# APPENDIX B

## Tree Inventory Technical Memorandum

# TECHNICAL MEMORANDUM

**DATE** November 4, 2015 **PROJECT No.** 1413940

**TO** Joe Boothe, Environmental Services
City of Sarnia

**CC** Wendy Ott and Marc Schwerzmann, Golder Associates Ltd.

**FROM** Jessalyn Oke, Golder Associates Ltd. **EMAIL** Jessalyn_Oke@golder.com

**MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT FOR SHORELINE PROTECTION OF CENTENNIAL PARK ALONG THE SARNIA BAY HARBOUR FRONT – TREE INVENTORY**

## Introduction

Ongoing remedial activities are occurring to address historical contaminants in fill used to construct Centennial Park (the Park), which opened in 1967. The proposed solution (i.e., the placement of a clean soil cap at the Park) to contain historic contaminants requires an overall increase in site grading by 0.5 metres (m), which necessitates the installation of shoreline protection at the Park's southern waterfront along Sarnia Bay. The Project will also include removal of the existing boat ramps and installation of new ramps closer to the existing marina.

Under the Municipal Class Environmental Assessment (EA) process, there is a requirement to complete a Schedule 'C' level assessment when municipal plans: *include the construction of new shore line works, such as off-shore breakwaters, shore-connected breakwaters, groynes and sea walls (MEA, 2011; Page 1-19, No.9).* As part of this work, a tree inventory was completed by our landscape architects and a qualified arborist to identify the current condition of all trees with a diameter at breast height (DBH) of 10 centimeter (cm) or greater within the EA Study Area. The EA Study Area consists of a 30 m buffer from the proposed edge of water. The objective of the inventory was to identify if there were any significant trees within the Study Area that required preservation and protection to minimize the impact of construction injury. For the purposes of this technical memorandum (memo), the definition of a significant tree has been derived from the Ontario Urban Forestry Council's and Forest's Ontario's definition of a heritage tree[1]. For the purposes of this memo, a significant tree is considered one that is a:

- Notable specimen because of its size, form, shape, beauty, age, colour, rarity, genetic constitution, or other distinctive features;
- Living relic that displays evidence of cultural modification by Aboriginal or non-Aboriginal people, including strips of bark or knot-gree wood removed, test hole cut to determine soundness, furrows cut to collect pitch or sap, or blazes to mark a trail;

[1] Forest's Ontario Website: http://www.forestsontario.ca/index.php/heritage-tree

- Prominent community landmark;
- Specimen associated with a historic person, place, event or period;
- Representative of a crop grown by ancestors and their successors that is at risk of disappearing from cultivation; and/or,
- Tree associated with local folklore, myths, legends, or traditions.

## Limitations

This memorandum is limited to assessing and documenting the condition of the trees with a DBH of 10 cm or greater within the Study Area during three separate site visits on November 3, 2014, December 8, 2014, and June 11, 2015. The inventories were conducted by David Waverman, Senior Landscape Architect and Qualified Arborist; Erin Eldridge, Landscape Architect, and Jeff Thomson, Landscape Design Consultant. The evaluations are based on a visual inspection of the trees from the ground at the time of the respective visits.

## Existing Trees

The Study Area contained 74 trees comprised of both deciduous and coniferous species. Refer to Figure 001 and Figure 002 for the locations and list of existing trees within the Study Area. Figure 003 lists trees that are adjacent to the Study Area.

No significant trees were identified within the Study Area at the time of the inventories.

## Anticipated Impacts

To remediate the soils within the Study Area, a 0.5 m addition of fill is proposed in order to 'cap' the contaminated soils. It is anticipated that 41 trees within the Study Area will require removal to adequately cap contaminated soils. The existing grades will need to be significantly raised to accommodate the sea wall and tie into the surrounding grades. These anticipated significant grading changes will also prevent tree preservation within specific parts of the Study Area. The remaining 33 trees to be retained shall be preserved as outlined in below in Recommendations.

## Recommendations

Trees on public property are regulated by the City of Sarnia By-Law Number 34 of 1992 *By-Law to Regulate the Planting, Maintenance, and Removal of Trees in Public Places within the City of Sarnia.* Point 12 of the by-law identifies that the provisions of the by-law relating to planting, removal or replacement of trees in public places shall not apply to persons operating under any contract with the City. Such persons will be bound by the provisions, if any, of the contract with respect to planting, removal, or replacement of trees in public places.

Replacement planting will be determined as part of detailed design. As part of the detailed design and construction phases, it will be recommended that:

- No removals of trees on public property shall occur without the issuance of written approval from the City's Arborist;
- Proposed trees shall have a minimum caliper of 150 millimeters to lessen the risk of damage to trees due to vandalism, as the trunks of smaller caliper trees are easily broken; and
- Any trees on public or private property (e.g., adjacent to the Study Area) to be retained, shall be protected to the satisfaction of the City's Arborist. A tree protection plan shall be prepared for the written approval of the City's Arborist prior to the commencement of construction activities;

Trees to be retained shall be protected with tree protection fencing that is at least 1.2 m in height and consisting of orange plastic snow fencing on a wood frame made of 2-inch x 4-inch boards. Tree protection fencing shall be placed, at a minimum, 1 m beyond the limit of the extent of the canopy for all trees to be retained. Construction activities, grade changes, surface treatment or excavations of any kind shall not be permitted within this tree protection zone.

The final location of tree protection fencing shall be determined as part of forthcoming detailed design.

Yours truly,

Marc Schwerzmann, P.Eng.
Senior Engineer

DW/MS/CJR/

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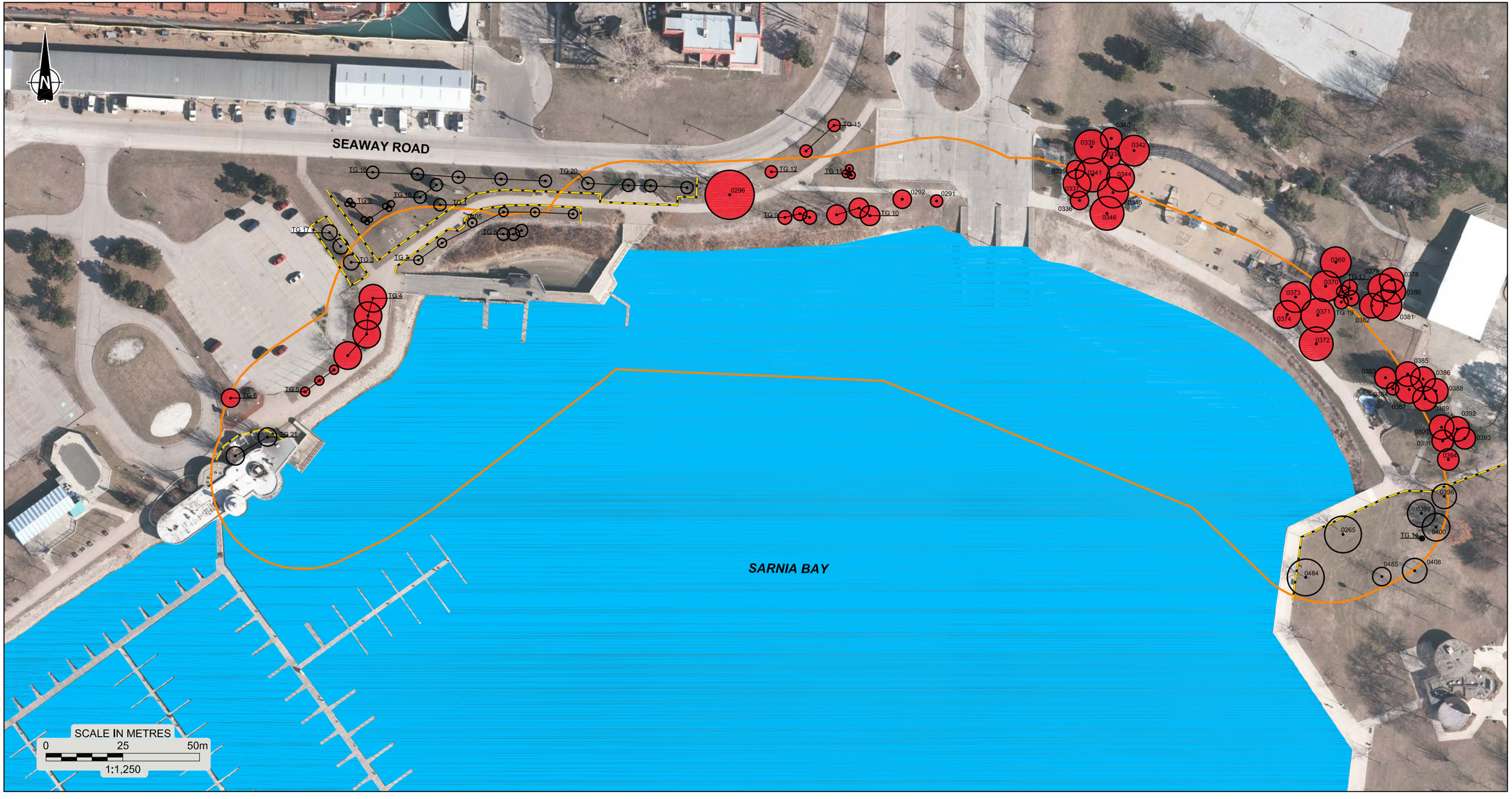


## LEGEND

- STUDY AREA
- TG — TREE GROUP*
- 0000 — EXISTING TREE TO BE RETAINED
- 0000 — EXISTING TREE TO BE REMOVED
- TREE PROTECTION FENCING

## REFERENCE

DRAWING BASED ON 2013 AERIAL IMAGE BY FIRST BASE SOLUTIONS;
MONTEITH & SUTHERLAND LIMITED, OLS, SURVEY PLAN, FILE No. SAR-5854, PLAN FILE No. E-1520 AND
CANMAP STREETFILES V2008.4.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

ALL INVENTORY DATA WAS COLLECTED DURING SITE VISITS ON NOVEMBER 3, 2014, DECEMBER 8, 2014, AND JUNE 11, 2015.

* INDIVIDUAL TREES THAT ARE THE SAME SPECIES WITH SIMILAR CHARACTERISTICS (CANOPY, HEIGHT), HAVE BEEN IDENTIFIED AS TREE GROUPS

PROJECT

CENTENNIAL PARK
SARNIA, ONTARIO

TITLE

**EA TREE INVENTORY**

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | 1413940 | FILE No. | TREE INVENTORY_REV2 |
| | | | SCALE | AS SHOWN |
| CADD | JT | June 23/15 | REV. | 1 |
| CHECK | EE/DW | July 24/15 | | |

001

Drawing file: EA TREE INVENTORY_REV2.dwg Aug 09, 2015 - 11:51pm

## TREE INVENTORY CHART - TREES WITHIN EA STUDY AREA*

| TREE GROUP / TREE TAG No. | BOTANICAL NAME | COMMON NAME | HT (m) / DBH (cm) | CANOPY (R in m) | CONDITION | ADDITIONAL COMMENTS | ACTION |
|---|---|---|---|---|---|---|---|
| TG 1 | *Picea pungens* | Colorado blue spruce | 5.5m | 2.5 | Good | One (1) trees; very full | Retain |
| TG 3 | *Acer plantanoides* | Norway maple | 26cm | 2.5 | Good | One (1) trees | Retain |
| TG 4 | *Gleditsia triacanthos* | honey locust | 22cm, 24cm, 26cm, 31cm | avg. 4 | Good / Fair | Four (4); surface root exposure | Remove |
| TG 5 | *Malus sp.* | crab apple species | | avg. 1 | Good | Three (3) trees | Renove |
| TG 6 | *Quercus robur* | English Oak | 50cm | 3 | Good | Mature | Renove |
| TG 7 | *Celtis sp.* | Hackberry species | | avg. 1.5 | Good | Five (5) trees; newly planted | Retain |
| TG 8 | *Fraxinus pennsylvanica* | red ash | avg. 20cm | avg. 2 | 2 trees: Fair; 1 tree dead | Three (3) trees; located in sand; stunted leaf growth | Retain |
| TG 9 | *Populus deltoides* | eastern cottonwood | avg. 17cm | avg. 2.5 | Good | Three (3) trees; all trees multi-stem | Renove |
| TG 10 | *Populus deltoides* | eastern cottonwood | avg. 32cm | avg. 3.5 | Good | Three (3) trees | Renove |
| TG 11 | *Malus sp.* | crab apple species | avg. 10cm | 1 | Good | Three (3) trees; ornamental trees | Renove |
| TG 12 | *Prunus 'Kanzan'* | Kwanzan cherry | 20cm | 2 | Good | Street tree | Remove |
| TG 14 | *Picea pungens* | Colorado blue spruce | 2.75m | 0.5 | Good | One (1) tree | Retain |
| TG 19 | *Malus sp.* | crab apple tree | 25cm | 3 | Good / Fair | Some broken branches | Remove |
| TG 20 | *Prunus 'Kanzan'* | Kwanzan cherry | avg. 20cm | 2 | Good | Four (4) trees; street trees | Retain |
| TG 21 | *Quercus robur* | English Oak | avg. 50cm | avg. 3 | Good | Two (2) trees; mature | Retain |
| 0291 | *Platanus x acerifolia* | London planetree | 15cm | 2 | Good | | Remove |
| 0292 | *Platanus x acerifolia* | London planetree | 21cm | 3 | Good | | Remove |
| 0296 | *Populus deltoides* | eastern cottonwood | avg. 55cm | 7.5 | Good | Mature; multi-stem (2) | Remove |
| 0335 | *Acer plantanoides* | Norway maple | 28cm | 3 | Good | Tar spots | Remove |
| 0336 | *Acer plantanoides* | Norway maple | 27cm | 3 | Good | Tar spots | Remove |
| 0337 | *Acer plantanoides* | Norway maple | 36cm | 4.5 | Good / Fair | Tar spots; suppressed growth | Remove |
| 0338 | *Pinus resinosa* | red pine | 36cm | 3 | Fair | | Retain |
| 0339 | *Pinus resinosa* | red pine | 48cm | 5 | Good / Fair | Significant lean | Retain |
| 0340 | *Pinus resinosa* | red pine | 28cm | 3.5 | Good / Fair | | Retain |
| 0341 | *Gleditsia triacanthos* | honey locust | 32cm | 6 | Good | | Remove |
| 0342 | *Pinus resinosa* | red pine | 41cm | 5 | Good | | Retain |
| 0344 | *Gleditsia triacanthos* | honey locust | 21cm | 4.5 | Good | | Remove |
| 0345 | *Gleditsia triacanthos* | honey locust | 20cm | 5 | Good | | Remove |
| 0346 | *Gleditsia triacanthos* | honey locust | 37cm | 6 | Good | | Remove |
| 0370 | *Gleditsia triacanthos* | honey locust | 27cm | 5 | Good | | Remove |
| 0371 | *Gleditsia triacanthos* | honey locust | 31cm | 5.5 | Good | | Remove |
| 0372 | *Gleditsia triacanthos* | honey locust | 27cm | 5.5 | Good | | Remove |
| 0373 | *Gleditsia triacanthos* | honey locust | 32cm | 5 | Good | Located in playground | Remove |
| 0374 | *Gleditsia triacanthos* | honey locust | 29cm | 4.5 | Good | | Remove |
| 0383 | *Malus sp.* | crab apple species | avg. 16cm | 3.5 | Good | Multi-stem | Remove |
| 0384 | *Malus sp.* | crab apple species | 20cm | 2 | Good | | Remove |
| 0385 | *Pinus nigra* | Austrian pine | 37cm | 4 | Good | | Remove |
| 0387 | *Pinus nigra* | Austrian pine | 36cm | 4.5 | Good | | Remove |
| 0389 | *Pinus nigra* | Austrian pine | 43cm | 4 | Good | | Remove |
| 0390 | *Pinus nigra* | Austrian pine | 53cm | 4.5 | Good | | Remove |
| 0391 | *Pinus nigra* | Austrian pine | 32cm | 3.5 | Good | | Remove |
| 0394 | *Acer rubrum x Acer saccharinum* | hybrid red / silver maple | 27cm | 3.5 | Good | | Remove |
| 0398 | *Tilia americana* | basswood | 46cm | 5 | Good | | Retain |
| 0399 | *Quercus palustris* | pin oak | 30cm | 5.5 | Good | | Retain |
| 0400 | *Quercus palustris* | pin oak | 38cm | 5.5 | Good / Fair | | Retain |
| 0405 | *Pyrus calleryana* | ornamental pear | 8cm | 1.5 | Good | Newly planted | Retain |
| 0408 | *Liriodendron tulipifera* | tulip tree | 27cm | 4 | Good | | Retain |
| 0484 | *Gleditsia triacanthos* | honey locust | 36cm | 6 | Good | | Retain |
| 0485 | *Liriodendron tulipifera* | tulip tree | 24cm | 3 | Good | | Retain |
| 0265 | *Gleditsia triacanthos* | honey locust | 39cm | 6 | Good | Exposed surface roots; minor dieback | Retain |

## TREE INVENTORY NOTES

1. TREES INCLUDED WITHIN THE STUDY AREA ARE THOSE THAT ARE WHOLEY OR PARTIALLY WITHIN THE 30m BUFFER. THIS INCLUDES TREES WHERE THE TRUNK IS OUTSIDE THE STUDY AREA LIMIT/30m BUFFER, BUT THE TREE CANOPY IS WITHIN THE STUDY AREA LIMIT/30m BUFFER.

2. DUE TO THE CONTAMINATION OF THE SOILS, ALL TREES WITHIN THE EA STUDY AREA ARE ANTICIPATED TO BE REMOVED.

PROJECT

CENTENNIAL PARK
SARNIA, ONTARIO

TITLE

**EA TREE INVENTORY**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT No. | | | 1413940 |
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| CADD | JT | June 23/15 | |
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002

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## TREE INVENTORY CHART - TREES ADJACENT TO EA STUDY AREA

| TREE GROUP / TREE TAG No. | BOTANICAL NAME | COMMON NAME | HT (m) / DBH (cm) | CANOPY (R in m) | CONDITION | ADDITIONAL COMMENTS | ACTION |
|---|---|---|---|---|---|---|---|
| TG 2 | *Thuja occidentalis* | eastern white cedar | avg. 3m | avg. 0.75 | Good | Nine (9) trees; groupings of 3 trees as seen on plan | Retain |
| TG 14 | *Picea pungens* | Colorado blue spruce | 2.75m | 0.5 | Good | -- | Retain |
| TG 13 | *Malus sp.* | crab apple tree | avg. 25cm | avg. 3 | Good / Fair | Three (3) trees; spaced 3' from one and other; some broken branches | Remove |
| TG 15 | *Prunus 'Kanzan'* | Kwanzan cherry | avg. 20cm | 2 | Good | Two (2) trees; street trees | Remove |
| TG 16 | *Prunus 'Kanzan'* | Kwanzan cherry | avg. 20cm | 3 | Good | Five (5) trees; street trees | Retain |
| TG 17 | *Acer plantanoides* | Norway maple | 22cm, 24cm | avg. 2.5 | Good | Two (2) trees | Retain |
| TG 18 | *Picea pungens* | Colorado blue spruce | avg. 5.5m | avg. 2.5 | Good | Two (2) trees; very full | Retain |
| 0338 | *Pinus resinosa* | red pine | 36cm | 3 | Fair | | Remove |
| 0339 | *Pinus resinosa* | red pine | 48cm | 5 | Good / Fair | Significant lean | Remove |
| 0340 | *Pinus resinosa* | red pine | 28cm | 3.5 | Good / Fair | | Remove |
| 0342 | *Pinus resinosa* | red pine | 41cm | 5 | Good | | Remove |
| 0344 | *Gleditsia triacanthos* | honey locust | 21cm | 4.5 | Good | | Retain |
| 0369 | *Gleditsia triacanthos* | honey locust | 25cm | 5 | Good | | Remove |
| 0378 | *Pinus nigra* | Austrian pine | 34cm | 4 | Good | | Remove |
| 0379 | *Pinus nigra* | Austrian pine | 50cm | 5 | Good | Significant lean | Remove |
| 0380 | *Pinus nigra* | Austrian pine | 31cm | 4 | Good | | Remove |
| 0381 | *Pinus nigra* | Austrian pine | 39cm | 5 | Good | | Remove |
| 0382 | *Pinus nigra* | Austrian pine | 34cm | 4 | Good | | Remove |
| 0386 | *Pinus nigra* | Austrian pine | 33cm | 4 | Good | | Remove |
| 0388 | *Pinus nigra* | Austrian pine | 39cm | 4 | Good | | Remove |
| 0392 | *Pinus nigra* | Austrian pine | 35cm | 4.5 | Good | | Remove |
| 0393 | *Pinus nigra* | Austrian pine | 44cm | 4 | Good | | Remove |

## NOTES

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PROJECT

CENTENNIAL PARK
SARNIA, ONTARIO

TITLE

**EA TREE INVENTORY**

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT No. | | 1413940 | FILE EA TREE INVENTORY_REV2 |
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# APPENDIX C

## Surface Water Environment Technical Memorandum

# TECHNICAL MEMORANDUM

**DATE** October 28,2015 **PROJECT No.** 1413940

**TO** Joe Booth
City of Sarnia

**CC** Wendy Ott, Jessalyn Oke

**FROM** Terry Winhold **EMAIL** twinhold@golder.com

**MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT FOR SHORELINE PROTECTION OF CENTENNIAL PARK ALONG THE SARNIA BAY HARBOUR FRONT –SURFACE WATER ENVIRONMENT**

This technical memorandum documents the baseline surface water component of the Class Environmental Assessment (EA) for shoreline protection of Centennial Park along the Sarnia Bay harbour front. On-going remedial activities are occurring to address historical contaminants in fill used to construct Centennial Park (the Park), which opened in 1967. The proposed solution (i.e., the placement of a clean soil cap at the Park) to contain contaminants requires an overall increase in site grading by 0.5 metres, which necessitates the installation of shoreline protection at the Park's southern waterfront along Sarnia Bay. The Project will also include removing the existing boat ramps and installing new ramps closer to the Sarnia Bay Marina (Figure 1).

The scope of the baseline surface water component consists of the following:

- review of available data and relevant information;
- determination of flood risk, including stormwater management;
- assessing wind-wave climate in Sarnia Bay;
- assessing bathymetry and sediment transport processes; and
- alternatives development.

## 1.0 REVIEW OF AVAILABLE DATA

A detailed review of available information relating to surface water conditions affecting the Project location and proposed shoreline improvements has been completed. The review of information included the following:

- 1:100 year flood level information;
  - Source: St. Clair Region Conservation Authority (3 July 2015 email communication from Chris Durrand)
- Lake Huron-St. Clair River historic water level data:
  - Source: *International Upper Great Lakes Study – International Joint Commission* (December, 2009)

- Sarnia Bay Sediment and Bathymetric data;
  - Source: *Sarnia Bay Dredge Spoil Management Investigation – Proposed Boat Launch* (Polutech Enviroquatics Limited, June 30, 2015)
  - Source: *Sarnia Bay Dredge Spoil Management Investigation – Final Report* (Polutech Enviroquatics Limited, April 10, 2014)
  - Source: *Morphologic Change in the St. Clair River 2007 – 2012 Phase 1 Report (*USGS Great Lakes Science Center, U.S. Army Corps of Engineers, Detroit District)
- Centennial Park existing and proposed topography; and
  - Source: Survey data and Park plans, produced by Golder Associates Ltd.
- Wind data for wind-wave analysis
  - Source: Environment Canada Climate Normals 1981 - 2010 for Sarnia Airport (on-line data base).

*Figure 1: Project Location*


## 2.0 FLOOD RISK ASSESSMENT

### 2.1 Lake Huron - St Clair River Flood Levels

Sarnia Bay is hydraulically connected to the St. Clair River, which forms the outlet to Lake Huron a short distance (approximately 2.5 km) upstream of the Project. Consequently, the water level in Sarnia Bay and the Park is directly affected by the water level and outflow from Lake Huron.

Information on historic Lake Huron, water levels is reported in the Sarnia Waterfront Management Plan (2005). More recent information on Lake Huron – St Clair River water levels is available from the International Upper Great Lakes Study: *Impacts on Upper Great Lakes Water Levels: St Clair River Summary Report* (December 2009). This is the first of two major reports presenting the findings and recommendations of the bi-national International Upper Great Lakes Study launched by the International Joint Commission in 2007. Attachment 1 and 2 taken from the IJC report provide historic data on mean monthly water levels for each of the great lakes and the difference in water levels between Lake Huron and Lake Erie, which represents the average hydraulic gradient (water slope) of the interconnecting channel (the St Clair and Detroit Rivers) between the two water bodies. The later has been shown to be highly variable over time. The data relevant to this surface water assessment is summarized below (Attachment 1):

- Lake Huron Historic High Monthly Water Level = 177.5 m (1985 to 1986)
- Lake Huron Historic Low Monthly Water Level = 175.6 m (1963 to 1964)
- Approximate Lake Huron Long-term Average Monthly Water Level = 176.6 m

Since the early 1960s the head differential between Lake Huron and Lake Erie has varied between highs of 2.6 m and lows of 1.8 m (Attachment 2). The average drop in elevation is therefore in the order of 2.2 m. Thus, a representative hydraulic gradient or water surface slope between the two lakes (along the interconnecting channels) can be determined by dividing the average head differential (2.2 m) by the distance (220 km). The result is a slope of 0.00001 m/m or 10 mm/km. This can be compared to a recent 2012 bathymetric survey by the US Corps of Engineers (Detroit District) that measured a 1.5 m drop in water level over a distance of 68 km along the St. Clair River, between the outlet of Lake Huron and Lake St. Clair, that translates to a water slope of about 0.00002 or 20 mm/km.

Based on the above, the drop in water level between Lake Huron and Sarnia Bay should typically vary from about 25 mm to 50 mm (i.e., 10 to 20 mm/km x 2.5 km). Consequently, the range in mean monthly water levels for Sarnia Bay can be estimated from the historic Lake Huron water levels by subtracting approximately 2 to 5 cm.

## 2.2 1:100 Year Flood Level

The 1:100 year flood elevation for the Park, as provided by the St. Clair Region Conservation Authority (SCRCA) is 177.6 masl (meters above sea level). Of note, this elevation is higher but within 10 cm of the historic high mean monthly water level for Lake Huron. This relatively small difference between the two water levels may be explained by a number of factors, including:

- difference (by definition) between 1:100 year river level and maximum historic lake levels;
- higher daily (compared to mean monthly) maximum water levels on Lake Huron; and
- additional flow entering from local tributaries to the St. Clair River (i.e., Black River at Port Huron).

## 2.3 Stormwater Management

Presently, the areas encompassed by the shoreline at the Park drain towards Sarnia Bay and surface water runoff from the Park does not discharge to the City of Sarnia stormwater collection system (i.e., street storm sewers). Any fill placement or regrading proposed in connection with the shoreline protection will be designed to maintain the existing surface water drainage towards Sarnia Bay.

## 3.0 WIND-WAVE CLIMATE

The wind generated wave conditions in Sarnia Bay and its potential to cause shoreline erosion was assessed using simplistic wave hind casting approaches developed largely by the US Corps of Engineers and documented in various references.

### 3.1 Maximum Hourly Winds

The first step in estimating wave heights over a water body is to characterize the potential for extreme wind speeds from directions that may impact the Project location. For this type of assessment, published data from Environment Canada Climate Normals: 1981 to 2010 was examined from the closest station (Sarnia Airport) where wind statistics are readily available. Maximum recorded hourly (1-hour duration) wind speeds by direction for the open water season and for all months are shown in Table 1. A design wind speed of 83 km/hr for the open water season (assumed to be April-December) and a southerly direction (i.e., blowing on shore from the south-west) was selected for this assessment.

**Table 1: Maximum Hourly Wind Speeds (km/hr) Direction for Sarnia Airport**

| Month | J | F | M | A | M | J | J | A | S | O | N | D | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Speed | 78 | 81 | 67 | 74 | 65 | 56 | 53 | 67 | 56 | 72 | 83 | 93 | 93 |
| Direction | W | S | S | N | N | N | N | S | S | S | S | W | W |

Notes:

1. Maximum hourly wind speeds for the period of record 1981 to 2010 are reported by month.
2. Measurement Height is 10 m above ground level.

### 3.2 Fetch Distance

The second step in the analysis is to determine the fetch distance, defined as the maximum distance over water that an unobstructed wind generating waves could be blowing onshore at the project location. For the most part, the Project location remains sheltered from direct wave action due to its location within Sarnia Bay. However, waves generated by a wind from the south-south west could potentially reach the Project location along a fetch distance of approximately 5 km as indicated by the red line on Figure 2.

### 3.3 Significant Wave Height

The third step involves estimating the potential height of wind generated waves, which is a function of wind speed and duration, fetch distance and depth of water. For the initial estimate, the depth of water is assumed to be sufficient to support the predicted wave height. Significant wave heights were determined from nomographs sourced from *Virginia Department of Transportation Drainage Manual – Chapter 13 Shore Protection, Appendix 13B-1 Nomograph of Significant Deep Water Wave Height Prediction Curves*. The estimated deep water significant wave height for Sarnia Bay is 0.8 m as shown in Table 2.

**Table 2: Significant Wave Height For Sarnia Bay**

| Fetch Distance (km) | Wind Direction | Wind Speed (km/hr) | Duration (hrs) | Wave Height (m) |
|---|---|---|---|---|
| 5.0 | S-SW | 83 | 1.0 | 0.8 |

Notes:

1. Significant wave heights are rounded
2. Fetch distances are derived from Google Imagery (Figure 2)

*Figure 2: Maximum Fetch Distance for Sarnia Bay*


Source: 2010 Aerial Image Provided by the United States Department of Agriculture, Natural Resources Conservation Service; 2010 Aerial Image from the County of Lambton Interactive Web Mapping SITE BATHYMETRY and Sediment Transport Processes

A review of information available on sediment deposited in Sarnia Bay was completed and a qualitative assessment of the apparent on-going sediment transport processes likely to affect or be affected by the proposed shoreline improvements was undertaken. Data on bottom sediments (grain size) and bathymetry (water depths) is available from two recent studies conducted by Polutech Enviroquatics Limited (PEL) on behalf of the City of Sarnia (Section 1.0).

## 3.4 Sediment Size

Sediment quality and grain size distributions were analyzed in both of the PEL reports based on field sampling (sediment coring) carried out in June 2013 and June 2015. The results are fairly consistent and are summarized in Table 3.

**Table 3: Sediment Grain Size Results**

| Sampling Date | No of samples | Average % Gravel | Average % Sand | Average % Silt/Clay |
|---|---|---|---|---|
| June 2013 | 15 | 0 | 45 | 55 |
| June 2015 | 7 | 0 | 47 | 53 |

## 3.5 Bathymetry

A hydrographic survey of Sarnia Bay was carried out by PEL in May 2015 to determine the depth of water above the bottom sediments throughout the inner bay area. The survey extended from the shoreline along the Park (north) out as far as the marina jetty (south), and from the first row of marina docks (west) across to the shoreline on the east side of the bay. The survey was completed on May 29, 2015 when the average water level in Sarnia Bay was 0.66 m above Chart Datum measured at the Point Edward gauge. Chart Datum is 175.65 m IGLD (International Great Lakes Datum); therefore, the water level in the bay on the day of survey was 176.31 m IGLD, which is approximately 0.3 m lower than the long-term mean monthly water level for Lake Huron. Taking into account the drop in water level between Lake Huron and Sarnia Bay (as determined in Section 2.1), the water level in Sarnia Bay on the day of survey would have been about 25 to 30 cm lower than its long-term average.

The results of this survey are presented graphically in Figure 2 of the PEL report (Attachment 3) and generally described in Table 4:

**Table 4: Hydrographic Survey Results**

| Range of Water Depth (m) | Location in Sarnia Bay |
|---|---|
| < 0.5 to 1.25 | Offshore 100 m from the Park – west of existing boat ramp |
| < 0.5 to 1.25 | Offshore 100 m from the Park – east of existing boat ramp |
| <1.0 to 2.0 | Offshore from existing Boat Ramp (nearshore to 250 m out) |
| 1.5 +/- | Adjacent to Marina Dock A |
| 1.5 +/- | Adjacent to Marina Dock Y |
| 2.0 +/- | Off end of marina jetty |
| 3.0 to 4.0 | Offshore from south end of east shore sheet pile wall |
| 1.0 to 2.5 | Offshore from middle section of east shore sheet pile wall |
| < 1.0 m | Offshore from north section of east shore sheet pile wall |

## 3.6 Sediment Transport Processes

Based on the assessment of the sediment sampling and hydrographic survey results, it is apparent that much of Sarnia Bay is in a depositional zone. Except for the area out from the south end of the east shore sheet pile wall, the entire inner bay lies in water less than about 2 m depth and most of the area within 100 m of the shore along the Park is in shallower water less than 1 m deep. The shape and alignment of the bottom contours extending outwards from the existing boat launch suggests that periodic dredging has been necessary to maintain adequate depths for boaters. These relatively shallow depths compare to depths in the order of 7 to 8 m in the shipping lanes of the nearby St. Clair River.

No data was found relating to current magnitudes and directions in Sarnia Bay. During periods of falling water levels in Lake Huron (and in the St. Clair River), there will be a very gradual outflow of water from the bay into the St. Clair River, thus setting up a very small underlying current in that direction. Similarly, during periods when lake and river levels are rising, there will be a small current entering the bay. It is expected, however, that local currents generated by storms and boat wakes will dominate over any minor inflow/outflow currents, both in terms of magnitude and direction.

# 4.0 ALTERNATIVES DEVELOPMENT

## 4.1 Hydraulic Design Parameters

The surface water assessment will provide design parameters and/or criteria needed to support the conceptual design for the shoreline protection alternative, including high and low water levels, expected wave heights in Sarnia Bay and potential wave runnup on shore during severe windstorms.

### 4.1.1 Static Water Levels

Based on the analysis in Section 2, recommended static water levels for design are provided in Table 5.

**Table 5: Recommended Static Water Levels**

| Design Condition | Water Level (m) IGLD |
|---|---|
| 1:100 Year Water Level | 177.6 |
| Maximum Mean Monthly Water Level | 177.5 |
| Long-term Average Mean Monthly Water Level | 176.5 |
| Minimum Mean Monthly Water Level | 175.5 |

### 4.1.2 Breaking Waves

Waves generated in deeper water may undergo shoaling or break as they approach shallower water in the nearshore zone. For design, it is important to determine the maximum size wave that will reach the shoreline still in possession of the deep-water energy. Significant wave heights derived from hindcasts (Section 3.3) should be checked against the maximum breaking wave that the still water level depth and near-shore bottom slope can support (i.e., the maximum breaker height (Hb) is dependent on the depth of water at the shoreline (ds), and the slope of the foreshore area ($S_o$)).

Breaking wave heights for selected water level conditions in Sarnia Bay are provided in Table 6 along with the recommended design wave height. The design wave height (Hd) is the smaller of the breaking wave height and the significant wave height (Hs).

**Table 6: Breaking Wave and Design Wave Heights**

| Water Level Condition | $d_s$ (m) | $S_o$ (m/m) | $H_b$ (m) | $H_s$ (m) | $H_d$ (m) |
|---|---|---|---|---|---|
| Maximum Monthly | 1.5 | 75H:1V | 1.2 | 0.8 | 0.8 |
| Long-term Average | 0.5 | 75H:1V | 0.4 | 0.8 | 0.4 |
| Minimum Monthly | 0.0 | 75H:1V | 0.0 | 0.8 | 0.0 |

Notes:

1. Reference: Virginia Department of Transportation Drainage Manual, Chapter 13 – Shore Protection
2. ds (water depth at shore) from Table 4
3. So (nearshore slope) from hydrographic survey (Attachment 3)
4. Hb (maximum breaker height)
5. Hs (significant wave height) from Section 3.3
6. Hd (design wave height) smaller of Hs and Hb

### 4.1.3 Wave Runup

Wave runup is the vertical height above the still water level that a wave breaking on shore will travel up the proposed shoreline protection works (or spill over the top of the bank or structure). Wave runup is a function of the design wave height, the wave period, bank angle (slope), and the roughness of the embankment protection material. For wave heights up to about 0.8 m, simplified calculation procedures offered in the literature were used to estimate potential wave runup for two water level conditions and four bank configurations as shown in Table 7.

**Table 7: Estimated Wave Runup**

| **Water Level Condition** | **Wave Runup (m)** | | | |
|---|---|---|---|---|
| | **Vertical** Wall | **1H:1V** Bank Slope | **2H:1V** Bank Slope | **3H:1V** Bank Slope |
| Maximum Monthly | 1.5 | 2.0 | 3.0 | 3.5 |
| Long-term Average | 0.8 | 0.9 | 1.2 | 1.4 |

Notes:

1. Reference: Virginia Department of Transportation Drainage Manual, Chapter 13 – Shore Protection
2. Based on simplified wave runnup calculation procedures
3. Values shown are for smooth concrete.
4. For rough surfaces apply following correction factors
    a. 0.5 for stone or concrete blocks (void ratios 40-60%)
    b. 0.6 for stone or concrete blocks (void ratios 20-40%)
    c. 0.6 for angular riprap
    d. 0.7 for round riprap

## 4.2 Erosion Protection

The significant wave height (Hs) is defined as the average height of the highest one-third of all the waves in a wave train and is the wave height commonly used in the design of flexible revetments such as conventional stone riprap. Simple procedures available in the literature for designing erosion protection from wave action due to wind or boat traffic are applicable in situations where wave heights are less than 1.5 m and there is minimal overtopping. Table 8 provides guidance for sizing conventional stone riprap for two breaking wave conditions.

**Table 8: Erosion Protection – Conventional Riprap**

| Water Level Condition | Design Wave Height (m) | Median Diameter $D_{50}$ (mm) | Median Weight ($W_{50}$) (kg) |
|---|---|---|---|
| Maximum Monthly | 0.8 | 70 | 500 |
| Long-term Average | 0.4 | 15 | 300 |

Notes:

1. Reference: US Department of Transportation Highways in the Coastal Environment, Chapter 6 - Coastal Revetments for Wave Attack
2. Values shown are for an embankment slope of 2H:1V.

## 4.3 Best Design Practices for Shoreline Protection

Best design practices for critical shoreline protection works that serve to protect developed areas against flooding due to high water levels, extreme wave action and accompanying storm surges would typically consider the following:

- design static water level having a minimum return period of 100 years (i.e., a 1% probability of recurrence);
- additional freeboard above design static water level to prevent overtopping caused by wind generated waves, wave runup and storm surge occurring during a major storm event in combination with 1:100 year static water levels; and
- armour protection to withstand scour and erosion during a major storm event (i.e., minimum 100 year return period).

In the case of less critical shoreline improvements, such as those intended to protect recreational facilities and parklands, best design practices are typically much less stringent and should consider the following:

- design static water level sufficient to prevent frequent or sustained periods of flooding that would interfere with the functionality of the facility or land use (e.g., maximum historic mean monthly water level);
- additional freeboard above design static water level to prevent frequent or sustained periods of overtopping caused by wind generated waves and wave runup occurring in combination with the expected range of static water levels (i.e., long-term average to maximum mean monthly water level); and
- armour protection to withstand scour and erosion during a major wind/wave storm event (i.e., design based on significant wave heights, breaking waves and wave runnup analysis).

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TW/AF/JO/wlm

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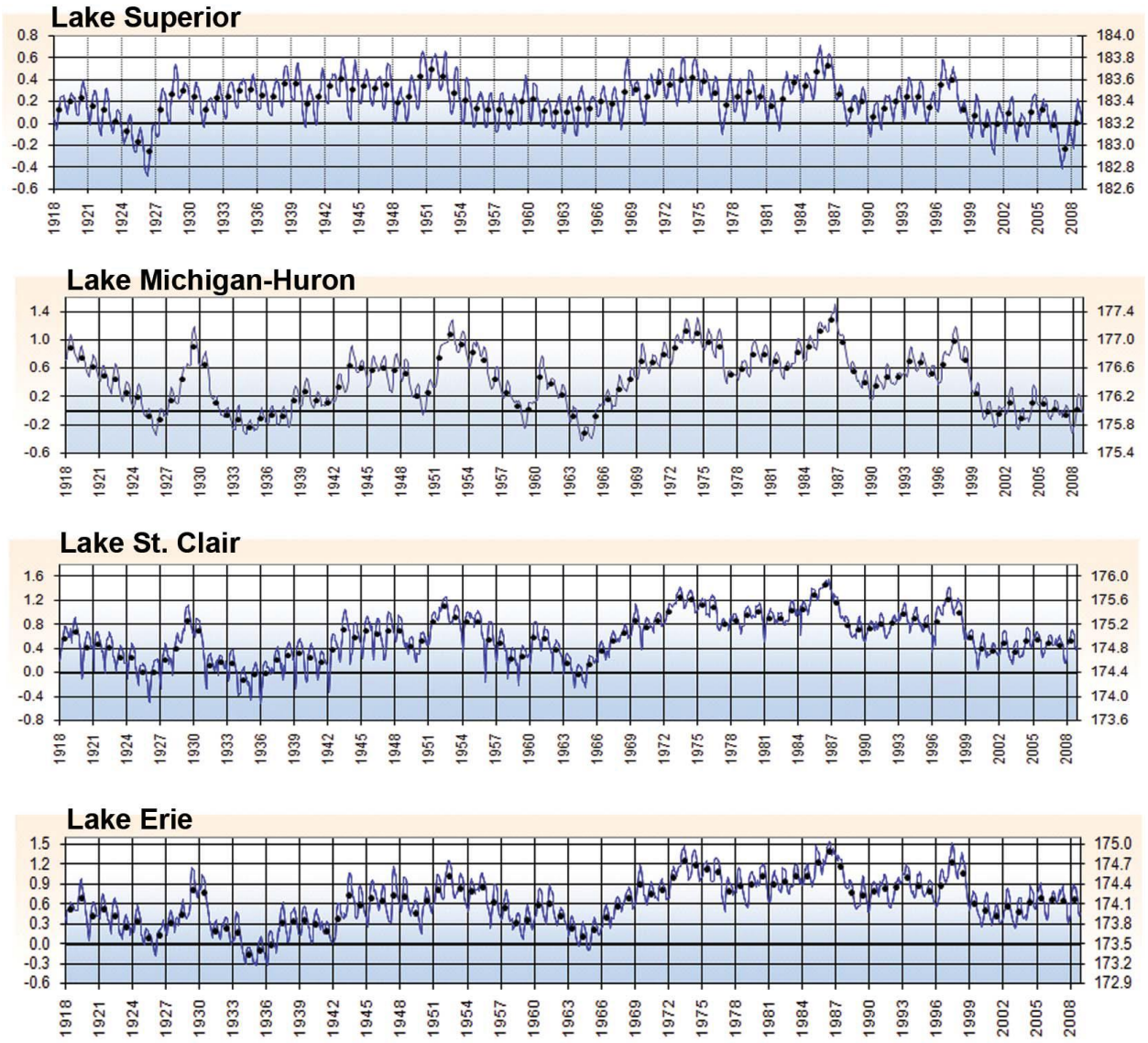
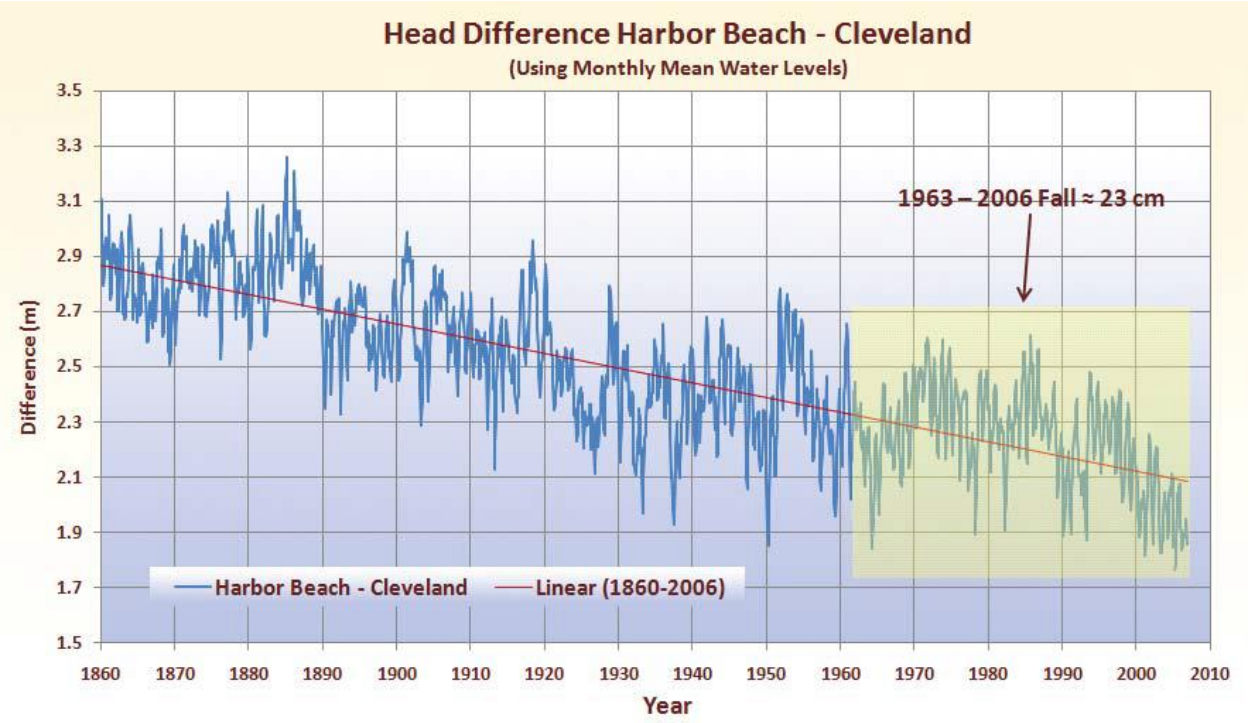
## ATTACHMENT 1: Upper Great Lakes Water Levels, 1918-2008



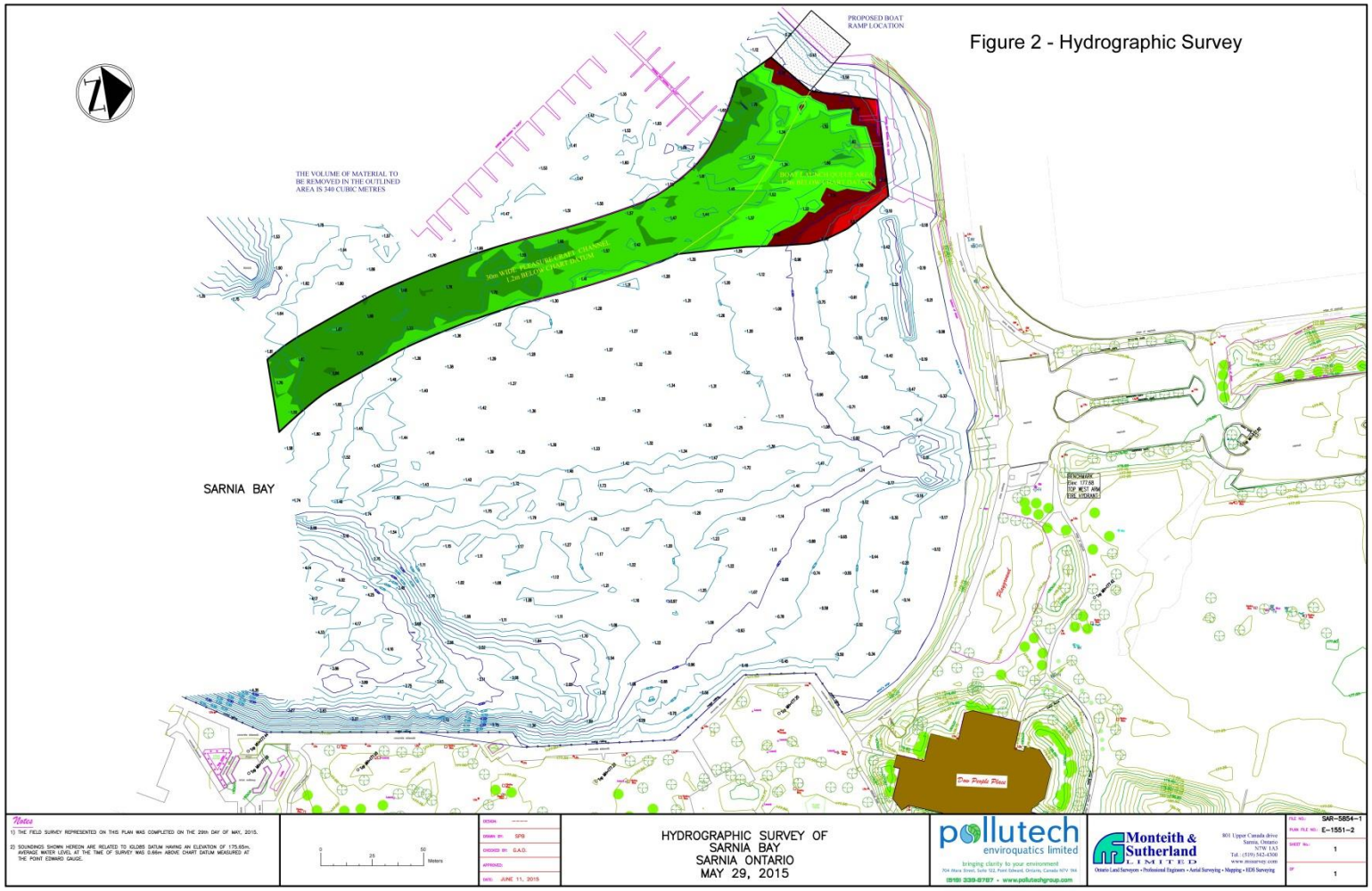

Source: Figure 2, *International Upper Great Lakes Study – International Joint Commission* (December, 2009).

## ATTACHMENT 2: Head Difference (Lake-to-Lake Fall) between Lake Michigan-Huron and Lake Erie




Source: Figure 3, *International Upper Great Lakes Study – International Joint Commission* (December, 2009).

## ATTACHMENT 3: Hydrographic Survey




Source: *Sarnia Bay Dredge Spoil Management Investigation – Proposed Boat Launch* (*Polutech Enviroquatics Limited*, June 30, 2015)

# APPENDIX D

## Geotechnical Investigations

**February 2016**

# GEOTECHNICAL INVESTIGATION

## Centennial Park Phase 2 Design and Specifications
## Sarnia, Ontario

**Submitted to:**
Mr. Joe Boothe, Superintendent, Environmental Services
Corporation of the City of Sarnia
2100 Confederation Line
Sarnia, ON N7T 7H3

REPORT

**Report Number: 1413940-2000-R02**

**Distribution:**

2 Copies - Corporation of the City of Sarnia
1 Copy - Golder Associates Ltd.

Golder Associates

# Table of Contents

# 1.0 INTRODUCTION

This report presents the results of the geotechnical investigation carried out for the design of the new armour stone seawall to be constructed in conjunction with Phase 2 of the Centennial Park remediation project in Sarnia, Ontario ("site"). The location of the site is shown on the Key Plan, Figure 1. The purpose of the work was to explore the subsurface soil and groundwater conditions in the general area of the new seawall and to provide geotechnical engineering recommendations for the design of the work.

Important information on the limitations of this report is attached.

# 2.0 FIELD PROCEDURES

The field work for this component of the project was carried out on September 9, 2015 during which time five boreholes were drilled at the approximate locations shown on the Location Plan, Figure 1. The boreholes were drilled using a track-mounted drill rig supplied and operated by a specialist drilling contractor under the direction of a member of our engineering staff. The subsurface conditions encountered in the boreholes are shown in detail on the attached Record of Borehole sheets.

Standard penetration testing and sampling was carried out in the boreholes at suitable intervals of depth using 38 millimetre inside diameter split spoon sampling equipment. All of the samples obtained during the investigation were transported to the Golder laboratory for further examination and testing. The soil stratigraphy encountered in the boreholes and the results of the field and laboratory testing are shown on the Record of Borehole sheets.

Groundwater levels were observed in the boreholes during drilling and the encountered groundwater levels are shown on the Record of Borehole sheets. Upon completion of drilling and sampling, the boreholes were backfilled in accordance with Ontario Regulation (O.Reg.) 903, as amended.

Members of our engineering staff designated the borehole locations in the field, obtained underground utility clearances, monitored the drilling, logged the boreholes and cared for the samples obtained.

The ground surface elevations at the borehole locations were referenced to information provided on Monteith and Sutherland Limited Drawing No.E-1520 and are referenced to geodetic datum.

# 3.0 SUBSURFACE CONDITIONS

## 3.1 General

The subsurface conditions encountered in the boreholes drilled at the site are shown in detail on the attached Record of Borehole sheets. The following discussion has been simplified in terms of major soil strata for the purposes of geotechnical design. The soil boundaries discussed in this report and illustrated on the Record of Borehole sheets have been inferred from non-continuous samples and observations of drilling resistance. They represent a transition from one soil type to another and should not necessarily be interpreted to represent exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

The subsurface conditions encountered in the boreholes generally consisted of the surficial topsoil and/or fill material overlying layers of sand, sandy silt and silty sand.

## 3.2 Summary of Soil and Groundwater Conditions

Topsoil was encountered at the ground surface in BH-101 and BH-102. The topsoil was approximately 0.3 metres thick at the borehole locations.

Fill materials were encountered at the ground surface in BH-103, BH-104 and BH-105. The fill materials typically consisted of sand to silty sand. Silty clay fill was also encountered in BH-105. The fill materials were approximately 0.3 to 2.0 metres thick at the borehole locations. The fill had N values, as determined in the standard penetration testing, of 7 to 24 blows per 0.3 metres with water contents ranging from about 6 to 30 percent. Asphalt, cinders and topsoil were present in the fill materials. In addition, the fill in BH-101 had a slight hydrocarbon odour.

Beneath the fill, BH-102 through BH-105 encountered sand to silty sand. BH-105 was terminated in the silty sand after exploring it for about 3.5 metres. In BH-102, BH-103 and BH-104, these materials were about 0.8 to 2.1 metres thick. The sand to silty sand had N values of 2 to 12 blows per 0.3 metres with water contents ranging from about 20 to 42 percent.

Silt was encountered beneath the fill in BH-101 and sandy silt was encountered in BH-102 through BH-104. The aforementioned boreholes were terminated in the silt. The silt had N values of nil (split spoon sampler advanced under the weight of the hammer) to 4 blows per 0.3 metres. Samples of the silt had natural water contents ranging from about 29 to 41 percent. One sample of the silt in BH-101 had a water content of nearly 300 percent indicating that organics were present in the sample.

Groundwater was encountered at depths of about 0.3 to 1.6 metres below ground surface or between elevation 174.8 and 176.7 metres. The average water level in the St. Clair River is understood to be at elevation 176.5 metres. Groundwater levels should be expected to fluctuate seasonally and in response to significant precipitation events and changes in river level.

# 4.0 DISCUSSION

This section of the report provides our preliminary recommendations related to the geotechnical aspects of design of the proposed seawall to be constructed as part of Phase 2 of the Centennial Park remediation project. The interpretation and recommendations provided are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

Based on the information provided, the new seawall will be located along the existing waterfront.

## 4.1 Foundations

Based on the conditions encountered in the boreholes, the new retaining wall may be founded on 450 millimetres of Ontario Provincial Standard Specifications (OPSS) Granular B Type II or crushed concrete. The Granular B or crushed concrete should be placed in a single lift and compacted to the degree feasible. The Granular B or crushed concrete will likely be placed in the wet. Alternatively, the new retaining wall may be founded on 450 millimetres of nominal 100 millimetre diameter rip rap. The rip rap should be placed in a single lift and nominally compacted to seat the stones. Due to the sensitivity of the founding soils to disturbance and water ponding, placement of the founding materials in a single lift is preferred.

Prior to placing the rip rap, the base and sides of the foundation excavation should be lined with a robust, non-woven geotextile. The geotextile is considered critical with the rip rap to prevent migration of fine soil particles into the rip rap which could result in loss of ground and settlements. The geotextile should be free from rips and tears and each sheet should overlap the adjacent sheet by at least 600 millimetres. A 75 millimetre thick layer of sand should be placed over the geotextile in the base of the excavation prior to placing the rip rap to minimize the potential for damage of the geotextile during placement of the rip rap.

A levelling course of Granular A may be required prior to placing the armour stone.

## 4.2 Excavations

Based on the results of the investigation, the excavations will extend through the existing fill and into native, fine grained granular materials. It is suggested that the construction be carried out during dry periods and the excavations not extend below the groundwater level. This will require some of the fill materials remaining in place. This could result in some relatively minor post construction deformations of the wall which are estimated to be on the order of about 25 to 50 millimetres; however, it is expected that these will be readily tolerated by the armour stones.

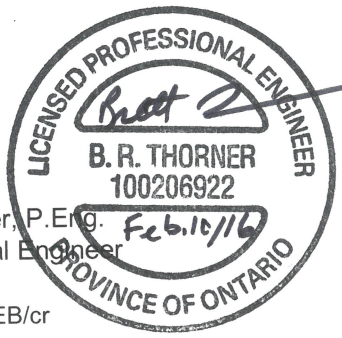
# 5.0 GEOTECHNICAL INPUT INSPECTIONS AND TESTING

Once the details of the proposed wall have been finalized, this report should be revisited and the global stability of the proposed wall section confirmed. At that time, additional recommendations regarding drainage, backfill and erosion protection can be provided.

A regular program of geotechnical inspections and materials testing should be carried out during construction to confirm that the conditions encountered are consistent with the results of the boreholes, to determine that the intent of the design recommendations provided are being met and that the various project and material specifications are consistently achieved.

We trust that this report provides sufficient information for your present requirements. Should any point require clarification please contact this office.

**GOLDER ASSOCIATES LTD.**

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Associate

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**Standard of Care:** Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

**Basis and Use of the Report:** This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

**Soil, Rock and Groundwater Conditions:** Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

**Sample Disposal:** Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

**Follow-Up and Construction Services:** All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

**Changed Conditions and Drainage:** Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

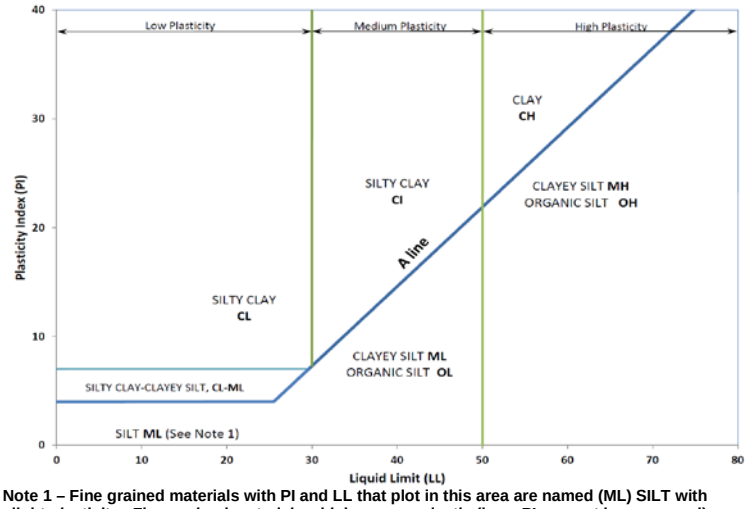
Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

# METHOD OF SOIL CLASSIFICATION

## The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

| Organic or Inorganic | Soil Group | Type of Soil | | Gradation or Plasticity | $Cu = \frac{D_{60}}{D_{10}}$ | $Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$ | Organic Content | USCS Group Symbol | Group Name |
|---|---|---|---|---|---|---|---|---|---|
| INORGANIC (Organic Content ≤30% by mass) | COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm) | GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm) | Gravels with ≤12% fines (by mass) | Poorly Graded | <4 | ≤1 or ≥3 | ≤30% | GP | GRAVEL |
| | | | | Well Graded | ≥4 | 1 to 3 | | GW | GRAVEL |
| | | | Gravels with >12% fines (by mass) | Below A Line | n/a | | | GM | SILTY GRAVEL |
| | | | | Above A Line | n/a | | | GC | CLAYEY GRAVEL |
| | | SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm) | Sands with ≤12% fines (by mass) | Poorly Graded | <6 | ≤1 or ≥3 | | SP | SAND |
| | | | | Well Graded | ≥6 | 1 to 3 | | SW | SAND |
| | | | Sands with >12% fines (by mass) | Below A Line | n/a | | | SM | SILTY SAND |
| | | | | Above A Line | n/a | | | SC | CLAYEY SAND |

| Organic or Inorganic | Soil Group | Type of Soil | | Laboratory Tests | Field Indicators | | | | | Organic Content | USCS Group Symbol | Primary Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Dilatancy | Dry Strength | Shine Test | Thread Diameter | Toughness (of 3 mm thread) | | | |
| INORGANIC (Organic Content ≤30% by mass) | FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm) | SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below) | | Liquid Limit <50 | Rapid | None | None | >6 mm | N/A (can't roll 3 mm thread) | <5% | ML | SILT |
| | | | | | Slow | None to Low | Dull | 3mm to 6 mm | None to low | <5% | ML | CLAYEY SILT |
| | | | | | Slow to very slow | Low to medium | Dull to slight | 3mm to 6 mm | Low | 5% to 30% | OL | ORGANIC SILT |
| | | | | Liquid Limit ≥50 | Slow to very slow | Low to medium | Slight | 3mm to 6 mm | Low to medium | <5% | MH | CLAYEY SILT |
| | | | | | None | Medium to high | Dull to slight | 1 mm to 3 mm | Medium to high | 5% to 30% | OH | ORGANIC SILT |
| | | CLAYS (PI and LL plot above A-Line on Plasticity Chart below) | | Liquid Limit <30 | None | Low to medium | Slight to shiny | ~ 3 mm | Low to medium | 0% to 30% (see Note 2) | CL | SILTY CLAY |
| | | | | Liquid Limit 30 to 50 | None | Medium to high | Slight to shiny | 1 mm to 3 mm | Medium | | CI | SILTY CLAY |
| | | | | Liquid Limit ≥50 | None | High | Shiny | <1 mm | High | | CH | CLAY |
| HIGHLY ORGANIC SOILS (Organic Content >30% by mass) | | Peat and mineral soil mixtures | | | | | | | | 30% to 75% | PT | SILTY PEAT, SANDY PEAT |
| | | Predominantly peat, may contain some mineral soil, fibrous or amorphous peat | | | | | | | | 75% to 100% | | PEAT |




**Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.**
**Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.**

**Dual Symbol** — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

**Borderline Symbol** — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

# ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

**PARTICLE SIZES OF CONSTITUENTS**

| Soil Constituent | Particle Size Description | Millimetres | Inches (US Std. Sieve Size) |
|---|---|---|---|
| BOULDERS | Not Applicable | >300 | >12 |
| COBBLES | Not Applicable | 75 to 300 | 3 to 12 |
| GRAVEL | Coarse<br>Fine | 19 to 75<br>4.75 to 19 | 0.75 to 3<br>(4) to 0.75 |
| SAND | Coarse<br>Medium<br>Fine | 2.00 to 4.75<br>0.425 to 2.00<br>0.075 to 0.425 | (10) to (4)<br>(40) to (10)<br>(200) to (40) |
| SILT/CLAY | Classified by plasticity | <0.075 | < (200) |

**MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS**

| Percentage by Mass | Modifier |
|---|---|
| >35 | Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY) |
| > 12 to 35 | Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable |
| > 5 to 12 | some |
| ≤ 5 | trace |

**PENETRATION RESISTANCE**

**Standard Penetration Resistance (SPT), N:**

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

**Cone Penetration Test (CPT)**

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 $cm^2$ pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ($q_t$), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

**Dynamic Cone Penetration Resistance (DCPT); $N_d$:**

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure
**PM:** Sampler advanced by manual pressure
**WH:** Sampler advanced by static weight of hammer
**WR:** Sampler advanced by weight of sampler and rod

**SAMPLES**

| | |
|---|---|
| AS | Auger sample |
| BS | Block sample |
| CS | Chunk sample |
| DO or DP | Seamless open ended, driven or pushed tube sampler – note size |
| DS | Denison type sample |
| FS | Foil sample |
| RC | Rock core |
| SC | Soil core |
| SS | Split spoon sampler – note size |
| ST | Slotted tube |
| TO | Thin-walled, open – note size |
| TP | Thin-walled, piston – note size |
| WS | Wash sample |

**SOIL TESTS**

| | |
|---|---|
| w | water content |
| PL , $w_p$ | plastic limit |
| LL , $w_L$ | liquid limit |
| C | consolidation (oedometer) test |
| CHEM | chemical analysis (refer to text) |
| CID | consolidated isotropically drained triaxial test[1] |
| CIU | consolidated isotropically undrained triaxial test with porewater pressure measurement[1] |
| $D_R$ | relative density (specific gravity, Gs) |
| DS | direct shear test |
| GS | specific gravity |
| M | sieve analysis for particle size |
| MH | combined sieve and hydrometer (H) analysis |
| MPC | Modified Proctor compaction test |
| SPC | Standard Proctor compaction test |
| OC | organic content test |
| $SO_4$ | concentration of water-soluble sulphates |
| UC | unconfined compression test |
| UU | unconsolidated undrained triaxial test |
| V (FV) | field vane (LV-laboratory vane test) |
| γ | unit weight |

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

**NON-COHESIVE (COHESIONLESS) SOILS**

**Compactness[2]**

| Term | SPT 'N' (blows/0.3m)[1] |
|---|---|
| Very Loose | 0 - 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | >50 |

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average $N_{60}$ values.

**Field Moisture Condition**

| Term | Description |
|---|---|
| Dry | Soil flows freely through fingers. |
| Moist | Soils are darker than in the dry condition and may feel cool. |
| Wet | As moist, but with free water forming on hands when handled. |

**COHESIVE SOILS**

**Consistency**

| Term | Undrained Shear Strength (kPa) | SPT 'N'[1] (blows/0.3m) |
|---|---|---|
| Very Soft | <12 | 0 to 2 |
| Soft | 12 to 25 | 2 to 4 |
| Firm | 25 to 50 | 4 to 8 |
| Stiff | 50 to 100 | 8 to 15 |
| Very Stiff | 100 to 200 | 15 to 30 |
| Hard | >200 | >30 |

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

**Water Content**

| Term | Description |
|---|---|
| w < PL | Material is estimated to be drier than the Plastic Limit. |
| w ~ PL | Material is estimated to be close to the Plastic Limit. |
| w > PL | Material is estimated to be wetter than the Plastic Limit. |

# LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

## I. GENERAL

| | |
|---|---|
| $\pi$ | 3.1416 |
| ln x | natural logarithm of x |
| $\log_{10}$ | x or log x, logarithm of x to base 10 |
| g | acceleration due to gravity |
| t | time |

## II. STRESS AND STRAIN

| | |
|---|---|
| $\gamma$ | shear strain |
| $\Delta$ | change in, e.g. in stress: $\Delta\sigma$ |
| $\varepsilon$ | linear strain |
| $\varepsilon_v$ | volumetric strain |
| $\eta$ | coefficient of viscosity |
| $\upsilon$ | Poisson's ratio |
| $\sigma$ | total stress |
| $\sigma'$ | effective stress ($\sigma' = \sigma - u$) |
| $\sigma'_{vo}$ | initial effective overburden stress |
| $\sigma_1$, $\sigma_2$, $\sigma_3$ | principal stress (major, intermediate, minor) |
| $\sigma_{oct}$ | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$ | shear stress |
| u | porewater pressure |
| E | modulus of deformation |
| G | shear modulus of deformation |
| K | bulk modulus of compressibility |

## III. SOIL PROPERTIES

### (a) Index Properties

| | |
|---|---|
| $\rho(\gamma)$ | bulk density (bulk unit weight)* |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight) |
| $\rho_w(\gamma_w)$ | density (unit weight) of water |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles |
| $\gamma'$ | unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$) |
| $D_R$ | relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly $G_s$) |
| e | void ratio |
| n | porosity |
| S | degree of saturation |

* Density symbol is $\rho$. Unit weight symbol is $\gamma$ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

### (a) Index Properties (continued)

| | |
|---|---|
| w | water content |
| $w_l$ or LL | liquid limit |
| $w_p$ or PL | plastic limit |
| $I_p$ or PI | plasticity index = $(w_l - w_p)$ |
| $w_s$ | shrinkage limit |
| $I_L$ | liquidity index = $(w - w_p) / I_p$ |
| $I_C$ | consistency index = $(w_l - w) / I_p$ |
| $e_{max}$ | void ratio in loosest state |
| $e_{min}$ | void ratio in densest state |
| $I_D$ | density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density) |

### (b) Hydraulic Properties

| | |
|---|---|
| h | hydraulic head or potential |
| q | rate of flow |
| v | velocity of flow |
| i | hydraulic gradient |
| k | hydraulic conductivity (coefficient of permeability) |
| j | seepage force per unit volume |

### (c) Consolidation (one-dimensional)

| | |
|---|---|
| $C_c$ | compression index (normally consolidated range) |
| $C_r$ | recompression index (over-consolidated range) |
| $C_s$ | swelling index |
| $C_\alpha$ | secondary compression index |
| $m_v$ | coefficient of volume change |
| $c_v$ | coefficient of consolidation (vertical direction) |
| $c_h$ | coefficient of consolidation (horizontal direction) |
| $T_v$ | time factor (vertical direction) |
| U | degree of consolidation |
| $\sigma'_p$ | pre-consolidation stress |
| OCR | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

| | |
|---|---|
| $\tau_p$, $\tau_r$ | peak and residual shear strength |
| $\phi'$ | effective angle of internal friction |
| $\delta$ | angle of interface friction |
| $\mu$ | coefficient of friction = tan $\delta$ |
| c′ | effective cohesion |
| $c_u$, $s_u$ | undrained shear strength ($\phi = 0$ analysis) |
| p | mean total stress $(\sigma_1 + \sigma_3)/2$ |
| p′ | mean effective stress $(\sigma'_1 + \sigma'_3)/2$ |
| q | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$ | compressive strength $(\sigma_1 - \sigma_3)$ |
| $S_t$ | sensitivity |

**Notes:** 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1413940

# RECORD OF BOREHOLE BH-101

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: September 9, 2015
DRILLING CONTRACTOR: Direct Environmental Drilling Inc.

DATUM: GEODETIC

HAMMER TYPE: Auto Hammer

| DEPTH SCALE METRES | BORING METHOD | DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | NUMBER | TYPE | BLOWS/0.3m | ELEVATION |
|---|---|---|---|---|---|---|---|---|
| | | GROUND SURFACE | | 176.97 | | | | |
| 0 | POWER AUGER 210mm ID HOLLOW STEM | **TOPSOIL** sandy; black to brown | | 0.00 / 176.72 | 1 | AS | | 177 |
| | | **FILL** - (SM) SILTY SAND, with topsoil, trace to some clay, trace asphalt, trace cinders; black; slight hydrocarbon odour | | 0.25 | 2 | SS | 21 | |
| 1 | | | | | 3 | SS | 10 | 176 |
| | | | | 175.75 | | | | |
| | | **FILL** - (SW-SP) SAND, some silt, some gravel, some wood, some topsoil; black | | 1.22 | 4 | SS | 7 | |
| 2 | | | | 174.99 | | | | 175 |
| | | (ML) sandy **SILT**, some clay, trace shells, rootlets; grey; very loose | | 1.98 | 5 | SS | 4 | |
| 3 | | | | | 6 | SS | WH | 174 |
| 4 | | | | | 7 | SS | WH | 173 |
| | | | | | 8 | SS | WH | |
| 5 | | | | 171.91 | | | | 172 |
| | | END OF BOREHOLE | | 5.06 | | | | |
| 6 | | | | | | | | 171 |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: 20 40 60 80 — nat V. + Q - ● — rem V. ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s: $10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$

WATER CONTENT PERCENT: Wp — W — WI; 10 20 30 40

294

ADDITIONAL LAB. TESTING

INSTALLATION AND GROUNDWATER OBSERVATIONS

Groundwater encountered at about elev. 175.4m during drilling on September 9, 2015.

DEPTH SCALE
1 : 50

LOGGED: KB
CHECKED:

Golder Associates

LDN_BHS_07 1413940.GPJ GLDR_LON.GDT 04/02/16 DATA INPUT: LMK

PROJECT: 1413940

# RECORD OF BOREHOLE BH-102

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: September 9, 2015
DRILLING CONTRACTOR: Direct Environmental Drilling Inc.

DATUM: GEODETIC

HAMMER TYPE: Auto Hammer

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | ELEVATION | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) | HYDRAULIC CONDUCTIVITY, k, cm/s ($10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40) | ADDITIONAL LAB. TESTING | INSTALLATION AND GROUNDWATER OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | POWER AUGER 210mm ID HOLLOW STEM | GROUND SURFACE | | 176.32 | | | | 177 | | | | |
| | | **TOPSOIL**, sand; black | | 0.00<br>176.02 | 1 | AS | | | | | | |
| 1 | | **FILL** - (SM) SILTY SAND, trace to some gravel, some cinders, some topsoil; black; loose to compact | | 0.30 | 2 | SS | 24 | 176 | | | | |
| | | | | | 3 | SS | 7 | | | | | |
| | | | | 175.10 | | | | 175 | | | | |
| 2 | | (SM) **SILTY SAND**, trace to some topsoil, trace clay; grey; compact | | 1.22 | 4 | SS | 12 | | | | | Groundwater encountered at about elev. 174.8m during drilling on September 9, 2015. |
| | | | | 174.34 | | | | 174 | | | | |
| | | (ML) sandy **SILT**, trace topsoil, trace clay, trace shells | | 1.98 | 5 | SS | 1 | | | | | |
| 3 | | | | | 6 | SS | WH | 173 | | | | |
| 4 | | | | | 7 | SS | WH | | | | | |
| | | | | | | | | 172 | | | | |
| | | | | | 8 | SS | WH | | | | | |
| 5 | | | | 171.26 | | | | | | | | |
| | | END OF BOREHOLE | | 5.06 | | | | 171 | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KB
CHECKED:

LDN_BHS_07 1413940.GPJ GLDR_LON.GDT 04/02/16 DATA INPUT: LMK

PROJECT: 1413940

# RECORD OF BOREHOLE BH-103

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: September 9, 2015
DRILLING CONTRACTOR: Direct Environmental Drilling Inc.

DATUM: GEODETIC

HAMMER TYPE: Auto Hammer

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | ELEVATION | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80) | HYDRAULIC CONDUCTIVITY, k, cm/s ($10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40) | ADDITIONAL LAB. TESTING | INSTALLATION AND GROUNDWATER OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | POWER AUGER 210mm ID HOLLOW STEM | GROUND SURFACE | | 177.04 / 0.00 | 1 | AS | | 178 | | | | |
| | | **FILL** - (SW-SP) SAND, some gravel, trace to some silt, trace roots; brown; compact | | | 2 | SS | 15 | 177 | | | | |
| 1 | | | | | 3 | SS | 10 | | | | | |
| | | | | 175.82 / 1.22 | | | | 176 | | | | |
| | | (SM) **SILTY SAND**, some clay, some topsoil, roots; grey; very loose | | | 4 | SS | 2 | | | | | |
| 2 | | | | 174.91 / 2.13 | | | | 175 | | | | |
| | | | | | 5 | SS | WH | | | | | |
| 3 | | | | | | | | 174 | | | | |
| | | (ML) sandy **SILT**, some clay, some silty clay seams; grey; very loose | | | 6 | SS | WH | | | | | |
| 4 | | | | | 7 | SS | WH | 173 | | | | |
| | | | | | 8 | SS | WH | | | | | |
| 5 | | | | 171.98 | | | | 172 | | | | |
| | | END OF BOREHOLE | | 5.06 | | | | | | | | |
| 6 | | | | | | | | 171 | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |

Groundwater encountered at about elev. 176.7m during drilling on September 9, 2015.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KB
CHECKED:

LDN_BHS_07 1413940.GPJ GLDR_LON.GDT 04/02/16 DATA INPUT: LMK

PROJECT: 1413940

# RECORD OF BOREHOLE BH-104

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: September 9, 2015

DATUM: GEODETIC

DRILLING CONTRACTOR: Direct Environmental Drilling Inc.

HAMMER TYPE: Auto Hammer

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | ELEVATION | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) | HYDRAULIC CONDUCTIVITY, k, cm/s ($10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40) | ADDITIONAL LAB. TESTING | INSTALLATION AND GROUNDWATER OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | POWER AUGER 210mm ID HOLLOW STEM | GROUND SURFACE | | 176.76 | | | | 177 | | | | |
| | | **FILL** - (SP) SAND, some silt, some topsoil, trace gravel | | 0.00 / 176.46 | 1 | AS | | | | | | |
| | | (SP) **SAND**, fine, some silt, trace roots, trace topsoil | | 0.30 / 175.24 | 2 | SS | 10 | 176 | | | | |
| 1 | | | | | 3 | SS | 10 | | | | | |
| | | (SM) **SILTY SAND**, some topsoil, trace roots, trace shells; grey; loose | | 1.52 / 174.32 | 4 | SS | 7 | 175 | | | | |
| 2 | | | | | 5 | SS | 4 | | | | | |
| | | (ML) sandy **SILT**, some clay, trace shells; grey; very loose | | 2.44 / 171.70 | 6 | SS | WH | 174 | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | 7 | SS | WH | 173 | | | | |
| | | | | | 8 | SS | WH | 172 | | | | |
| 5 | | END OF BOREHOLE | | 5.06 | | | | | | | | |
| | | | | | | | | 171 | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |

Groundwater encountered at about elev. 176.0m during drilling on September 9, 2015.

DEPTH SCALE

1 : 50

LOGGED: KB

CHECKED:

Golder Associates

LDN_BHS_07 1413940.GPJ GLDR_LON.GDT 04/02/16 DATA INPUT: LMK

PROJECT: 1413940

# RECORD OF BOREHOLE BH-105

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: September 9, 2015
DRILLING CONTRACTOR: Direct Environmental Drilling Inc.

DATUM: GEODETIC

HAMMER TYPE: Auto Hammer

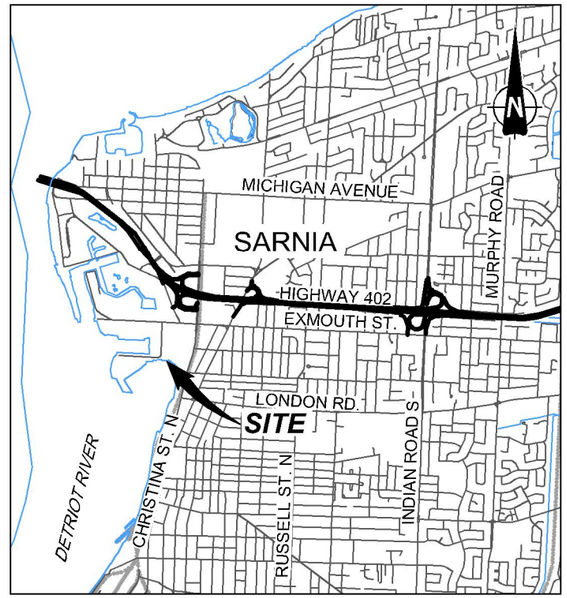
| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION | STRATA PLOT | ELEV. / DEPTH (m) | SAMPLES: NUMBER | TYPE | BLOWS/0.3m | ELEVATION | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕; Q - ●, U - ○) | HYDRAULIC CONDUCTIVITY, k, cm/s ($10^{-6}$ $10^{-5}$ $10^{-4}$ $10^{-3}$) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40) | ADDITIONAL LAB. TESTING | INSTALLATION AND GROUNDWATER OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GROUND SURFACE | | 177.61 | | | | | | | | |
| 0 | POWER AUGER 210mm ID HOLLOW STEM | **FILL** - (SW-SP) SAND, trace to some silt, trace roots, trace topsoil; brown; compact | | 0.00 | 1 | AS | | 178 | | | | |
| | | | | | 2 | SS | 15 | | | | | |
| | | | | 176.83 | | | | 177 | | | | |
| 1 | | **FILL** - (CL) SILTY CLAY, trace sand, trace gravel; trace topsoil; brown-grey; firm | | 0.78 | 3 | SS | 8 | | | | | |
| | | | | 176.09 | | | | | | | | |
| | | (SM) **SILTY SAND**, trace to some clay; grey; very loose | | 1.52 | 4 | SS | 7 | 176 | | | | Groundwater encountered at about elev. 176.2m during drilling on September 9, 2015. |
| 2 | | | | | | | | | | | | |
| | | | | | 5 | SS | 5 | 175 | | | | |
| 3 | | | | | | | | | | | | |
| | | | | | 6 | SS | 7 | | | | | |
| | | | | | | | | 174 | | | | |
| 4 | | | | | 7 | SS | 3 | | | | | |
| | | | | | | | | 173 | | | | |
| | | | | | 8 | SS | 4 | | | | | |
| 5 | | | | 172.55 | | | | | | | | |
| | | END OF BOREHOLE | | 5.06 | | | | 172 | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: KB
CHECKED:

LDN_BHS_07 1413940.GPJ GLDR_LON.GDT 04/02/16 DATA INPUT: LMK


KEY PLAN

## LEGEND

BOREHOLE

## REFERENCE

DRAWING BASED ON 2013 AERIAL IMAGE BY FIRST BASE SOLUTIONS;
MONTEITH & SUTHERLAND LIMITED, OLS, SURVEY PLAN, FILE No. SAR-5854, PLAN FILE No. E-1520 AND
CANMAP STREETFILES V2008.4.

## NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

GEOTECHNICAL INVESTIGATION
CENTENNIAL PARK REMEDIATION PROJECT STAGE 2
SARNIA, ONTARIO

TITLE

**LOCATION PLAN**

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. | | | 1413940 | FILE No. 1413940-2000-R02001 |
| | | | | SCALE AS SHOWN REV. |
| CADD | DH/WF/LK | Nov. 11/15 | | |
| CHECK | | | | |

**FIGURE 1**

Drawing file: 1413940-2000-R02001.dwg Nov 11, 2015 - 9:43am

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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| | |
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Golder Associates

# APPENDIX E

## Criteria for Evaluating Archaeological Potential A Checklist for the Non-specialist

Ontario

**Ministry of Tourism, Culture and Sport**

Programs & Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7

# Criteria for Evaluating Archaeological Potential

## A Checklist for the Non-Specialist

The **purpose of the checklist** is to determine:

- if a property(ies) or project area may contain archaeological resources i.e., have archaeological potential
- it includes all areas that may be impacted by project activities, including – but not limited to:
  - the main project area
  - temporary storage
  - staging and working areas
  - temporary roads and detours

**Processes covered** under this checklist, such as:

- *Planning Act*
- *Environmental Assessment Act*
- *Aggregates Resources Act*
- *Ontario Heritage Act* – Standards and Guidelines for Conservation of Provincial Heritage Properties

**Archaeological assessment**

If you are not sure how to answer one or more of the questions on the checklist, you may want to hire a licensed consultant archaeologist (see page 4 for definitions) to undertake an archaeological assessment.

The assessment will help you:

- identify, evaluate and protect archaeological resources on your property or project area
- reduce potential delays and risks to your project

**Note**: By law, archaeological assessments **must** be done by a licensed consultant archaeologist. Only a licensed archaeologist can assess – or alter – an archaeological site.

**What to do if you:**

- **find an archaeological resource**

  If you find something you think may be of archaeological value during project work, you must – by law – stop all activities immediately and contact a licensed consultant archaeologist

  The archaeologist will carry out the fieldwork in compliance with the *Ontario Heritage Act* [s.48(1)].

- **unearth a burial site**

  If you find a burial site containing human remains, you must immediately notify the appropriate authorities (i.e., police, coroner's office, and/or Registrar of Cemeteries) and comply with the *Funeral, Burial and Cremation Services Act*.

**Other checklists**

Please use a separate checklist for your project, if:

- you are seeking a Renewable Energy Approval under Ontario Regulation 359/09 – separate checklist
- your Parent Class EA document has an approved screening criteria (as referenced in Question 1)

Please refer to the Instructions pages when completing this form.

  

Project or Property Name

CENTENNIAL PARK SHORELINE PROTECTION - SARNIA BAY

Project or Property Location (upper and lower or single tier municipality)

SARNIA WATERFRONT

Proponent Name

CENTENNIAL PARK

Proponent Contact Information

CITY OF SARNIA - ENGINEERING DEPARTMENT

## Screening Questions

| | Yes | No |
|---|---|---|
| 1. Is there a pre-approved screening checklist, methodology or process in place? | ☐ | ☑ |

**If Yes**, please follow the pre-approved screening checklist, methodology or process.

**If No**, continue to Question 2.

| | Yes | No |
|---|---|---|
| 2. Has an archaeological assessment been prepared for the property (or project area) and been accepted by MTCS? | ☐ | ☑ |

**If Yes**, do **not** complete the rest of the checklist. You are expected to follow the recommendations in the archaeological assessment report(s).

The proponent, property owner and/or approval authority will:

- summarize the previous assessment
- add this checklist to the project file, with the appropriate documents that demonstrate an archaeological assessment was undertaken e.g., MTCS letter stating acceptance of archaeological assessment report

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g., environmental assessment document
- maintained by the property owner, proponent or approval authority

**If No**, continue to Question 3.

| | Yes | No |
|---|---|---|
| 3. Are there known archaeological sites on or within 300 metres of the property (or the project area)? | ☐ | ☑ |
| 4. Is there Aboriginal or local knowledge of archaeological sites on or within 300 metres of the property (or project area)? | ☐ | ☑ |
| 5. Is there Aboriginal knowledge or historically documented evidence of past Aboriginal use on or within 300 metres of the property (or project area)? | ☐ | ☑ |
| 6. Is there a known burial site or cemetery on the property or adjacent to the property (or project area)? | ☐ | ☑ |
| 7. Has the property (or project area) been recognized for its cultural heritage value? | ☐ | ☑ |

**If Yes** to any of the above questions (3 to 7), do **not** complete the checklist. Instead, you need to hire a licensed consultant archaeologist to undertake an archaeological assessment of your property or project area.

**If No**, continue to question 8.

| | Yes | No |
|---|---|---|
| 8. Has the entire property (or project area) been subjected to recent, extensive and intensive disturbance? | ☑ | ☐ |

**If Yes** to the preceding question, do **not** complete the checklist. Instead, please keep and maintain a summary of documentation that provides evidence of the recent disturbance.

An archaeological assessment is not required.

**If No**, continue to question 9.

| | Yes | No |
|---|---|---|
| 9. Are there present or past water sources within 300 metres of the property (or project area)? | ☐ | ☐ |

**If Yes**, an archaeological assessment is required.

**If No**, continue to question 10.

| | Yes | No |
|---|---|---|
| 10. Is there evidence of two or more of the following on the property (or project area)? | ☐ | ☐ |

- elevated topography
- pockets of well-drained sandy soil
- distinctive land formations
- resource extraction areas
- early historic settlement
- early historic transportation routes

**If Yes**, an archaeological assessment is required.

**If No**, there is low potential for archaeological resources at the property (or project area).

The proponent, property owner and/or approval authority will:

- summarize the conclusion
- add this checklist with the appropriate documentation to the project file

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g., under the *Environmental Assessment Act, Planning Act* processes
- maintained by the property owner, proponent or approval authority

## Instructions

Please have the following available, when requesting information related to the screening questions below:

- a clear map showing the location and boundary of the property or project area
  - large scale and small scale showing nearby township names for context purposes
- the municipal addresses of all properties within the project area
- the lot(s), concession(s), and parcel number(s) of all properties within a project area

In this context, the following definitions apply:

- **consultant archaeologist** means, as defined in Ontario regulation as an archaeologist who enters into an agreement with a client to carry out or supervise archaeological fieldwork on behalf of the client, produce reports for or on behalf of the client and provide technical advice to the client. In Ontario, these people also are required to hold a valid professional archaeological licence issued by the Ministry of Tourism, Culture and Sport.
- **proponent** means a person, agency, group or organization that carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.

### 1. Is there a pre-approved screening checklist, methodology or process in place?

An existing checklist, methodology or process may be already in place for identifying archaeological potential, including:

- one prepared and adopted by the municipality e.g., archaeological management plan
- an environmental assessment process e.g., screening checklist for municipal bridges
- one that is approved by the Ministry of Tourism, Culture and Sport under the Ontario government's Standards & Guidelines for Conservation of Provincial Heritage Properties [s. B.2.]

### 2. Has an archaeological assessment been prepared for the property (or project area) and been accepted by MTCS?

Respond 'yes' to this question, if all of the following are true:

- an archaeological assessment report has been prepared and is in compliance with MTCS requirements
  - a letter has been sent by MTCS to the licensed archaeologist confirming that MTCS has added the report to the Ontario Public Register of Archaeological Reports (Register)
- the report states that there are no concerns regarding impacts to archaeological sites

Otherwise, if an assessment has been completed and deemed compliant by the MTCS, and the ministry recommends further archaeological assessment work, this work will need to be completed.

For more information about archaeological assessments, contact:

- approval authority
- proponent
- consultant archaeologist
- Ministry of Tourism, Culture and Sport at archaeology@ontario.ca

### 3. Are there known archaeological sites on or within 300 metres of the property (or project area)?

MTCS maintains a database of archaeological sites reported to the ministry.

For more information, contact MTCS Archaeological Data Coordinator at archaeologicalsites@ontario.ca.

### 4. Is there Aboriginal or local knowledge of archaeological sites on or within 300 metres of the property?

Check with:

- Aboriginal communities in your area
- local municipal staff

They may have information about archaeological sites that are not included in MTCS' database.

Other sources of local knowledge may include:

- property owner
- local heritage organizations and historical societies
- local museums
- municipal heritage committee
- published local histories

**5. Is there Aboriginal knowledge or historically documented evidence of past Aboriginal use on or within 300 metres of the property (or property area)?**

Check with:

- Aboriginal communities in your area
- local municipal staff

Other sources of local knowledge may include:

- property owner
- local heritage organizations and historical societies
- local museums
- municipal heritage committee
- published local histories

**6. Is there a known burial site or cemetery on the property or adjacent to the property (or project area)?**

For more information on known cemeteries and/or burial sites, see:

- Cemeteries Regulation Unit, Ontario Ministry of Consumer Services – for database of registered cemeteries
- Ontario Genealogical Society (OGS) – to locate records of Ontario cemeteries, both currently and no longer in existence; cairns, family plots and burial registers
- Canadian County Atlas Digital Project – to locate early cemeteries

In this context, 'adjacent' means 'contiguous', or as otherwise defined in a municipal official plan.

**7. Has the property (or project area) been recognized for its cultural heritage value?**

There is a strong chance there may be archaeological resources on your property (or immediate area) if it has been listed, designated or otherwise identified as being of cultural heritage value by:

- your municipality
- Ontario government
- Canadian government

This includes a property that is:

- designated under *Ontario Heritage Act* (the OHA ), including:
  - individual designation (Part IV)
  - part of a heritage conservation district (Part V)
  - an archaeological site (Part VI)
- subject to:
  - an agreement, covenant or easement entered into under the OHA (Parts II or IV)
  - a notice of intention to designate (Part IV)
  - a heritage conservation district study area by-law (Part V) of the OHA
- listed on:
  - a municipal register or inventory of heritage properties
  - Ontario government's list of provincial heritage properties
  - Federal government's list of federal heritage buildings
- part of a:
  - National Historic Site
  - UNESCO World Heritage Site
- designated under:
  - *Heritage Railway Station Protection Act*
  - *Heritage Lighthouse Protection Act*
- subject of a municipal, provincial or federal commemorative or interpretive plaque.

To determine if your property or project area is covered by any of the above, see:

- Part A of the MTCS Criteria for Evaluating Potential for Built Heritage and Cultural Heritage Landscapes

**Part VI – Archaeological Sites**

Includes five sites designated by the Minister under Regulation 875 of the Revised Regulation of Ontario, 1990 (Archaeological Sites) and 3 marine archaeological sites prescribed under Ontario Regulation 11/06.

For more information, check Regulation 875 and Ontario Regulation 11/06.

**8. Has the entire property (or project area) been subjected to recent extensive and intensive ground disturbance?**

Recent: after-1960

Extensive: over all or most of the area

Intensive: thorough or complete disturbance

Examples of ground disturbance include:

- quarrying
- major landscaping – involving grading below topsoil
- building footprints and associated construction area
  - where the building has deep foundations or a basement
- infrastructure development such as:
  - sewer lines
  - gas lines
  - underground hydro lines
  - roads
  - any associated trenches, ditches, interchanges. **Note**: this applies only to the excavated part of the right-of-way; the remainder of the right-of-way or corridor may not have been impacted.

A ground disturbance does **not** include:

- agricultural cultivation
- gardening
- landscaping

**Site visits**

You can typically get this information from a site visit. In that case, please document your visit in the process (e.g., report) with:

- photographs
- maps
- detailed descriptions

If a disturbance isn't clear from a site visit or other research, you need to hire a licensed consultant archaeologist to undertake an archaeological assessment.

**9. Are there present or past water bodies within 300 metres of the property (or project area)?**

Water bodies are associated with past human occupations and use of the land. About 80-90% of archaeological sites are found within 300 metres of water bodies.

**Present**

- Water bodies:
  - primary - lakes, rivers, streams, creeks
  - secondary - springs, marshes, swamps and intermittent streams and creeks
- accessible or inaccessible shoreline, for example:
  - high bluffs
  - swamps
  - marsh fields by the edge of a lake
  - sandbars stretching into marsh

Water bodies not included:

- man-made water bodies, for example:
  - temporary channels for surface drainage
  - rock chutes and spillways
  - temporarily ponded areas that are normally farmed
  - dugout ponds
- artificial bodies of water intended for storage, treatment or recirculation of:
  - runoff from farm animal yards
  - manure storage facilities
  - sites and outdoor confinement areas

**Past**

Features indicating past water bodies:

- raised sand or gravel beach ridges – can indicate glacial lake shorelines
- clear dip in the land – can indicate an old river or stream
- shorelines of drained lakes or marshes
- cobble beaches

You can get information about water bodies through:

- a site visit
- aerial photographs
- 1:10,000 scale Ontario Base Maps - or equally detailed and scaled maps.

**10. Is there evidence of two or more of the following on the property (or project area)?**

- elevated topography
- pockets of well-drained sandy soil
- distinctive land formations
- resource extraction areas
- early historic settlement
- early historic transportation routes

- **Elevated topography**

  Higher ground and elevated positions - surrounded by low or level topography - often indicate past settlement and land use.

  Features such as eskers, drumlins, sizeable knolls, plateaus next to lowlands, or other such features are a strong indication of archaeological potential.

  Find out if your property or project area has elevated topography, through:

  - site inspection
  - aerial photographs
  - topographical maps

- **Pockets of well-drained sandy soil, especially within areas of heavy soil or rocky ground**

  Sandy, well-drained soil - in areas characterized by heavy soil or rocky ground - may indicate archaeological potential

  Find out if your property or project area has sandy soil through:

  - site inspection
  - soil survey reports

- **Distinctive land formations**

  Distinctive land formations include – but are not limited to:

  - waterfalls
  - rock outcrops
  - rock faces
  - caverns
  - mounds, etc.

  They were often important to past inhabitants as special or sacred places. The following sites may be present – or close to – these formations:

  - burials
  - structures
  - offerings
  - rock paintings or carvings

  Find out if your property or project areas has a distinctive land formation through:

  - a site visit
  - aerial photographs
  - 1:10,000 scale Ontario Base Maps - or equally detailed and scaled maps.

- **Resource extraction areas**

  The following resources were collected in these extraction areas:

  - food or medicinal plants e.g., migratory routes, spawning areas, prairie
  - scarce raw materials e.g., quartz, copper, ochre or outcrops of chert
  - resources associated with early historic industry e.g., fur trade, logging, prospecting, mining

  Aboriginal communities may hold traditional knowledge about their past use or resources in the area.

- **Early historic settlement**

  Early Euro-Canadian settlement include – but are not limited to:

  - early military or pioneer settlement e.g., pioneer homesteads, isolated cabins, farmstead complexes
  - early wharf or dock complexes
  - pioneers churches and early cemeteries

  For more information, see below – under the early historic transportation routes.

- **Early historic transportation routes** - such as trails, passes, roads, railways, portage routes, canals.

  For more information, see:

  - historical maps and/or historical atlases
    - for information on early settlement patterns such as trails (including Aboriginal trails), monuments, structures, fences, mills, historic roads, rail corridors, canals, etc.
    - Archives of Ontario holds a large collection of historical maps and historical atlases
    - digital versions of historic atlases are available on the Canadian County Atlas Digital Project
  - commemorative markers or plaques such as local, provincial or federal agencies
  - municipal heritage committee or other local heritage organizations
    - for information on early historic settlements or landscape features (e.g., fences, mill races, etc.)
    - for information on commemorative markers or plaques

Ontario

**Ministry of Tourism, Culture and Sport**

Programs & Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7

# Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes

## A Checklist for the Non-Specialist

The **purpose of the checklist** is to determine:

- if a property(ies) or project area:
  - is a recognized heritage property
  - may be of cultural heritage value
- it includes all areas that may be impacted by project activities, including – but not limited to:
  - the main project area
  - temporary storage
  - staging and working areas
  - temporary roads and detours

**Processes covered** under this checklist, such as:

- *Planning Act*
- *Environmental Assessment Act*
- *Aggregates Resources Act*
- *Ontario Heritage Act* – Standards and Guidelines for Conservation of Provincial Heritage Properties

**Cultural Heritage Evaluation Report (CHER)**

If you are not sure how to answer one or more of the questions on the checklist, you may want to hire a qualified person(s) (see page 5 for definitions) to undertake a cultural heritage evaluation report (CHER).

The CHER will help you:

- identify, evaluate and protect cultural heritage resources on your property or project area
- reduce potential delays and risks to a project

**Other checklists**

Please use a separate checklist for your project, if:

- you are seeking a Renewable Energy Approval under Ontario Regulation 359/09 – separate checklist
- your Parent Class EA document has an approved screening criteria (as referenced in Question 1)

Please refer to the Instructions pages for more detailed information and when completing this form.

  

Project or Property Name

Project or Property Location (upper and lower or single tier municipality)

Proponent Name

Proponent Contact Information

## Screening Questions

| | Yes | No |
|---|---|---|
| 1. Is there a pre-approved screening checklist, methodology or process in place? | ☐ | ☑ |

**If Yes,** please follow the pre-approved screening checklist, methodology or process.

**If No,** continue to Question 2.

## Part A: Screening for known (or recognized) Cultural Heritage Value

| | Yes | No |
|---|---|---|
| 2. Has the property (or project area) been evaluated before and found **not** to be of cultural heritage value? | ☐ | ☑ |

**If Yes,** do **not** complete the rest of the checklist.

The proponent, property owner and/or approval authority will:

- summarize the previous evaluation and
- add this checklist to the project file, with the appropriate documents that demonstrate a cultural heritage evaluation was undertaken

The summary and appropriate documentation may be:

- submitted as part of a report requirement
- maintained by the property owner, proponent or approval authority

**If No**, continue to Question 3.

| | Yes | No |
|---|---|---|
| 3. Is the property (or project area): | | |
| a. identified, designated or otherwise protected under the *Ontario Heritage Act* as being of cultural heritage value? | ☐ | ☑ |
| b. a National Historic Site (or part of)? | ☐ | ☑ |
| c. designated under the *Heritage Railway Stations Protection Act*? | ☐ | ☑ |
| d. designated under the *Heritage Lighthouse Protection Act*? | ☐ | ☑ |
| e. identified as a Federal Heritage Building by the Federal Heritage Buildings Review Office (FHBRO)? | ☐ | ☑ |
| f. located within a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site? | ☐ | ☑ |

**If Yes** to any of the above questions, you need to hire a qualified person(s) to undertake:

- a Cultural Heritage Evaluation Report, if a Statement of Cultural Heritage Value has not previously been prepared or the statement needs to be updated

If a Statement of Cultural Heritage Value has been prepared previously and if alterations or development are proposed, you need to hire a qualified person(s) to undertake:

- a Heritage Impact Assessment (HIA) – the report will assess and avoid, eliminate or mitigate impacts

**If No**, continue to Question 4.

## Part B: Screening for Potential Cultural Heritage Value

| | Yes | No |
|---|---|---|
| 4. Does the property (or project area) contain a parcel of land that: | | |
| a. is the subject of a municipal, provincial or federal commemorative or interpretive plaque? | ☐ | ☑ |
| b. has or is adjacent to a known burial site and/or cemetery? | ☐ | ☑ |
| c. is in a Canadian Heritage River watershed? | ☐ | ☑ |
| d. contains buildings or structures that are 40 or more years old? | ☐ | ☑ |

## Part C: Other Considerations

| | Yes | No |
|---|---|---|
| 5. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area): | | |
| a. is considered a landmark in the local community or contains any structures or sites that are important in defining the character of the area? | ☐ | ☑ |
| b. has a special association with a community, person or historical event? | ☐ | ☑ |
| c. contains or is part of a cultural heritage landscape? | ☐ | ☑ |

**If Yes** to one or more of the above questions (Part B and C), there is potential for cultural heritage resources on the property or within the project area.

You need to hire a qualified person(s) to undertake:

- a Cultural Heritage Evaluation Report (CHER)

If the property is determined to be of cultural heritage value and alterations or development is proposed, you need to hire a qualified person(s) to undertake:

- a Heritage Impact Assessment (HIA) – the report will assess and avoid, eliminate or mitigate impacts

**If No** to all of the above questions, there is low potential for built heritage or cultural heritage landscape on the property.

The proponent, property owner and/or approval authority will:

- summarize the conclusion
- add this checklist with the appropriate documentation to the project file

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g. under the *Environmental Assessment Act, Planning Act* processes
- maintained by the property owner, proponent or approval authority

## Instructions

Please have the following available, when requesting information related to the screening questions below:

- a clear map showing the location and boundary of the property or project area
  - large scale and small scale showing nearby township names for context purposes
- the municipal addresses of all properties within the project area
- the lot(s), concession(s), and parcel number(s) of all properties within a project area

For more information, see the Ministry of Tourism, Culture and Sport's Ontario Heritage Toolkit or Standards and Guidelines for Conservation of Provincial Heritage Properties.

In this context, the following definitions apply:

- **qualified person(s)** means individuals – professional engineers, architects, archaeologists, etc. – having relevant, recent experience in the conservation of cultural heritage resources.
- **proponent** means a person, agency, group or organization that carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.

### 1. Is there a pre-approved screening checklist, methodology or process in place?

An existing checklist, methodology or process may already be in place for identifying potential cultural heritage resources, including:

- one endorsed by a municipality
- an environmental assessment process e.g. screening checklist for municipal bridges
- one that is approved by the Ministry of Tourism, Culture and Sport (MTCS) under the Ontario government's Standards & Guidelines for Conservation of Provincial Heritage Properties [s.B.2.]

## Part A: Screening for known (or recognized) Cultural Heritage Value

### 2. Has the property (or project area) been evaluated before and found not to be of cultural heritage value?

Respond 'yes' to this question, if all of the following are true:

A property can be considered not to be of cultural heritage value if:

- a Cultural Heritage Evaluation Report (CHER) - or equivalent - has been prepared for the property with the advice of a qualified person and it has been determined not to be of cultural heritage value and/or
- the municipal heritage committee has evaluated the property for its cultural heritage value or interest and determined that the property is not of cultural heritage value or interest

A property may need to be re-evaluated, if:

- there is evidence that its heritage attributes may have changed
- new information is available
- the existing Statement of Cultural Heritage Value does not provide the information necessary to manage the property
- the evaluation took place after 2005 and did not use the criteria in Regulations 9/06 and 10/06

**Note**: Ontario government ministries and public bodies [prescribed under Regulation 157/10] may continue to use their existing evaluation processes, until the evaluation process required under section B.2 of the Standards & Guidelines for Conservation of Provincial Heritage Properties has been developed and approved by MTCS.

To determine if your property or project area has been evaluated, contact:

- the approval authority
- the proponent
- the Ministry of Tourism, Culture and Sport

### 3a. Is the property (or project area) identified, designated or otherwise protected under the *Ontario Heritage Act* as being of cultural heritage value e.g.:

i. designated under the *Ontario Heritage Act*

- individual designation (Part IV)
- part of a heritage conservation district (Part V)

**Individual Designation – Part IV**

A property that is designated:

- by a municipal by-law as being of cultural heritage value or interest [s.29 of the *Ontario Heritage Act*]
- by order of the Minister of Tourism, Culture and Sport as being of cultural heritage value or interest of provincial significance [s.34.5]. **Note**: To date, no properties have been designated by the Minister.

**Heritage Conservation District – Part V**

A property or project area that is located within an area designated by a municipal by-law as a heritage conservation district [s. 41 of the *Ontario Heritage Act*].

For more information on Parts IV and V, contact:

- municipal clerk
- Ontario Heritage Trust
- local land registry office (for a title search)

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ii. subject of an agreement, covenant or easement entered into under Parts II or IV of the *Ontario Heritage Act*

An agreement, covenant or easement is usually between the owner of a property and a conservation body or level of government. It is usually registered on title.

The primary purpose of the agreement is to:

- preserve, conserve, and maintain a cultural heritage resource
- prevent its destruction, demolition or loss

For more information, contact:

- Ontario Heritage Trust - for an agreement, covenant or easement [clause 10 (1) (c) of the *Ontario Heritage Act*]
- municipal clerk – for a property that is the subject of an easement or a covenant [s.37 of the *Ontario Heritage Act*]
- local land registry office (for a title search)

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iii. listed on a register of heritage properties maintained by the municipality

Municipal registers are the official lists - or record - of cultural heritage properties identified as being important to the community.

Registers include:

- all properties that are designated under the *Ontario Heritage Act* (Part IV or V)
- properties that have not been formally designated, but have been identified as having cultural heritage value or interest to the community

For more information, contact:

- municipal clerk
- municipal heritage planning staff
- municipal heritage committee

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iv. subject to a notice of:

- intention to designate (under Part IV of the *Ontario Heritage Act*)
- a Heritage Conservation District study area bylaw (under Part V of the *Ontario Heritage Act*)

A property that is subject to a **notice of intention to designate** as a property of cultural heritage value or interest and the notice is in accordance with:

- section 29 of the *Ontario Heritage Act*
- section 34.6 of the *Ontario Heritage Act.* **Note**: To date, the only applicable property is Meldrum Bay Inn, Manitoulin Island. [s.34.6]

An area designated by a municipal by-law made under section 40.1 of the *Ontario Heritage Act* as a **heritage conservation district study area**.

For more information, contact:

- municipal clerk – for a property that is the subject of notice of intention [s. 29 and s. 40.1]
- Ontario Heritage Trust

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v. included in the Ministry of Tourism, Culture and Sport's list of provincial heritage properties

Provincial heritage properties are properties the Government of Ontario owns or controls that have cultural heritage value or interest.

The Ministry of Tourism, Culture and Sport (MTCS) maintains a list of all provincial heritage properties based on information provided by ministries and prescribed public bodies. As they are identified, MTCS adds properties to the list of provincial heritage properties.

For more information, contact the MTCS Registrar at registrar@mtc.gov.on.ca.

**3b. Is the property (or project area) a National Historic Site (or part of)?**

National Historic Sites are properties or districts of national historic significance that are designated by the Federal Minister of the Environment, under the *Canada National Parks Act*, based on the advice of the Historic Sites and Monuments Board of Canada.

For more information, see the National Historic Sites website.

**3c. Is the property (or project area) designated under the *Heritage Railway Stations Protection Act*?**

The *Heritage Railway Stations Protection Act* protects heritage railway stations that are owned by a railway company under federal jurisdiction. Designated railway stations that pass from federal ownership may continue to have cultural heritage value.

For more information, see the Directory of Designated Heritage Railway Stations.

**3d. Is the property (or project area) designated under the *Heritage Lighthouse Protection Act*?**

The *Heritage Lighthouse Protection Act* helps preserve historically significant Canadian lighthouses. The Act sets up a public nomination process and includes heritage building conservation standards for lighthouses which are officially designated.

For more information, see the Heritage Lighthouses of Canada website.

**3e. Is the property (or project area) identified as a Federal Heritage Building by the Federal Heritage Buildings Review Office?**

The role of the Federal Heritage Buildings Review Office (FHBRO) is to help the federal government protect the heritage buildings it owns. The policy applies to all federal government departments that administer real property, but not to federal Crown Corporations.

For more information, contact the Federal Heritage Buildings Review Office.

See a directory of all federal heritage designations.

**3f. Is the property (or project area) located within a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site?**

A UNESCO World Heritage Site is a place listed by UNESCO as having outstanding universal value to humanity under the Convention Concerning the Protection of the World Cultural and Natural Heritage. In order to retain the status of a World Heritage Site, each site must maintain its character defining features.

Currently, the Rideau Canal is the only World Heritage Site in Ontario.

For more information, see Parks Canada – World Heritage Site website.

## Part B: Screening for potential Cultural Heritage Value

**4a. Does the property (or project area) contain a parcel of land that has a municipal, provincial or federal commemorative or interpretive plaque?**

Heritage resources are often recognized with formal plaques or markers.

Plaques are prepared by:

- municipalities
- provincial ministries or agencies
- federal ministries or agencies
- local non-government or non-profit organizations

For more information, contact:

- municipal heritage committees or local heritage organizations – for information on the location of plaques in their community
- Ontario Historical Society's Heritage directory – for a list of historical societies and heritage organizations
- Ontario Heritage Trust – for a list of plaques commemorating Ontario's history
- Historic Sites and Monuments Board of Canada – for a list of plaques commemorating Canada's history

**4b. Does the property (or project area) contain a parcel of land that has or is adjacent to a known burial site and/or cemetery?**

For more information on known cemeteries and/or burial sites, see:

- Cemeteries Regulations, Ontario Ministry of Consumer Services – for a database of registered cemeteries
- Ontario Genealogical Society (OGS) – to locate records of Ontario cemeteries, both currently and no longer in existence; cairns, family plots and burial registers
- Canadian County Atlas Digital Project – to locate early cemeteries

In this context, adjacent means contiguous or as otherwise defined in a municipal official plan.

**4c. Does the property (or project area) contain a parcel of land that is in a Canadian Heritage River watershed?**

The Canadian Heritage River System is a national river conservation program that promotes, protects and enhances the best examples of Canada's river heritage.

Canadian Heritage Rivers must have, and maintain, outstanding natural, cultural and/or recreational values, and a high level of public support.

For more information, contact the Canadian Heritage River System.

If you have questions regarding the boundaries of a watershed, please contact:

- your conservation authority
- municipal staff

**4d. Does the property (or project area) contain a parcel of land that contains buildings or structures that are 40 or more years old?**

A 40 year 'rule of thumb' is typically used to indicate the potential of a site to be of cultural heritage value. The approximate age of buildings and/or structures may be estimated based on:

- history of the development of the area
- fire insurance maps
- architectural style
- building methods

Property owners may have information on the age of any buildings or structures on their property. The municipality, local land registry office or library may also have background information on the property.

**Note**: 40+ year old buildings or structure do not necessarily hold cultural heritage value or interest; their age simply indicates a higher potential.

A building or structure can include:

- residential structure
- farm building or outbuilding
- industrial, commercial, or institutional building
- remnant or ruin
- engineering work such as a bridge, canal, dams, etc.

For more information on researching the age of buildings or properties, see the Ontario Heritage Tool Kit Guide Heritage Property Evaluation.

## Part C: Other Considerations

**5a. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) is considered a landmark in the local community or contains any structures or sites that are important to defining the character of the area?**

Local or Aboriginal knowledge may reveal that the project location is situated on a parcel of land that has potential landmarks or defining structures and sites, for instance:

- buildings or landscape features accessible to the public or readily noticeable and widely known
- complexes of buildings
- monuments
- ruins

**5b. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) has a special association with a community, person or historical event?**

Local or Aboriginal knowledge may reveal that the project location is situated on a parcel of land that has a special association with a community, person or event of historic interest, for instance:

- Aboriginal sacred site
- traditional-use area
- battlefield
- birthplace of an individual of importance to the community

**5c. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) contains or is part of a cultural heritage landscape?**

Landscapes (which may include a combination of archaeological resources, built heritage resources and landscape elements) may be of cultural heritage value or interest to a community.

For example, an Aboriginal trail, historic road or rail corridor may have been established as a key transportation or trade route and may have been important to the early settlement of an area. Parks, designed gardens or unique landforms such as waterfalls, rock faces, caverns, or mounds are areas that may have connections to a particular event, group or belief.

For more information on Questions 5.a., 5.b. and 5.c., contact:

- Elders in Aboriginal Communities or community researchers who may have information on potential cultural heritage resources. Please note that Aboriginal traditional knowledge may be considered sensitive.
- municipal heritage committees or local heritage organizations
- Ontario Historical Society's "Heritage Directory" - for a list of historical societies and heritage organizations in the province

An internet search may find helpful resources, including:

- historical maps
- historical walking tours
- municipal heritage management plans
- cultural heritage landscape studies
- municipal cultural plans

Information specific to trails may be obtained through Ontario Trails.

# APPENDIX F

## Land Use History of Centennial Park Technical Memorandum

**February 9, 2016**
**Report No.** 1413940/7000

# TECHNICAL MEMORANDUM

**DATE** 19 October 2012 **PROJECT No.** 12-1134-0140-1000-M01

**TO** Mr. Bryan Prouse, Operations Manager
City of Sarnia

**CC** Sandra Carrelas, P.Eng.; Laura Jones, M.A.Sc., P.Eng.

**FROM** Christopher Andreae, Ph.D., Associate **EMAIL** candreae@golder.com

**LAND USE HISTORY OF CENTENNIAL PARK AREA**
**CITY OF SARNIA, LAMBTON COUNTY, ONTARIO**

## 1.0 STUDY PURPOSE AND METHOD

The Site is irregular in shape and occupies an area of approximately 10.5 hectares of land located north of Sarnia Bay, east of Harbour Road, west of Front Street North and south of Exmouth Street in Sarnia. This property consists primarily of Centennial Park.

This land use history covers the time period of c.1870, when the earliest reliable site records were identified, to c.1970. O.Reg 153/04 *Records of Site Conditions* Schedule D states that 1875 is a date to which a Phase One records review may be required. The terminal date of c.1970 was the conclusion of any industrial activity at, or directly adjacent to, the study area.

The sources used in completing this study included published corporate and local histories, hydrographic mapping from the 1860s to the 1960s, Fire insurance plans, and reports of the former Ontario Department of Mines. Archival maps were also acquired from the National Archives of Canada.

## 2.0 PHYSICAL SETTING

Until the late 1920s, the study area consisted of two distinct components. Front Street was the approximate shoreline dividing Sarnia Bay from the built-up land to the east. Sarnia Bay was a shallow body of water with a maximum natural depth no greater than 2.4 metre (8 ft). The study area was generally 1.2 m (4 ft) deep with a clay bottom. The St. Clair River channel was defined by a very sharp increase in depth from shallow Sarnia Bay to a typical river depth of 10 m (33 ft).

The bay gradually became shallower north towards Port Huron and ended approximately where the Blue Water Highway Bridge crosses the St. Clair River today. The north end of the bay appears to have been created by a bay-mouth bar that had been built out from the Ontario shore. When it reached the river channel, the bar hooked southward forming the boundary between the St. Clair River and Sarnia Bay

During the 1920s most of Sarnia Bay from the study area north was land-filled to provide new harbour and rail transportation facilities.

# 3.0 HISTORIC SHORELINE DEVELOPMENT

## 3.1 Transportation

### 3.1.1 Road Development

By 1880, the centre of Sarnia was south of the study area. The study area was semi-rural with a scattering of houses. London Road, Maxwell, Nelson and Exmouth Streets all terminated at the shoreline. Christina Street was the major north-south street and ran between Exmouth and Maxwell Streets (Plates 1-3).

Front Street seems to have existed more as a surveyed road than an open road within the study area. In 1864, it formed an extension of Water Street, (Plates 1 & 2) while in c1880 the road was unopened south of Maxwell Street. (Plate 3) Until the early 20$^{th}$ century, Front Street in the study area was used as a railway right of way and passed through an immense sawmill operation.

### 3.1.2 Railways

In 1875, a street railway line was laid along Front Street to connect Sarnia with Port Huron. Later, in the 1880s, the Grand Trunk Railway built a line along the road allowance to connect its terminals in Sarnia and Port Huron. By 1929, the Canadian National Railways had built a four-track yard west of Front Street and south of Exmouth to provide car storage for the newly opened grain elevator terminal (Plate 13).

### 3.1.3 Filling the Harbour

In 1867, Sarnia Bay at the foot of Maxwell Street was approximately 0.6-0.9 m (2-3 ft) deep with a clay bottom. The bay gradually became shallower as one proceeded north towards Point Edward. The bay ended approximately where the Blue Water Highway Bridge crosses the St. Clair River today. There was a very sharp drop in depth between Sarnia Bay and St. Clair River proper.

The bay was a maximum of 2.4m (8 ft) deep but within a few metres the river channel was 10 m (33 feet) deep. A scattering of buildings was shown on the shoreline on the south side of Maxwell Street. Otherwise there was no economic activity indicated in the area. This was the general condition of the Bay by 1914.[1]

The shallow bay could not be used for commercial shipping but was used to store log booms adjacent to the sawmills.

The earliest identified dredging in Sarnia Bay occurred in 1905 at the Sarnia Bay Lumber Company's docks. The Bay became very shallow due to the accumulation of sawmill waste and periodic dredging had to be undertaken.[2] Additional dredging to a depth of 4.6 m (15 ft) took place the following year in front of, and between, the docks of the Sarnia Bay Lumber company and the Cleveland-Sarnia Sawmill Company. This area was dredged again to 4.8 m (16 ft) depth in 1909.[3]

During the 1920s, the bay between Point Edward and the Sarnia Elevator Company was filled and a shipping channel dredged. As late as the early 1930s, the dock ruins of the sawmill were still evident and portions of the fill area were depicted as marsh. The remnant of Sarnia Bay south of the grain elevator is shown as 0.6-0.9 m (2-3 feet) deep.[4]

In 1915, a 335 m (1,100 ft) long channel, 3.7 m (12 ft) deep from deep water to the Cleveland-Sarnia Saw Mill dock, was dredged. By 1937, the channel had been allowed to fill-in but by 1940 it had been dredged again and marked with buoys. It was still marked in 1972.[5]

Prior to the filling of Sarnia Bay, there had been shoreline encroachment into the Bay by industries at the foot of Maxwell Street, particularly from the Dominion Salt Company and the Cleveland and Sarnia Lumber Company. Land filling had also extended into the harbour from Front Street.[6]

During the 1950s or 1960s, additional harbour filling was undertaken to the south of the Sarnia Elevator Company.[7] This work was probably undertaken in anticipation of increased shipping due to construction of the St. Lawrence Seaway. Presumably "Seaway Road" was constructed at this time.

## 3.2 Industrial Development

### 3.2.1 Hall's Tannery

Hall's Tannery is the earliest identified industrial building in the study area. Two tanneries had been built in Sarnia by 1850. Plate 3 illustrates Hall's Tannery at the foot of Maxwell Street in c.1880.[8]

[1] "St. Clair River," Surveyed by James Mercur. 1867. Scale 1:16,000; US *Hydrographic Chart* 1908, 1914; 1:40,000

[2] V Lauriston, p.299

[3] *History Of Dredging And Compensation St. Clair And Detroit Rivers* February 2009 - Accessed On Line July 23, 2012

[4] *Hydrographic Chart* 1933, Scale 1:16,000

[5] *History Of Dredging And Compensation St. Clair And Detroit Rivers* February 2009 - Accessed On Line July 23, 2012; *Hydrographic Chart* 1933, 1937, 1940, 1972 Scale 1:16,000)

[6] *Hydrographic Chart* 1933, Scale 1:16,000

[7] *Hydrographic Chart* 1951, 1972, Scale 1:16,000)

[8] V Lauriston, p.98

### 3.2.2 Sarnia Gas

The Sarnia Consumers Gas Company was organized in 1884[9] or 1891.[10] Although built to supply manufactured coal gas, the company was obligated to supply electricity when called upon by City Council. In 1893, the company was required to generate electricity and changed its name changed to Sarnia Gas and Electric Light Company. Power production began the following year providing a service from 4:30 pm to midnight. In 1900 it began to provide a 24 hour service.

The gasworks in 1900 consisted of four buildings (Plate 5, 6). Adjacent to the railway tracks was a coal storage building. Adjacent to that was the "generator" which is assumed to be the coal gas retort rather than an electrical generator. The purifying building was attached to the gasworks and contained filters to remove sulphur, tar and other unwanted chemicals. Two gasholder tanks were filled gradually over 24 hours to provide storage when high demand in the evening would draw down supplies. A separate, and larger electrical generating building was located south of the gasworks. The boilers were fuelled with sawmill waste from the adjacent sawmill. The gasworks buildings and gasholder tanks had been removed by 1929.

Coal gas was produced by the destructive distillation of coal. The main products were coal gas and coke with lesser amounts of tar, and ammonia liquor. There is no indication that the tar and ammonia were removed at the Sarnia works. Coal tar was sometimes burned as an industrial fuel. Given the quantity of wood waste available and apparently small production of the Sarnia works, this seems unlikely. The amount of crude tar produced varied from 8 to 12 gallons of tar per ton of coke.[11]

In about 1908, the company began to distribute natural gas in Sarnia from the Tilbury gas field.[12] It is not clear if the company gave up manufactured gas production at that time. By 1916, the company was solely a distributor for natural gas. By 1924 it was known as the Sarnia Gas Company and in 1924 or 1925 purchased by Union Natural Gas Company.[13]

The electricity plant was destroyed by fire in 1912 but service was restored within a month and an entirely new building constructed by 1913. This is assumed to be the building that is standing today (Plate 6). In 1917, the City of Sarnia decided to buy power from the Ontario Hydro Electric Power Commission and the municipal franchise to deliver hydro was given to the Sarnia Public Utilities Commission.[14] After that time, the building became an electrical substation.

### 3.2.3 Cleveland and Sarnia Lumber Company

The Cleveland and Sarnia Lumber Company was organized in the late 19th century and soon occupied an immense area of land along the shoreline at the foot of Maxwell Street. (Plates 7-9) The logs were floated down in booms from the shores of upper Lake Huron.

[9] (MOE *Inventory of Coal Gasification* 1987)

[10] Lauriston, p.111

[11] (Shreve, *Chemical Process Industries*, 1945 p.83, 85, 94,97-98)

[12] V Lauriston, p.111-2

[13] (OBM vol 25 pt1, p.38;1924 vol 34 pt. 5, p.3, 1925 Vol 35, pt.4)

[14] (V Lauriston, p.111-2)

The main mill buildings were built on timber piles. Until the works closed in the 1920s, the entire shoreline from Maxwell Street north to Exmouth Street was filled with timber stacks. The most striking feature of the operation was a very long timber dock that projected across the entire width of Sarnia Bay. By 1929, all of the milling operation had disappeared.

### 3.2.4 Edmund Hall Sawmill

Directly north of the Cleveland and Sarnia operation was the E. Hall Sawmill and pier. (Plate 9) Almost all of this operation was located in Sarnia Bay. The sawmill seems to have been built on landfill. The property was shared with one of the salt mine operators The operation was reorganized as the Sarnia Bay Lumber, Timber & Salt Co in 1904 upon the death of Edmund Hall. This operation had closed by 1913.

### 3.2.5 Dominion Salt Company

The Empire Salt Company Limited was incorporated in 1904. The company constructed its plant on the south side of Cleveland-Sarnia Sawmill and burned mill waste for energy (Plate 8). By 1960, the property was owned by Sifto Salt Limited. Ten salt wells were drilled on the property since 1903 of which six were abandoned by the 1960s.[15]

Initially the company burned sawmill waste to evaporate the salt. After the mills closed, the company switched to coal as a fuel.

The actual date of closure of the operation was not determined. It is considered that it probably occurred in about 1966 when the last brine well was plugged.

The earliest identified salt well was located on the 1903 Fire Insurance Plan on the island shared with the Hall Sawmill. This had closed by 1913.

The Ontario Oil, Gas and Salt Resource Library has well reports for seven wells within the study area. The earliest was drilled in 1916 and the last well was plugged in 1966. Three of these wells are identified on the Fire Insurance Plans:

- No.4 Well near east-central portion of the Site, opposite Nelson Street was drilled in 1916 and plugged in 1955 (Identification # N002467).[16]
- Well No.6 On-Site along east boundary, 50 m south of Nelson Street was drilled in 1924 and plugged in 1966 (Identification # N002470).[17]
- Well No.1 Along east Site boundary, opposite and south Maxwell Street was drilled in 1921 and plugged in 1955 (Identification # N002464).[18]

[15] Lawrsan, 304; ODM – 1962

[16] FIP 1929, 1947

[17] FIP 1929)

### 3.2.6 Fire Insurance Plan Building

In 1929, the land to the east of the elevator basin was occupied by the Sarnia Wine Cognac Co distillery. By 1947, the property had been rebuilt at the Blue Water Boat Works. This complex of buildings occupied the same footprint as the 1958 MacCraft Industries Ltd. (Plate 10).

### 3.2.7 Lumber Docks

Prior to construction of the Sarnia Elevator Company docks, two long timber wharves were the largest structures in Sarnia Bay (Plate 9). The Cleveland and Sarnia Lumber Company had its mill at the foot of Maxwell Street. Just north of Maxwell Street, a lumber dock extended completely across the bay to the shipping channel. South and north of the pier is the indication that log booms were moored in these areas. Directly north of the Cleveland and Sarnia pier was the pier of the E. Hall Sawmill. The actual sawmill is depicted on a small island away from the shoreline and connected by a causeway. A lumber dock extended from this island out to the shipping channel.[19]

It appears that, by the end of the 1920s, the Hall dock (by then the Sarnia Bay Mill) had been removed. The Cleveland and Sarnia Lumber Company closed in the 1920s but the ruin remained into the 1930s.

Due to the survey of the waterlots, the former Cleveland and Sarnia Lumber Company dock alignment formed the south side of the basin for the Sarnia Elevator Company.[20]

### 3.2.8 Sarnia Elevator Co.

In 1926, a group of Sarnia entrepreneurs purchased 22 ha (55 acres) of waterlots on which to construct a grain elevator. The federal government dredged the area for the elevator docks and most of the land north of the docks filled at this time. A one million bushel elevator was completed in 1927. It was sold the following year to the Toronto Elevator Company and expanded. A new two million bushel elevator had been completed in August 1929 bringing the capacity to three million bushels[21] (Plates 11, 12). In 1941, a temporary three million bushel storage shed was built; it was demolished after the war.[22]

The elevator company was connected by a rail spur to the Canadian National Railway. The track passed over the former dock of the Hall Sawmill. A rail storage yard was built on the former edge of the harbour.

[18] FIP 1913, 1929

[19] US *Hydrographic Chart* 1908, 1:40,000

[20] *(Hydrographic Chart* 1933, Scale 1:16,000)

[21] Montreal Gazette (April 12, 1929 (p.25)

[22] V Lauriston, p.300-1

# 4.0 SOURCES

## 4.1 Published

*Historical Atlas of Lambton County*

Laurseon. *Lambton County*

Ontario. Department Of Mines *Annual report* various years, *Salt in Ontario* Industrial Mineral Report #6, 1962

Shreve, R. Norris. *The Chemical Process Industries*. New York: McGraw-Hill Book Company, 1945

## 4.2 Archival

Ontario. Ministry of the Environment – *Inventory of Coal Gasification Plant Waste Sites* (1987) "St. Clair River," Surveyed by James Mercur. 1867. Scale 1:16,000

US *Hydrographic Chart* 1908, 1:40,000

*Canadian Hydrographic Chart* 1933, Scale 1:16,000 [scale of the hydrographic charts changed from 1:16,000 in 1934 to 1:15,000 in 1937]

National Air Photo Library 1931, 1947, 1953, 1966, 1974, 1986

## 4.3 Online

*History Of Dredging And Compensation St. Clair And Detroit Rivers* February 2009 - Accessed On Line July 23, 2012)

*Resources* April 1904 Vol 2,No. 4 [Online July 23, 2012]

# 5.0 PLATES

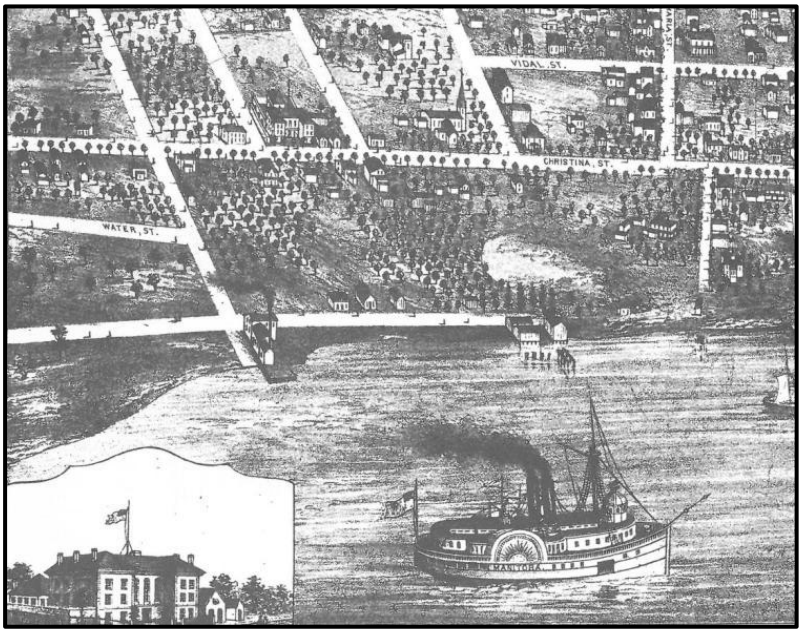


*Plate 1: Sarnia Bay, 1864*

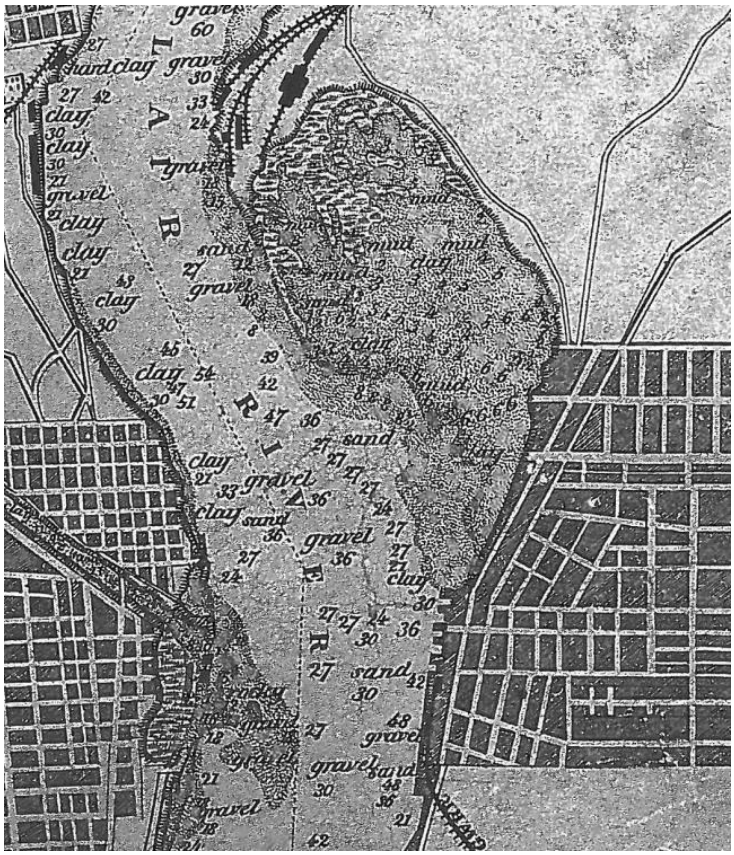


*Plate 2: Sarnia Bay, 1864*

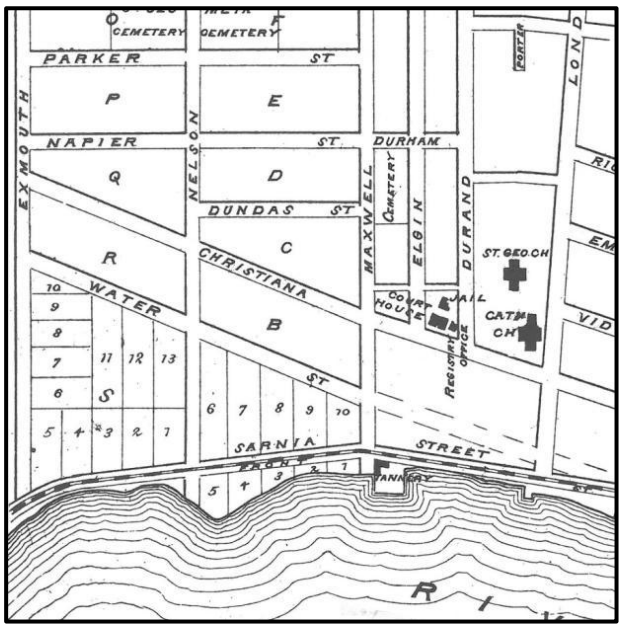


*Plate 3: Sarnia Harbour c. 1880*

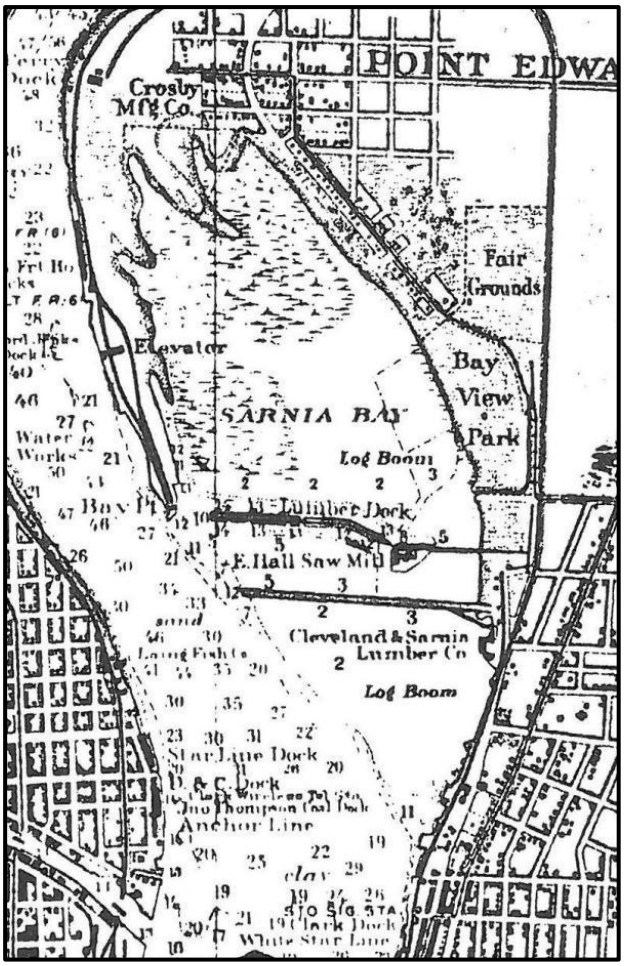


*Plate 4: Sarnia Bay 1914*

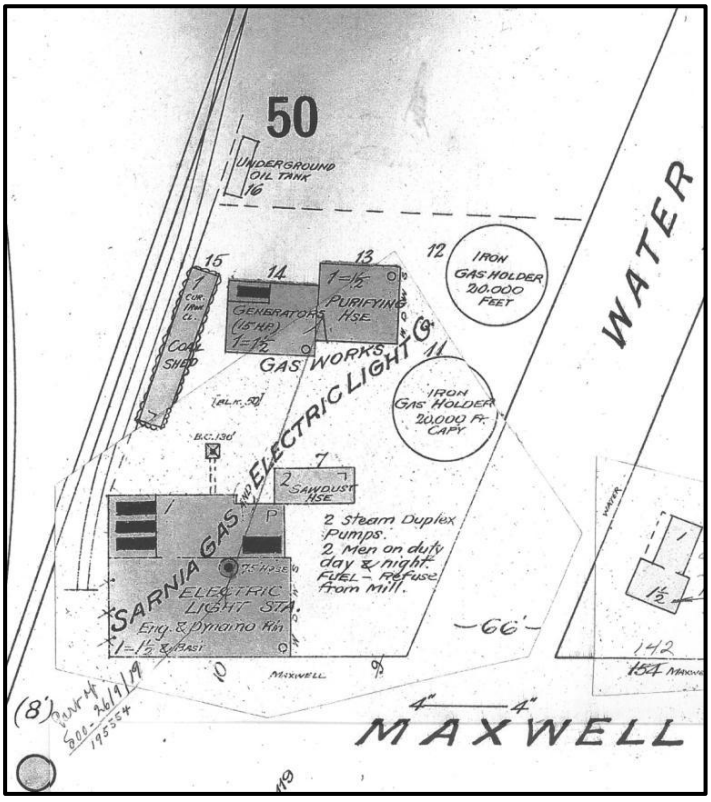


*Plate 5: Gas Works 1903*

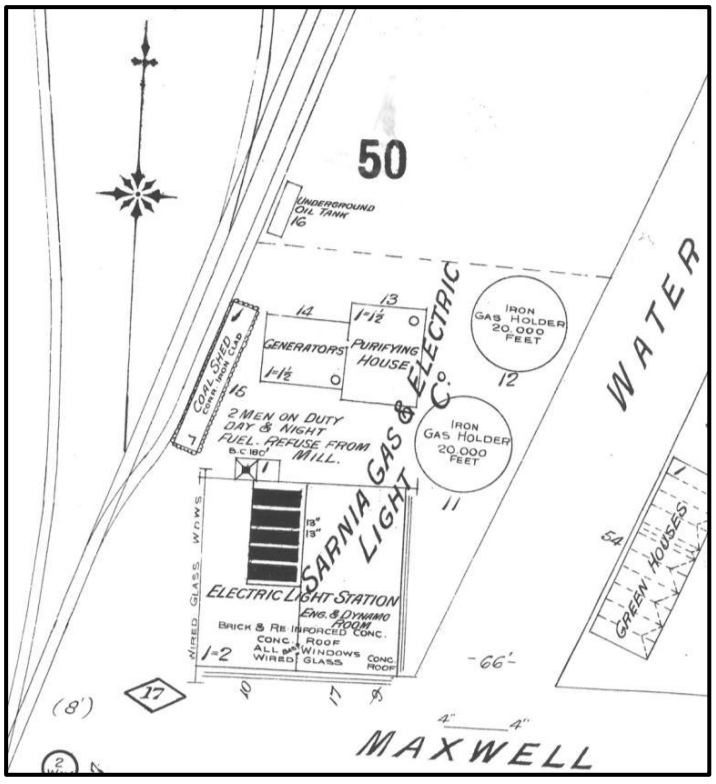


*Plate 6: Gas Works 1913*

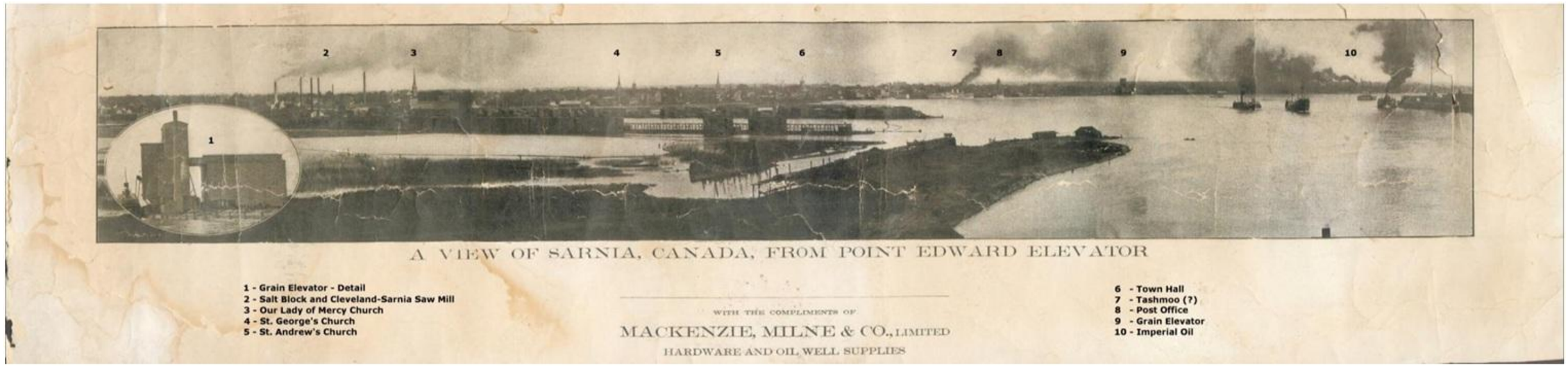


*Plate 7: c. 1900*

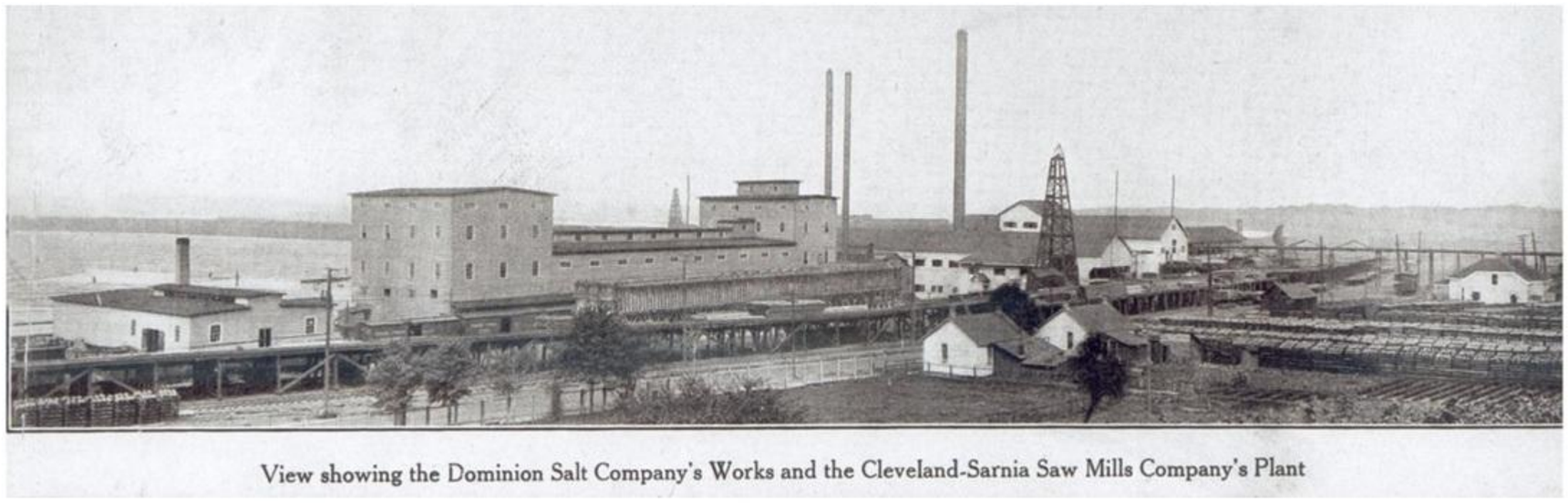
View showing the Dominion Salt Company's Works and the Cleveland-Sarnia Saw Mills Company's Plant

*Plate 8: Dominion Salt and Cleveland Sarnia Saw Mills, c. 1900*

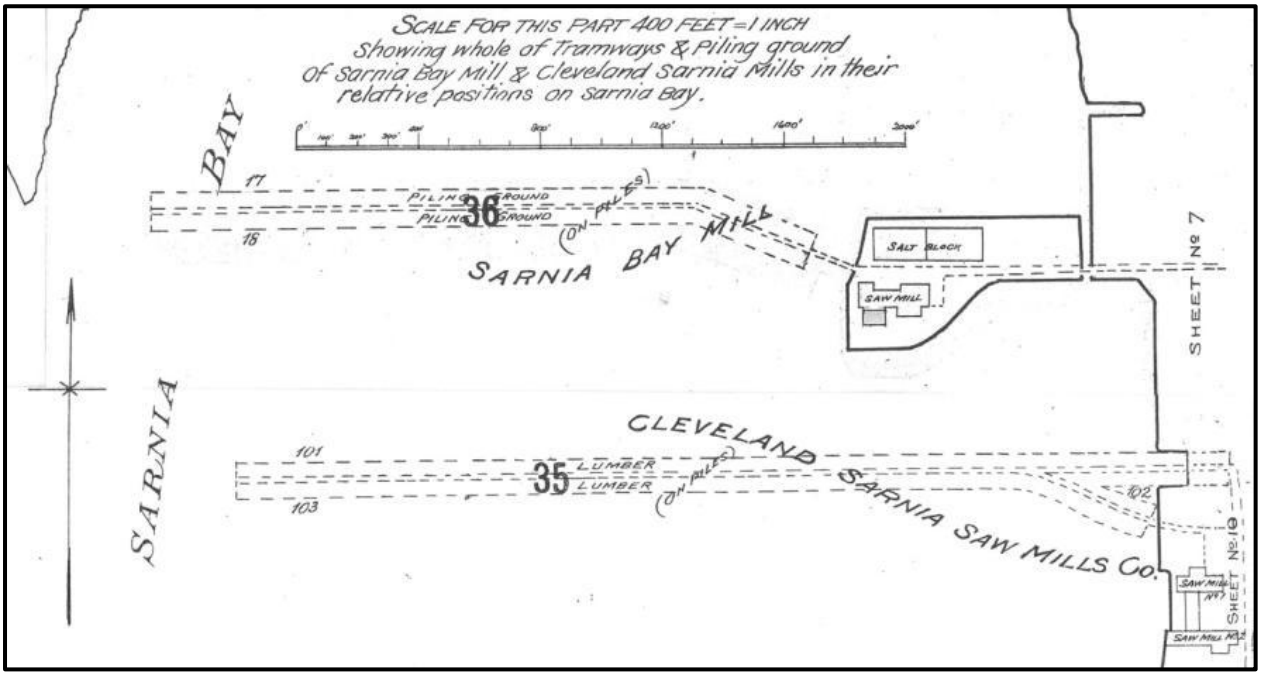


*Plate 9: Timber Wharves 1913*

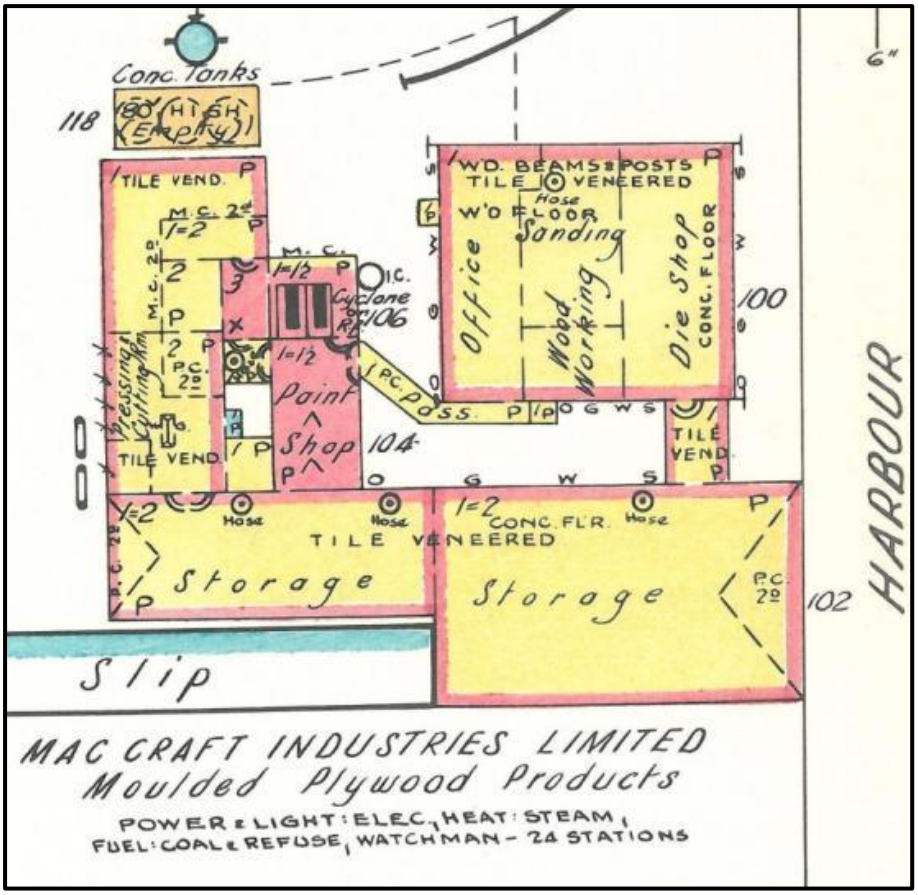


*Plate 10: Fire Insurance Plan 1958*

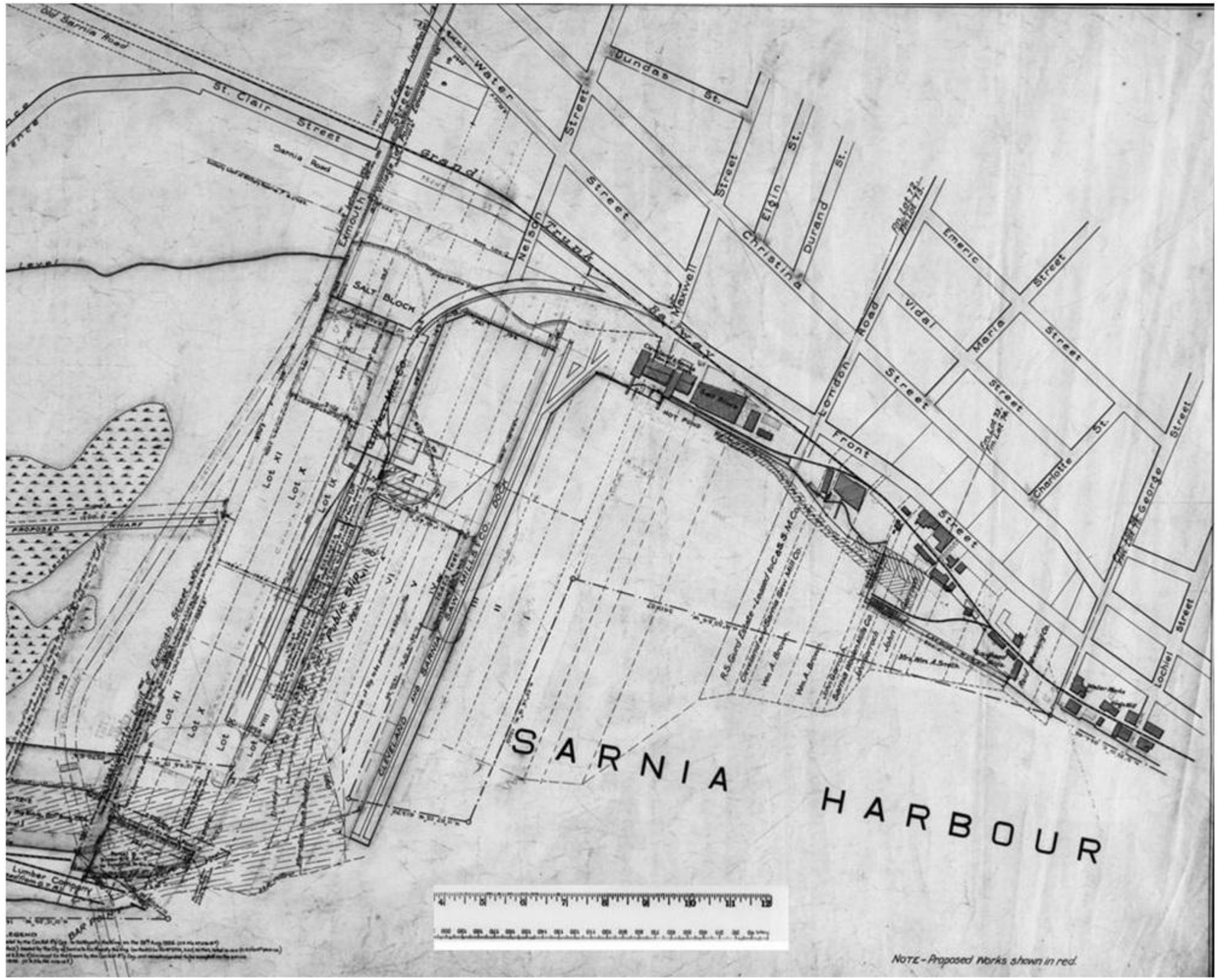

*Plate 11: Sarnia Harbour c1930 showing waterlots*

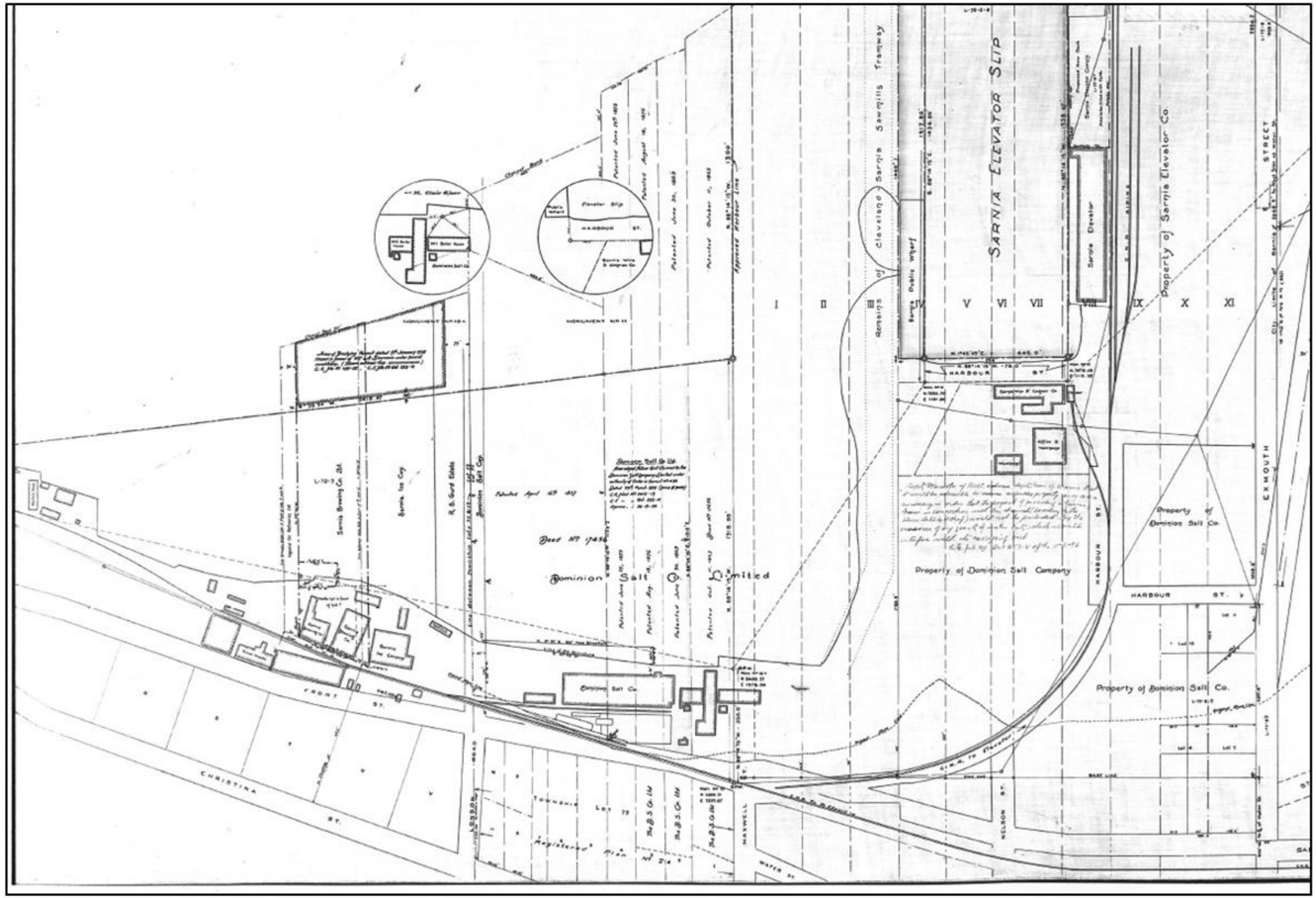


*Plate 12: Harbour Line Fronting Sarnia & Point Edward. Canada. Public Works, 1932, 1 inch: 100 feet*

*Plate 13: Air Photo 1931 The white areas represent recently filled areas. Rail yard on top right*

*Plate 14: Air Photo 1947*

*Plate 15: Air Photo 1966 showing newly constructed Seaway Road*

*Plate 16: Air Photo Sarnia Harbour 1996*

## 6.0 CLOSURE

We trust this technical memorandum is satisfactory for your current requirements; however, should you have any questions or concerns, or require additional information or clarification, please don't hesitate to contact the undersigned. Thank you for the opportunity to be of assistance on this project.

**GOLDER ASSOCIATES LTD.**

Christopher Andreae, Ph.D.
Associate, Senior Built Heritage Specialist

Keith G. Lesarge, M.Sc., P.Geo.
Principal

CA/KGL/SC/LJ/slc

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# APPENDIX G

## Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes A Checklist for the Non-specialist

Ontario

**Ministry of Tourism, Culture and Sport**

Programs & Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7

# Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes

## A Checklist for the Non-Specialist

The **purpose of the checklist** is to determine:

- if a property(ies) or project area:
  - is a recognized heritage property
  - may be of cultural heritage value
- it includes all areas that may be impacted by project activities, including – but not limited to:
  - the main project area
  - temporary storage
  - staging and working areas
  - temporary roads and detours

**Processes covered** under this checklist, such as:

- *Planning Act*
- *Environmental Assessment Act*
- *Aggregates Resources Act*
- *Ontario Heritage Act* – Standards and Guidelines for Conservation of Provincial Heritage Properties

**Cultural Heritage Evaluation Report (CHER)**

If you are not sure how to answer one or more of the questions on the checklist, you may want to hire a qualified person(s) (see page 5 for definitions) to undertake a cultural heritage evaluation report (CHER).

The CHER will help you:

- identify, evaluate and protect cultural heritage resources on your property or project area
- reduce potential delays and risks to a project

**Other checklists**

Please use a separate checklist for your project, if:

- you are seeking a Renewable Energy Approval under Ontario Regulation 359/09 – separate checklist
- your Parent Class EA document has an approved screening criteria (as referenced in Question 1)

Please refer to the Instructions pages for more detailed information and when completing this form.

  

Project or Property Name

Project or Property Location (upper and lower or single tier municipality)

Proponent Name

Proponent Contact Information

## Screening Questions

| | Yes | No |
|---|---|---|
| 1. Is there a pre-approved screening checklist, methodology or process in place? | ☐ | ☑ |

**If Yes,** please follow the pre-approved screening checklist, methodology or process.

**If No,** continue to Question 2.

## Part A: Screening for known (or recognized) Cultural Heritage Value

| | Yes | No |
|---|---|---|
| 2. Has the property (or project area) been evaluated before and found **not** to be of cultural heritage value? | ☐ | ☑ |

**If Yes,** do **not** complete the rest of the checklist.

The proponent, property owner and/or approval authority will:

- summarize the previous evaluation and
- add this checklist to the project file, with the appropriate documents that demonstrate a cultural heritage evaluation was undertaken

The summary and appropriate documentation may be:

- submitted as part of a report requirement
- maintained by the property owner, proponent or approval authority

**If No**, continue to Question 3.

| | Yes | No |
|---|---|---|
| 3. Is the property (or project area): | | |
| a. identified, designated or otherwise protected under the *Ontario Heritage Act* as being of cultural heritage value? | ☐ | ☑ |
| b. a National Historic Site (or part of)? | ☐ | ☑ |
| c. designated under the *Heritage Railway Stations Protection Act*? | ☐ | ☑ |
| d. designated under the *Heritage Lighthouse Protection Act*? | ☐ | ☑ |
| e. identified as a Federal Heritage Building by the Federal Heritage Buildings Review Office (FHBRO)? | ☐ | ☑ |
| f. located within a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site? | ☐ | ☑ |

**If Yes** to any of the above questions, you need to hire a qualified person(s) to undertake:

- a Cultural Heritage Evaluation Report, if a Statement of Cultural Heritage Value has not previously been prepared or the statement needs to be updated

If a Statement of Cultural Heritage Value has been prepared previously and if alterations or development are proposed, you need to hire a qualified person(s) to undertake:

- a Heritage Impact Assessment (HIA) – the report will assess and avoid, eliminate or mitigate impacts

**If No**, continue to Question 4.

## Part B: Screening for Potential Cultural Heritage Value

| | Yes | No |
|---|---|---|
| 4. Does the property (or project area) contain a parcel of land that: | | |
| a. is the subject of a municipal, provincial or federal commemorative or interpretive plaque? | ☐ | ☑ |
| b. has or is adjacent to a known burial site and/or cemetery? | ☐ | ☑ |
| c. is in a Canadian Heritage River watershed? | ☐ | ☑ |
| d. contains buildings or structures that are 40 or more years old? | ☐ | ☑ |

## Part C: Other Considerations

| | Yes | No |
|---|---|---|
| 5. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area): | | |
| a. is considered a landmark in the local community or contains any structures or sites that are important in defining the character of the area? | ☐ | ☑ |
| b. has a special association with a community, person or historical event? | ☐ | ☑ |
| c. contains or is part of a cultural heritage landscape? | ☐ | ☑ |

**If Yes** to one or more of the above questions (Part B and C), there is potential for cultural heritage resources on the property or within the project area.

You need to hire a qualified person(s) to undertake:

- a Cultural Heritage Evaluation Report (CHER)

If the property is determined to be of cultural heritage value and alterations or development is proposed, you need to hire a qualified person(s) to undertake:

- a Heritage Impact Assessment (HIA) – the report will assess and avoid, eliminate or mitigate impacts

**If No** to all of the above questions, there is low potential for built heritage or cultural heritage landscape on the property.

The proponent, property owner and/or approval authority will:

- summarize the conclusion
- add this checklist with the appropriate documentation to the project file

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g. under the *Environmental Assessment Act, Planning Act* processes
- maintained by the property owner, proponent or approval authority

## Instructions

Please have the following available, when requesting information related to the screening questions below:

- a clear map showing the location and boundary of the property or project area
  - large scale and small scale showing nearby township names for context purposes
- the municipal addresses of all properties within the project area
- the lot(s), concession(s), and parcel number(s) of all properties within a project area

For more information, see the Ministry of Tourism, Culture and Sport's Ontario Heritage Toolkit or Standards and Guidelines for Conservation of Provincial Heritage Properties.

In this context, the following definitions apply:

- **qualified person(s)** means individuals – professional engineers, architects, archaeologists, etc. – having relevant, recent experience in the conservation of cultural heritage resources.
- **proponent** means a person, agency, group or organization that carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.

### 1. Is there a pre-approved screening checklist, methodology or process in place?

An existing checklist, methodology or process may already be in place for identifying potential cultural heritage resources, including:

- one endorsed by a municipality
- an environmental assessment process e.g. screening checklist for municipal bridges
- one that is approved by the Ministry of Tourism, Culture and Sport (MTCS) under the Ontario government's Standards & Guidelines for Conservation of Provincial Heritage Properties [s.B.2.]

## Part A: Screening for known (or recognized) Cultural Heritage Value

### 2. Has the property (or project area) been evaluated before and found not to be of cultural heritage value?

Respond 'yes' to this question, if all of the following are true:

A property can be considered not to be of cultural heritage value if:

- a Cultural Heritage Evaluation Report (CHER) - or equivalent - has been prepared for the property with the advice of a qualified person and it has been determined not to be of cultural heritage value and/or
- the municipal heritage committee has evaluated the property for its cultural heritage value or interest and determined that the property is not of cultural heritage value or interest

A property may need to be re-evaluated, if:

- there is evidence that its heritage attributes may have changed
- new information is available
- the existing Statement of Cultural Heritage Value does not provide the information necessary to manage the property
- the evaluation took place after 2005 and did not use the criteria in Regulations 9/06 and 10/06

**Note**: Ontario government ministries and public bodies [prescribed under Regulation 157/10] may continue to use their existing evaluation processes, until the evaluation process required under section B.2 of the Standards & Guidelines for Conservation of Provincial Heritage Properties has been developed and approved by MTCS.

To determine if your property or project area has been evaluated, contact:

- the approval authority
- the proponent
- the Ministry of Tourism, Culture and Sport

### 3a. Is the property (or project area) identified, designated or otherwise protected under the *Ontario Heritage Act* as being of cultural heritage value e.g.:

i. designated under the *Ontario Heritage Act*

- individual designation (Part IV)
- part of a heritage conservation district (Part V)

**Individual Designation – Part IV**

A property that is designated:

- by a municipal by-law as being of cultural heritage value or interest [s.29 of the *Ontario Heritage Act*]
- by order of the Minister of Tourism, Culture and Sport as being of cultural heritage value or interest of provincial significance [s.34.5]. **Note**: To date, no properties have been designated by the Minister.

**Heritage Conservation District – Part V**

A property or project area that is located within an area designated by a municipal by-law as a heritage conservation district [s. 41 of the *Ontario Heritage Act*].

For more information on Parts IV and V, contact:

- municipal clerk
- Ontario Heritage Trust
- local land registry office (for a title search)

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ii. subject of an agreement, covenant or easement entered into under Parts II or IV of the *Ontario Heritage Act*

An agreement, covenant or easement is usually between the owner of a property and a conservation body or level of government. It is usually registered on title.

The primary purpose of the agreement is to:

- preserve, conserve, and maintain a cultural heritage resource
- prevent its destruction, demolition or loss

For more information, contact:

- Ontario Heritage Trust - for an agreement, covenant or easement [clause 10 (1) (c) of the *Ontario Heritage Act*]
- municipal clerk – for a property that is the subject of an easement or a covenant [s.37 of the *Ontario Heritage Act*]
- local land registry office (for a title search)

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iii. listed on a register of heritage properties maintained by the municipality

Municipal registers are the official lists - or record - of cultural heritage properties identified as being important to the community.

Registers include:

- all properties that are designated under the *Ontario Heritage Act* (Part IV or V)
- properties that have not been formally designated, but have been identified as having cultural heritage value or interest to the community

For more information, contact:

- municipal clerk
- municipal heritage planning staff
- municipal heritage committee

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iv. subject to a notice of:

- intention to designate (under Part IV of the *Ontario Heritage Act*)
- a Heritage Conservation District study area bylaw (under Part V of the *Ontario Heritage Act*)

A property that is subject to a **notice of intention to designate** as a property of cultural heritage value or interest and the notice is in accordance with:

- section 29 of the *Ontario Heritage Act*
- section 34.6 of the *Ontario Heritage Act.* **Note**: To date, the only applicable property is Meldrum Bay Inn, Manitoulin Island. [s.34.6]

An area designated by a municipal by-law made under section 40.1 of the *Ontario Heritage Act* as a **heritage conservation district study area**.

For more information, contact:

- municipal clerk – for a property that is the subject of notice of intention [s. 29 and s. 40.1]
- Ontario Heritage Trust

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v. included in the Ministry of Tourism, Culture and Sport's list of provincial heritage properties

Provincial heritage properties are properties the Government of Ontario owns or controls that have cultural heritage value or interest.

The Ministry of Tourism, Culture and Sport (MTCS) maintains a list of all provincial heritage properties based on information provided by ministries and prescribed public bodies. As they are identified, MTCS adds properties to the list of provincial heritage properties.

For more information, contact the MTCS Registrar at registrar@mtc.gov.on.ca.

**3b. Is the property (or project area) a National Historic Site (or part of)?**

National Historic Sites are properties or districts of national historic significance that are designated by the Federal Minister of the Environment, under the *Canada National Parks Act*, based on the advice of the Historic Sites and Monuments Board of Canada.

For more information, see the National Historic Sites website.

**3c. Is the property (or project area) designated under the *Heritage Railway Stations Protection Act*?**

The *Heritage Railway Stations Protection Act* protects heritage railway stations that are owned by a railway company under federal jurisdiction. Designated railway stations that pass from federal ownership may continue to have cultural heritage value.

For more information, see the Directory of Designated Heritage Railway Stations.

**3d. Is the property (or project area) designated under the *Heritage Lighthouse Protection Act*?**

The *Heritage Lighthouse Protection Act* helps preserve historically significant Canadian lighthouses. The Act sets up a public nomination process and includes heritage building conservation standards for lighthouses which are officially designated.

For more information, see the Heritage Lighthouses of Canada website.

**3e. Is the property (or project area) identified as a Federal Heritage Building by the Federal Heritage Buildings Review Office?**

The role of the Federal Heritage Buildings Review Office (FHBRO) is to help the federal government protect the heritage buildings it owns. The policy applies to all federal government departments that administer real property, but not to federal Crown Corporations.

For more information, contact the Federal Heritage Buildings Review Office.

See a directory of all federal heritage designations.

**3f. Is the property (or project area) located within a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site?**

A UNESCO World Heritage Site is a place listed by UNESCO as having outstanding universal value to humanity under the Convention Concerning the Protection of the World Cultural and Natural Heritage. In order to retain the status of a World Heritage Site, each site must maintain its character defining features.

Currently, the Rideau Canal is the only World Heritage Site in Ontario.

For more information, see Parks Canada – World Heritage Site website.

## Part B: Screening for potential Cultural Heritage Value

**4a. Does the property (or project area) contain a parcel of land that has a municipal, provincial or federal commemorative or interpretive plaque?**

Heritage resources are often recognized with formal plaques or markers.

Plaques are prepared by:

- municipalities
- provincial ministries or agencies
- federal ministries or agencies
- local non-government or non-profit organizations

For more information, contact:

- municipal heritage committees or local heritage organizations – for information on the location of plaques in their community
- Ontario Historical Society's Heritage directory – for a list of historical societies and heritage organizations
- Ontario Heritage Trust – for a list of plaques commemorating Ontario's history
- Historic Sites and Monuments Board of Canada – for a list of plaques commemorating Canada's history

**4b. Does the property (or project area) contain a parcel of land that has or is adjacent to a known burial site and/or cemetery?**

For more information on known cemeteries and/or burial sites, see:

- Cemeteries Regulations, Ontario Ministry of Consumer Services – for a database of registered cemeteries
- Ontario Genealogical Society (OGS) – to locate records of Ontario cemeteries, both currently and no longer in existence; cairns, family plots and burial registers
- Canadian County Atlas Digital Project – to locate early cemeteries

In this context, adjacent means contiguous or as otherwise defined in a municipal official plan.

**4c. Does the property (or project area) contain a parcel of land that is in a Canadian Heritage River watershed?**

The Canadian Heritage River System is a national river conservation program that promotes, protects and enhances the best examples of Canada's river heritage.

Canadian Heritage Rivers must have, and maintain, outstanding natural, cultural and/or recreational values, and a high level of public support.

For more information, contact the Canadian Heritage River System.

If you have questions regarding the boundaries of a watershed, please contact:

- your conservation authority
- municipal staff

**4d. Does the property (or project area) contain a parcel of land that contains buildings or structures that are 40 or more years old?**

A 40 year 'rule of thumb' is typically used to indicate the potential of a site to be of cultural heritage value. The approximate age of buildings and/or structures may be estimated based on:

- history of the development of the area
- fire insurance maps
- architectural style
- building methods

Property owners may have information on the age of any buildings or structures on their property. The municipality, local land registry office or library may also have background information on the property.

**Note**: 40+ year old buildings or structure do not necessarily hold cultural heritage value or interest; their age simply indicates a higher potential.

A building or structure can include:

- residential structure
- farm building or outbuilding
- industrial, commercial, or institutional building
- remnant or ruin
- engineering work such as a bridge, canal, dams, etc.

For more information on researching the age of buildings or properties, see the Ontario Heritage Tool Kit Guide Heritage Property Evaluation.

## Part C: Other Considerations

**5a. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) is considered a landmark in the local community or contains any structures or sites that are important to defining the character of the area?**

Local or Aboriginal knowledge may reveal that the project location is situated on a parcel of land that has potential landmarks or defining structures and sites, for instance:

- buildings or landscape features accessible to the public or readily noticeable and widely known
- complexes of buildings
- monuments
- ruins

**5b. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) has a special association with a community, person or historical event?**

Local or Aboriginal knowledge may reveal that the project location is situated on a parcel of land that has a special association with a community, person or event of historic interest, for instance:

- Aboriginal sacred site
- traditional-use area
- battlefield
- birthplace of an individual of importance to the community

**5c. Is there local or Aboriginal knowledge or accessible documentation suggesting that the property (or project area) contains or is part of a cultural heritage landscape?**

Landscapes (which may include a combination of archaeological resources, built heritage resources and landscape elements) may be of cultural heritage value or interest to a community.

For example, an Aboriginal trail, historic road or rail corridor may have been established as a key transportation or trade route and may have been important to the early settlement of an area. Parks, designed gardens or unique landforms such as waterfalls, rock faces, caverns, or mounds are areas that may have connections to a particular event, group or belief.

For more information on Questions 5.a., 5.b. and 5.c., contact:

- Elders in Aboriginal Communities or community researchers who may have information on potential cultural heritage resources. Please note that Aboriginal traditional knowledge may be considered sensitive.
- municipal heritage committees or local heritage organizations
- Ontario Historical Society's "Heritage Directory" - for a list of historical societies and heritage organizations in the province

An internet search may find helpful resources, including:

- historical maps
- historical walking tours
- municipal heritage management plans
- cultural heritage landscape studies
- municipal cultural plans

Information specific to trails may be obtained through Ontario Trails.

# APPENDIX H

## Detailed Evaluation Matrices for Alternatives

**EVALUATION OF ALTERNATIVES – ARMOUR STONE WALL**

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no shoreline protection) | ALTERNATIVE 2 -Vertical | ALTERNATIVE 3 -Tiered |
|---|---|---|---|---|---|---|
| Natural Environment | Compliance with natural heritage policies of the Provincial Policy Statement (2014) | Protection of fish habitat | Minimize development or site alteration in fish habitat or riparian areas (defined as areas within 15 m from top of bank) | No direct loss of fish habitat or riparian areas. | Project construction would occur primarily beyond the high water mark and in the dry.<br>There would be ~270 m² of direct permanent habitat loss.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works outside of the cool/cold water fisheries window would be negotiated with MNRF. | Project construction would occur primarily beyond the high water mark and in the dry.<br>There would be ~270 m² of direct permanent habitat loss.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works outside of the cool/cold water fisheries window would be negotiated with MNRF. |
| | Compliance with the *Endangered Species Act* (2007) | Protection of species listed as threatened or endangered in Ontario | No killing, harming or harassing of species, or impacting the habitat of species identified as endangered or threatened | No direct impact to habitat but habitat would be affected through continued exposure to contaminated fill. | The existing boat ramps and 53 trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. | The existing boat ramps and 53 trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. |
| | Compliance with the *Species at Risk Act* (SARA)(2002) | Protection of species listed as endangered, threatened or extirpated in Canada, and migratory birds listed under the SARA | No impact to critical habitat of endangered, threatened or extirpated aquatic species or habitat of migratory birds | No direct impact to habitat but habitat would be affected through continued exposure to contaminated fill. | Project construction would occur primarily beyond the high water mark and in the dry.<br>There would be ~270 m² of direct permanent habitat loss.<br>The existing boat ramps and 53 trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. | Project construction would occur primarily beyond the high water mark and in the dry.<br>There would be ~270 m² of direct permanent habitat loss.<br>The existing boat ramps and 53 trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. |
| | Compliance with the *Migratory Birds Convention Act* (1994) | Protection of nesting habitat of migratory birds in Canada | No clearing of trees, shrubs, meadow grasses or existing structures that would result in the destruction of nests of migratory birds during the breeding season | No clearing of trees, shrubs, meadow grasses or existing structures would be affected. | 53 trees will be removed and ~270 m² of riparian zone affected. | 53 trees will be removed and ~270 m² of riparian zone affected. |
| | Compliance with Ontario Regulation 171/06 – St. Clair Region Conservation Authority | Protection of public safety and property from natural hazards, and prevention of pollution and destruction of sensitive environmental areas such as wetlands, shorelines and watercourses | Minimize excavation, filling, site grading or development within the regulated limit | No work within the regulated limit; however, there would be continued exposure to contaminated fill. | Construction within regulated limit with ~3,075 m² of regulated lands affected. | Construction within regulated limit with ~3,535 m² of regulated lands affected. |
| | Consideration of best practices for watershed protection | Preservation of riparian zones adjacent to shorelines, minimization of shoreline erosion and sedimentation and maintenance of stormwater runoff at pre-development levels | Maintain natural drainage patterns and manage stormwater runoff | No change to natural drainage patterns, erosion or sedimentation. | ~270 m² of riparian zone affected.<br>Designed to withstand shoreline erosion due to high water, wave action and ice forces.<br>Reduction in sedimentation due to reduced potential for shoreline erosion.<br>No change to existing stormwater runoff. | ~270 m² of riparian zone affected.<br>Lower-tier planting beds would be more vulnerable to sustained periods of high water, frequent wave action and ice damage. Therefore, shoreline erosion and sedimentation may occur in lower-tier planting beds if water levels are well above normal for sustained periods. |

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no shoreline protection) | ALTERNATIVE 2 -Vertical | ALTERNATIVE 3 -Tiered |
|---|---|---|---|---|---|---|
| Social and Economic Environment | Compliance with the City of Sarnia Adopted Official Plan (2014) | Protection of lands designated as natural heritage systems (i.e., natural areas, parks, open space, natural hazards) | Protect, maintain, enhance and restore natural heritage systems where it is not feasible to direct development away from these areas | No park land or natural hazards areas would be affected but the contaminated fill would remain in place. | ~3,075 m² of park land / natural hazards areas affected and the contaminated fill would be contained. | ~3,535 m² of park land / natural hazards areas affected and the contaminated fill would be contained. |
| | | Avoidance of building / structure construction within identified one-zone floodplain policy areas | Allow construction in support of public recreation only where construction will not affect flood levels | No one-zone floodplain policy areas would be affected but the Park shoreline area would remain closed to recreational uses. | ~3,075 m² of the one-zone floodplain policy area affected.<br>No effect on flood levels and the Park shoreline area would be opened allowing for recreational uses. | ~3,535 m² of the one-zone floodplain policy area affected.<br>No effect on flood levels and the Park shoreline area would be opened allowing for recreational uses. |
| | | Consideration for public safety through protection of the St. Clair River waterfront and shoreline | Protect, maintain and enhance the waterfront through naturalization and improved stability of the shoreline | No changes to the waterfront and shoreline but the Park would remain closed along the shoreline due to continued exposure to contaminated fill and shoreline would remain fenced, limiting habitat use and aesthetics. | Improved stability of shoreline and the Park will be safe for public use since contaminated fill will be contained.<br>Improved public safety because no public access to water would be provided; however, less separation between pedestrians and waters edge.<br>Vertical armour stone provides limited naturalization for terrestrial species. | Improved stability of the shoreline and Park will be safe for public use since contaminated fill will be contained.<br>Improved public safety because no public access to water would be provided and greater separation between pedestrians and waters edge.<br>Tiered planting bed is more naturalized for terrestrial species and aesthetics. |
| | | Provision for bicycle and pedestrian corridors and linkages within urban natural areas | Maintain or improve existing multi-use walking / bicycling corridor along Sarnia Bay shoreline at the Park | Existing multi-use corridor maintained. | A new dedicated paved multi-use pathway would be provided. | A new dedicated paved multi-use pathway would be provided. |
| | | Protection of lands designated as park and open space | Protect, maintain, enhance and improve parks and open spaces | No park land would be affected; but the Park would remain closed due to continued exposure to contaminated fill. | Multi-use pathway would be closer to shoreline; therefore, more useable park space to the north of the pathway would be available. | Multi-use pathway would be further from shoreline; therefore, less useable park space to the north of the pathway would be available. |
| | Compliance with the City of Sarnia Adopted Official Plan (2014) (continued) | Application of high standards of urban design wherever possible | Maintain uniformity of design for elements such as benches, railings, lighting fixture, walkways and signs | Existing park elements maintained but the Park would remain closed along the shoreline due to continued exposure to contaminated fill. | Designed to AODA, CPETED principles, DFO Land Development Guidelines for the Protection of Aquatic Habitat and Ontario Building Code.<br>Armour stone seat wall, continuous walkway and signs included in design.<br>Electrical network will be replaced and matched to existing fixtures. | Designed to AODA, CPETED principles, DFO Land Development Guidelines for the Protection of Aquatic Habitat and Ontario Building Code.<br>Armour stone seat wall, continuous walkway and signs included in design.<br>Electrical network will be replaced and matched to existing fixtures. |
| | | Consideration of the protection of urban City trees | Protect and preserve existing mature trees within the same site, or in an adjacent natural area or natural hazard lands, where possible | No trees will be removed but trees would continue to be exposed to contaminated fill. | 53 non-significant trees will be removed.<br>At minimum, all trees will be replaced. | 53 non-significant trees will be removed.<br>At minimum, all trees will be replaced. |

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no shoreline protection) | ALTERNATIVE 2 -Vertical | ALTERNATIVE 3 -Tiered |
|---|---|---|---|---|---|---|
| Social and Economic Environment | Compliance with the City of Sarnia Waterfront Master Plan (2005) | Enhance the opportunity for public enjoyment of the waterfront and waterfront character | Development consistent with land designations and plans of George Street to Exmouth Street and West of Harbour Road waterfront areas | The Park would remain closed along the waterfront due to continued exposure to contaminated fill. | Park will be safe for public use; playground removed despite George Street to Exmouth Street plans to retain in place. | Park will be safe for public use; playground removed despite George Street to Exmouth Street plans to retain in place. |
| | | Protection of continuous public walkway at or near water edge | Maintain or improve continuous walkway | Existing multi-use corridor maintained. | A new dedicated paved multi-use pathway would be provided. | A new dedicated paved multi-use pathway would be provided. |
| | Consideration of Public concerns identified for the project | Consideration of power sources for recreational uses, such as the Celebration of Lights | Maintain or improve adequate power source for recreational uses | Existing power sources would be maintained. | New electrical network would be provided and matched to existing fixtures. | New electrical network would be provided and matched to existing fixtures. |
| Technical | Consideration of construction duration and timing | Efficient duration of construction that is protective of the natural heritage environment | Limit and reduce construction duration and timing within wildlife protection windows, as applicable | No construction would occur. | 4 month construction period planned.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works required outside of the cold water fisheries window will be negotiated with MNRF. | 4 month construction period planned.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works required outside of the cold water fisheries window will be negotiated with MNRF. |
| | Consideration for the protection of public safety | Safe separation of pedestrians from shoreline | Improve and protect public safety through provision for buffer between sidewalks and shoreline | Average of ~3.3 m separation between paved multi-use pathway and waters edge. | Average of ~3.1 m separation between paved multi-use pathway and waters edge. | Average of ~4.8 m average separation between paved multi-use pathway and waters edge. |
| | Consideration of durability and life expectancy | Long-term solution to shoreline protection | Design that has long life expectancy and can withstand environmental factors | No shoreline protection provided; therefore, shoreline is exposed to high water, wave action and ice forces. | Designed to withstand erosion due to high water, wave action and ice forces. | Lower-tier planting beds will be more vulnerable to sustained periods of high water, more frequent wave action and ice damage. Therefore, shoreline erosion and sedimentation may occur in lower-tier planting beds if water levels are well above normal for sustained periods. |
| | Consideration for flooding potential | Consideration of public safety against flood potential appropriate for an urban park environment (i.e., 10-year return period) | Provision of a feasible design that considers protection of the public against flood events having a return period of 10 years taking into account water levels, waves and wave run up | Shoreline would continue to be flooded (overtopped) during extreme events, including the 1:100 year flood. | Shoreline works will only be overtopped during extreme flood events (i.e., those greatly exceeding 1:10 year return period). | Lower-tier planting beds will be overtopped during moderately large flood events (i.e., 1:10 year return period flood). |
| | Consideration of coastal hydraulics and compliance with appropriate technical guidelines for shoreline protection in an urban park environment | Feasible design that can be implemented, given expected water level and wave conditions | Provision of a feasible design that considers the historic range of water levels in Sarnia Bay, including significant wave height and wave run up | Shoreline would continue to be exposed to flooding and significant wave action. | Designed to withstand shoreline erosion due to high water, wave action and ice forces.<br>Reduction in sedimentation due to reduced potential for shoreline erosion.<br>No change to existing flooding. | Lower-tier planting beds would be more vulnerable to sustained periods of high water, frequent wave action and ice damage.<br>Therefore, shoreline erosion and sedimentation may occur in lower tier planting beds if water levels are well above normal for sustained periods. |

**EVALUATION OF ALTERNATIVES – REPLACEMENT BOAT LAUNCH**

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no removal of boat ramps) | ALTERNATIVE 2 - Two Ramps | ALTERNATIVE 3 - Four Ramps |
|---|---|---|---|---|---|---|
| Natural Environment | Compliance with natural heritage policies of the Provincial Policy Statement (2014) | Protection of fish habitat | Minimize development or site alteration in fish habitat or riparian areas (defined as areas within 15 m from top of bank) | No direct loss of fish habitat or riparian areas. | There would be a permanent loss of ~400 $m^2$ of fish habitat.<br>Removal of existing boat ramps would result in a net gain of 530 $m^2$ of fish habitat.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works outside of the cool/cold water fisheries window would be negotiated with MNRF. | There would be a permanent loss of ~415 $m^2$ of fish habitat.<br>Removal of existing boat ramp would result in a net gain of 530 $m^2$ of fish habitat.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works outside of the cool/cold water fisheries window would be negotiated with MNRF. |
| | Compliance with the *Endangered Species Act* (2007) | Protection of species listed as threatened or endangered in Ontario | No killing, harming or harassing of species, or impacting the habitat of species identified as endangered or threatened | No direct loss of fish habitat or riparian areas. | The existing boat ramps and eight trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. | The existing boat ramps and eight trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. |
| | Compliance with the *Species at Risk Act* (SARA)(2002) | Protection of species listed as endangered, threatened or extirpated in Canada, and migratory birds listed under the SARA | No impact to critical habitat of endangered, threatened or extirpated aquatic species or habitat of migratory birds | No direct impact to habitat but habitat would be affected through continued exposure to contaminated fill. | There would be a permanent loss of ~400 $m^2$ of fish habitat.<br>Removal of existing boat ramps would result in a net gain of ~530 $m^2$ of fish habitat.<br>The existing boat ramps and eight trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. | There would be a permanent loss of ~400 $m^2$ of fish habitat.<br>Removal of existing boat ramps would result in a net gain of ~530 $m^2$ of fish habitat.<br>The existing boat ramps and eight trees will be removed; however, no permanent loss of forage or nesting habitat is anticipated because appropriate replanting and redevelopment. |
| | Compliance with the *Migratory Birds Convention Act* (1994) | Protection of nesting habitat of migratory birds in Canada | No clearing of trees, shrubs, meadow grasses or existing structures that would result in the destruction of nests of migratory birds during the breeding season | No clearing of trees, shrubs, meadow grasses or existing structures would be affected. | 8 trees will be removed and ~400 m² of riparian zone affected. | 8 trees will be removed and ~415 m² of riparian zone affected. |
| | Compliance with Ontario Regulation 171/06 – St. Clair Region Conservation Authority | Protection of public safety and property from natural hazards, and prevention of pollution and destruction of sensitive environmental areas such as wetlands, shorelines and watercourses | Minimize excavation, filling, site grading or development within the regulated limit | No work within the regulated limit; however, there would be continued exposure to contaminated fill. | Construction within regulated limit with ~300 m² of regulated lands affected. | Construction within regulated limit with ~320 m² of regulated lands affected. |
| | Consideration of best practices for watershed protection | Preservation of riparian zones adjacent to shorelines, minimization of shoreline erosion and sedimentation and maintenance of stormwater runoff at pre-development levels | Maintain natural drainage patterns and manage stormwater runoff | No change to natural drainage patterns, erosion or sedimentation. | ~400 m² of riparian zone affected<br>Designed to withstand erosion due to high water, wave action and ice forces.<br>Reduction in erosion and sedimentation.<br>No change to existing stormwater runoff. | ~415 m² of riparian zone affected<br>Designed to withstand erosion due to high water, wave action and ice forces.<br>Reduction in erosion and sedimentation.<br>No change to existing stormwater runoff. |

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no removal of boat ramps) | ALTERNATIVE 2 - Two Ramps | ALTERNATIVE 3 - Four Ramps |
|---|---|---|---|---|---|---|
| Social and Economic Environment | Compliance with the City of Sarnia Adopted Official Plan (2014) | Protection of lands designated as natural heritage systems (i.e., natural areas, parks, open space, natural hazards) | Protect, maintain, enhance and restore natural heritage systems where it is not feasible to direct development away from these areas | No park land or natural hazards areas would be affected but the contaminated fill would remain in place. | ~300 m² of park land / natural hazards areas affected. | ~320 m² of park land / natural hazards areas affected. |
| | | Avoidance of building / structure construction within identified one-zone floodplain policy areas | Allow construction in support of public recreation only where construction will not affect flood levels | No one-zone floodplain policy areas would be affected but there would be no recreational use of the boat ramps. | ~300 m² of the one-zone floodplain policy area affected.<br>No effect on flood levels. | ~320 m² of the one-zone floodplain policy area affected.<br>No effect on flood levels. |
| | | Consideration for public safety through protection of the St. Clair River waterfront and shoreline | Protect, maintain and enhance the waterfront through naturalization and improved stability of the shoreline | No changes to the waterfront and shoreline but there would be no recreational use of the boat ramps. | No change to shoreline stability or public safety. | No change to shoreline stability or public safety. |
| | | Provision for bicycle and pedestrian corridors and linkages within urban natural areas | Maintain or improve existing multi-use walking / bicycling corridor along Sarnia Bay shoreline at the Park | Existing multi-use corridor maintained. | A new dedicated paved multi-use pathway would be provided. | A new dedicated paved multi-use pathway would be provided. |
| | | Protection of lands designated as park and open space | Protect, maintain, enhance and improve parks and open spaces | No park land would be affected but there would be no recreational use of the boat ramps. | ~300 m² of park land affect; therefore more usable park space. | ~320 m² of park land affected; therefore less usable park space. |
| | Compliance with the City of Sarnia Adopted Official Plan (2014) (continued) | Application of high standards of urban design wherever possible | Maintain uniformity of design for elements such as benches, railings, lighting fixture, walkways and signs | Existing boat ramp elements maintained but there would be no recreational use of the boat ramps. | In absence of local jurisdiction standards and guidelines for boat ramp design, designed to the Virginia Department of Game and Inland Fisheries guidelines, and the United States National Park Service guidelines. | In absence of local jurisdiction standards and guidelines for boat ramp design, designed to the Virginia Department of Game and Inland Fisheries guidelines, and the United States National Park Service guidelines. |
| | | Consideration of the protection of urban City trees | Protect and preserve existing mature trees within the same site, or in an adjacent natural area or natural hazard lands, where possible | No trees will be removed. | Eight non-significant trees will be removed.<br>At minimum, all trees will be replaced. | Eight non-significant trees will be removed.<br>At minimum, all trees will be replaced. |
| | Compliance with the City of Sarnia Waterfront Master Plan (2005) | Enhance the opportunity for public enjoyment of the waterfront and waterfront character | Development consistent with land designations and plans of George Street to Exmouth Street and West of Harbour Road waterfront areas | Consistent with George Street to Exmouth Street plans to retain in place but there would be no recreational use of the boat ramps. | Boat ramps replaced at alternate location despite George Street to Exmouth Street plans to retain in place.<br>~10.5 m width ramps accommodate more pleasure craft sizes. | Boat ramps replaced at alternate location with additional ramps despite George Street to Exmouth Street plans to retain in place.<br>~4.9 m width ramps accommodate less pleasure craft sizes. |
| | | Protection of continuous public walkway at or near water edge | Maintain or improve continuous walkway | Existing multi-use corridor maintained. | A new dedicated paved multi-use pathway would be provided. | A new dedicated paved multi-use pathway would be provided. |
| | Consideration of Public concerns identified for the project | Consideration of power sources for recreational uses, such as the Celebration of Lights | Maintain or improve adequate power source for recreational uses | No power sources at existing boat ramps. | No power sources would be provided. | No power sources would be provided. |

| Category | Regulatory / Policy / Design Requirement | General Objectives | Project-specific Target | ALTERNATIVE 1<br>**Do nothing**<br>(no soil cap; no removal of boat ramps) | ALTERNATIVE 2 - Two Ramps | ALTERNATIVE 3 - Four Ramps |
|---|---|---|---|---|---|---|
| Technical | Consideration of construction duration and timing | Efficient duration of construction that is protective of the natural heritage environment | Limit and reduce construction duration and timing within wildlife protection windows, as applicable | No construction would occur. | 2 month construction period planned.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works required outside of the cold water fisheries window will be negotiated with MNRF. | 2 month construction period planned.<br>A portion of the construction period is planned during the general permissible cool/cold water fisheries window where in water work is permitted between June 15 and September 15 only. Any works required outside of the cold water fisheries window will be negotiated with MNRF. |
| | Consideration for the protection of public safety | Safe separation of pedestrians from shoreline | Improve and protect public safety through provision for buffer between sidewalks and shoreline | Pedestrian access to shoreline maintained. | Pedestrian access to shoreline maintained. | Pedestrian access to shoreline maintained. |
| | Consideration of durability and life expectancy | Long-term solution to shoreline protection | Design that has long life expectancy and can withstand environmental factors | No improvements to existing boat ramps; therefore, shorter life expectancy. | Designed to withstand damage due to wave action and ice forces. | Designed to withstand damage due to wave action and ice forces. |
| | Consideration for flooding potential | Consideration of public safety against flood potential appropriate for an urban park environment (i.e., 10-year return period) | Provision of a feasible design that considers protection of the public against flood events having a return period of 10 years taking into account water levels, waves and wave run up | Shoreline would continue to be flooded (overtopped) during extreme events, including the 1:100 year flood. | Boat ramps would be submerged during floods. | Boat ramps would be submerged during floods. |
| | Consideration of coastal hydraulics and compliance with appropriate technical guidelines for shoreline protection in an urban park environment | Feasible design that can be implemented, given expected water level and wave conditions | Provision of a feasible design that considers the historic range of water levels in Sarnia Bay, including significant wave height and wave run up | Shoreline would continue to be exposed to flooding and significant wave action. | Designed to withstand erosion due to high water, wave action and ice forces.<br>Reduction in erosion and sedimentation.<br>No change to existing flooding. | Design to withstand erosion due to high water, wave action and ice forces.<br>Reduction in erosion and sedimentation.<br>No change to existing flooding. |