Final Report

Wheatley Harbour Dredging and Sand Bypassing Assessment

Public Works and Government Services Canada

prepared by

Shore**plan**
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1. Introduction

Wheatley Harbour is located on the north shore of Lake Erie near the west end of the lake, as shown on Figure 1.1. The harbour is an important commercial fishing facility, arguably the most important on the Great Lakes. It also accommodates a recreational boat harbour. Figure 1.2 is a 2001 aerial photograph of the entrance to Wheatley Harbour and was obtained from an on-line geographical information system maintained by the Municipality of Chatham-Kent. Recent changes to the launch ramp on the west side of the harbour are not shown in Figure 1.2. Figure 1.3 shows nearshore contours determined from a 2005 sounding survey carried out by Public Works and Government Services Canada. Dredging has been carried out since that survey was completed.

In 2003 Shoreplan Engineering Limited (Shoreplan) was retained by Public Works and Government Services Canada (PWGSC) to carry out a review of sedimentation conditions at the entrance to Wheatley Harbour and to develop concepts to manage the dredging requirements. The preferred concept consisted of an armour stone extension of the existing east harbour pier to connect the pier to the existing offshore breakwater. As part of the selection of the preferred concept it was recommended that additional sediment transport analyses be undertaken with revised wave data. That additional work is described in Shoreplan (2006).

The armour stone extension was selected as the preferred concept because it was the most cost effective means of dealing with the primary cause of sedimentation, which is sediment transported from the northeast along a pathway between the breakwater and the pier. It was estimated that closing the gap to the offshore breakwater would cause the existing beach to increase in width by approximately 110 metres by retaining approximately 15 to 30 years worth of the average annual supply of littoral drift. The implications of removing that volume of sand from the supply of littoral drift to downdrift shores were not evaluated. Those implications were to be considered following completion of a detailed sediment budget that was being prepared for the Essex Region Conservation Authority.

That sediment budget was completed as part of the Sustainable Management Strategy for Southeast Leamington. In the Phase 2 report Baird et al (2007) concluded that the interruption of littoral drift at Wheatley Harbour and at Wheatley Provincial Park were significant factors in the loss of beach deposits between Wheatley and Point Pelee.

It was subsequently concluded that the proposed works at Wheatley Harbour would lead to an unacceptable interruption of littoral sediments to the down drift shoreline. The entrance sedimentation problem at Wheatley Harbour would have to be addressed by some sort of dredging and/or sand bypassing program that kept the sand within the downdrift littoral system. This report explores alternate methods of achieving that objective.

The report is divided into six chapters. Chapter 1 provides an introduction to the study. Chapter 2 provides a description of the background information used in the study. Chapter 3 provides an overview of three types of dredging solutions that could be implemented at this site. Chapter describes 4 dredging program options and the selection of a preferred solution. Chapter 5 provides a brief comment on the steps necessary to implement the preferred dredging program. Chapter 6 presents our conclusions and recommendations.

Figures referenced in this report are placed at the end of the report section in which they are first mentioned.

Figure 1.1 Site Plan

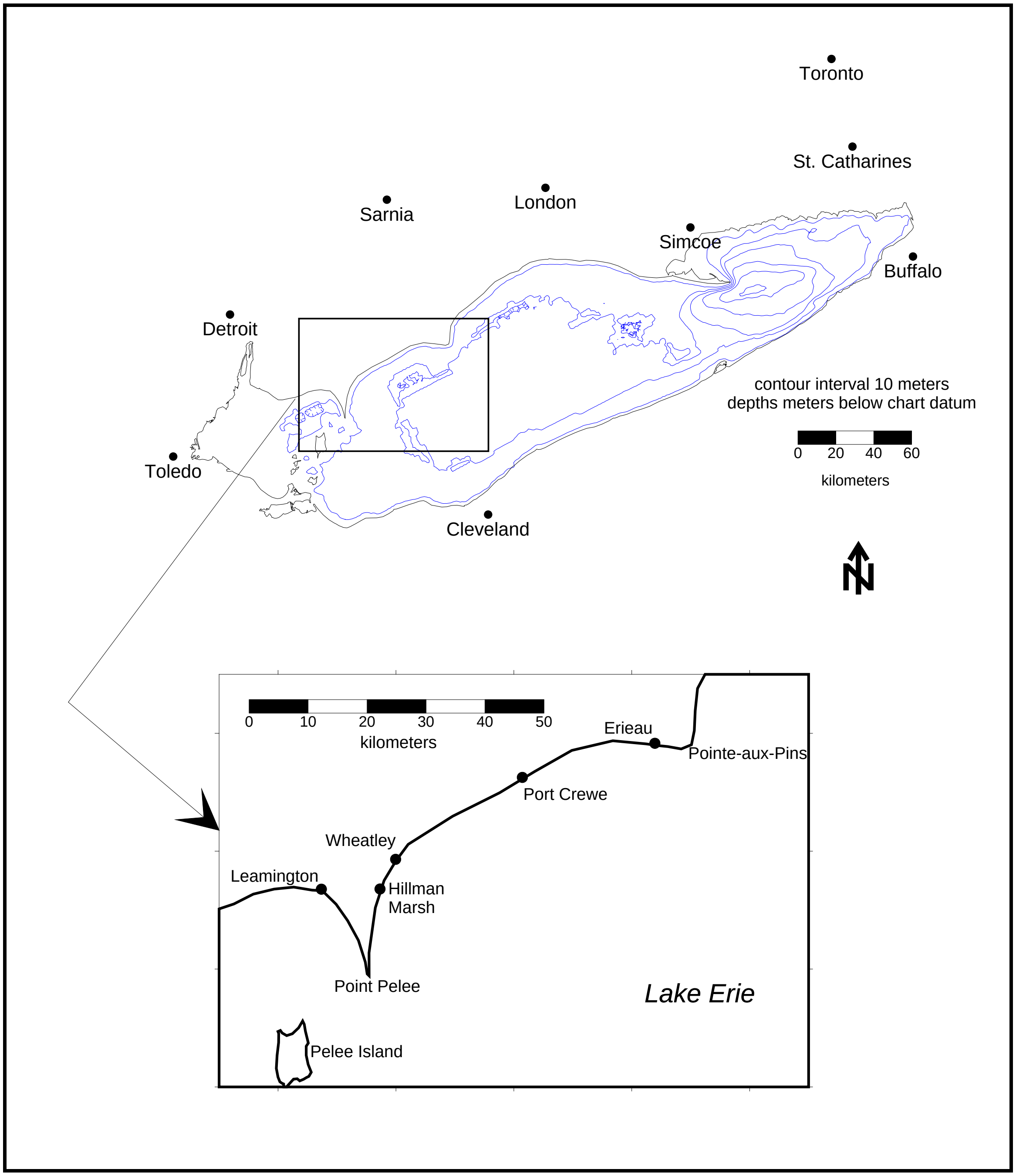
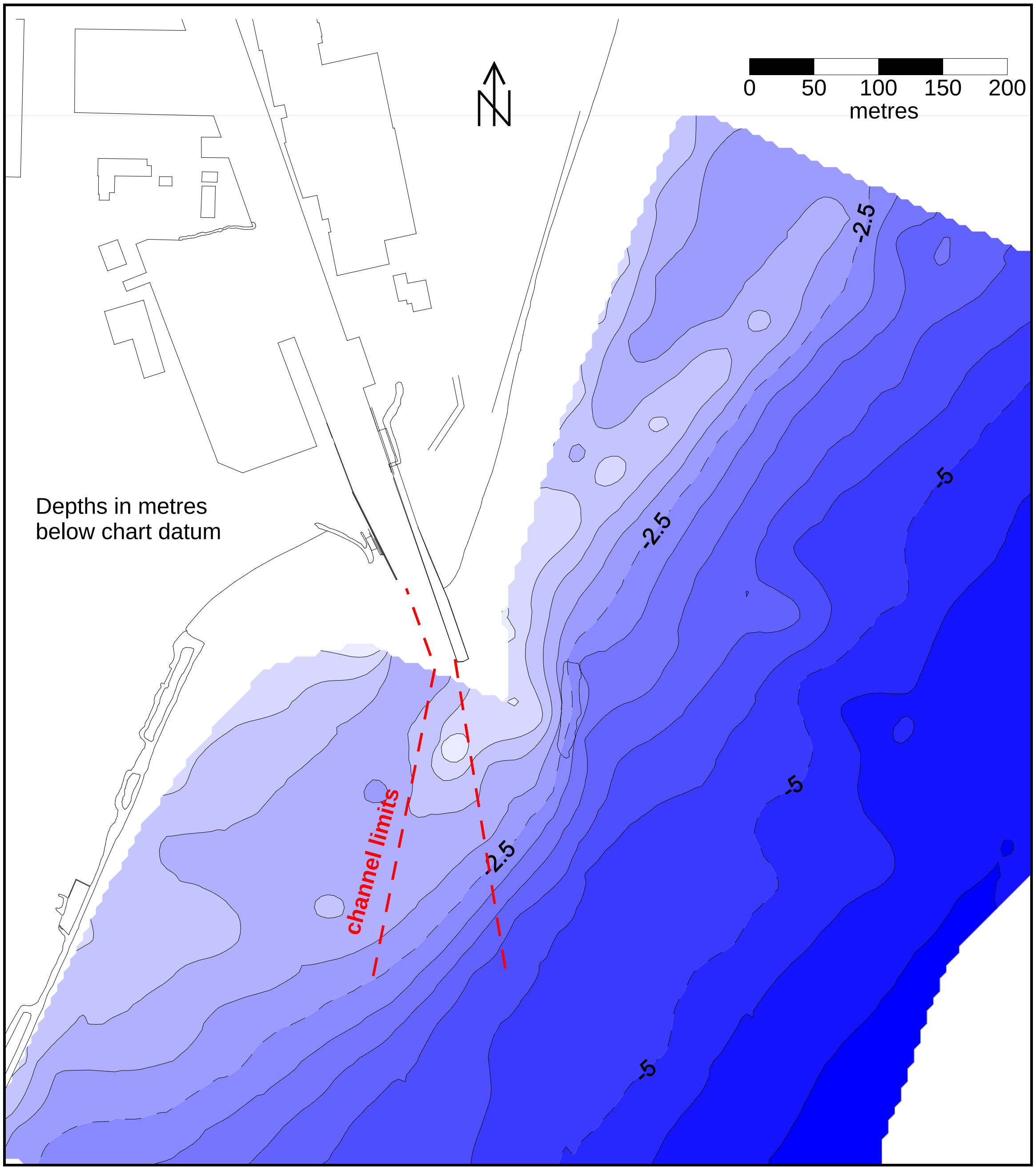


Figure 1.2 Entrance to Wheatley Harbour

Aerial image reproduced by permission of First Base Solutions Inc.

Figure 1.3 Bathymetry from 2005 PWGSC Sounding Survey



2. Background Information

This section of the report describes the background information used in this study.

2.1. Dredging Requirements

The amount of sediment that needs to be dredged from the entrance channel on an annual basis is directly related to the supply rate of littoral drift coming from the updrift (northeast) shore. There are, however, conflicting estimates of the sediment supply rate updrift of Wheatley Harbour. Reinders (1988) estimated that out of the approximately 170,000 m^3 of total material eroded from the bluffs between Wheatley and Port Alma, 45,000 m^3 was sand and gravel and would be transported towards Wheatley. That estimate was used in the previous study of sedimentation at Wheatley Harbour (Shoreplan 2003, 2006).

As part of the South-East Leamington Sustainability Study, Baird et al (2007) concluded that the net alongshore transport divergent node between Wheatley and Rondeau was much closer to Wheatley than previously assumed. This conclusion was based on numerical modeling results but was not verified with any field observations or grain size analyses. On the basis of both this conclusion and estimates of the volume of sand either trapped in the fillet beach or removed by dredging, they estimated that the net transport rate of littoral material was in the order of 15,000 m^3/yr.

Shoreplan (2003) summarized the dredging history at Wheatley up to the year 2000. Baird et al (2007) list volumes dredged from 2000 to 2006 including 18,000 to 20,000 m^3 in 2000 and 21,000 m^3 dredged between October 2005 and September 2006. Recently smaller dredging contracts have been used to keep the entrance clear on an as-needed basis. Those contracts were based on hours of operation and not a specific dredging volume. The volumes dredged varied depending upon a number of factors including weather conditions and the depth of dredging required. A typical operation removes about 4,600 m^3 of sand, on average. Four contracts were issued during the Harbour Authority's last fiscal year (October 1, 2006 to September 30, 2007) and two have already been issued this year. The Harbour Authority has estimated that 3 to 4 contracts per year will be required to keep the entrance clear.

On the basis of the most recent dredging contracts we have assumed that approximately 15,000 m^3 must be dredged on an annual basis. That number is consistent with the sediment budget estimate from Baird et al (2007) although it must be recognized that the sediment budget was itself estimated in part based on the fillet beach and dredge volumes at Wheatley Harbour. To evaluate the different dredging and bypassing alternatives we assumed that, on average, 15,000 m^3 of sand should be bypassed annually.

Assuming an average annual bypassing rate of 15,000 m^3/yr does not specifically mean that 15,000 m^3 of sand must be bypassed each and every year. It may be preferable to bypass greater volumes of sand in discrete operations that occur at a lesser frequency than once per year. It may also be necessary to bypass more than 15,000 m^3 in any given year in order to keep the entrance clear if a number of severe storms occur over a short period of time. Alongshore sediment transport is very episodic with the majority of the total annual transport being caused by a limited number of storms.

Dredging will not be permitted between March 15 and June 30, annually, due to fishery issues. There is also a reasonable probability that winter ice cover will prevent dredging before March 15. We therefore developed our dredging options with the assumption that all work must take place between July 1 and the winter freeze-up.

In Shoreplan (2003, 2006) it was noted that the offshore breakwater is anchoring the toe of the fillet beach retained by the east pier and promoting the build-up of sand between the pier and the breakwater. That sand is easily transported into the dredged channel because of the gradient in the bottom elevation caused by the dredging. The fillet beach tends to act as a reservoir of sand storing littoral drift until a severe easterly storm occurs and forces the sand between the pier and the breakwater. As long as that reservoir is maintained there is a risk that spring storms will be able to fill in the dredged channel during the March 15 to June 30 no in-water work window. Therefore, the key to achieving the best long-term sustainable dredging and bypassing program is to manage the size of the fillet beach retained by the east pier.

The preferred means of managing the fillet beach is to remove a significant volume of sand from the end of the beach beside the pier in an initial dredging operation. Once that sand is removed the area will act a sink for littoral drift and will tend to fill back in sooner than the entrance channel. The annual dredging and bypassing operation can use that sink area as the primary dredging site. Some dredging of the entrance channel will still be needed as the fillet beach sink will not catch all of the littoral drift. As there is considerable uncertainty about the actual long-term average sediment supply rate, extensive monitoring of the dredged area will be required. The objectives of that monitoring will be to accurately establish a sustainable bypassing rate and to determine how far updrift the beach shape changes occur.

We have assumed that the fillet beach is sitting on crown land and not private property, but that assumption needs to be verified. If it is crown land then issues associated with the Public Lands Act will be identified and dealt with as part of the MNR Work Permit. Figure 2.1 shows the ownership of the land parcels in the vicinity of the north fillet beach. It can be seen that the properties adjacent to the beach are commercial to the west of Fisherman Road and residential to the east. As the commercial properties are associated with either the harbour or the Wheatley fishery we have assumed that the property owners will be amenable to a dredging program. That is not necessarily the case for the residential properties so any impacts on the fillet beach in front of those residential properties should be minimized.

The extent of impacts to the fillet beach will dependant on the amount and location of sand removed from the beach. The location of sand to be removed will be dependant upon the dredging method used and is discussed in more detail in Section 3. The fillet beach is in the order of 800 metres long and was estimated by Baird et al (2006) to contain 314,000 m^3 of sand and gravel. The private property on the east side of Fisherman Road is approximately 380 metres updrift of the Wheatley Harbour east pier. We propose limiting excavation at a point 250 metres northeast of the pier, or about $^2/_3$ of the way to the first private property. The last $^1/_3$ of the way will be left as a buffer to help minimize impacts.

We believe an initial excavation of approximately 30,000 m^3 of beach material would be appropriate. That constitutes approximately 10% of the total volume of the beach and corresponds to 2 years of littoral drift if the assumed average annual littoral transport rate of 15,000 m^3/yr is correct.

Baird et al (2006) produced a figure showing the fillet beach changes from 1954 to 2004. The beach has grown in width by approximately 70 metres near the pier and by approximately 45 metres at the end of Fisherman Road. We propose limiting the beach excavation to a width of 35 metres near the pier, which is ½ of the beach growth since the pier was constructed. If the beach crest were to be pulled back 35 metres and the beach were to be dredged at the existing slope down to the existing toe depth then approximately 30,000 m^3 of material would be removed by excavating the area shown in Figure 2.2. The excavation limit shown in Figure 2.2 is 35 metres back from the water line for a length of 150 metres, then tapers to no dredging at the point 250 metres from the pier. The lakeward limit of that area follows the toe of the beach retained by the offshore breakwater.

Dredging at the existing beach slope down to the existing toe depth would minimize the impacts associated with natural beach profile changes after dredging. In reality the dredging will not take place over the entire area shown in Figure 2.2. The existing beach slope is in the order of 30 to 35:1 (horizontal: vertical). The depth of cut required to dredge at a similar slope is less than 1 metre and is not practical. We propose to remove approximately 30,000 m^3 of sand from the beach in a manner best suited to the equipment used for that dredging. If that 30,000 m^3 is distributed along a 250 metre length of beach then the natural beach profile adjustments that take place (both subaerial and subaqueous) should occur roughly within the limits of the area shown in Figure 2.2. Beach profile response modeling could be applied to estimate what the likely changes would be but the uncertainty associated with those estimates would limit their value. It is more reasonable to monitor the beach response to the dredging and adjust the dredging program as required on a trial and error basis.

The fillet beach in its present location is providing protection to the east side of the east pier. Excavating the beach as described above could put the pier at risk of damage if the pier has deteriorated below the beach level. The state of the pier should be investigated before a significant quantity of beach is removed so that the beach removal plans can be modified if required.

2.2. Bypassing Return Location

As part of a bypassing operation the sediments removed by dredging must be returned to the littoral zone. In the past, sand trucked from Wheatley Harbour has been placed on a feeder beach at Hillman Marsh. Scows have been dumped offshore of the end of Pulley Road. Both of those locations are shown in Figure 2.3. Both sites are still considered to be acceptable locations for returning sand dredged from future operations.

From a coastal processes perspective there is justification for returning the sand to the littoral zone as close to Wheatley Harbour as possible. Any beaches that form as a result of the returned sand should decrease the downcutting rate of the cohesive lakebed. If the sand is returned at a point that is too close to the harbour, however, there is a significant risk that it will end up being transported back into the entrance channel rather than downdrift. It is a complex relationship between the frequency of occurrence of different wave conditions and the size of the shadow zone caused by the harbour structures for those wave conditions that will ultimately dictate what return point is too close to the harbour. Determining that point is beyond the scope of this study and would require either a detailed sediment transport analysis or trial and error.

One possible means of returning the dredged sand to the shore is through a slurry pipeline running alongside Pulley Road. There are four road allowances running from Pulley Road to the lake that presumably could be used to support the discharging end of the slurry pipe. Figure 2.4 shows the location of those road allowances. Access to the north end of the Pulley Road allowance could physically be achieved by running the pipeline through an undeveloped property at the end of Beach Boulevard. That property is privately owned so some arrangement would be required with the owner. How the slurry pipeline could be used is discussed in more detail in Section 3 of the report.

2.3. Recent Dredging Practices at Wheatley Harbour

A number of dredging methods have been employed at Wheatley since the early 1950's. A review of dredging records suggests that the dredged material was historically either disposed of in deep water or trucked away and disposed of off-site. That practice has changed so that dredged sand is now returned to the littoral zone, downdrift of Wheatley Harbour. In 2000 and 2004 sand was excavated from the entrance channel with a long-reach backhoe, stockpiled on the fillet beach and trucked to the Hillman Marsh. At the marsh it was placed on a feeder beach so that it could be eroded and washed downdrift. Figure 2.3 shows a map of the roads between Wheatley Harbour and Hillman Marsh. It is our understanding that the trucks followed a route from Wheatley Harbour, westward along Mersea Road 4, Southward on Mersea Road 21, then eastward on Mersea Road 2 to the feeder beach located at the northeast corner of the Hillman Marsh.

Trucking along this route was suspended in 2004 due to damage being done to Mersea Road 21. Dredged material has subsequently been placed in a dump scow, towed downdrift and dumped close to shore near the end of Pulley Road. The dumping location was selected by the Essex Region Conservation Authority (ERCA). Sand is dredged with a long-reach backhoe on a work barge anchored at the dredge site with two spuds. The dump scow is tethered to the spud barge. Figure 2.5 shows the backhoe, spud barge and dump scow used during a dredging operation carried out in December 2005.

Dredged sand from the St. Clair River was trucked to the Hillman Marsh site in 2007. It is our understanding that some improvements were made to Mersea Road 21 as part of that work. We therefore assumed that the road condition is not an impediment to again trucking sand from Wheatley Harbour to the Hillman Marsh, although that was not discussed with the municipality.

2.4. Wheatley Harbour Entrance Traffic

Wheatley Harbour is an important commercial fishing facility, arguably the most important on the Great Lakes. The fishery operates year round if ice conditions permit. When they are operating, fishing boats typically exit the harbour between 4:00 and 6:00 a.m. The can be expected to return any time between 11:00 a.m. and approximately

7:00 p.m. It is important to the fishing boats that access to and from the harbour not be blocked with dredging equipment during those times.

The spud barge used for recent dredging (see photograph 2.1) has had to be moved on a number of occasions to allow access to the harbour. That is disruptive to the dredging operation and reduces the efficiency of the operation.

2.5. Essex Region Conservation Authority

The Essex Region Conservation Authority (ERCA) is the lead contact agency for obtaining the necessary approvals to implement a dredging program. Approvals likely to be required include ERCA's Ontario Regulation 158/06, the Ministry of Natural Resources' (MNR) work permit and the Department of Fisheries and Ocean's (DFO) authorization under the Fisheries Act. ERCA has agreements with both MNR and DFO to issue permits on their behalf. All three of these permits or approvals have been issued by ERCA for the past dredging at Wheatley Harbour.

The dredged sand must also meet Ministry of Environment guidelines for open water disposal if it is placed back in the lake, although no formal MOE permit is required. In the past ERCA has tested the dredged material to confirm that it meets the required quality guidelines.

One of the conclusions of the ERCA commissioned Sustainable Management Strategy for Southeast Leamington (Baird et al, 2007) is that retention of littoral drift by the Wheatley Harbour structures has in part contributed to shoreline erosion between Wheatley and Point Pelee. That study recommends that any sediment dredged from Wheatley Harbour be returned to the littoral system. ERCA has endorsed that recommendation. The need to return any dredged material to a downdrift location is one of the parameters of this study.

On the basis of a preliminary discussion with ERCA staff we do not expect any significant regulatory difficulties with the dredging options we have considered. It should be noted, however, that past dredging has been within the Federal Government's waterlot so the MNR work permit did not need to consider any Public Lands Act issues at the dredging site. If dredging is extended outside the waterlot the permitting process could be more complicated that it was previously. Reducing the size of the fillet beach as discussed in Section 2.1 will require dredging outside the waterlot.

Figure 2.1 Property Ownership Near the North Fillet Beach

Aerial images reproduced by permission of First Base Solutions Inc.

Figure 2.2 Proposed Initial Beach Excavation Area

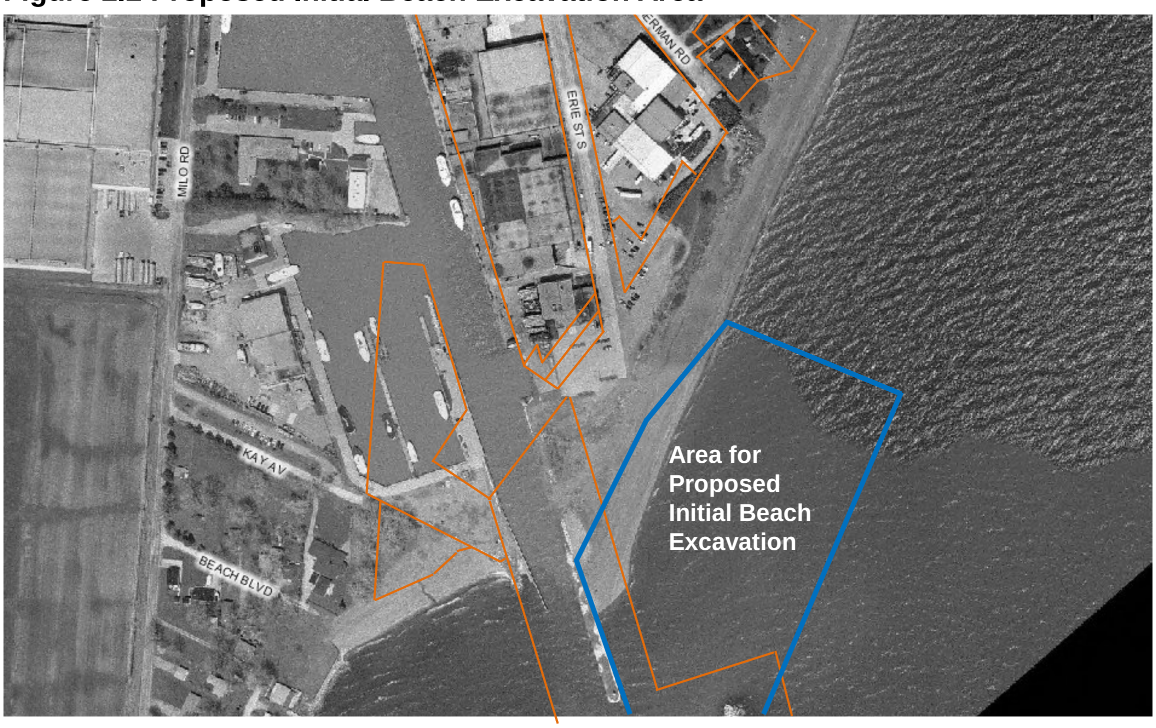


Figure 2.3 Bypass Return Locations Currently Used

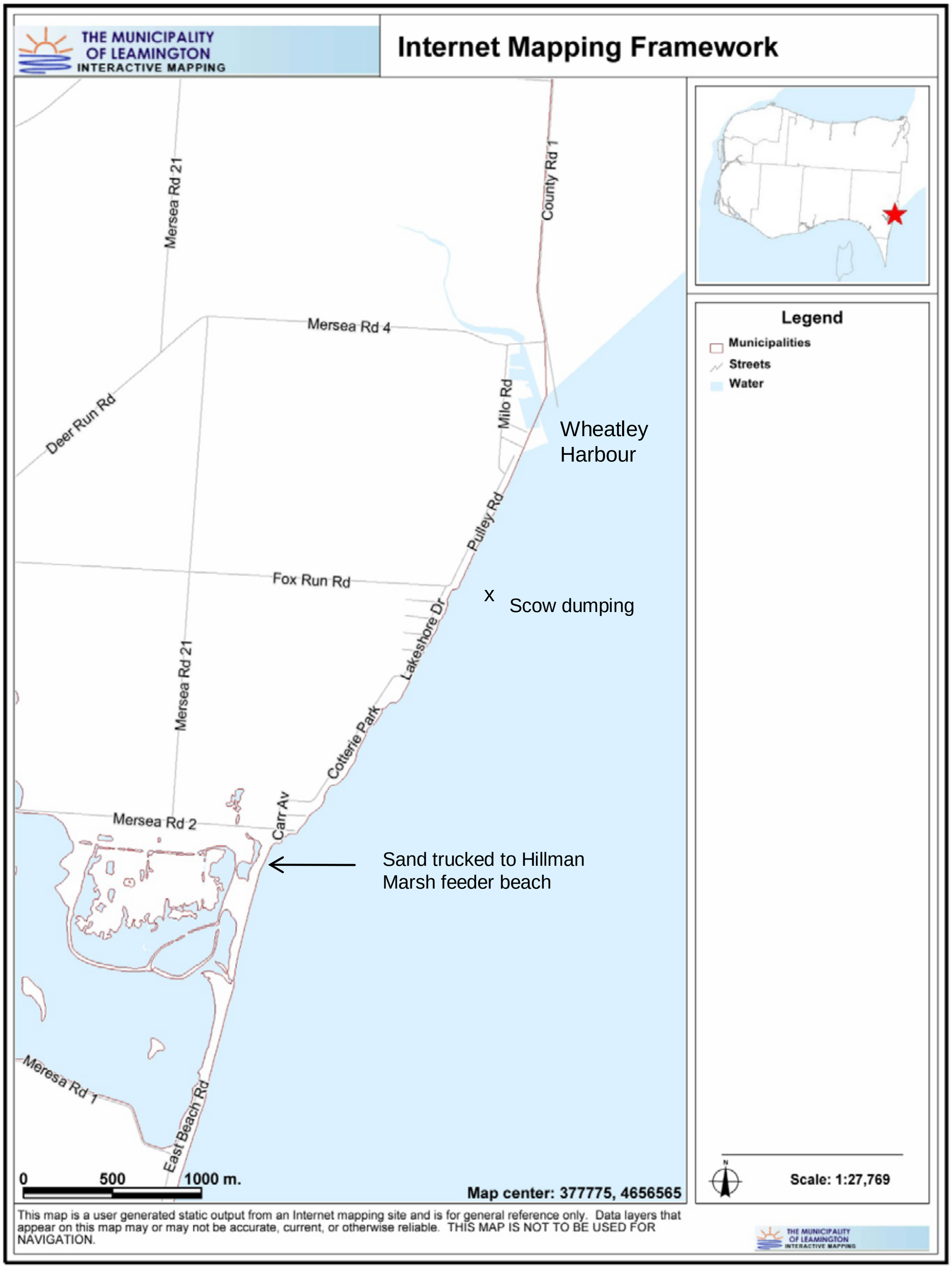


Figure 2.4 Potential Bypass Return Locations for Hydraulic Dredging

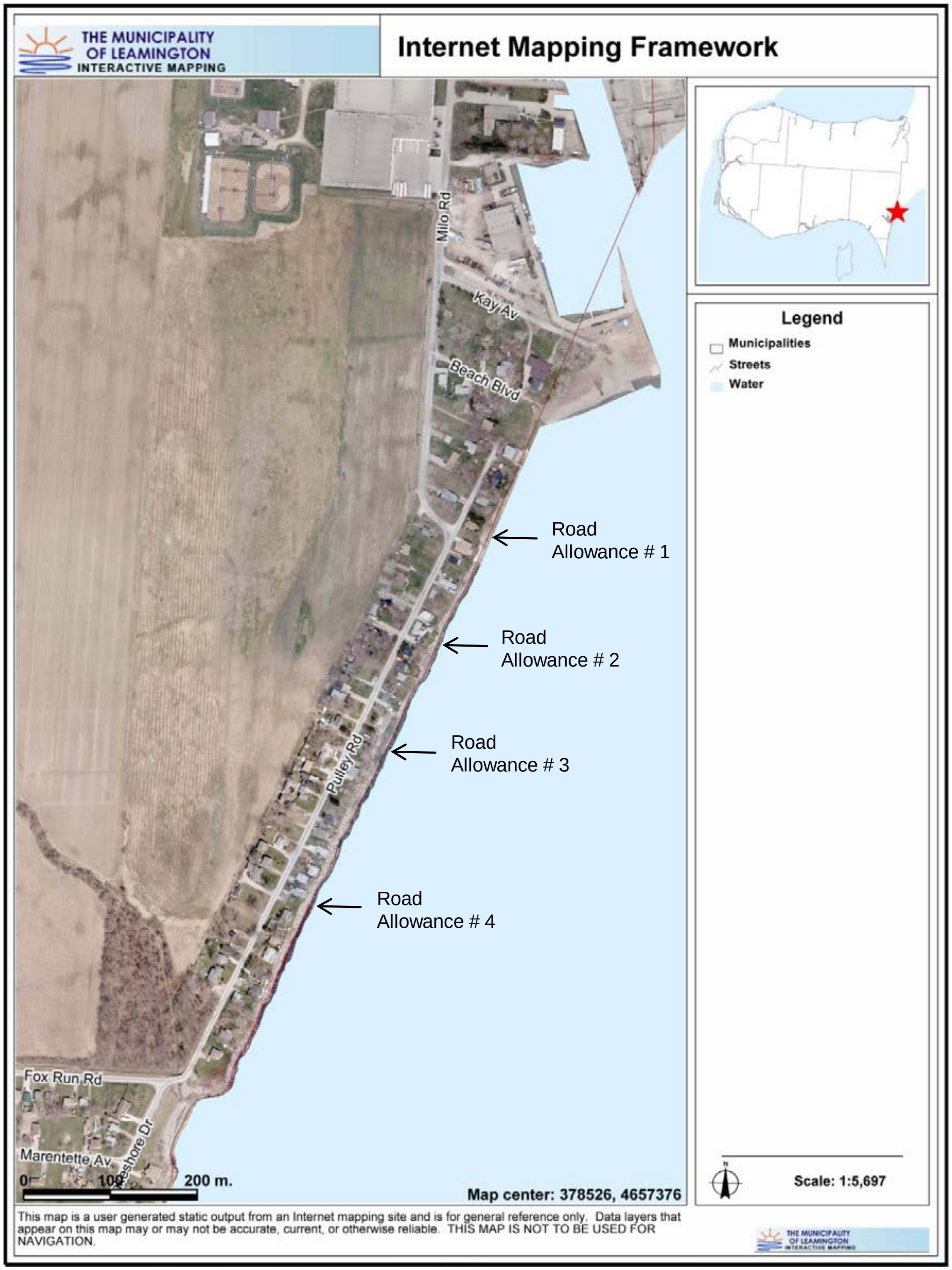


Figure 2.5 Backhoe, Spud Barge and Dump Scow, December 2005

3. Overview of Dredging Methods

There are three categories of dredging that could be reasonably employed at Wheatley Harbour: mechanical dredging, hydraulic dredging and hydrodynamic dredging. Each category is described separately below.

3.1. Mechanical Dredging

Mechanical dredging involves the use of draglines, backhoes, bucket wheels or clamshells to excavate the bottom material and generally place it in a container such as a barge or scow. The excavated material is then towed away for off-site disposal on land or in water. Backhoe or dipper dredging is frequently used when force is required to penetrate hard bottom material. One of the main advantages of mechanical dredging is the high ratio of sediment to water excavated by the dredge. This can be significant if the dredged material is not decanted on-site.

The recent dredging practices at Wheatley of using backhoes and either dump trucks or dump scows are examples of mechanical dredging.

3.2. Hydraulic Dredging

Hydraulic dredging creates a slurry mix of the dredged material and then transports it off-site, either by pumping it through pipes and hoses or storing it in hoppers for transportation. There are a number of ways of collecting the material to be excavated and combining it with water to create a slurry mix: Both suction dredges and cutter suction dredges are commonly used on the Great Lakes. Suction dredges generally do not have a tool at the end of the suction pipe to disturb the bottom material and therefore collect only loose sediment. Cutter suction dredges use a variety of cutter heads to excavate the bottom sediment and transport it to the suction mouth. Cutter suction dredges can be used to dredge rock and clay deposits as well as silts and sands. Some small dredges use high pressure water jets to agitate sand and silt so that it may be sucked up by a separate slurry pump. Jet-pump dredges use a high-speed stream of water to create a venture effect that sucks up a slurry mix.

Different methods for disposal of the dredged material include the use of hopper overflow, sidecasting, and pipe discharge into either receiving waters or distilling basins. Hopper overflow and sidecasting can be considered to be hydrodynamic dredging and are included in the third dredging category that follows. Discharging slurry with fine sediments into receiving water bodies is no longer a common practice due to the adverse environmental impacts associated with the turbidity caused by the discharge. It is more common to see large settling basins constructed to dewater the slurry if there is a significant concentration of silt or clay. That is not the case at Wheatley harbour where the dredgate consists of medium sand.

With respect to typical hydraulic dredging projects, the need to dredge 15,000 m^3 of sand annually is a small requirement. We examined two types of small dredges that could be suitable for use at Wheatley. We also examined land-based and floating pipe discharge options for dealing with the slurry produced by the dredges.

3.2.1. Small Manned Dredges

There are a number of manufacturers of small capacity diesel-powered self-propelled hydraulic dredges that are typically used for marina, lake and lagoon clearing. An example of this type of dredge, shown in Figure 3.1, is the Rotomite 6000 manufactured by SRS Crisafulli in Montana, USA. The Rotomite 6000 is a cutter suction dredge with a 6 inch slurry pump. It can excavate up to 20 feet deep (6 metres) and has a discharge rate in the order of 2,500 gallons per minute (aprox 160 litres per second), depending upon the total head differential. The dredge is approximately 10 metres long and 2.5 metres wide.

VMI Inc. of Oklahoma, USA makes a number of similar sized dredges in two categories referred to as horizontal dredges and cutter suction dredges. The cutter suction dredge is described as a more robust, heavier piece of equipment than the horizontal dredge. It sees frequent application in sand and gravel quarries. Two of their models, the MD-415 horizontal dredge and the MD-820 cutter section dredge seem to straddle the capabilities of the Rotomite 6000 dredge and can be used to show a typical range of possible application.

The dredge manufacturers claim that it is not uncommon to dredge slurries with up to 30% solids and that assuming a 20% solid slurry is relatively conservative. For our productivity analyses we considered slurries with both 20% and 30% solids.

The VMI MD-615 horizontal dredge has a 6 inch slurry pump and can dredge to a depth of 15 feet (4.6m). It is capable of pumping a 20% solids slurry at a rate of 1,200 gallons (US) per minute. That corresponds to 55 cubic metres of sand per hour so it would take 275 hours or 34 working days (8 hours/day) to bypass 15,000 m^3 of sand. Assuming a 30% solid slurry gives 23 working days to bypass 15,000 m^3 of sand. The 6 inch pump has a maximum discharge pipe length of about 450 metres, depending on the total head differential.

The VMI MD-820 cutter suction dredge has an 8 inch slurry pump and can dredge to a depth of 20 feet (6m). It is capable of pumping a 20% solids slurry at a rate of 2,500 gallons (US) per minute. That corresponds to 114 cubic metres of sand per hour so it would take 132 hours or 17 working days (8 hours/day) to bypass 15,000 m^3 of sand. Assuming a 30% solid slurry gives 11 working days to bypass 15,000 m^3 of sand. The 8 inch pump has a maximum discharge pipe length of about 750 metres, depending on the total head differential.

Either of these dredges would be suitable for implementing a bypassing procedure at Wheatley Harbour. Depending upon the dredge discharge method (discussed in Section 3.4.4) it is quite possible that the rate at which the littoral system is able to receive the bypassed sand may determine the overall productivity rate. It may not be physically possible to bypass 15,000 m^3 of sand in 11 days without causing other problems at the dredge discharge site.

These dredges are only suitable for use in calm to light wave conditions. It can be seen from Figure 3.1 that the dredge does not have a significant freeboard. A dredge of this type was once tried at Wheatley Harbour and it almost sank in the entrance due to wave activity. When the dredge is rocked by waves the cutter arm bangs on the bottom and can be damaged. These dredges should not be used with wave heights in the order of 0.6 metres or higher.

3.2.2. Remote Controlled Mini Dredges

Piranha Pump of New Mexico, USA, manufactures a line of remote controlled mini-dredges with reported capabilities similar to the small dredges described above. These dredges use 460v submersible electric slurry pumps with mechanical agitators. The pump is attached to a hoist mounted on 2 pontoons. Figure 3.2 shows an example of one of these dredges.

The mini-dredges are designed to be steered with a stayed cable system. One end of the cable could be attached to the end of the east pier at Wheatley. The other end could be attached to an anchored mooring that is placed and removed as required during dredging. This would require the use of a work boat or barge with a hoist and is considered to be one of the major disadvantages of this system. The dredge is not self-propelled and would need to be towed to the dredging site. The submersible pump is raised and lowered with a remotely controlled hoist and works most effectively when it can dig a cone shaped hole with material falling towards the pump.

An operator's control panel must be set up near the dredging site and must have a suitable supply of electricity. A generator can be used to provide the electricity so the operator's station could be placed on a barge if desired. If this system were to be used at Wheatley the most logical location for the control station would be on the east pier near the lighthouse.

We examined production capabilities and costs for two of these mini-dredges: the P-30 and the P-75. The P-30 has a 30 horsepower, 4 inch pump with an average production capability of approximately 61 cubic metres of sand per hour. Dredging at that rate would take 245 hours or 31 working days to bypass 15,000 m^3 of sand. The P-75 has a 75 horsepower, 6 or 8 inch pump with an average production capability of approximately 172 cubic metres of sand per hour. Dredging at that rate would take 87 hours or 11 working days to bypass 15,000 m^3 of sand. Both systems are capable of dredging down to 40 feet (25m), which is far deeper than required for Wheatley Harbour.

Like the small manned dredges, these dredges are intended for calm to moderate wave conditions. However, because these dredges do not have a cutter arm they are less susceptible to damage when rocked by waves. The manufacturer recommends not operating these dredges when wave heights are in the order of 1 metre or higher.

3.2.3. Discharge Options

Each of the dredges described has a maximum discharge pipe length over which it can pump at its maximum flow rate. Pumping over longer lengths risks reducing the flow velocity to the point that sediment drops out of suspension and clogs the pipe. Table 3.1 shows the manufactures recommended maximum discharge pipe length assuming little static head loss. These maximum lengths assume the use of HDPE pipe as it has a low friction coefficient. Table 3.2 shows two pipe lengths required to reach the potential bypass return sites identified in Section 2.2 and shown in Figure 2.4. The floating pipe length was measured as a straight line distance from the end of the east pier plus an additional 300 metres to allow the dredge to work that far updrift of the east pier. The floating discharge pipes would not specifically need to go to one of the bypass return sites shown in Figure 2.4, as those were for a fixed pipe, but they serve as reasonable comparison points.

By examining Tables 3.1 and 3.2 it can be seen that the use of floating pipe only is feasible but imposes some limitations on the dredging operation. The smaller dredges (VMI 615 and Piranha P-30) can only be used in the vicinity of the harbour entrance, not further up the north fillet beach. If the larger dredges (VMI820 and Piranha P-75) are used over the full length of the proposed fillet beach excavation then they can only discharge as far as road allowance 1 (Piranha P-30) or road allowance 2 (VMI 820). They could pump further down shore but that would limit where they dredge the fillet beach. The pipe would also have to pass across the harbour entrance which would be disruptive to harbour traffic.

It must also be recognized that although the empty pipe will float on its own it will need a significant number of attached floats when it is full of slurry. Working with a 600 metre or 750 metre long pipe will not be easy.

As an alternative to using a floating pipe discharge we also considered a fixed pipe system. Using a fixed pipe allows the sediment return point to be moved further downdrift but requires the use of a booster pump due to the longer pipe length. The preferred location for a booster pump is at the end of the east pier. The discharge line from that pump would run down the end (south face) of the pier and be buried in the lakebed below the dredge depth. It would be run through the lakebed and back onto land through the fillet beach on the downdrift side of the harbour. The pipe would run across a privately owned vacant lot at the end of Beach Boulevard, onto the Pulley Road allowance. It would then run along Pulley Road to the desired return location. This solution would of course require the cooperation of both the private landowner at the end of Beach Boulevard and the Municipality of Leamington.

At the discharge site the pipe would be terminated at an on-grade “terminal box” with a hose connection. A discharge hose would be attached to the connection and positioned at a desired point offshore. That point could be moved, as required, during the dredging operation to manage the size of the sand deposit at the discharge site.

A number of manholes would be required to service the slurry pipe if required. We have assumed that manholes would be placed approximately 200 metres apart once the pipeline emerges from the lakebed.

Table 3.3 shows the estimated cost of constructing the slurry pipeline to the potential bypassing return points shown in Figure 2.2. Those include the booster pump station and the floating pipe between the dredge and the booster pump.

Use of a fixed pipe system like this would allow hydraulic dredging to take place without having to trail a discharge hose across the harbour entrance. It would allow dredging further up the north fillet beach and it would allow the use of the smaller dredges not capable of pumping through 750 metres of floating pipe.

3.3. Hydrodynamic Dredging

The following chapters are a synopsis of van Raalte and Bray (1999).

> *Hydrodynamic dredging is a new term which describes all dredging techniques which use the re-suspension of sediments and transport by means of natural hydrodynamic processes. The term covers mixing to make a density current (water injection), stirring into suspension (ploughs, rakes and water erosion techniques) and the release of materials into the surface waters (hopper overflow, sidecasting etc.). Hydrodynamic dredging is the deliberate (re)suspension of the fine fraction of sediment from the sea/riverbed with the aim of removing this material from the dredging area using natural processes for transportation. The water column itself is used as the primary transport medium for the dredged material, instead of pipes, barges or hoppers, as with conventional dredging techniques.*
>
> *The degree of transportation of sediment by a moving water column is determined by the properties of the sediment particles and those of the carrying fluid. The fall velocity of the particles is the most important property influencing transport. The fall velocity is defined as the terminal speed of a particle when it is released in a stationary fluid. The turbulence of the carrying fluid plays a part in maintaining particles in suspension.*
>
> *Lighter particles tend to have a lower fall velocity, taking them longer to sink down once brought into suspension. Therefore light weight particles are susceptible to transportation. In some cases a dense fluid is formed by the particles and their carrying water, in which suspended particles remain for very long times in suspension.*
>
> *Hydrodynamic dredging can only be undertaken under suitable circumstances. First of all, the material to be removed needs to be susceptible to transport by the water column. Secondly, the water needs to flow in the direction where the transported material is intended to go to and where it does not interfere with other interests.*
>
> *Hydrodynamic dredging by means of agitation is a method which uses specifically designed trailing equipment such as a rake or a beam. These tools are dragged along the sea/riverbed and stir up the material mechanically. It is difficult to stir up the material throughout the water column using this type of equipment. But the propeller of the ship, towing the rake, may create enough turbulence to spread the material. Another method for stirring the material up to a higher level is by blowing air at high pressure near the dragging device.*

> *The effectiveness of hydrodynamic dredging in the dredging area is difficult to demonstrate. Production figures cannot easily be derived from standard process monitoring systems, as the agitated material will often not pass measuring instrumentation, unless it is highly sophisticated. The effectiveness of hydrodynamic dredging also has to be defined by reference to the location or area where the material is ultimately deposited. Hydrodynamic dredging is not effective if deposition occurs in an area from where the material, for various (economic) reasons, has to be removed again, or if the deposition in that area is, for certain (environmental) reasons, unacceptable. However in some cases hydrodynamic dredging still might be cheaper, even if the same particle has to be agitated 2 or 3 times to achieve the same result, than dredging it one time.*
>
> *Hydrodynamic dredging appears to be most effective for fine, recently deposited sediment, especially in areas where sedimentation occurs in well-defined places. With specific techniques it is also possible to remove tops of ripple formations in waterways formed by coarse material such as sand and gravel. When hydrodynamic dredging is less successful, it is often because there is insufficient knowledge about the interaction between the hydrodynamic dredging process and the water movements in the surrounding area.*

One method of hydrodynamic dredging frequently seen on the Great Lakes is agitation dredging with propeller wash. For example, the Municipality of Lambton Shores has been using propeller-wash dredging to keep the Grand Bend and Port Franks harbour entrances clear on Lake Huron. It was suggested that a similar approach might be suitable for Wheatley Harbour.

At Grand Bend a private contractor keeps the harbour/marina entrance open on an as-needed basis using an old flat-bottomed logging boat converted for propeller-wash dredging. The boat has a single spud, located near mid-ship, which is used to anchor the boat within the entrance channel. The boat is then pivoted about the spud using the turbulence generated from the propeller to agitate and transport away the sand. The boat is equipped with an adjustable “beaver-tail” to deflect the propeller turbulence as desired. Dredging is not effective in wave conditions higher than about 0.3 metres because the boat rocks and the propeller cavitates when near the surface. Part of this is thought to be due to the mid-ship position of the spud as the boat would rock less if the spud was more forward.

The Grand Bend dredge is used frequently to keep that entrance open, typically about 40 times per season. It must be used after every significant storm. The operator reports that once he is able to get a flow going he is able to move the sand about 50 metres if he has a place to move it to. It is most easily moved “downhill” to deeper water, particularly if a there is a hole to fill. He has described his dredging operation as moving the bar offshore. Dredging is most efficient when he is able to get a continuous flow going. Ambient currents have a significant impact on where the sand will end up but he is unable to determine what the current effects will be until he starts dredging. It is not uncommon to have sand that was moved out of the entrance be blown back in during the next storm.

It is difficult to assess what the cost of agitation dredging would be at Wheatley Harbour. A prop-wash dredging boat like the one used at Grand Band can be operated by contract for about $150 per hour. The length of time required to bypass 15,000 cubic metres of sand cannot be accurately estimated without some local experience. Cobby Marine of Leamington has some local prop-wash dredging experience but their tug does not have a spud. They have used the same spud barge currently used for dredging at Wheatley to anchor their tug for the prop-washing.

It is our expectation that prop-wash dredging on its own would not be very effective at Wheatley Harbour. We believe the key to managing the dredging and bypassing at Wheatley in an effective manner is to control the position and growth of the fillet beach retained by the east pier. That sand needs to be moved outside the shadow zone of the harbour structures so that it can be transported downdrift. Moving that sand with agitation dredging would require that it be pushed across the entrance channel in order to get it outside the shadow zone (see Figure 1.3). It would be difficult to push the sand up the side slope of the entrance so in practice it would need to be pushed south along the channel, in the offshore direction, until it is deep enough to stop. Agitation dredging is not the best method to move the given volume of sand this distance. However, prop-wash dredging could feasibly be used at Wheatley Harbour to supplement other dredging/bypassing methods that are not overly efficient for use in the entrance channel but are suitable for managing the fillet beach.

Figure 3.1 Rotomoite 6000 Hydraulic Dredge

Figure 3.2 Piranha Pumps Mini-Dredge

Table 3.1 Maximum Dredge Discharge Pipe Lengths with Low Static Head Loss

Dredge	Discharge Length (m)
VMI 615 horizontal dredge	400
VMI 820 cutter suction dredge	750
Piranha P-30 min-dredge	400
Piranha P-75 min-dredge	600

Table 3.2 Fixed and Floating Pipe Discharge Lengths

Bypass Return Site	Floating Pipe Length (metres)			Floating and Fixed Pipe Length (metres)
	From East Pier to Return Site	From Dredge to East Pier	Total Floating Length	
Road Allowance 1	275	300	575	825
Road Allowance 2	400	300	700	950
Road Allowance 3	525	300	825	1,175
Road Allowance 4	700	300	1,000	1,375
Fox Run Road	900	300	1,200	1,600

Table 3.3 Fixed and Floating Pipe Costs

Bypass Return Site	Cost ($ 2008)	
	Floating Pipe [1]	Floating and Fixed Pipe [2]
Road Allowance 1	$35,000	$270,000
Road Allowance 2	$42,000	$290,000
Road Allowance 3		$320,000
Road Allowance 4		$345,000
Fox Run Road		$380,000

1) includes 300m pipe from dredge to east pier

2) includes 300m pipe from dredge to east pier, booster pump station and submerged pipe from east pier to south fillet beach

4. Dredging and Sand Bypassing Alternatives

A total of 4 dredging and bypassing options were developed and evaluated. Each of the alternative options and the selection of a preferred option are discussed separately below.

4.1. Option 1 – Continue Current Practice

The first option considered would be to continue the current practice of dredging the entrance channel area with a barge mounted excavator and a dump scow. We have assumed that the dredged sand would continue to be dumped close to shore near the end of Pulley Road. It is possible that ERCA could select a new dump site and that would affect the cost of dredging if the new dump was significantly further away from Wheatley Harbour. It is our understanding that the dump scows and spud barges used in the dredging operation are kept at Wheatley Harbour so there has been little mobilization charge on the recent contacts. If those circumstances change the cost of dredging with this method could increase.

Using the recent contract prices and volumes of sand dredged we have estimated the dredging rate to be 66 m^3 per hour and to cost approximately $8.75/$m^3$. At those rates it will take $131,000 and approximately 29 working days to carry out an annual dredging program of 15,000 m^3.

It is feasible to perform an initial excavation of the fillet beach area using this dredging method. The dredging would start between the east pier and the offshore breakwater and move up the shore to the northeast, keeping the toe of the dredged area in line with the east pier. The sand would be excavated down to a depth of 3 metres below datum, which is the design dredge depth for the entrance channel. The side slope of the dredged area would be cut at a slope of about 10:1 (horizontal: vertical) and would extend up to approximately chart datum. Continuing that cross-section 150 metres up the shore then tapering off over the next 100 metres would yield approximately 30,000 m^3 of sand. The time and cost required to complete this work would be approximately twice that of the annual bypassing operation.

The main advantage of Option 1 is that it continues what has been shown to be a workable dredging procedure. This method has been approved by ERCA in the past so we do not anticipate any new regulatory difficulties if this were to be continued. It should be noted, however, that ERCA is not likely to favour this option as a long-term solution. It would be preferable to dump the sand closer to shore than current practice, so that the sand can be more readily moved downdrift. The current dumping depth is governed by a minimum operable depth for the dump scow when its bottom doors are open. It is thought that only large storms are fully mobilizing the deposited sand; placing it closer to shore would put it within the breaker zone of smaller, more frequently occurring waves.

The main disadvantages of Option 1 are that it is not the most cost-effective dredging method and that it occasionally blocks access to and from the Harbour. Adverse weather conditions also affect the efficiency of this operation but not necessarily to any greater degree than the other types of marine operations considered. However, because this method of dredging is carried out by contractors rather than Harbour Authority staff there may be standby costs incurred when dredging is suspended due to weather conditions.

In the past this method of dredging was used to deal with sedimentation problems after they occurred rather than managing the sedimentation as it occurred. It would generally not be considered efficient to mobilize the equipment required to dredge the entrance channel when only a small amount of dredging is required, although having the dump scows and spud barge available on site tempers this. Current practice is to wait until the channel has filled in to the point that navigation starts to be hampered then excavate a significant volume of sand. This increases the risk of severe sedimentation if a significant storm event occurs just prior to when a normal contract would typically be issued. Switching to a formal bypassing operation would lessen this risk if dredging is carried out every year.

4.2. Option 2 – Land Based Excavation of Fillet Beach

The second option considered is to excavate the fillet beach with a backhoe on the beach. The excavated beach material would be trucked to Hillman Marsh. The last time material was trucked to Hillman Marsh the round-trip time for the trucks was ½ hour. Assuming a similar turn around time, a single backhoe with four tri-axle dump trucks can excavate 80 m^3 of sand per hour at an estimated cost of \$6.50/m^3. The cost estimate includes the use of a dozer or front-end loader at Hillman Marsh to place the dumped sand along the beach. It would take 23 working days and a cost of \$97,500 to excavate and place the estimated average annual littoral transport volume of 15,000 m^3.

The recommended initial fillet beach excavation preceding the average annual bypassing operation can be readily carried out using this equipment. The backhoe would dredge to a depth of 2 metres below datum and cut a side slope of approximately 10:1 (horizontal: vertical). Excavation would move landward until the top of the beach had been cut back approximately 10 metres horizontally. Continuing that cross-section 150 metres up the shore then tapering off over the next 100 metres would yield approximately 30,000 m^3 of sand. The time and cost required to complete this work would be approximately twice that of the annual bypassing operation.

The beach excavation would not extend down to the channel design dredge depth of 3 metres below chart datum. That means sand will continue to move past the east pier and into the entrance channel. That sand would be excavated with a barge-mounted backhoe and dump scows and dumped offshore of Fox Run Road, as is currently done.

The rate at which the channel will fill in is not known but it will be considerably slower than the rate at which the channel has recently filled. Sediment transport modeling could be applied to estimate the likely infilling rate but uncertainty associated with that modeling would limit its usefulness. It would be better to monitor the infilling rate and dredge the channel before the infilling becomes a serious issue.

To estimate the dredging cost of keeping the channel clear we have assumed that about 20% of the average annual drift will pass the excavated beach area and end up in the entrance channel. That is an arbitrary but plausible estimate given the extent of dredging being carried out on the beach. Assuming that 20% of the average annual drift would be dredged using the marine operation and 80% would be dredged using land operations increases the unit dredging rate to approximately \$7.00/m^3 and the annual cost to \$105,000. That only applies to the ongoing annual bypassing program; the initial 30,000 m^3 fillet beach excavation will be done at the land operation rate of \$6.50/m^3.

The main advantages of this option are the low unit cost for dredging and the relative insensitivity to adverse wave conditions. Dredging of the beach can continue during wave conditions that would halt marine operations.

The main disadvantage is the amount of truck traffic added to the local community. Based on our assumed average annual littoral transport rate and dredging rate there will be approximately 64 truck trips per day for 19 days per year, going from Wheatley Harbour to Hillman Marsh. Performing this work in the winter could minimize the impacts.

4.3. Option 3 – Hydraulic Dredging with Floating Pipe Discharge

Option three is to use a hydraulic dredge with a floating discharge pipe. Of the hydraulic dredges we examined the VMI 820 cutter suction dredge would be the best dredge to use in this application due to the length of output pipe required to place the discharge at a location far enough down shore. It should be noted, however, that there are a number of dredges with similar capabilities on the market and a detailed analysis of alternative equipment would be warranted.

It should also be noted that larger more powerful dredges capable of pumping further down shore are also available but were not considered. At full production capacity the VMI 820 requires only 17 working days to dredge 15,000 m^3 of sand. The annual bypassing operation at Wheatley represents a significant underuse of the equipment. A more powerful dredge would be even more underused.

The purchase price of the VMI 820 is $400,000. We have estimated the cost of purchasing and assembling 750 metres of discharge pipe and floats to be $45,000 but note that there are a number of variables associated with the pipe system that cannot be considered within this level of analysis. For example, where and how the pipe can be stored when not in use will determine how it is assembled.

How the pipe is assembled will also determine what effort is required to mobilize and demobilize the dredge each time it is used. For this study we made some basic estimates about the level of effort and labour costs required to deal with the pipeline and assumed it will take place in addition to the 8 hours per day assumed for dredging. The number of working days required to dredge should be adjusted if that is not the case.

Using information provided by the dredge manufacturer we estimated the annual operating cost to dredge 15,000 m^3 of sand to be $34,000. The dredge can move 114 m^3 of sand per hour so it will take 17 working days to complete the annual operation. It is possible that the actual pace of work may be governed by the rate at which the discharged sand is distributed by natural wave action. We do not expect that to be the case, however, because the actual discharge points on different days can be distributed over a wide area at the selected discharge site.

The area to be dredged for the recommended initial fillet beach removal is the same as for Option 1. The dredging would start between the east pier and the offshore breakwater and move up the shore to the northeast, keeping the toe of the dredged area in line with the east pier. The sand would be excavated down to a depth of 3 metres below datum, which is the design dredge depth for the entrance channel. The side slope of the dredged area would be cut at a slope of approximately 10:1 (horizontal: vertical) and would extend up to about chart datum. Continuing that cross-section 150 metres up the shore then tapering off over the next 100 metres would yield approximately 30,000 m^3 of sand. The time and cost required to complete this work would be approximately twice that of the annual bypassing operation.

As part of this option we considered building a retaining structure on the west side of the pier so that an artificial feeder beach could be constructed. The dredged sand would be pumped onto the beach and allowed to move downdrift under normal wave action. The west pier extension option presented in Shoreplan (2003) was considered as a possible type of structure. Figure 4.1 shows that extension. It was estimated to cost in excess of $600,000 in 2003.

After a preliminary review it was concluded that the beach that formed in the lee of that structure would also be within the shadow zone of the offshore breakwater during easterly wave conditions. Without the balancing action of the easterly waves it is probable that the beach would form in such a shape that it would be susceptible to being pushed around the tip of the west pier extension and into the entrance channel during southwesterly wave events. Constructing a beach retaining structure further downdrift was considered impractical due to the impacts that structure could have on the shoreline between that structure and Wheatley Harbour. Consideration of a feeder beach retaining structure was subsequently dropped.

The floating discharge pipe will cross the harbour entrance when dredging the fillet beach area. That should be considered to be a significant disadvantage of this option.

4.4. Option 4 – Hydraulic Dredging with Fixed Pipe Discharge

Option 4 is to use a hydraulic dredge with a fixed pipe discharge pipe. As discussed in Section 3.2.3, using a fixed pipe requires a booster pump on the end of the east pier. Adding that pump allows a lower capacity dredge to be used when compared to the floating discharge pipe of Option 3. For this option we have selected the Piranha P-30 mini-dredge. It should be noted, however, that there are other small remote controlled dredges with similar capabilities on the market and a detailed analysis of alternative equipment would be warranted.

We estimated the initial cost of purchasing and setting up the P-30 dredge to be $100,000. That includes an allowance for providing a suitable electric source at the end of the east pier (the P-30 uses a 460v electric motor). In Section 3.2.3 the cost of installing a booster pump station and fixed pipe system from the east pier to road allowance 3 was estimated to be $320,000. Road allowance 3 was selected as a reasonable bypass return location without the benefit of a detailed analysis of the likelihood of sand being transported back into the harbour. We consider it to be a reasonable estimate but if this Option is selected for implementation the implications of sediment coming back to the harbour should be considered in more detail.

The fixed pipe will pass through the lakebed between the east pier and the south fillet beach so that the harbour entrance is not blocked during dredging operations.

Using information provided by the dredge manufacturer we estimated the annual operating cost to dredge 15,000 m^3 of sand to be $29,000. The dredge can move 61 m^3 of sand per hour so it will take 31 working days to complete the annual operation. It is possible that the actual pace of work may be governed by the rate at which the discharged sand is distributed by natural wave action. We do not expect that to be the case, however, because the actual discharge points on different days can be distributed over an area at the selected discharge site. This is possible because a floating pipe is used to transport the slurry from the on-land pipeline termination point out to the nearshore discharge point.

The area dredged for the recommended initial fillet beach removal is the same as for Options 1 and 3. The dredging would start between the east pier and the offshore breakwater and move up the shore to the northeast, keeping the toe of the dredged area in line with the east pier. The sand would be excavated down to a depth of 3 metres below datum, which is the design dredge depth for the entrance channel. The side slope of the dredged area would be cut at a slope of approximately 10:1 (horizontal: vertical) and would extend up to about chart datum. Continuing that cross-section 150 metres up the shore then tapering off over the next 100 metres would yield approximately 30,000 m^3 of sand. The time and cost required to complete this work would be approximately twice that of the annual bypassing operation.

For this option we made some basic estimates about the level of effort and labour costs required to position the offshore cable anchor. It was assumed that work will take place in addition to the 8 hours per day assumed for dredging. The number of working days required to dredge should be adjusted if that is not the case.

4.5. Comparison of Options

Four dredging options were developed and presented above. Table 4.1 summarizes the dredging capabilities and estimated costs for the four options. These are concept level costs estimates only.

Options 1 and 2 assume that the dredging work will be carried out by contractors. They have a higher annual cost than Options 3 and 4, but no initial cost. Options 3 and 4 assume that equipment will be purchased and operated by the Wheatley Harbour Authority. They have significant initial costs but lower annual operating costs.

In order to allow the costs of Options 1 and 2 to be compared to the cost of Options 3 and 4 we estimated an equivalent annual cost for the upfront costs of Options 3 and 4. We caution that these are very rough estimates only and should be considered to have a high degree of uncertainty. We recommend that the selection of a preferred option not be based on these costs alone.

The equivalent annual cost of the dredging and pipeline equipment and construction was estimated by assigning a design life to the dredging equipment then dividing the initial cost of the equipment by its life. That is an approximate method of estimating annual costs that does not consider the future value of present day costs incurred.

We assigned the VMI 820 dredge a design life of 5 years and the Piranha P-30 dredge a design life of 10 years. The Piranha dredge was given a longer life because it is a simpler system that it said to have very low maintenance requirements. Actual design life will be determined by a number of factors that cannot be contemplated at this level of analysis.

4.6. Preferred Solution

We recommend that Option 2 be considered as the preferred solution for dredging and bypassing at Wheatley Harbour. Option 2 is to remove a volume of sand corresponding to approximately 80% of the average annual littoral drift from the north fillet beach with land based equipment and truck it to Hillman Marsh. It is assumed that the remaining 20% of the average annual littoral drift will be transported past the beach excavation site and be deposited in the entrance channel. That material will be excavated with a barge-mounted backhoe and dumped offshore of the end of Fox Run Road.

We recommend this solution because of its ease of implementation. Option 4 seems to have a lower annual dredging cost, assuming the design life estimates are reasonable, but it is a more complex operation.

Experience shows that the Hillman Marsh and Fox Run Road bypass return locations of Option 2 are feasible and that sand does not move back into the harbour.

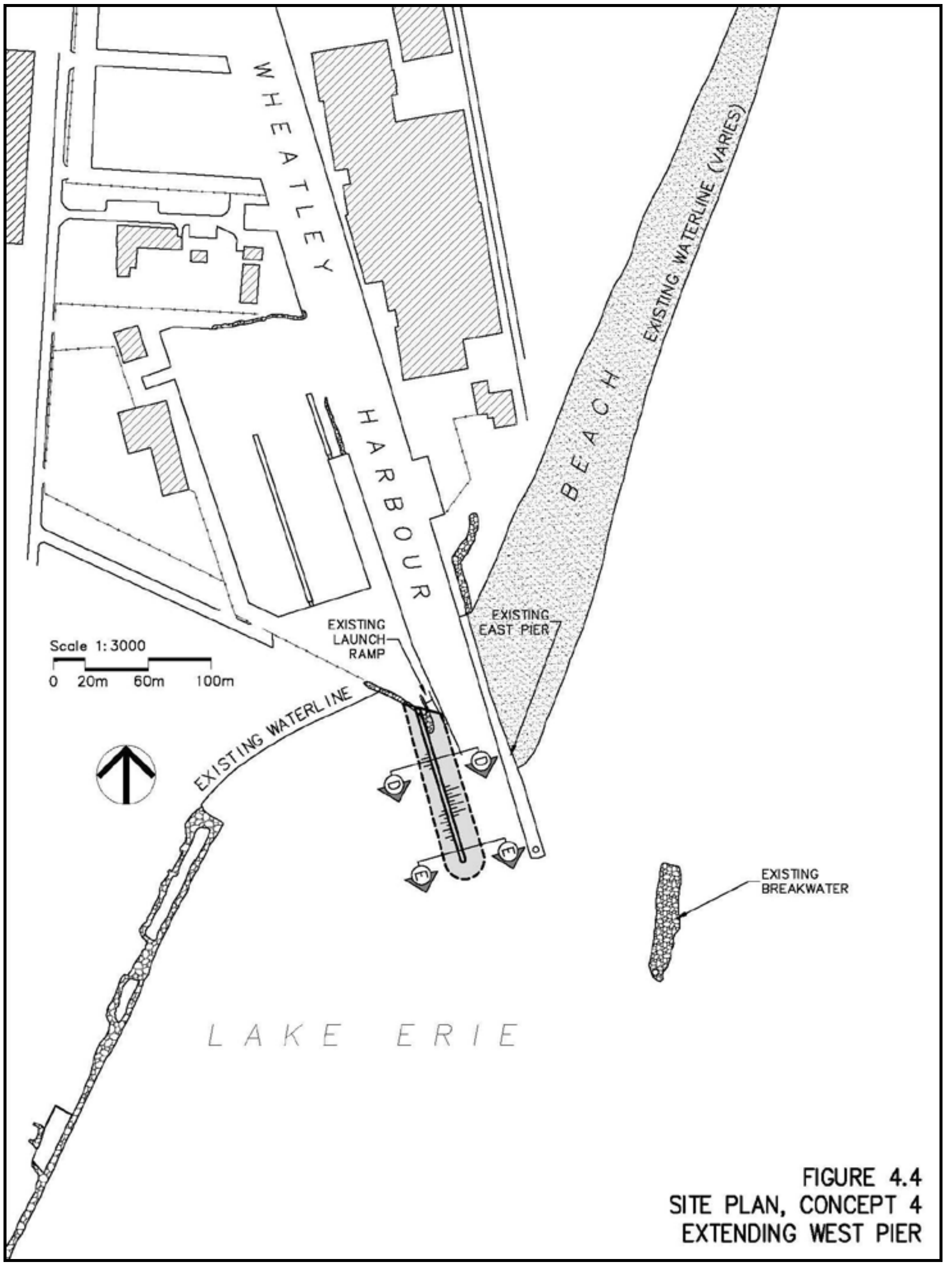
This option can be implemented with no start-up cost, as opposed to Option 2 and Option3. It could be run for a number of years then re-evaluated, if required, once the actual average annual littoral transport rate has been better defined.

Table 4.1 Cost Comparison of Dredging Alternatives

Item	Option 1	Option 2	Option 3	Option 4
Description	Mechanical dredge with marine equipment	Mechanical dredge with land based equipment for 80% and marine equipment for 20%	Hydraulic dredge with floating pipe discharge (VMI 820 cutter suction dredge or Pirahna P-75 spud barge)	Hydraulic dredge with fixed pipe discharge (Piranha P-30 mini-dredge)
Productivity				
Cubic metres per hour	66	80	114	61
Hours per year	229	188	132	245
Working days per year	29	23	17	31
Capital Cost				
purchase price - dredge			$400,000	$100,000
- pipe			$45,000	$320,000
assumed life (years) [1]			5	10
equival annual cost			$89,000	$42,000
unit price per cubic metre			$5.93	$2.80
Operating Cost (per m^3)				
Contract cost	$8.75	$7.00		
Operating Cost			$2.29	$1.92
Total Cost (per m^3)	$8.75	$7.00	$8.22	$4.72
Total Annual Cost [1]	$131,000	$105,000	$123,000	$71,000

1) Assumed life of dredging equipment must be considered within context of accompanying text

Figure 4.1 West Pier Extension from Shoreplan (2003)



5. Implementing a Dredging and Bypassing Program

As part of implementing a dredging and bypassing program the necessary approvals must be obtained, the exact location to be dredged should be confirmed and a monitoring program should be devised. The Essex Region Conservation Authority acts as a lead agency for the various governmental departments that require permits and approvals. Whether or not it is acceptable to excavate the north fillet beach will be addressed as part of the Public Lands Act component of the MNR work permit.

The area to be dredged should be surveyed before dredging. That will ensure that the proposed fillet beach excavation area is sufficient and will serve as a baseline data set for monitoring. Monitoring of both the dredge and placement sites is recommended so that the average annual littoral drift rate can be confirmed. It is possible that a detailed monitoring plan will need to be developed as part of the approval process..

6. Conclusions and Recommendations

The most effective way of managing the dredging requirements at Wheatley Harbour is to reduce the size of the north fillet beach retained by the east harbour pier. That beach is acting as a reservoir of sand that can be pushed into the entrance channel during easterly storms. We recommend removing approximately 30,000 m^3 of sand from the south end of the beach, near the east harbour pier, prior to implementing an annual bypassing operation. That excavated area will act as a littoral sink trapping the majority of the average annual drift.

We examined four technical options for implementing a dredging and bypassing operation at Wheatley Harbour. We recommend that Option 2 be considered as the preferred option from a coastal engineering view. We did not consider any broader socioeconomic issues or impacts associated with this option.

Option 2 is to remove a volume of sand corresponding to approximately 80% of the average annual littoral drift from the north fillet beach with land based equipment and truck it to Hillman Marsh. It is assumed that the remaining 20% of the average annual littoral drift will be transported past the beach excavation site and be deposited in the entrance channel. That material will be excavated with a barge-mounted backhoe and dumped offshore of the end of Fox Run Road.

Initial dredging should be based on the assumption that the average annual littoral drift rate is 15,000 m^3/yr. That rate should be confirmed as part of the monitoring process.

References

Baird et al, 2007. Sustainable Management Strategy for South-East Leamington – Phase 2 Report. Unpublished report prepared for Essex Region Conservation Authority by W.F. Baird & Associates , Bill Stephenson, Gartner Lee Limited, Golder Associates, The Outspan Group Inc., Todgham & Case Associates Inc, and University of Guelph, Ridgetown. April 20, 2007.

van Raalte, G.H. and R.N. Bray. 1999. Hydrodynamic Dredging: Principles, Effects and Methods. Proc. CEDA Dredging Days 1999.

Reinders, 1988. Littoral Cell Definition and Sediment Budget for Ontario's Great Lakes. Final Report. Unpublished report for Conservation Authorities and Water Management Branch, Ontario Ministry of Natural Resources by F.J. Reinders and Associates Canada Limited

Shoreplan, 2003. Wheatley Harbour Sedimentation Study. Unpublished report prepared for Public Works and Government Services Canada by Shoreplan Engineering Limited. Final Report. March 2003

Shoreplan, 2006. Wheatley Harbour Design Assessment. Unpublished report prepared for Public Works and Government Services Canada by Shoreplan Engineering Limited. Final Report. March 2006

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