible. Option 2 and 3 both assume that the material is non-hazardous waste and will be landfilled after it has been dried.

Option 1 and 2 both use Strathearne dock to unload and load dredge material. This is a convenient HOPA dock that could be used to access both disposal sites. Option 3 assumes that the material will be transferred from the harbour to the mixing tank directly.

Excess water is directed to a sanitary sewer and treated at a local waste water facility in all of the options. Figure 2.1 shows the locations of both HOPA and City sanitary and sewer lines and outlets in the study area. Option 2 relies on passive drying to reduce the water content in the material before disposal. Option 3 will generate the largest volume excess water. Alternative options for water management may be possible depending on the sample test results. Costs associated with water management for each option may be change with the results of the testing.

Option 2 is the least expensive option, $9M, based on our current understanding of the project. Option 1 is only slightly more expensive at $9.1M and Option 3 is estimated to cost $11M but does not include operational costs such as power consumption. These estimates do not include a design or construction contingency. We recommend a 30% allowance at this time.

Overall Option 2 Temporary storage at Pond N-2 and disposal at a landfill is considered the preferred option based on our current understanding of the project. This should be confirmed during detail design.

7 SUMMARY AND RECOMMENDATIONS

The following summarizes the study's findings and recommendations:

- It is anticipated that approximately 30,000m3 of dredge material will need to be removed from the area adjacent to Pier 25 in 2022.
- Dredging of Pier 25 may be carried out using mechanical or hydraulic equipment. The type of equipment selected should consider the preferred disposal option.
- Sediment samples and testing from the previous dredge project indicated that the material is non-hazardous waste.
- Disposal options were developed in this study were based on sampling and testing carried out for the previous dredge project. All of the options include disposal of some or all of the material offsite at a landfill unless a beneficial reuse or site specific risk assessment is carried out for this material. This assessment must be carried out by a Qualified Person.
- All options require management of excess water. For this study it was assumed that all water would be directed to a sanitary sewer and treated at a local waste water treatment plant. Water sample testing and the results compared to the relevant standard to confirm and determine other disposal options.
- All options will require permits or approvals from the regulating agencies. Other agencies may need to be informed of the project.
- Three options for disposing of the material were identified including:
    - Option 1 – Permanent Disposal at Cell #4
    - Option 2 – Temporary Storage at Pond N-2 and Disposal at a Landfill
    - Option 3 - Centrifuge and Disposal at a Landfill
- Permanent disposal at Cell #4 assumes that only minimal modifications to the cell are required to accept this material. Although it is anticipated that this is the case, there is a risk that the sediment sampling and testing will not support these assumptions. Permanent disposal at Cell #4 may not be feasible.
- The estimated cost of dredging and disposals ranges between $9M and $11M not including a design or contingency allowance. A 30% allowance is recommended at this stage of the project.
- Option 2 - Temporary Storage at Pond N-2 and Disposal at a Landfill is the recommended option based on the information currently available.

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