IMPERIAL ROAD PORT BRUCE BRIDGE REPLACEMENT

ENVIRONMENTAL ASSESSMENT (SCHEDULE B) PROJECT FILE

IMPERIAL ROAD AT CATFISH CREEK

SEPTEMBER 2019

KSAL File No. 18-283

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1. Municipal Class Environmental Assessment Process

1.1 Background

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1.1 Background

The Ontario Environmental Assessment Act (EA Act) is to provide for "*the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management in Ontario of the environment*" (Ontario Environmental Assessment Act, R.S.O 1990 Part I-Section 2). The EA Act further defines the "environment" as:

a) air, land or water;
b) plant and animal life, including human life;
c) the social, economic and cultural conditions that influence the life of humans or a community;
d) any building, structure, machine or other device or thing made by humans;
e) any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities;
f) any part of combination of the foregoing and the interrelationships between any two or more of them

In applying the requirements of the EA Act to an undertaking (i.e. a project such as a road, bridge, etc.), the EA Act identifies two types of environmental assessment planning and approval processes:

- Individual Environmental Assessments
  Projects for which a Terms of Reference and an individual environmental assessment is carried out and submitted to the Minister of the Environment for review and approval

- Class Environmental Assessments
  Projects which are approved subject to compliance with an approved class environmental assessment process with respect to a class of undertakings. Provided the approved process is followed, a proponent has complied with the EA Act.

The Municipal Engineers Association (MEA) has produced a document titled "Municipal Class Environmental Assessment" (MCEA Manual) which defines a five phase planning procedure that Municipalities (such as the County of Elgin) can use to plan, design, construct, operate, maintain, rehabilitate and retire the majority of infrastructure projects. The idea is to eliminate the need to seek individual approvals under the EA Act for each and every project a Municipality may undertake. The five phase planning procedure is as follows:

- Phase 1 - Identify the problem or opportunity

- Phase 2 - Identify, assess, and evaluate alternative solutions

- Phase 3 - Identify and evaluate alternative design concepts for the preferred solution

- Phase 4 - Prepare an Environmental Study Report

- Phase 5 - Implementation

As projects typically undertaken by municipalities vary in their environmental impact, the following types or schedules of projects have been defined. These schedules are as follows:

- Schedule A
  - May follow through to implementation without following the full Class EA planning process.
  - Activities include normal or emergency operational maintenance activities with minimal environmental impacts.

- Schedule A$^+$
  - The project is considered approved and only requires the public to be advised prior to project implementation.
  - Agency consultation may still be required.

- Schedule B
  - In general it includes improvements and minor expansions to existing facilities.
  - There is potential for some adverse environmental impacts.
  - The proponent is required to proceed through a screening process including public and agency consultation.

- Schedule C
  - Generally includes major expansions to existing facilities and construction of new facilities.
  - These projects proceed through the full Municipal Class EA planning process.

Consultation is a major component of the EA process. Communication between the proponent and affected/interested stakeholders provides opportunities for the exchange of information and to allow those affected to influence decisions being made. As per Municipal Class Environmental Assessment, stakeholders include the general public, review agencies, other municipalities as well as First Nations and Indigenous Peoples. The timing and quantity of consultation is also important. The following dictates the minimum level of consultation and with whom for Schedule A, A$^+$, B and C projects:

- Schedule A
  - No contact with the public, review agencies, other municipalities, First Nations and Aboriginal Peoples required.

- Schedule A$^+$
  - Formal advisory contact with the public required.
  -
- Schedule B
  - Two points of contact with the public, review agencies, other municipalities, First Nations and Indigenous Peoples required.

- Schedule C
  - Three points of contact with the public, review agencies, other municipalities, First Nations and Indigenous Peoples required.

1.2 Category and Process of this Environmental Assessment

Reference is made to MCEA Manual, specifically Appendix 1 – Project Schedules – General Operation and Maintenance of Linear Paved Facilities and Related Facilities – Project Description 24, which defines a project consisting of "Reconstruction of a water crossing where the reconstructed facility will be for the same purpose, capacity, and at the same location. (Capacity refers to either hydraulic or road capacity). This includes ferry docks." as a Schedule A^+ project with no limit on the project cost.

Given that Imperial Road Port Bruce Bridge at Catfish Creek will, for all intents and purposes, be replaced in the same location, be of similar size, and be similar in width to the existing structure, then this project could be completed as a Schedule A^+ activity.

However, given the scope of this project, it was decided to proceed with a Schedule B which has increased points of contact compared to a Schedule A^+. Therefore, this project will be completed as a **Schedule B** project.

As such, the following process will be used to satisfy the requirements of the EA Act.

- Phase 1
  - Identify the problem or opportunity
  - 1st point of mandatory public and agency consultation (Notice of Study Commencement)

- Phase 2
  - Identify possible alternative solutions
  - Evaluate alternatives and select a preferred alternative
  - 2nd point of public and agency consultation (Public Information Centre)
  - Complete preliminary design
  - Complete Project File Report
  - 3rd point of public and agency consultation (Notice of Study Completion)

- Phase 3
  - Not applicable for Schedule B projects

- Phase 4
  - Not applicable for Schedule B projects

- Phase 5
  - Complete detailed design (drawings, specifications and tender documents)
  - Proceed to construction and operation

2. Problem Statement / Opportunity

2.1 Problem Definition

2.1 Problem Definition

Port Bruce Bridge was a structure that spanned Catfish Creek on Imperial Road (also known as Elgin County Road 73), between Rush Creek Line and Dexter Line, in the village of Port Bruce, Ontario. The pre-existing structure was a three-span concrete structure constructed in 1964. On February 23, 2018, the structure collapsed as a truck traversed the structure. Reasons for the collapse are outside of the scope of this Report.

The existing bridge has since been removed entirely except for the south abutment, pier footings, and deep foundations. A temporary bridge has been constructed downstream of the existing bridge until a new permanent structure is built on Imperial Road.

The County of Elgin is studying available options to replace the Port Bruce Bridge.

3. Existing Conditions

3.1 Socio-Economic Environment

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3.1 Socio-Economic Environment

3.1.1 Socio-Economic Conditions

The general study area is within the village of Port Bruce in the Township of Malahide in the County of Elgin. The immediate study area is comprised of multiple residential properties, small businesses, marinas, seasonal recreational mobile parks, and Lake Erie. Port Bruce Provincial Park is located approximately 700m to the south of the bridge. Prior to the installation of a temporary bridge downstream of the pre-existing bridge, this crossing was the only way across Catfish Creek within the general study area.

The Township of Malahide is a rural municipality in southwestern Ontario. The primary economic activity in the Township is agriculture. According to Statistics Canada, the 2016 census indicated a Township population of 9,292 people in a land area of 395.05 square kilometres, which is a population density of 23.5 persons per square kilometer. Port Bruce is a small village within this geographical township. The median age in the Township of Malahide was 35.6.

Adjacent and upstream of the crossing are locally and provincially significant woodlands, hazard lands, a designated Area of Natural and Scientific Interest (ANSI) and a Provincially Significant Wetland (PSW) complex. Catfish Creek empties into Lake Erie downstream of this crossing.

Imperial Road (Elgin County Road 73) is classified as a minor arterial road comprised predominantly of a rural cross-section. This roadway connects areas south and west of Catfish Creek to areas north and east of Catfish Creek. This roadway also serves as the main link between the local area and the Town of Aylmer; approximately the closest major centre. Emergency services for the village of Port Bruce access the village from the northeast, and require a direct route with no restrictions to the southwest portion of the village. Re-establishing the crossing will give local residents, farmers, school buses, emergency services, and businesses a direct access with no restrictions, across the waterway.

3.1.2 Adjacent Landowners

Given that the study area is within a residential village, properties that abut Imperial Road, Rush Creek Line, and Dexter Line within the limits of the construction could be impacted by the project. Potential impacts to these properties could possibly include property acquisition, removal of existing vegetation, trees, and shrubs, alterations to grading, and reconstruction of driveways. Short term impacts may include additional noise and dust as a result of construction, however these impacts will be mitigated as best as possible during construction and should resolve shortly after the construction is complete.

3.1.3 Vehicular Traffic

As previously mentioned, prior to the installation of a temporary bridge downstream, the Port Bruce Bridge was the only way across Catfish Creek within the study area. Without this crossing, the only way to access the majority of this village is via County Road 24 (Dexter Line) from the west.

Currently, vehicular traffic is traversing Catfish Creek at a temporary bridge located approximately 150m downstream of the Port Bruce Bridge, however this bridge is a one lane structure controlled by traffic lights. Most motorists endure some delay while waiting for their turn to cross the bridge.

A permanent new bridge would eliminate wait times and re-establish the Imperial Road crossing.

3.1.4 Waterway Traffic

Catfish Creek is used for recreational boating by small motorized vessels and paddled watercraft. It is unlikely that large vessels navigate Catfish Creek due to the anticipated shallow depth of water. There are numerous private docks upstream and downstream of this crossing. There are also marinas downstream of this crossing.

A new bridge should provide a vertical navigational clearance at least equivalent to the old bridge.

In addition, adequate signage should be installed upstream and downstream of the new crossing to warn boaters of the construction. Furthermore, the construction needs to be staged such that there are minimal obstacles placed near or in the water which might hinder movement of waterway traffic. Any such obstacles need to be marked with navigational signage.

3.1.5 First Nations/Indigenous Peoples

Munsee-Delaware Nation Indian Reserve No. 1, Oneida Indian Reserve No. 41, and Chippewas of the Thames First Nation Indian Reserve No. 42 are all located approximately 39 kilometers northwest of the bridge site. Notices of this project were submitted to the aforementioned groups. In addition, Aamjiwnaang First Nation, Caldwell First Nation, Delaware Nation at Moraviantown, Haudenosaunee Confederacy, Kettle and Stoney Point First Nation, Mississaugas of the Credit First Nation, Six Nations of the Grand First Nation, and Walpole Island First Nation were contacted as well to determine if they have any interest in this project.

The notices were also submitted to the Ontario Ministry of Indigenous Affairs, Indigenous and Northern Affairs Canada, and the Metis Consultation Unit of the Metis Nation of Ontario.

Chippewas of the Thames First Nation (COTTFN) have identified that the project is located within the Mckee Treaty Area (1790) to which COTTFN is a signatory, it is also located within the Big Bear Creek Additions to Reserve (ATR) land selection area, and in COTTFN's Traditional Territory.

3.2 Official Plans and Policies

3.2.1 Township of Malahide Official Plan

Reference is made to the Township of Malahide's Official Plan (Malahide Plan). The following is noted:

- Purpose of the plan is to provide policy direction related to land use, development, and redevelopment in the Township;
- The Township of Malahide is agricultural in character and the goal is to keep it this way;
- There is a provincially significant ANSI (Catfish Creek Till Earth ANSI) located north and west of the village of Port Bruce;
- There is a regionally significant ANSI (Catfish Creek Slope and Floodplain Life ANSI) which includes approximately 170 hectares of Carolinian forest on the rim, slope, and floodplain of Catfish Creek;
- There is no inventory of cultural heritage resources provided within the Malahide Plan;
- The Malahide Plan does identify that there may be marine archaeological potential within the Township and may request a study to confirm the presence of said should it be prudent to do so;
- Land use within the village of Port Bruce is controlled and shall be in accordance with the Malahide Plan;
- The village of Port Bruce is identified as a recreational settlement area;
- The Malahide Plan encourages the concentration of seasonal residential developments and associated recreational land use in Port Bruce, but discourages the evolution of a continuous ribbon of residential development along the lake front;
- All development in Port Bruce must be in accordance with the Provincial Flood Plain Criteria;
- The village of Port Bruce contains hazard lands which may be subject to flooding, erosion, slopes, wave uprush, unstable slopes/bluffs, dynamic beach hazards, or the presence of wetlands;
- The existing road network within the Township is satisfactory and no significant improvements, besides those arising from normal maintenance and improvements, are expected or considered necessary;
- Where improvements are necessary, consideration should be given to the impact of said improvements on natural heritage areas, significant build heritage resources, and cultural heritage landscapes on the character of streetscapes and major crossroads or intersections;
- The Malahide Plan encourages the development of sidewalks for pedestrian movement within its settlement areas;
- The Malahide Plan also encourages the development of trails on public lands aimed at promoting public health through outdoor activities;
- The village of Port Bruce is serviced by piped potable water and private septic;
- The entire area of Port Bruce is designated as a community improvement area during the 2009 to 2029 planning period;
- These improvements include stabilizing, preserving, and improving existing and viable residential, recreational, and commercial areas;
- Specifically, parking and pedestrian facilities are to be improved, existing recreation-commercial and institutional developments are to be rehabilitated, the overall

attractiveness of the recreation and recreation-commercial areas in terms of aesthetics and public amenities are to be improved, the economic base and the range of services and shopping opportunities are to be diversified and expanded, the potential for damage to both private and public properties as a result of periodic flooding is to be minimized, as well as the overall area of natural heritage features achieved by the use of local or native plantings is to be increased;
- The Malahide Plan shall be implemented through the activities of both the private and public sector.

3.2.2 County of Elgin Official Plan

Reference is made to the County of Elgin Official Plan (Elgin Plan). The following is noted:

- Purpose of the plan is to provide direction and a policy framework for managing growth and land use decisions over the planning period to 2031;
- The community vision is based on the geography of the County and how people live, work, and travel within the County;
- Catfish Creek is a defining component of the County's geography;
- Where Catfish Creek joins Lake Erie, Ports have formed (i.e. Port Bruce) which attract tourism and recreational living to Elgin County;
- There is an expectation that about 80% of the expected population and employment growth in the County to 2031 will occur in the central and eastern parts of Elgin County which includes Port Bruce.
- Defined goals include directing development to urban areas, protecting and enhancing the character of existing settlement areas, ensuring the protection and enhancement of tourism and recreation opportunities in the ports throughout the County, to build and maintain a reliable transportation network, to protect and enhance significant heritage features and areas, and to direct development away from natural and man-made hazardous areas;
- Strategic objectives are used to implement the goals identified above. The objectives include planning and design, natural systems, economic prosperity, and infrastructure;
- The economic strategy identifies tourism as important to the local economy;
- Port Bruce is identified as a Tier 2 settlement area;
- Tier 2 settlement areas are partially serviced with respect to municipal water and sewage services;
- Agriculture is identified as the most prevalent land use within Elgin County;
- Provincially Significant Wetlands are identified as a land use within Elgin County;
- Wayside pits and quarries which include portable asphalt plants and portable concrete plants are permitted in all areas except where such a use is not permitted under Provincial regulations and guidelines;
- The Elgin Plan states that provincially significant wetlands, woodlands, Areas of Natural and Scientific Interest (ANSI), and significant wildlife habitat are very important to the natural heritage system of Elgin County;
- Mapping provided in the Elgin Plan shows an ANSI and woodlands all around the project site;
- The Elgin Plan does not identify any specific cultural or heritage resources, but rather encourages the local municipalities to promote and support these resources;
- Archaeological resources are likely present in the County and studies should be completed to confirm their presence prior to development or redevelopment;

- Public service facilities and infrastructure are permitted in all land use designations subject to any regulatory requirements;
- Sanitary sewers and water is not funded by the County, but should be developed by the local municipalities;
- Transportation objectives include facilitating safe and efficient movement of people and goods, establishing an integrated transportation system that safely and efficiently accommodates various modes of transportation, promotes cycling and walking as affordable and accessible forms of travel, protects transportation corridors, ensures adequate right-of-way widths are provided, encourages the use of alternative development standards where appropriate, and restricts development on private roads;
- Pedestrian and cycling facilities should be considered and provided in settlement areas;
- Imperial Road and Dexter Line are considered Minor Arterial County Roads;
- The County of Elgin Roads Plan and Polices Document (2009) should be consulted for design standards.

3.2.3 Elgin-St. Thomas Cycling Master Plan

Reference is made to the Elgin-St. Thomas Cycling Master Plan (Cycling Plan). The following is noted:

- Imperial Road along with Dexter Line are identified and accommodate on-street cycling;
- Paved shoulders are provided on these aforementioned roads to accommodate cycling;
- Signed bicycle routes with paved shoulders should typically have shoulders between 1.5 and 2.0 metres in width depending on the volume, speed, and mix of vehicular traffic;
- Signing should be a mixture of pavement markings, regulatory signs, and warning signs.

3.3 Source Water Protection

The Catfish Creek Conservation Authority (CCCA) Source Protection Plan along with an online policy mapping tool (https://maps.grandriver.ca/swp-policymapping/) was reviewed to determine whether this project is located in a vulnerable area and whether any project activities are a prescribed drinking water threat. The following is noted:

- Port Bruce is not located within a vulnerable area;
- Reconstruction of a bridge is not an activity identified as a “prescribed drinking water threat”;
- Some aspects of the work, such as refueling of equipment and dewatering, are activities identified as a “prescribed drinking water threat”, however any potential threats can be easily mitigated using best management practices described elsewhere in this Report.

3.4 Cultural and Heritage Environment

In keeping with the EA process, the Municipal Heritage Bridges Cultural, Heritage and Archaeological Resources Assessment Checklist has been completed and can be found in Section 6 of this Report.

In addition, a checklist for evaluating potential for built heritage resources and cultural heritage landscapes has been completed and can be found in Section 6 of this Report.

As a result of completing both of these checklists, a Cultural Heritage Evaluation Report (CHER), and a Heritage Impact Assessment (HIA) are not required since there is low potential for built heritage or cultural heritage landscapes near the project site. There is, however, a requirement to complete an Archaeological Assessment.

There are four stages associated with an archaeological assessment:

- Stage 1 – Background Study and Property Inspection
- Stage 2 – Property Assessment
- Stage 3 – Site Specific Assessment
- Stage 4 – Mitigation of Development Impacts
    - Long term avoidance and protection
    - Excavation

An Archaeological Assessment (AA) was conducted by Detritus Consulting Limited and a Stage 1-2 Report and a Stage 3 Report have been completed thus far and can be found in Section 7 of this Project File. The summary and recommendations found in these reports are generally as follows:

- Stage 1 background research indicated that the level ground portion of the manicured and overgrown grass components of the Study Area exhibited moderate to high potential for the identification and recovery of archaeological resources and were recommended for Stage 2 archaeological assessment
- Stage 2 assessment resulted in the identification and documentation of five (5) archaeological sites which require Stage 3 assessment
- Stage 3 assessment resulted in 4 of the 5 aforementioned sites being recommended for Stage 4 mitigation

Stage 4 mitigation by avoidance and protection is a viable option of the preferred alternative. In order to meet the standards for avoidance, temporary fencing will be installed around the archaeological sites and their protective buffers during construction, and any ground disturbance activities within this vicinity will be monitored by a licensed archaeological consultant in order to prevent any impacts to the sites. The location of the archaeological sites and the temporary fencing will be marked on the contract drawings and will include explicit instructions to avoid these areas.

For more detailed information please refer to the complete reports included herein.

3.5 Natural Environment

As part of this EA Study, an Environmental Screening Study was completed by Environmental Liability Management (ELM) and can be found in Section 9 of this Report. The summary and recommendations found in this report are generally as follows:

- Approximately 11 Species at Risk (SAR) are potentially present within 1000m of the project site as determined by ELM;
- Catfish Creek Conservation Authority have identified approximately 28 species of fish reside in Catfish Creek year round or migrate from Lake Erie to spawn in Catfish Creek;
- MNRF/MECP have identified 4 SAR present at the project site which are included within the 11 determined by ELM;
- In-water work cannot be completed between March 15 and July 15;
- Sheet pile cofferdams should be installed within Catfish Creek to isolate construction of the piers from the watercourse;
- Said cofferdams should be installed PRIOR to March 15 and removed AFTER August 15;
- Keep all construction well away from the shoreline in an effort to avoid disturbance of in-water channel features and shoreline areas which could be used by various SAR;
- Isolate the construction working area by placing erosion control fencing at the limits of construction;
- This same erosion control fencing will prevent wildlife including SAR from entering the construction area and prevent sediment from entering Catfish Creek;
- Limit removals of large diameter trees where possible;
- If large diameter trees are to be removed, do so AFTER the bat hibernation period and PRIOR to the migratory bird nesting period;
- Re-seed and re-vegetate all disturbed soils as soon as feasible.

For more detailed information please refer to the complete report included herein.

3.6 Technical Environment

3.6.1 Utilities

Based on locates obtained, the following utilities have been identified as being present in the study area:

- Buried watermains exist on Dexter Line and Rush Creek Line;
- Buried gas lines are present on Imperial Road, Dexter Line, and Rush Creek Line;
- Hydro is overhead throughout the study area;
- Telephone is mostly overhead in the study area;
- There are no cable television services within the study area.

Since reconstruction of a bridge generally results in changes to the horizontal and vertical alignment of the adjacent roadways, some utility relocation will likely be required. In addition, the nature of heavy construction also sometimes necessitates temporary or permanent relocations of some utilities. Correspondence with all utility companies should be commenced as soon as possible to ensure relocations or upgrades are scheduled and completed prior to construction of the new bridge.

3.6.2 Structural

Original drawings of the pre-existing structure are available and have been reviewed. The following is noted:

- The pre-existing structure was a 3 span concrete structure constructed in approximately 1964;
- The outside spans extended beyond the piers to support a drop-in central span;
- Structure was designed for H20 loading (approximately 20 tons spread over 2 axles) which was the common design load between 1953 and 1978;
- Abutments are founded on spread footings while the piers are founded on piles;
- The railing system was painted steel;
- Sidewalks were provided on both sides of the bridge;
- Two (2) lanes complete with shoulders were provided across the structure;

Again, as mentioned previously, reasons why the existing structure collapsed are outside of the scope of this Report.

3.6.3 Roadway Configuration and Capacity

Based on the drawings of the pre-existing structure, data provided by the County of Elgin, and a topographic engineering survey, the following is noted:

- Imperial Road and Dexter Line can be classified as rural arterial undivided (RAU) roadways;
- Rush Creek Line will be classified as a rural local undivided (RLU) roadway;
- Posted speed limit is 50 km/hr;
- Imperial Road over the pre-existing bridge was designed as a crest vertical curve with a K factor of 21.1;
- Based on this K factor, the design speed is estimated to be 60 km/hr;
- There are horizontal curves with superelevation on Imperial Road and Dexter Line;
- The pre-existing bridge is on a straight tangent;
- The average lane width is approximately 4.0m across the existing bridge and 3.68m north of the existing bridge;
- There is mountable curb and gutter in several areas to control and direct run-off;
- Sidewalks terminated at the end of the existing bridge;
- Roadways are all paved with asphalt throughout the immediate study area;
- Run-off from the right-of-way is collected and directed to Catfish Creek via roadside ditches;
- Data provided by the County of Elgin indicates that the Average Annual Daily Traffic (AADT) is 1100.

3.6.4 Hydrology/Hydraulics

As part of this EA Study, a Hydrology Report was completed and can be found in Section 10 of this Report. The following is noted:

- Design flows for the 10yr, 25yr, 50yr, 100yr and Regional design storm are 216.7, 272.4, 314.5, 356.6, and 551.2 cubic metres per second (m^3\s) respectively;
- The pre-existing structure is adequate to pass the Regional Storm;
- Imperial Road is classified as a rural arterial road and the bridge span is greater than 6.0m, then the proposed structure should be sized to pass the 50 year design storm with at least 1.0m clearance to the soffit;
- There should not be a significant increase in the level of the Regional Storm. An increase of more than 100mm would be considered a significant increase.

3.6.5 Geotechnical

As part of this EA Study, a Geotechnical Investigation was completed and can be found in Section 11 of this Report. The summary and recommendations found in this report are generally as follows:

- There is a surficial layer of topsoil and fill overtop sandy silt followed by hard silty clay till and hard sandy clayey silt till;
- Based on the type of bridge (integral abutment), the preferred foundation type is driven piles;
- Due to the type of soils encountered at this site, it is impossible to design the piles to be “end bearing”. As such, the piles will need to be “friction type”;

- A static pile load test is recommended to confirm the axial load capacity of the piles and should be completed at least 30 days AFTER the completion of piling;
- Piles should be driven with a hammer capable of delivering energy of at least 40 kJ but not more than 60 kJ;
- Temporary steel sheet pile cofferdams will be required to isolate Catfish Creek from the necessary working area required to construct the new piers. It will likely be necessary to seal the joints between individual sheets to prevent leakage;
- The existing pier footings, which are likely still in place, will need removal along with certain existing piles to avoid conflict with the new piles;
- A relatively thick layer of clear stone will likely be required underneath the new pier footings to support the formwork and concrete;
- Preconstruction building surveys are recommended for buildings in close proximity of the new structure;

For more detailed information please refer to the complete report included herein.

4. External Consultation

4.1 List of Agencies/Communities/Groups/Organizations Contacted

4.2 Notice of Study Commencement

4.3 Notice of Public Information Centre (PIC)

4.4 Public Information Centre (PIC) Materials

4.5 Notice of Study Completion

4.1 List of Agencies/Communities/Groups/Organizations Contacted

The following list identifies the agencies, communities, groups, and organizations that were contacted throughout the various stages of the Environmental Assessment process:

- *County of Elgin
- *Township of Malahide
- Ministry of Agriculture, Food, and Rural Affairs (OMAFRA)
- *Ministry of Environment, Conservation, and Parks (MECP)
- Ministry of Indigenous Affairs
- *Ministry of Natural Resources and Forestry (MNRF)
- *Ministry of Tourism, Culture, and Sport (MTCS)
- Department of Fisheries and Oceans (DFO)
- Environment and Climate Change Canada
- Indigenous and Northern Affairs Canada
- Transport Canada
- Aamjiwnaang First Nation
- Caldwell First Nation
- *Chippewas of the Thames First Nation (COTTFN)
- Delaware Nation at Moraviantown
- Haudenosaunee Confederacy
- Kettle and Stoney Point First Nation
- Metis Nation of Ontario
- Mississaugas of the Credit First Nation
- Munsee-Delaware Nation
- Oneida Nation of the Thames
- Six Nations of the Grand First Nation
- Walpole Island First Nation
- *Catfish Creek Conservation Authority (CCCA)
- *Eastlink Communications
- Elgin Middlesex Oxford Workforce Planning & Development Board
- *EPCOR
- *Hydro One Networks Inc.
- London District Catholic School Board (LDCSB)
- Port Bruce Ratepayers Association
- Thames Valley District School Board (TVDSB)

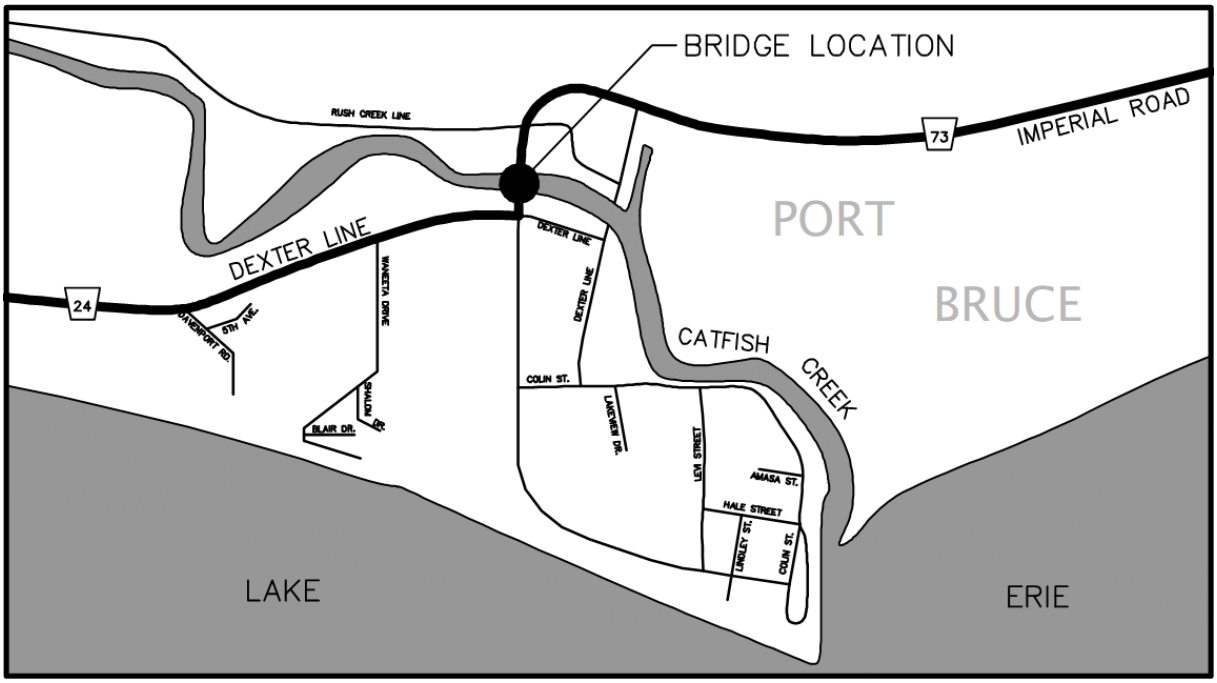
* Indicates additional correspondence occurred beyond submission of the Notice of Study Commencement. Copies of this correspondence is not included within this Report, but can be provided upon request.

4.2 Notice of Study Commencement

The following Notice of Study Commencement appeared in the Wednesday, March 6, 2019 and Wednesday, March 13, 2019 editions of the Aylmer Express. This same notice also appeared on the County of Elgin's and the Township of Malahide's webpage. Copies of this Notice were sent to those identified in Section 4.1:

CLASS ENVIRONMENTAL ASSESSMENT
IMPERIAL ROAD PORT BRUCE BRIDGE AT CATFISH CREEK
NOTICE OF STUDY COMMENCEMENT

The County of Elgin is studying available options to replace the Port Bruce Bridge.



The project is being planned as a Schedule B project under the Municipal Class Environmental Assessment process.

Public input and comments are invited and may be incorporated into the planning and design of this project. Subject to comments received and receipt of necessary approvals, the County of Elgin intends to proceed with the planning, design and construction of this project to be completed by late 2020.

If you have any questions or comments or wish to be added to the project mailing list, please contact:

Mr. Allan Garnham, P. Eng.
Project Engineer
K. Smart Associates Limited
85 McIntyre Drive
Kitchener ON N2R 1H6
Phone: 519-748-1199 ext. 246
E-mail: agarnham@ksmart.ca

or

Mr. Brian Lima, P. Eng.
Director of Engineering Services
County of Elgin
450 Sunset Drive
St. Thomas ON N5R 5V1
Phone: 519-631-1460 ext. 117
E-mail: blima@elgin.ca

Information will be collected in accordance with the *Freedom of Information* and *Protection of Privacy Act*. With the exception of personal information, all comments will become part of the public record.

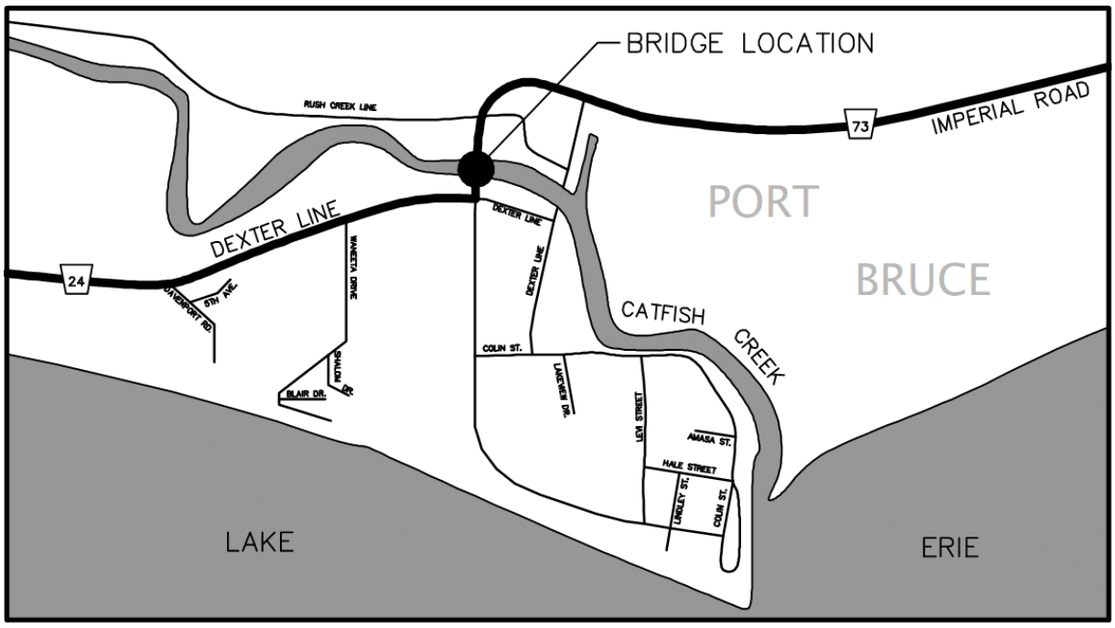
This Notice issued February 28, 2019.

4.3 Notice of Public Information Centre (PIC)

The following Notice of Public Information Centre (PIC) appeared in the Wednesday, July 3, 2019 edition of the Aylmer Express. This same notice also appeared on the County of Elgin's and the Township of Malahide's webpage:

CLASS ENVIRONMENTAL ASSESSMENT
IMPERIAL ROAD PORT BRUCE BRIDGE AT CATFISH CREEK
NOTICE OF PUBLIC INFORMATION CENTRE (PIC)

The County of Elgin is studying available options to replace the Port Bruce Bridge. As a result of work completed to date, a steel girder bridge along with reconstruction of the roadway approaches is being considered.



The project is being planned as a Schedule B project under the Municipal Class Environmental Assessment process. A Public Information Centre (PIC) is planned to provide further information to the public on the proposal and to receive input and comment from interested persons:

Public Information Centre (PIC):

Time: 5:00 – 7:00 PM
Date: Tuesday, July 16, 2019
Location: East Elgin Community Complex, 531 Talbot Street West, Aylmer

Following the Public Information Centre (PIC), further comments are invited, for incorporation into the planning and design of this project, and will be received until Friday, July 26, 2019.

For further information, please contact:

Mr. Allan Garnham, P. Eng.
Project Engineer
K. Smart Associates Limited
85 McIntyre Drive
Kitchener ON N2R 1H6
Phone: 519-748-1199 ext. 246
E-mail: agarnham@ksmart.ca

or

Mr. Brian Lima, P. Eng.
Director of Engineering Services
County of Elgin
450 Sunset Drive
St. Thomas ON N5R 5V1
Phone: 519-631-1460 ext. 117
E-mail: blima@elgin.ca

Subject to comments received as a result of this Notice, the County of Elgin intends to proceed with the detailed design of this project and a Project File will be prepared and placed on the public record for a minimum forty-five (45) day review period.

Information will be collected in accordance with the *Freedom of Information* and *Protection of Privacy Act*. With the exception of personal information, all comments will become part of the public record.

This Notice issued May 28, 2019.

4.4 Public Information Centre (PIC) Materials:

The following was presented at the Public Information Centre (PIC) held Tuesday, July 16, 2019:

PORT BRUCE BRIDGE REPLACEMENT

SCHEDULE B MUNICIPAL CLASS ENVIRONMENTAL ASSESSMENT

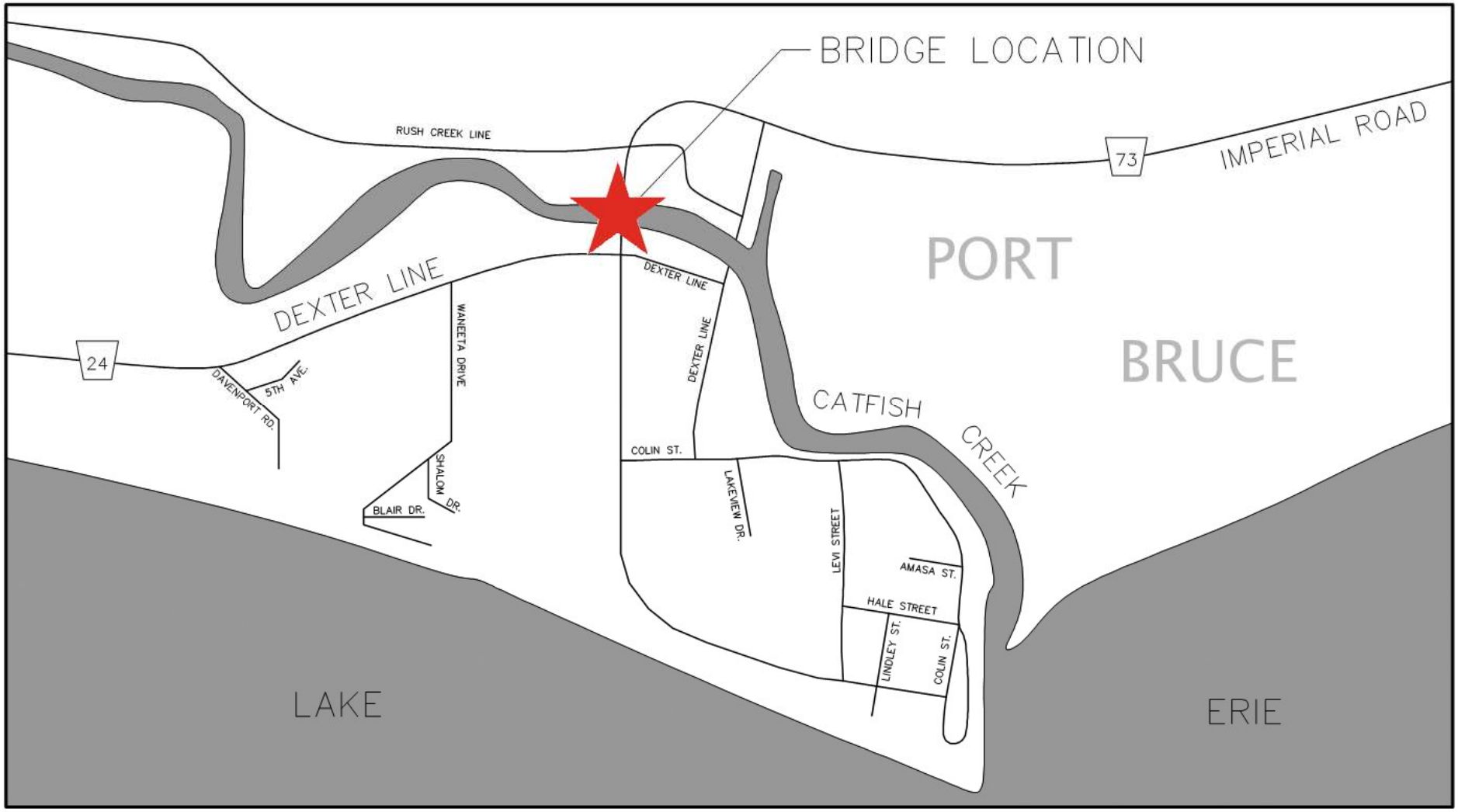
PUBLIC INFORMATION CENTRE

East Elgin Community Complex
531 Talbot Street West, Aylmer

5:00 - 7:00pm
Tuesday, July 16, 2019

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER SUDBURY

Project Location



WELCOME

Study Background

- The Port Bruce Bridge which spans Catfish Creek on Imperial Road (Elgin County Road 73) collapsed on February 23, 2018.
- The structure has been removed entirely with the exception of the south abutment, pier footings, and north abutment footing.
- A single lane modular panel bridge has been installed approximately 150m downstream to provide vehicular and pedestrian access across Catfish Creek until a new, permanent bridge is constructed.
- The study is being completed as a Schedule 'B' project, following the Municipal Class Environmental Assessment process.
- The Municipal Class EA provides a decision-making process to ensure that all relevant engineering and environmental features are considered in the planning and design of municipal infrastructure. The process requires public and agency involvement.

Municipal Class Environmental Assessment Process

Key principles of the MCEA process include:
- **Consultation with the affected parties**
- **Consideration of reasonable alternatives**
- **Identification of the effects of each alternative**
- **Evaluation of the advantages and disadvantages of each alternative**
- **Documentation of the decision-making process**

Phase 1: Identify the Problem

- Identify the current problem or deficiencies

Phase 2: Alternative Solutions

- Identify reasonable alternative solutions to the problem(s)
- Inventory natural, social and economic environments
- Evaluate the alternative solutions and identify the recommended solutions
- Consult review agencies and the public
- Select the preferred solution

We are here!

Phase 5: Implementation

- Complete contract drawings
- Proceed to design/ construction of the project
- Monitor for environmental provisions and commitments

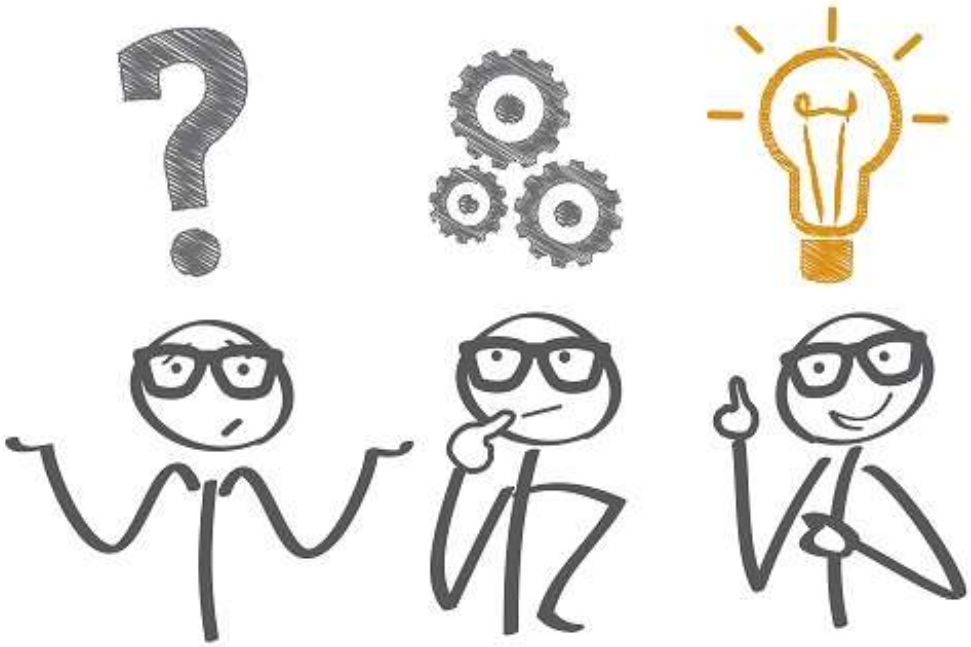
This study will follow the Schedule 'B' Class MCEA requirements

Note: Phase 3, *Alternative Design Concepts*, & Phase 4, *Environmental Study Report,* Do Not Apply to Schedule B Projects

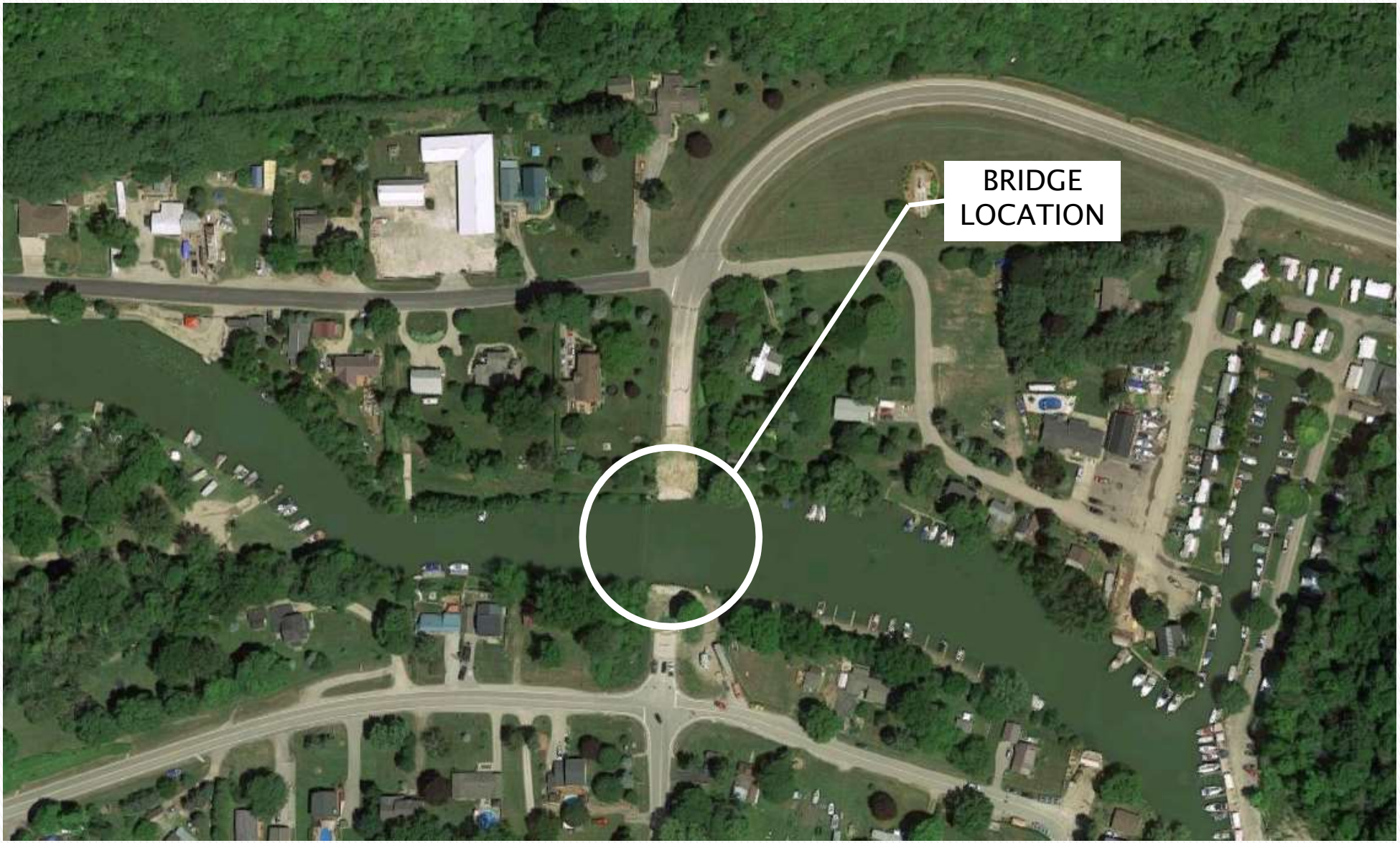
Study Objective

Problem/Opportunity Statement:

To investigate replacement alternatives of the Port Bruce Bridge to re-establish a permanent, two lane crossing of Catfish Creek.



The goal of this public information centre is to display background information, present the evaluation of considered alternatives to address the problem identified, and receive input on the preferred alternative.



https://www.google.com/maps/@42.6620659,-81.0147296,472m/data=!3m1!1e3

North Approach (looking south)

South Approach (looking north)

North Approach (looking north)

South Approach (looking south)

Far South Approach (looking north)

Looking west (upstream)

Existing South Abutment

Single Lane Modular Bridge 150m Downstream (looking east)

Evaluation of Alternatives (page 1 of 2)

Alternative 2 is chosen because it has the lowest overall score and addressess the problem statement.

Notes: Alternatives are ranked 1-4 with 1 having the least impact with 4 having the most impact except where noted.
Each row equals 10 points to ensure each criterion is weighted the same.

Criteria	Alternative 1 (Do Nothing)	Alternative 2 (Three-Span Steel Girder Bridge)	Alternative 3 (Single Span Steel Truss Bridge)	Alternative 4 (Single or Multi-Span Bailey Bridge)	Comment
Impacts to fish and fish habitat	1	3.5	2	3.5	Considers disruption to fish and potential loss of fish habitat
Impacts to vegetation and flora	1	3	3	3	Considers overall loss of vegetation 1 does not result in loss of vegetation 3 results in loss of vegetation
Impact to wildlife and wildlife habitat	2	1	3	4	1 will result in an overall improvement 4 will result in an overall loss
Changes to groundwater and surface water quantity and quality	4	2	2	2	2 can result in an overall improvement 4 will not result in an improvements
Impact on stream flow	1	3.5	2	3.5	1 has the least impact 2 has some impact 3.5 has the most impact
Potential for ice jams	1	3.5	2	3.5	1 has no potential for ice jams 2 has some potential for ice jams 3.5 has potential for ice jams
Impact to community	4	2	2	2	Considers impact to the community by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
Impact to residential areas	4	2	2	2	Considers loss of value of residential property by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
Impact to local business	4	2	2	2	Considers negative impact to local business by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
Impact to recreation	1.5	3.5	1.5	3.5	Considers potential changes to navigation
Impact to future development	4	2	2	2	Considers loss of future development by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
Need for property acquisition	1	2	3	4	1 requires no property to be purchased 4 requries the most amount of property to be purchased
Length of construction	1	4	3	2	1 is the shortest to construct 4 is the longest to construct
Improvement to traffic movment	4	2	2	2	2 will provide improvement 4 will not provide improvement
Changes to noise and vibration	3	1	2	4	1 will result in a reduction in noise and vibration 4 will result in changes to noise and vibration

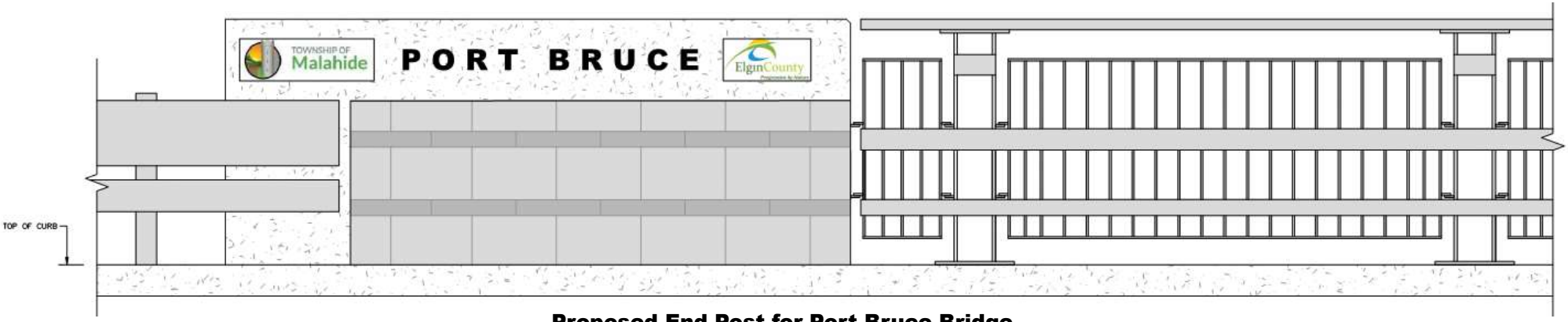
Evaluation of Alternatives (page 2 of 2)

Alternative 2 is chosen because it has the lowest overall score and addressess the problem statement.

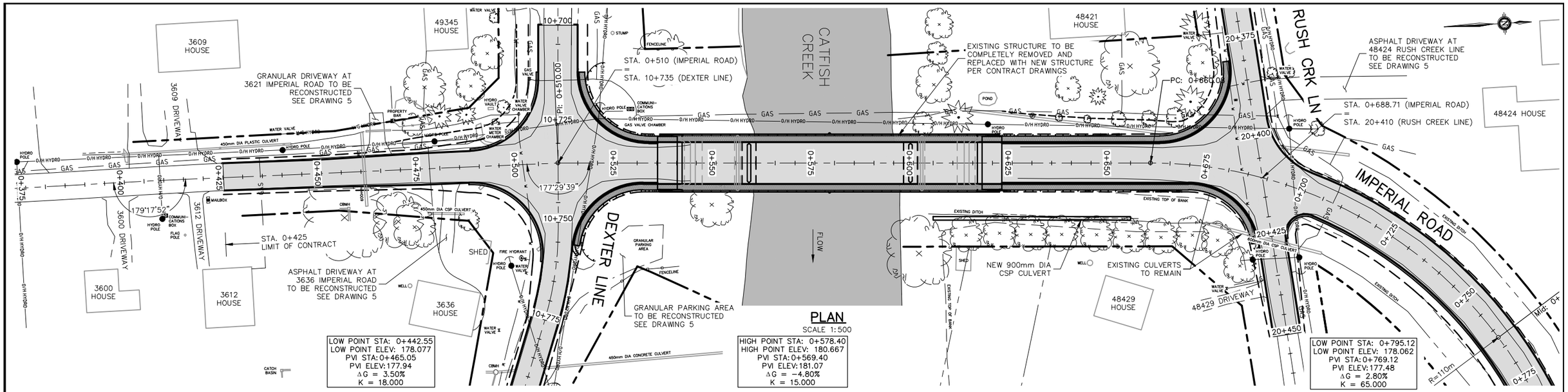
Notes: Alternatives are ranked 1-4 with 1 having the least impact with 4 having the most impact except where noted.
Each row equals 10 points to ensure each criterion is weighted the same.

Criteria	Alternative 1 (Do Nothing)	Alternative 2 (Three-Span Steel Girder Bridge)	Alternative 3 (Single Span Steel Truss Bridge)	Alternative 4 (Single or Multi-Span Bailey Bridge)	Comment
Changes to air quality	4	2	2	2	Considers positive change to air quality as a result of quicker travel times 2 if a new bridge is built 4 if no bridge is built
Access to emergency services	4	2	2	2	Considers response times 2 if a new bridge is built 4 if no bridge is built
Aesthetics	4	1	2	3	1 would restore the aesthetics of Port Bruce to a pre-collapse state 4 does not address any aesthetics
Extent the alternative addresses the problem statement	4	2	2	2	2 meets the problem statement 4 does not meet the problem statement
Height restrictions	2	2	4	2	4 if there is a height limit across the bridge 2 if not
Width restrictions	1.5	1.5	3.5	3.5	3.5 if the structure is limited in width 1.5 if there is no limit
Provision of sidewalks	4	1	2	3	Considers ease and relative cost to provide sidewalks
Provision of cycling lanes	4	1	2	3	Considers ease and relative cost to provide cycling lanes
Ability to improve hydrology/hydraulic conditions	4	2	2	2	2 allows for improvement 4 does not allow improvement
Constructability	1	3	4	2	1 is the easiest to construct 4 is the hardest to construct
Construction timeline	1	4	3	2	1 is the shortest to construct 4 is the longest to construct
Lifespan	4	1	2	3	1 is the longest period prior to reconstruction of the bridge 4 is the shortest period prior to reconstruction of the bridge
Need for ongoing maintenance	2	1	3	4	Assumes doing nothing requries no maintenance while checking transom clamps periodically results in the highest maintenance costs
Overall construction cost	1	3	4	2	1 is the lowest overall construction cost 4 is the highest overall construction cost
Maintenance costs	1	2	3	4	Assumes doing nothing requries no maintenance while checking transom clamps periodically results in the highest maintenance costs
Totals	**78**	**65.5**	**74**	**82.5**	

Proposed End Post



Proposed End Post for Port Bruce Bridge



PLAN

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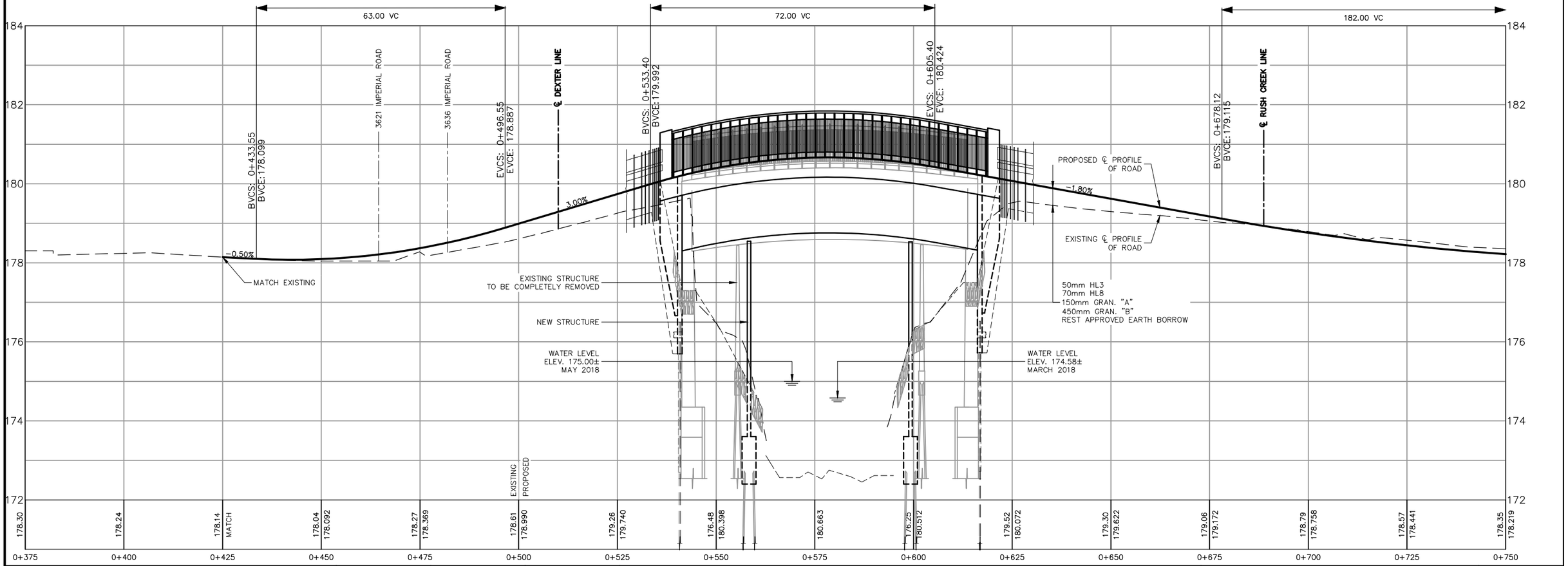

No.	REVISION	DATE
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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - IMPERIAL ROAD

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 1

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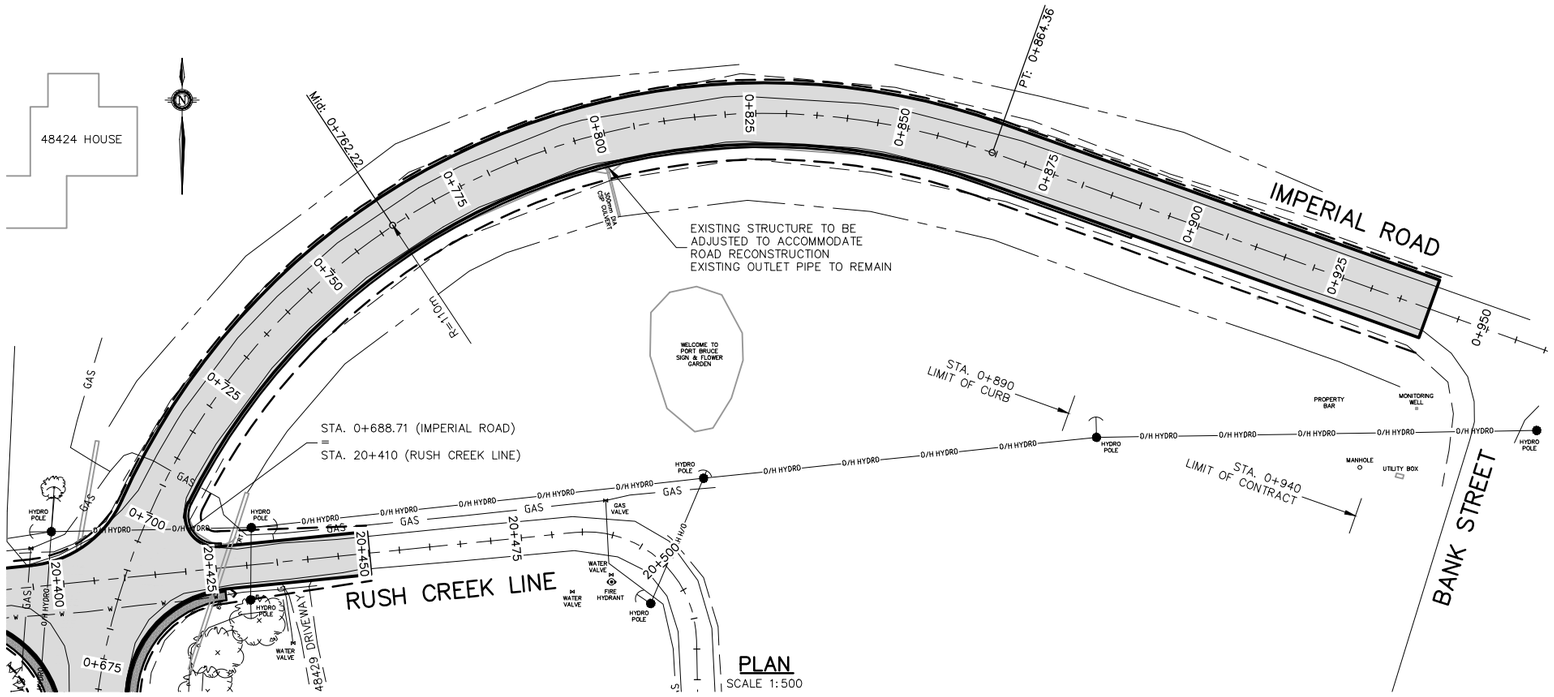
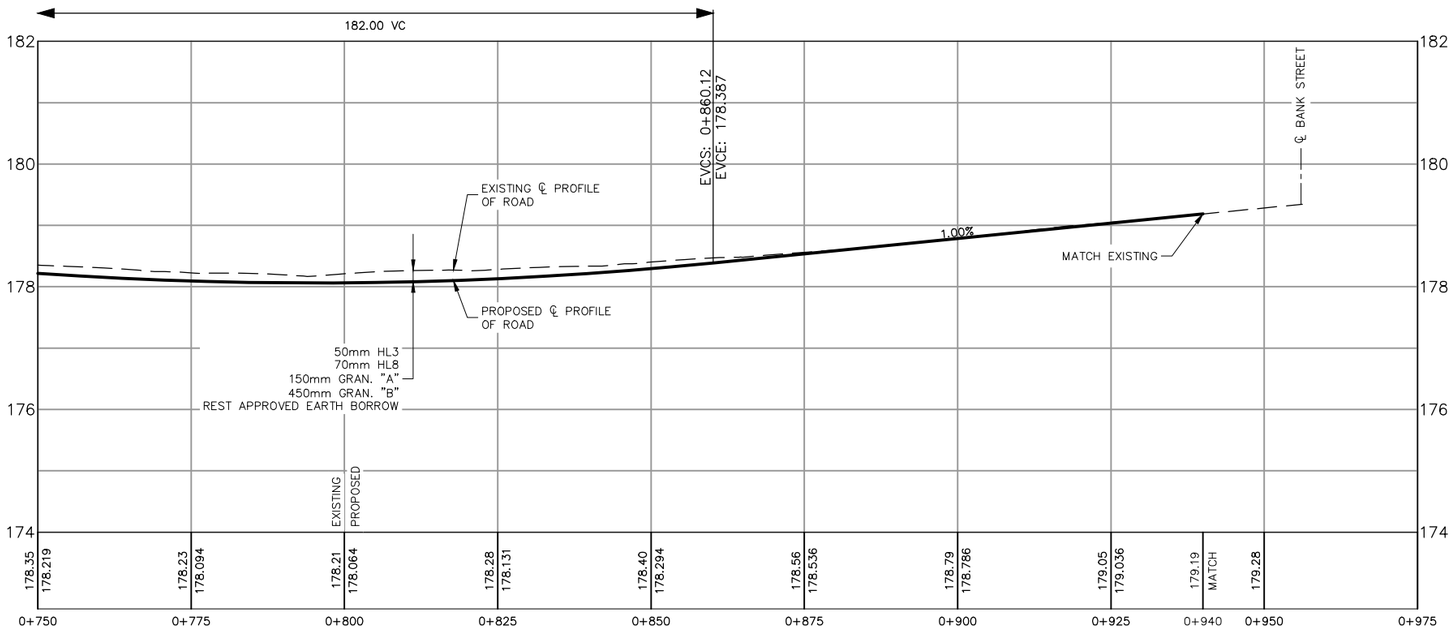


PLAN
SCALE 1:500

LOW POINT STA: 0+795.12
LOW POINT ELEV: 178.062
PVI STA: 0+769.12
PVI ELEV: 177.48
ΔG = 2.80%
K = 65.000



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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - IMPERIAL ROAD CONTINUED

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 2

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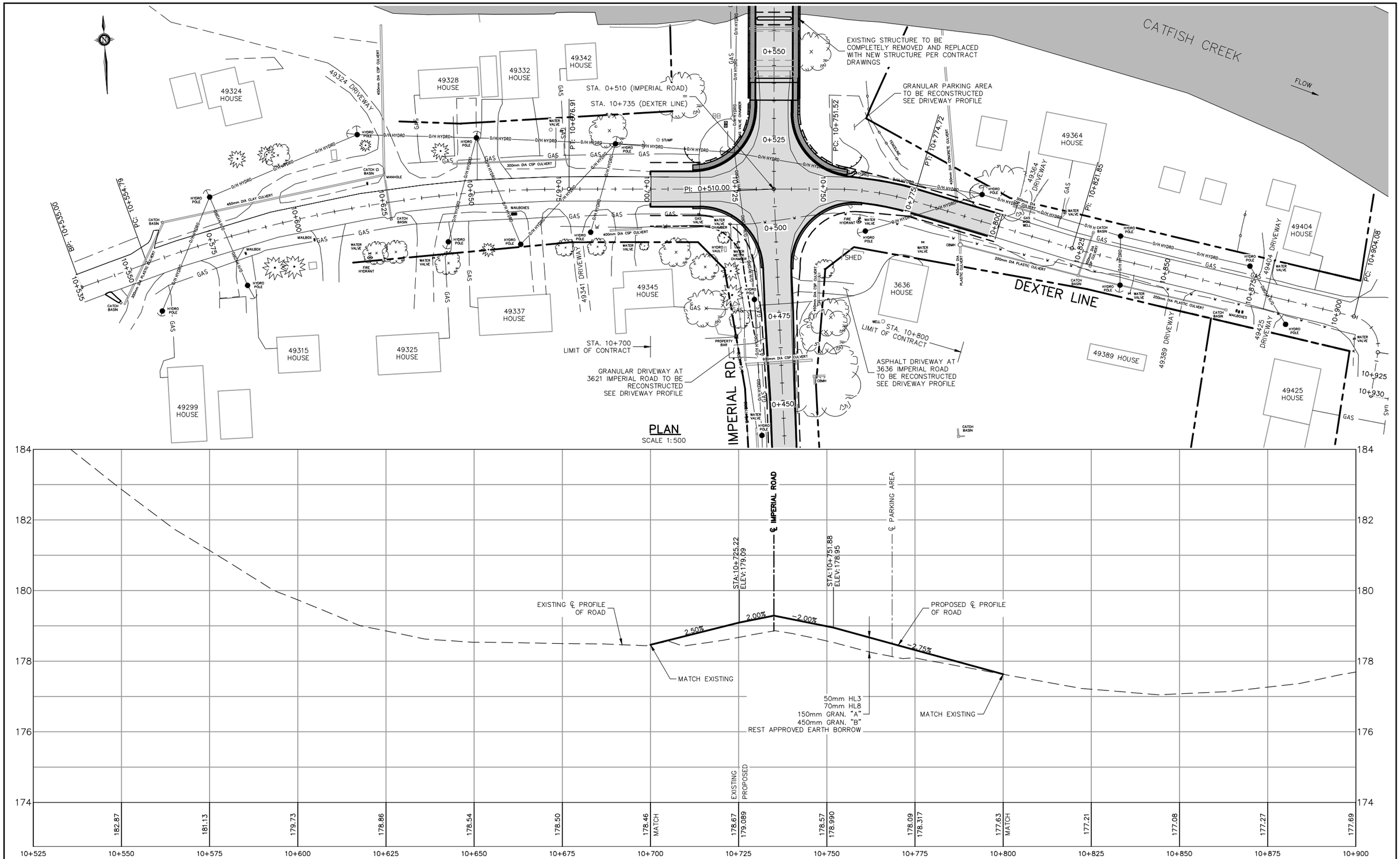

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - DEXTER LINE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 3

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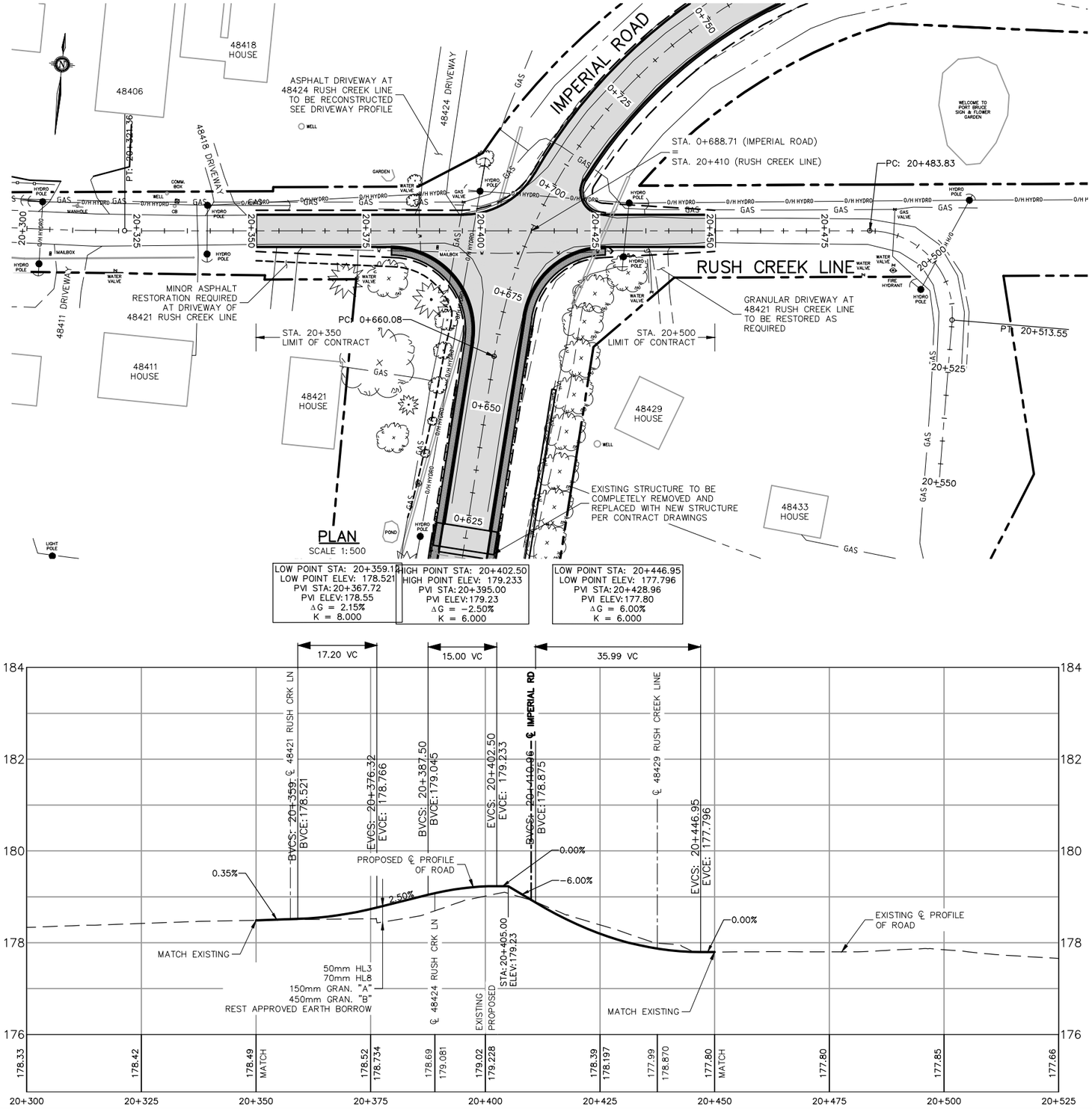

PLAN

SCALE 1:500

LOW POINT STA: 20+359.19 LOW POINT ELEV: 178.521 PVI STA: 20+367.72 PVI ELEV: 178.55 ΔG = 2.15% K = 8.000	HIGH POINT STA: 20+402.50 HIGH POINT ELEV: 179.233 PVI STA: 20+395.00 PVI ELEV: 179.23 ΔG = −2.50% K = 6.000	LOW POINT STA: 20+446.95 LOW POINT ELEV: 177.796 PVI STA: 20+428.96 PVI ELEV: 177.80 ΔG = 6.00% K = 6.000

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - RUSH CREEK LINE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 4

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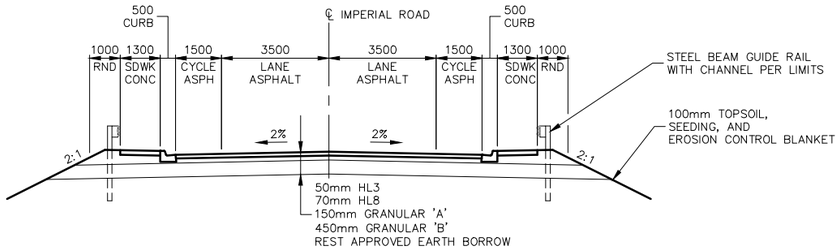
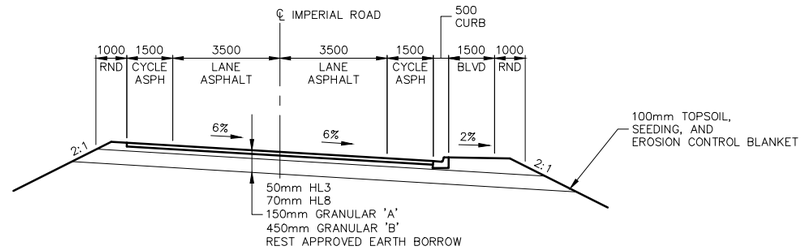


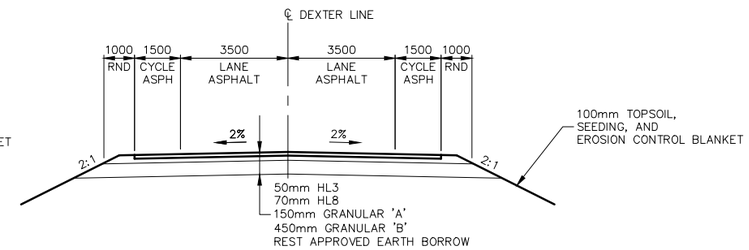
IMPERIAL ROAD
END OF BRIDGE BARRIER TO INTERSECTIONS

SCALE 1:100



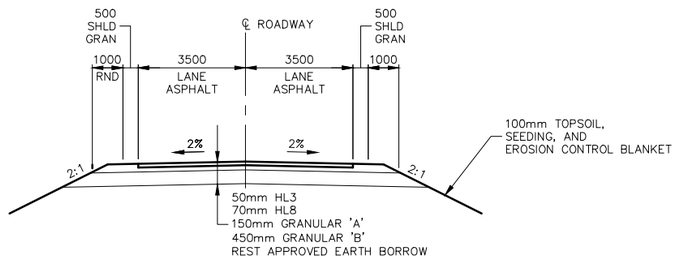
IMPERIAL ROAD
RUSH CREEK LINE TO BANK STREET
(SUPERELEVATED)

SCALE 1:100



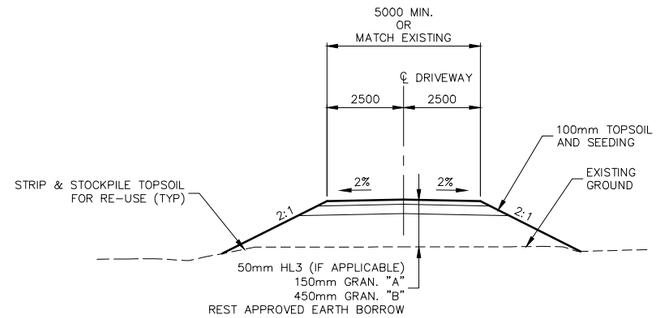
DEXTER LINE
WEST CONSTRUCTION LIMIT TO IMPERIAL ROAD

SCALE 1:100



RUSH CREEK LINE (FULL LENGTH)
IMPERIAL ROAD (SOUTH CONST. LIMIT TO DEXTER LINE)
DEXTER LINE (IMPERIAL ROAD TO EAST CONST. LIMIT)

SCALE 1:100



TYPICAL DRIVEWAY SECTION

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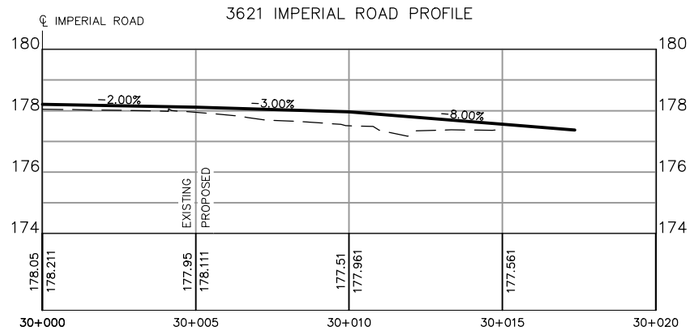

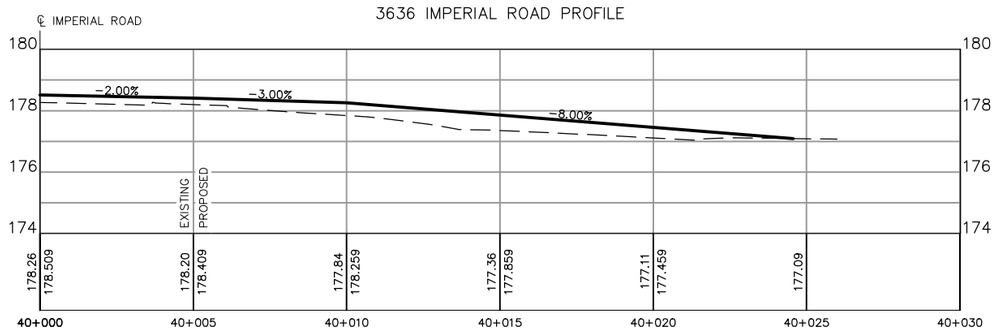

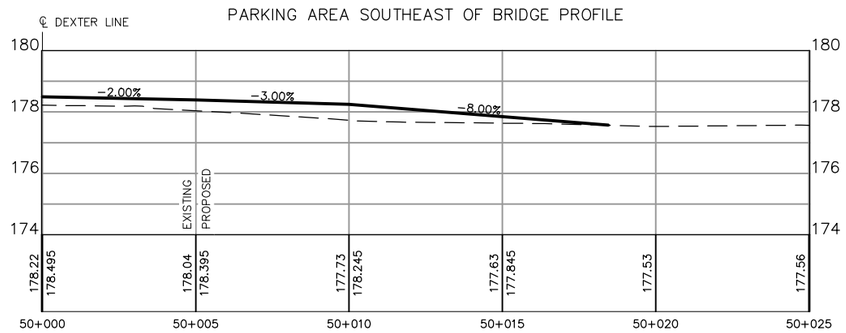

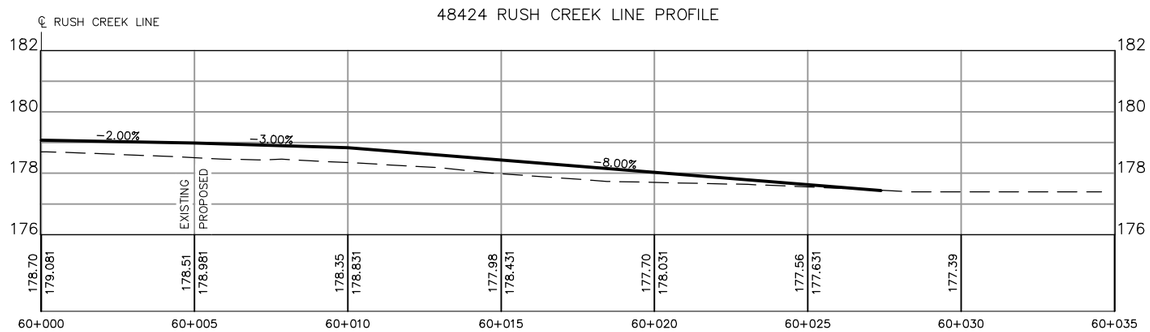

No.	REVISION	DATE
1.	ISSUED FOR PIC	JULY 16/19

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

ROADWAY CROSS SECTIONS & DRIVEWAY PROFILES

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 5

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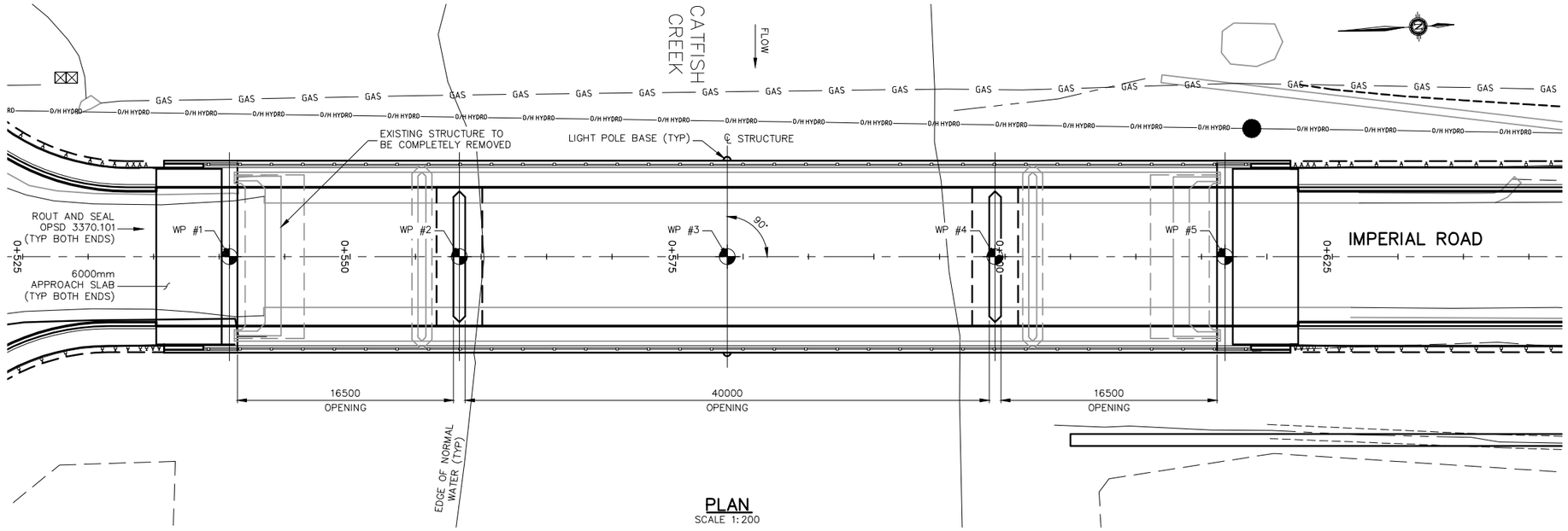
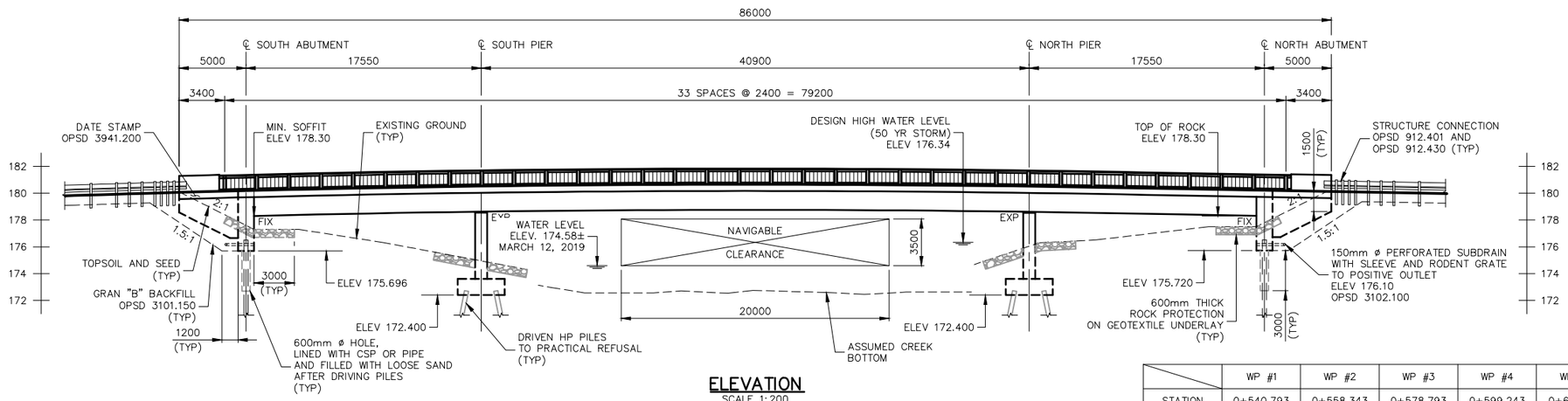


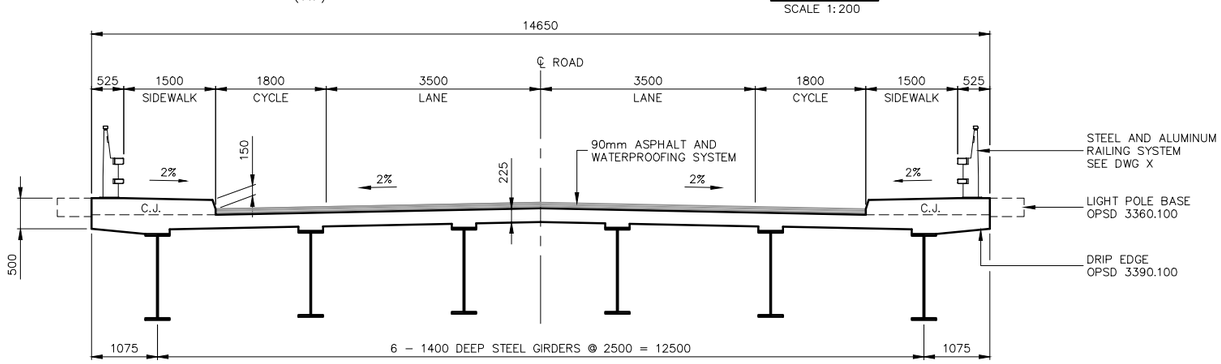
PLAN
SCALE 1:200



ELEVATION
SCALE 1:200

	WP #1	WP #2	WP #3	WP #4	WP #5
STATION	0+540.793	0+558.343	0+578.793	0+599.243	0+616.793
ELEVATION	180.196	180.533	180.667	180.523	180.219

NOTE: WORKING POINT ELEVATIONS GIVEN TO TOP OF ASPHALT



DECK CROSS SECTION
SCALE 1:50

GENERAL NOTES

1. STRUCTURE DESIGNED FOR CL–625 (ONT) LOADING PLUS 90mm ASPHALT AND WATERPROOFING SYSTEM IN ACCORDANCE WITH THE CANADIAN HIGHWAY BRIDGE DESIGN CODE 2014.
2. WORK ON THE STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE CONTRACT ADMINISTRATOR
3. STRUCTURE TO BE BUILT IN ACCORDANCE WITH THE MOST CURRENT OPS SPECIFICATIONS AND DRAWINGS AS WELL AS THE CONTRACT ADMINISTRATORS SPECIFICATIONS.
4. THE COMPLETE SOIL INVESTIGATION REPORT BY CHUNG & VANDER DOELEN ENGINEERING LTD. FORM PART OF THE CONTRACT DOCUMENTS. THE ENGINEER DOES NOT GUARANTEE THE ACCURACY OF THIS REPORT. THE CONTRACTOR SHALL REVIEW THE REPORT AND DETERMINE HIS OWN METHOD TO CONTROL GROUND WATER DURING THE CONSTRUCTION.
5. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS ON THE JOB AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK
6. CLASS OF CONCRETE:

   CAST–IN–PLACE CONCRETE 35 MPA C–1 MIX

   ALL CONCRETE SHALL INCLUDE AN APPROVED AIR ENTRAINING ADMIXTURE
7. CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25mm
BOTTOM OF ABUTMENTS	100 ± 25mm
BOTTOM OF DECK	40 ± 10mm
REMAINDER (UNLESS NOTED OTHERWISE)	70 ± 20mm

8. REINFORCING STEEL SHALL BE GRADE 400. BARS MARKED WITH A POSTFIX "S" DENOTE STAINLESS STEEL BARS. UNLESS OTHERWISE SHOWN, TENSION LENGTH LAPS NOT INDICATED ON THE CONTRACT DRAWINGS SHALL BE CLASS "B". BAR HOOKS SHALL BE MINIMUM LENGTH AND STIRRUPS SHALL HAVE MINIMUM HOOKS, UNLESS INDICATED OTHERWISE.
9. STAINLESS STEEL BARS SHALL BE TYPE 316 LN OR DUPLEX 2205 WITH A MINIMUM YIELD STRENGTH OF 500 MPA.
10. MINIMUM LAP OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH THE CHBDC (2014)
11. ALL CONCRETE SHALL BE PLACED IN THE DRY.
12. NO CONCRETE SHALL BE PLACED BEFORE MATERIALS, FORMWORK AND REINFORCING STEEL HAVE BEEN CHECKED BY THE CONTRACT ADMINISTRATOR
13. ALL EXPOSED EDGES TO BE CHAMFERED 19mm UNLESS OTHERWISE NOTED. ALL ACUTE ANGLES SHALL BE FILLETED AS NOTED.
14. CONSTRUCTION JOINTS NOT SHOWN ON THE PLANS MUST BE APPROVED BY THE CONTRACT ADMINISTRATOR.
15. BEARING SEATS SHALL BE FINISHED DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ±3mm.
16. THE BRIDGE DECK SHALL BE FINISHED USING AN APPROVED FINISHING MACHINE IN ACCORDANCE WITH OPS.MUNI 904.
17. ANY EXCAVATED OR IMPORTED MATERIAL SHALL BE STOCKPILED WELL AWAY FROM THE EDGE OF THE EXCAVATION AND AT APPROVED LOCATIONS.
18. NO BACKFILL SHALL BE PLACED UNLESS APPROVED BEFOREHAND BY THE CONTRACT ADMINISTRATOR. NATIVE MATERIAL SHALL NOT BE REMOVED FROM THE CONSTRUCTION SITE WITHOUT WRITTEN APPROVAL FROM THE CONTRACT ADMINISTRATOR.
19. ROCK PROTECTION SHALL BE 300mm NOMINAL SIZE WITH 50% LARGER THAN 300mm AND 50% SMALLER THAN 300mm. ROCK PROTECTION SHALL BE PLACED ON GEOTEXTILE UNDERLAY.

APPLICABLE STANDARD DRAWINGS

OPSD – 3101.150	WALLS, ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD – 3102.100	WALLS, ABUTMENT, BACKFILL DRAIN
OPSD – 3360.100	DECK, LIGHT POLE BASES, STRUCTURES WITH BARRIER WALLS
OPSD – 3419.100	BARRIERS AND RAILINGS STEEL GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD – 3941.200	FIGURES IN CONCRETE SITE NUMBER AND DATE LAYOUT
OPSD – 3370.100	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD – 3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS

SEQUENCE OF CONSTRUCTION

1. THE ABUTMENTS, WINGWALLS, AND PIERS SHALL BE CONSTRUCTED FIRST TO BEARING SEAT ELEVATIONS.
2. THE GIRDERS SHALL BE PLACED ON A SUPPORT THAT ALLOWS ROTATION AND DEFLECTION OF THE GIRDERS DUE TO SELF WEIGHT AND DEAD WEIGHT OF THE DECK.
3. THE DECK AND THE PORTION OF THE ABUTMENTS AND WINGWALLS ABOVE THE BEARING SEAT ELEVATIONS SHALL BE CAST INTEGRALLY WITH THE GIRDERS.
4. THE DECK AND THE PORTION OF THE ABUTMENTS AND WINGWALLS ABOVE THE BEARING SEAT ELEVATIONS SHALL BE POURED IN SEQUENCE SO THAT THE STRUCTURE BECOMES INTEGRAL WITH NO RESIDUAL STRESSES. THE ENDS OF THE DECK SHALL BE PLACED LAST UNLESS CONCRETE CAN BE SUFFICIENTLY RETARDED TO ALLOW THE PLACEMENT FROM ONE END TO THE OTHER IN A SINGLE POUR, SUBJECT TO THE APPROVAL OF THE CONTRACT ADMINISTRATOR
5. THE STABILITY AND INTEGRITY OF THE STRUCTURE SHALL BE MAINTAINED AT ALL STAGES OF CONSTRUCTION INCLUDING BREAKS IN THE CONSTRUCTION TIMELINE.
6. BACKFILL SHALL NOT BE PLACED BEHIND THE ABUTMENTS UNTIL THE DECK HAS REACHED 75% OF ITS SPECIFIED STRENGTH AND PERMISSION FROM THE CONTRACT ADMINISTRATOR IS GRANTED.
7. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN HEIGHTS OF BACKFILL BE GREATER THAN 500mm.

No.	REVISION	DATE
1.	ISSUED FOR PIC	JULY 16/19

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PORT BRUCE BRIDGE REPLACEMENT
TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

GENERAL ARRANGEMENT

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18–283
DATE JULY 2019
DRAWING NUMBER 6

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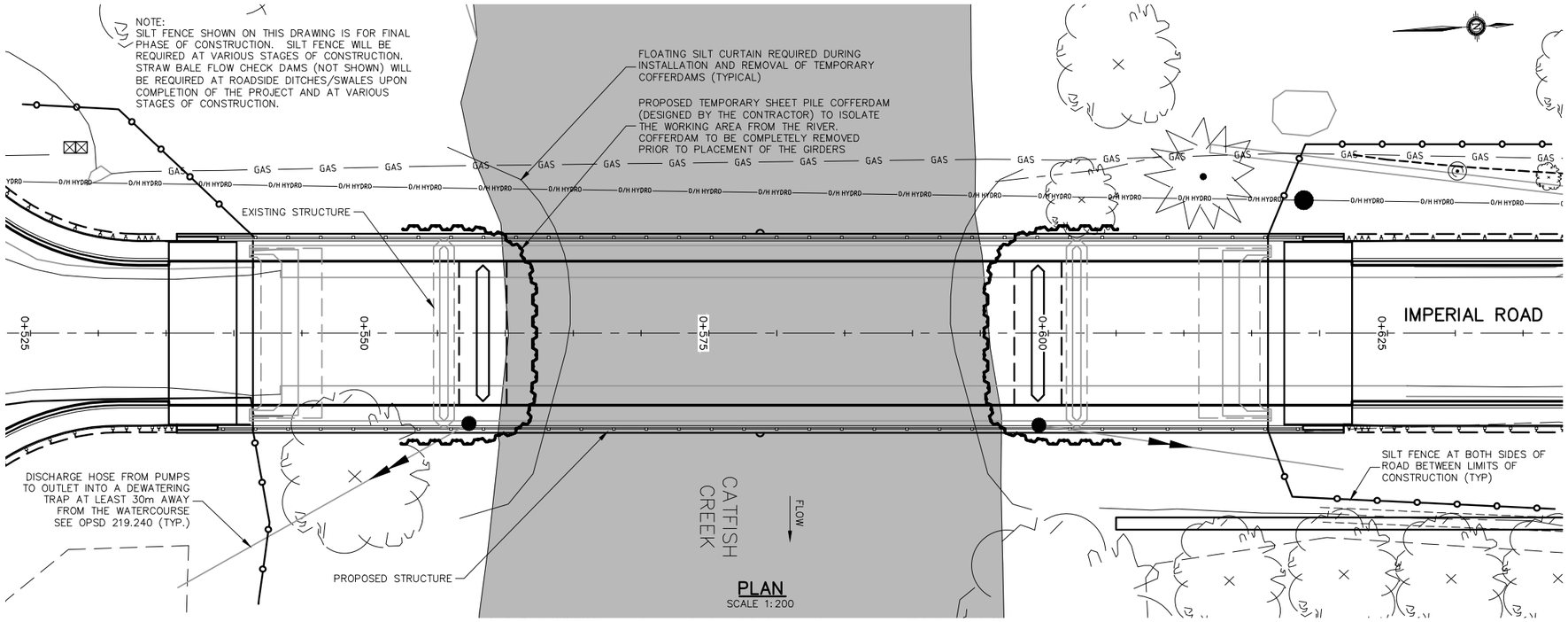

PLAN
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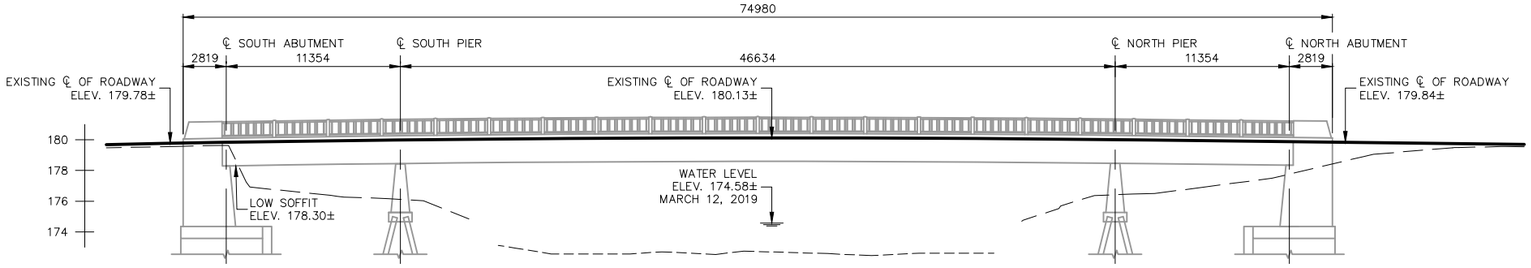

NOTE:
THE ORIGINAL STRUCTURE COLLAPSED IN FEBRUARY 2018 AND HAS SINCE BEEN REMOVED; ONLY THE SOUTH ABUTMENT AND PIER PILES REMAIN

ORIGINAL 1962± STRUCTURE
SCALE 1:200

NAVIGATION

1. SIGNS TO BE PLACED 50m UPSTREAM AND DOWNSTREAM WARNING BOATERS OF THE CONSTRUCTION WORK AHEAD.
2. SILT CURTAINS OR DEWATERING BERMS, INSTALLED DURING NAVIGATION SEASON, ARE TO BE MARKED WITH YELLOW BUOYS AND/OR YELLOW LIGHTS.
3. NO PERSON SHALL PERMIT ANY TOOLS, EQUIPMENT, VEHICLES, TEMPORARY STRUCTURES OR PARTS THEREOF USED OR MAINTAINED FOR THE PURPOSE OF BUILDING OR PLACING A WORK IN A NAVIGABLE WATER TO REMAIN IN SUCH WATER AFTER THE COMPLETION OF THE PROJECT.
4. WHERE A WORK OR PORTION OF A WORK THAT IS BEING CONSTRUCTED OR MAINTAINED IN A NAVIGABLE WATER CAUSES DEBRIS OR OTHER MATERIAL TO ACCUMULATE ON THE BED OR ON THE SURFACE OF THE WATER, THE OWNER OF THAT WORK OR PORTION OF THAT WORK SHALL CAUSE THE DEBRIS OR OTHER MATERIAL TO BE REMOVED TO THE SATISFACTION OF THE MINISTER OF TRANSPORT, INFRASTRUCTURE AND COMMUNITIES.

DEWATERING SEQUENCE

1. INSTALL SILT FENCE, STRAW BALE FLOW CHECK DAMS AND ANY OTHER EROSION CONTROL MEASURES WHICH MAY BE REQUIRED.
2. PLACE FLOATING SILT CURTAINS UPSTREAM AND DOWNSTREAM OF WORKING AREA.
3. INSTALL SHEET PILE COFFERDAMS OR OTHER CONTAINMENT SYSTEM(S) AS REQUIRED.
4. DEWATER AND DE-FISH THE WORKING AREA SIMULTANEOUSLY.
5. COMPLETE DEMOLITION AND REMOVAL OF THE EXISTING BRIDGE SUBSTRUCTURE.
6. EXCAVATE AS REQUIRED IN ORDER TO CONSTRUCT NEW FOUNDATIONS, ABUTMENTS, AND PIERS.
7. PLACE BACKFILL AS REQUIRED ON BOTH SIDES OF ABUTMENTS AND PIERS TO FACILITATE REMOVAL OF COFFERDAMS. PLACE ROCK PROTECTION.
8. REMOVE COFFERDAMS.
9. REMOVE FLOATING SILT CURTAINS.
10. COMPLETE REMAINING CONSTRUCTION OF THE BRIDGE.
11. COMPLETE ROADWORK.
12. INSTALL PERMANENT SILT FENCE AND STRAW BALE CHECK DAMS.

EROSION CONTROL – BRIDGE RECONSTRUCTION

1. ALL WORK SHALL BE DONE IN THE DRY.
2. NO IN-WATER WORK SHALL TAKE PLACE BETWEEN _____ AND _____.
3. DEWATERING OF THE SITE SHALL BE ACHIEVED BY THE INSTALLATION OF COFFERDAMS TO ISOLATE THE WORKING AREA, AND THE PLACEMENT OF CONVENTIONAL SUMP PUMPS WHERE REQUIRED. THE CONTRACTOR'S SPECIFIC METHOD SHALL BE APPROVED BEFOREHAND BY THE CONTRACT ADMINISTRATOR. ALTERNATIVE METHODS OF DEWATERING SUCH AS SHEET PILE COFFERDAMS AROUND THE ABUTMENTS MAY BE POSSIBLE PENDING THE WRITTEN APPROVAL OF THE CONTRACT ADMINISTRATOR.
4. THE CONTRACTOR SHALL APPLY AND OBTAIN A PERMIT TO TAKE WATER (PTTW) SHOULD PUMPING EXCEEED 50,000 LITRES PER DAY.
5. DISCHARGE FROM PUMPING OPERATIONS SHALL FIRST OUTLET INTO A SILTING POND OR SEDIMENT TRAP BEFORE THE WATER IS ALLOWED TO RE-ENTER THE RIVER OR ANOTHER WATERCOURSE.
6. COFFERDAMS SHALL BE DESIGNED BY THE CONTRACTOR AND SUBMITTED TO THE CONTRACT ADMINISTRATOR FOR APPROVAL.
7. ALL DISTURBED AREAS INCLUDING BANKS ABOVE WATER LEVEL SHALL BE REGRADED, TOPSOILED AND SEEDED TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR AS SOON AS POSSIBLE.
8. ALL EROSION CONTROL MEASURES (SILT FENCE, ROCK DAMS, SILTATION POND/DEWATERING TRAP, ETC.) SHALL BE CHECKED DAILY DURING ON-SITE WORK AND BE MAINTAINED IN GOOD STATE SO THAT THEY ARE FUNCTIONING PROPERLY. SILT FENCE AND STRAW BALE CHECK DAMS TO BE LEFT IN PLACE FOR 12 MONTHS OR UNTIL SUCH TIME AS THE SITE STABILIZES (THESE ARE LOCATED ABOVE HIGH WATER LEVEL).
9. NO MACHINERY SHALL CROSS THE RIVER AT ANY TIME. ANY MACHINERY THAT IS REQUIRED ON THE OTHER SIDE OF THE RIVER WHILE THE BRIDGE IS DISMANTLED OR UNDER CONSTRUCTION SHALL BE HAULED BY FLOAT OR DRIVEN AROUND ON THE ROADS. MACHINERY, VEHICLES, EQUIPMENT PUMPS, ETC., WILL NOT BE REFUELED WITHIN 30 METRES OF THE WATERCOURSE. MACHINERY SHALL NOT BE CLEANED WITHIN 30 METRES OF THE RIVER.
10. ALL WASTE MATERIAL FROM CONSTRUCTION SHALL BE STORED AWAY AND ABOVE THE HIGH WATERMARK AND AT NO TIME SHALL SUCH MATERIAL ENTER IN THE WATER.
11. FOR TYPICAL CHECK DAMS REFER TO OPSD 219.210
12. FOR SILT FENCE REFER TO OPSD 219.110.
13. SEED MIX TO BE STANDARD ROADSIDE MIX PER OPSS.MUNI 804.

ADDITIONAL ENVIRONMENTAL MEASURES TO BE ADHERED TO:

1. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT THE ENTRY OF SEDIMENT INTO THE WATER OR THE MOVEMENT OF RE-SUSPENDED SEDIMENT.
2. A FLOATING TURBIDITY CURTAIN OR SILT FENCE SHOULD BE PLACED IMMEDIATELY AROUND THE WORK SITE PRIOR TO THE INSTALLATION OF COFFERDAMS.
3. ALL DISTURBED WORK AREAS SHOULD BE STABILIZED AND RE-VEGETATED AS REQUIRED UPON THE COMPLETION OF WORK AND RESTORED TO A PRE-DISTURBED STATE OR BETTER.
4. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE LEFT IN PLACE UNTIL ALL DISTURBED AREAS HAVE BEEN STABILIZED.
5. EXISTING STREAM FLOWS SHOULD BE MAINTAINED DOWNSTREAM OF THE DE-WATERED WORK AREA WITHOUT INTERRUPTION, DURING ALL STAGES OF WORK. THERE SHOULD BE NO INCREASE IN WATER LEVELS UPSTREAM OF THE DE-WATERED WORK AREA.
6. FISH SHOULD BE REMOVED FROM THE WORK AREA PRIOR TO DE-WATERING AND RELEASED ALIVE IMMEDIATELY DOWNSTREAM.
7. SILT OR DEBRIS THAT HAS ACCUMULATED AROUND THE TEMPORARY COFFERDAMS SHOULD BE REMOVED PRIOR TO THEIR WITHDRAWAL.
8. NATURAL STRUCTURES SUCH AS LOGJAMS AND IN-STREAM WOODY COVER SHOULD NOT BE REMOVED UNLESS THEY REPRESENT A BARRIER TO FLOWS OR FISH MOVEMENT.
9. OPERATE HEAVY MACHINERY ON LAND AND IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OR BED OF THE RIVER.
10. ENSURE THAT MACHINERY ARRIVES ON SITE IN A CLEAN, WASHED CONDITION AND IS MAINTAINED FREE OF FLUID LEAKS.
11. WASH, REFUEL AND SERVICE MACHINERY AND STORE FUEL AND OTHER MATERIALS FOR THE MACHINERY AWAY FROM THE WATER TO PREVENT ANY DELETERIOUS SUBSTANCE FROM ENTERING THE WATER OR SPREADING ONTO THE ICE SURFACE.
12. KEEP AN EMERGENCY SPILL KIT ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.
13. STABILIZE ANY WASTE MATERIALS REMOVED FROM THE WORK SITE TO PREVENT THEM FROM ENTERING THE WATERBODY. THIS COULD INCLUDE COVERING STOCKPILES WITH BIODEGRADABLE MATS OR TARPS, OR PLANTING STOCKPILES WITH GRASS OR SHRUBS.
14. ALL UNSTABLE BANKS OF THE WATERCOURSE SHOULD BE STABILIZED AND SIDE RUN-OFF DITCHES SHOULD BE CONSTRUCTED TO DIVERT ROAD RUN-OFF THROUGH THE GREENBELT BEFORE ENTERING THE STREAM.
15. VEGETATE AND STABILIZE ANY DISTURBED AREAS BY SEEDING AND PLANTING TREES, SHRUBS, OR GRASSES.
16. STREAM CROSSINGS SHOULD ALLOW FOR UNIMPEDED UPSTREAM AND DOWNSTREAM MOVEMENT OF FISH.
17. CONCRETE LEACHATE IS ALKALINE AND HIGHLY TOXIC TO FISH AND AQUATIC LIFE AND MEASURES MUST BE TAKEN TO PREVENT ANY INCIDENCE OF CONCRETE OR CONCRETE LEACHATE FROM ENTERING THE WATERCOURSE. ALL CAST-IN-PLACE CONCRETE, GROUT, MORTARS, ETC. SHOULD BE TOTALLY ISOLATED FROM PRECIPITATION AND THE WATERS OF THE CANAL FOR A MINIMUM 48 HOUR PERIOD OR UNTIL SIGNIFICANTLY CURED TO ALLOW THE pH TO REACH NEUTRAL LEVELS. CONTAINMENT FACILITIES SHOULD BE PROVIDED AT THE SITE FOR THE WASH-DOWN FROM CONCRETE DELIVERY TRUCKS, CONCRETE PUMPING EQUIPMENT, AND OTHER TOOLS AND EQUIPMENT AS REQUIRED.

No.	REVISION	DATE
1.	ISSUED FOR PIC	JULY 16/19

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CHECKED BY: A.G.
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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

EROSION AND SEDIMENT CONTROL / DEWATERING PLAN

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 7

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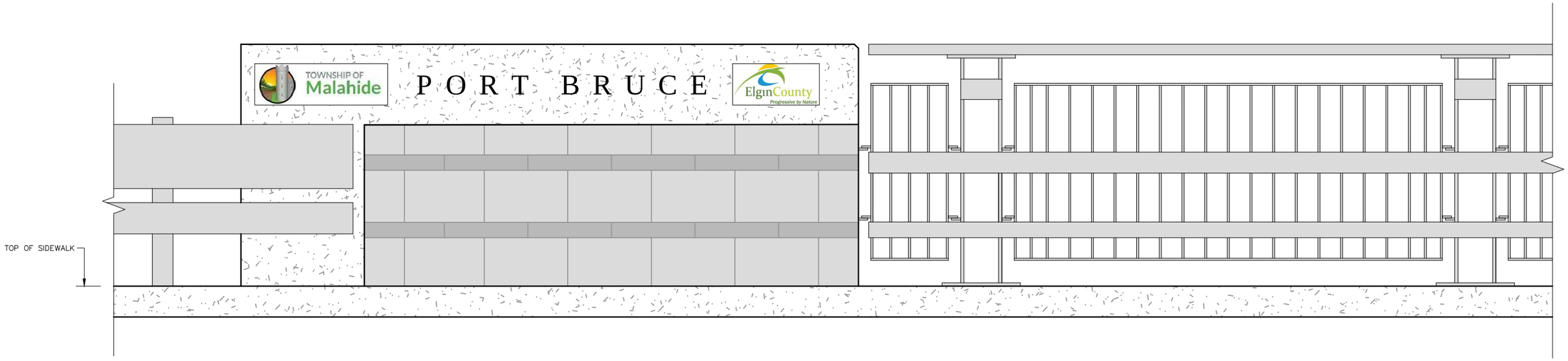

BRIDGE RAILING & CONCRETE END POST
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No.	REVISION	DATE
1.	ISSUED FOR PIC	JULY 16/19

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DRAWN BY: D.S.
CHECKED BY: A.G.
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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

BRIDGE RAILING & CONCRETE END POST

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 8

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Next Steps:

- **Receive feedback on preferred alternative.**
- **Finalize the 'Project File'**
- **Publish a 'Notice of Completion.' The Notice will identify the opportunity to review the 'Project File' over a 45 calendar day period.**
- **Assuming that comments raised during the 45 day review period can be resolved, the County will proceed with the Detailed Design, Tendering, and Construction.**
- **Construction to commence in Fall 2019**

Comments regarding this PIC will be received until July 26, 2019. Please complete a comment sheet and place in the comment box or submit via e-mail to:

Mr. Brian Lima, P. Eng.
County of Elgin
450 Sunset Drive
St. Thomas, ON N5R 5V1
Phone: 519.631.1460 ext. 117
Email: bilma@elgin.ca

Mr. Allan Garnham, P. Eng.
K. Smart Associates Limited
85 McIntyre Drive
Kitchener, ON, N2R 1H6
Phone: 519-748-1199 ext. 229
Email: agarnham@ksmart.ca

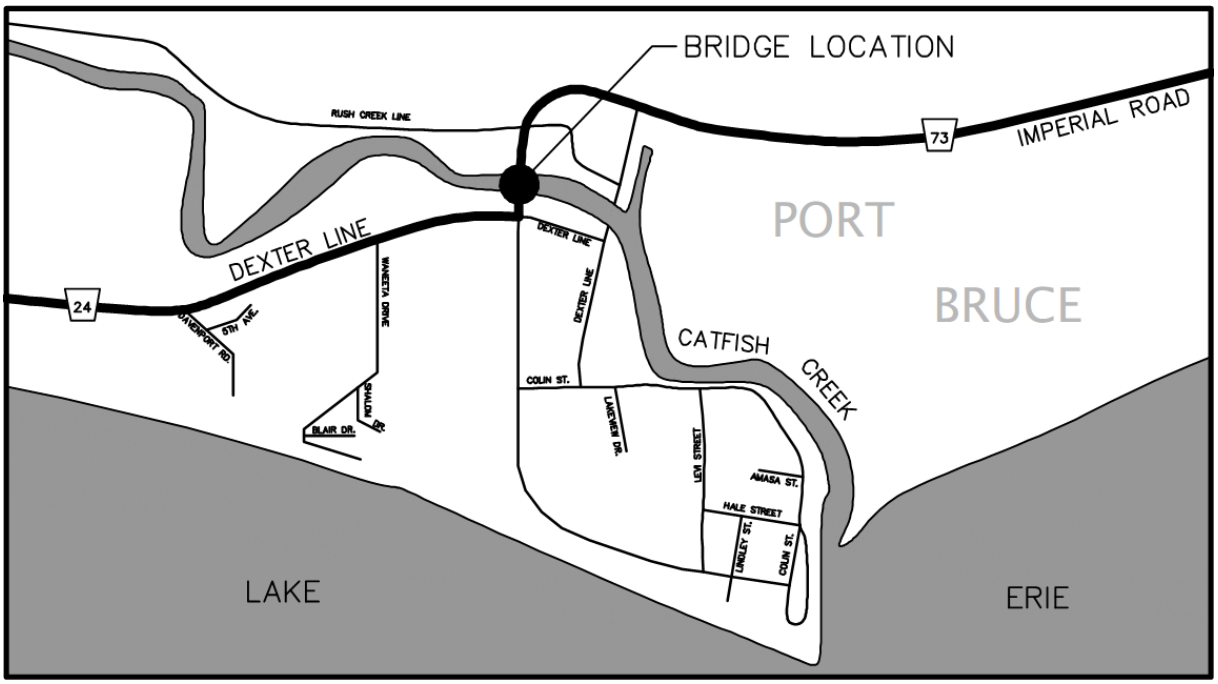
THANK YOU FOR ATTENDING

4.5 Notice of Study Completion

The following Notice of Study Completion will be placed in two (2) consecutive editions editions of the Aylmer Express. This same notice will be placed on the County of Elgin's and the Township of Malahide's webpage. Copies of this Notice will also be sent to those identified in Section 4.1:

CLASS ENVIRONMENTAL ASSESSMENT
IMPERIAL ROAD PORT BRUCE BRIDGE AT CATFISH CREEK
NOTICE OF STUDY COMPLETION

The County of Elgin has studied available options to replace the Port Bruce Bridge. The preferred alternative is a three span steel girder bridge constructed at the same location.



The project is being planned as a Schedule B project under the Municipal Class Environmental Assessment process. Subject to comments received as a result of this Notice, the County of Elgin intends to obtain the necessary approvals and proceed with the design and construction of this project to be completed in late 2020.

To obtain a copy of the Project File or to comment on this project, please contact:

Mr. Allan Garnham, P. Eng.
Project Engineer
K. Smart Associates Limited
85 McIntyre Drive
Kitchener, Ontario N2R 1H6
Phone: 519-748-1199 ext. 246
E-mail: agarnham@ksmart.ca

or

Mr. Brian Lima, P. Eng.
Director of Engineering Services
County of Elgin
450 Sunset Drive
St. Thomas, Ontario N5R 5V1
Phone: 519-631-1460 ext. 117
E-mail: blima@elgin.ca

Interested persons should provide written comment to the County on the proposal within 30 calendar days from the date of this notice. Comments should be directed to either of the contact persons noted above.

If concerns arise regarding this project which cannot be resolved in discussion with the County, a person may request that the Minister of the Environment make an order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order), which addresses individual

environmental assessments. As of July 1, 2018, a Part II Order Request Form must be used to request a Part II Order in accordance with O. Reg. 152/18. The Part II Order Request Form is available online on the Forms Repository website (http://www.forms.ssb.gov.on.ca/) by searching "Part II Order" or "012-2206E" (the form ID number). The Minister, the Director, and the County (as per addresses provided within this notice) must receive requests within 30 calendar days of this Notice. If there are no requests received by November 15, 2019, the project will proceed to design and construction as presented.

Minister
Ministry of the Environment, Conservation and Parks
Ferguson Block, 77 Wellesley Street West, 11th Floor
Toronto, Ontario
M7A 2T5
Fax: 416-314-8452
Minister.mecp@ontario.ca

Director, Environmental Assessment and Permissions Branch
Ministry of the Environment, Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5
enviropermissions@ontario.ca

Information will be collected in accordance with the *Freedom of Information* and *Protection of Privacy Act*. With the exception of personal information, all comments will become part of the public record.

This Notice issued October 8, 2019.

5. Alternatives Considered and Selection of the Preferred Alternative

5.1 Alternatives Considered

5.2 Selection of the Preferred Alternative

5.3 Repurposing of the Temporary Modular Panel Bridge

5.1 Alternatives Considered

Four (4) alternatives are considered to address the problem statement:

Alternative 1 – Do Nothing
The "Do Nothing" alternative is defined as not constructing a new bridge, but leaving the temporary bridge downstream intact. Per the EA Manual, the "Do Nothing" alternative needs to be considered.

Alternative 2 – Three-span Steel Girder Bridge
This type of structure consists of steel girders which would span between concrete abutments and piers. For this particular structure, two (2) piers and two (2) abutments would be required. The deck would be cast-in-place concrete. The structure would be founded on steel piles. Sidewalks would be provided on both sides of the bridge. The railing system is envisioned to be steel box beam type, but other types of railing systems could be used. The overall look and appearance of the bridge would be similar to the existing bridge, but the main structural system would be different. This style of bridge is very common in Ontario and the materials required for construction are readily available.

Alternative 3 – Single Span Steel Truss Bridge
This type of structure consists of steel trusses which would span between concrete abutments. Transverse beams would connect between the trusses to support either a steel or concrete deck. Sidewalks can be provided by either cantilevering them off the side or placing them between the trusses. The railing system would likely be steel box beam. Although this bridge style was very common in Ontario up to the 1950's, it has fallen out of favour due to their cost. In recent years, these types of bridges have made a resurgence for pedestrian crossings.

Alternative 4 – Single or Multi-Span Bailey Bridge
This type of bridge is also known as a modular bridge. Essentially, prefabricated modular steel panels would be connected at their ends to form trusses. These trusses would span between piers and abutments (in the case of a multi-span bridge) or between abutments (in the case of a single span bridge). Transverse beams would connect between the trusses to support steel deck pans. The steel deck pans would be the driving surface. The exact configuration of the trusses would need to be determined based on the final layout of the bridge (i.e. whether the bridge is single span or multi-span) and the overall width of the bridge. Sidewalks are not likely possible, but two (2) or three (3) lanes could be provided across the bridge. The railing system would likely be flex beam type. The overall look and appearance of the bridge would be very similar to the temporary bridge downstream. This style of bridge is common in Northern Ontario and other countries and is very popular for temporary bridges.

Alternatives which consist of two-span structures, i.e. with a pier centred in the Creek, have not been considered due to the potential for ice jamming as well as to preserve the navigability of Catfish Creek.

Other types of structures, such as precast concrete girders, are not viable alternatives because these types of girders cannot achieve the required span-to-depth ratio.

5.2 Selection of the Preferred Alternative

The general methodology to compare and evaluate the four (4) possible alternatives is a tabular ranking system. For a given criteria, alternatives are ranked 1-4 with 1 either being the best or having the least impact and 4 being the worst or having the most impact, except as noted otherwise. To ensure each criterion is weighted the same, each row equals 10 points.

The following criteria will be used to guide the decision making:

- Impacts to fish and fish habitat;
- Impacts to vegetation and flora;
- Impact to wildlife and wildlife habitat;
- Changes to groundwater and surface water quantity and quality;
- Impact on stream flow;
- Potential for ice jams;
- Impact to community;
- Impact to residential areas;
- Impact to local business;
- Impact to recreation;
- Impact to future development;
- Need for property acquisition;
- Length of construction;
- Improvement to traffic movement;
- Changes to noise and vibration;
- Changes to air quality;
- Access to emergency services;
- Aesthetics;
- Extent the alternative addresses the problem statement;
- Height restrictions;
- Width restrictions;
- Provision of sidewalks;
- Provision of cycling lanes;
- Ability to improve hydrology/hydraulic conditions;
- Constructability;
- Construction timeline;
- Lifespan;
- Need for ongoing maintenance;
- Overall construction cost;
- Maintenance costs.

To simplify the evaluation process to eliminate the possibility of one stakeholder group from having more influence over the decision making process over another stakeholder group, a ranking system was used. Criterion were all be given the same weight. It can be said that one particular criterion is no more important than any other criterion. Although this ranking system will be controversial to some stakeholders, there is no other reasonable methodology to compare alternatives.

Table 1 – Evaluation of Alternatives summarizes the decision making process. Per Table 1, the following final scores were determined:

Alternative 1 (Do Nothing)	78.0
Alternative 2 (Three-Span Steel Girder Bridge)	65.5
Alternative 3 (Single Span Steel Truss Bridge)	74.0
Alternative 4 (Single or Multi-Span Bailey Bridge)	82.5

From the above listed results, Alternative 2 has the lowest score. Therefore, Alternative 2 is the most viable alternative to address the problem statement. It is recommended to proceed with Alternative 2 – Three-Span Steel Girder Bridge.

Table 1 - Evaluation of Alternatives

No.	Criteria	Alternative 1 (Do Nothing)	Alternative 2 (Three-Span Steel Girder Bridge)	Alternative 3 (Single Span Steel Truss Bridge)	Alternative 4 (Single or Multi-Span Modular Panel Bridge)	Comment
1	Impacts to fish and fish habitat	1	3.5	2	3.5	Considers disruption to fish and potential loss of fish habitat
2	Impacts to vegetation and flora	1	3	3	3	Considers overall loss of vegetation 1 does not result in loss of vegetation 3 results in loss of vegetation
3	Impact to wildlife and wildlife habitat	2	1	3	4	1 will result in an overall improvement 4 will result in an overall loss
4	Changes to groundwater and surface water quantity and quality	4	2	2	2	2 can result in an overall improvement 4 will not result in an improvement
5	Impact on stream flow	1	3.5	2	3.5	1 has the least impact 2 has some impact 3.5 has the most impact
6	Potential for ice jams	1	3.5	2	3.5	1 has no potential for ice jams 2 has some potential for ice jams 3.5 has potential for ice jams
7	Impact to community	4	2	2	2	Considers impact to the community by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
8	Impact to residential areas	4	2	2	2	Considers loss of value of residential property by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
9	Impact to local business	4	2	2	2	Considers negative impact to local business by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
10	Impact to recreation	1.5	3.5	1.5	3.5	Considers potential changes to navigation
11	Impact to future development	4	2	2	2	Considers loss of future development by not having a permanent crossing 2 if a new bridge is built 4 if no bridge is built
12	Need for property acquisition	1	2	3	4	1 requires no property to be purchased 4 requries the most amount of property to be purchased
13	Length of construction	1	4	3	2	1 is the shortest to construct 4 is the longest to construct
14	Improvement to traffic movment	4	2	2	2	2 will provide improvement 4 will not provide improvement
15	Changes to noise and vibration	3	1	2	4	1 will result in a reduction in noise and vibration 4 will result in changes to noise and vibration

Table 1 - Evaluation of Alternatives

No.	Criteria	Alternative 1 (Do Nothing)	Alternative 2 (Three-Span Steel Girder Bridge)	Alternative 3 (Single Span Steel Truss Bridge)	Alternative 4 (Single or Multi-Span Modular Panel Bridge)	Comment
16	Changes to air quality	4	2	2	2	Considers positive change to air quality as a result of quicker travel times 2 if a new bridge is built 4 if no bridge is built
17	Access to emergency services	4	2	2	2	Considers response times 2 if a new bridge is built 4 if no bridge is built
18	Aesthetics	4	1	2	3	1 will restore aesthetics of Port Bruce to a pre-collapse state 4 does not address any aesthetics
19	Extent the alternative addresses the problem statement	4	2	2	2	2 meets the problem statement 4 does not meet the problem statement
20	Height restrictions	2	2	4	2	4 if there is a height limit across the bridge 2 if there is no limit
21	Width restrictions	1.5	1.5	3.5	3.5	3.5 if the structure is limited in width 1.5 if there is no limit
22	Provision of sidewalks	4	1	2	3	Considers ease and relative cost to provide sidewalks
23	Provision of cycling lanes	4	1	2	3	Considers ease and relative cost to provide cycling lanes
24	Ability to improve hydrology/hydraulic conditions	4	2	2	2	2 allows for improvement 4 does not allow improvement
25	Constructability	1	3	4	2	1 is the easiest to construct 4 is the hardest to construct
26	Construction timeline	1	4	3	2	1 is the shortest to construct 4 is the longest to construct
27	Lifespan	4	1	2	3	1 is the longest period prior to reconstruction of the bridge 4 is the shortest period prior to reconstruction of the bridge
28	Need for ongoing maintenance	2	1	3	4	Assumes doing nothing requries no maintenance Assumes checking transom clamps periodically results in the highest maintenance costs
29	Overall construction cost	1	3	4	2	1 is the lowest overall construction cost 4 is the highest overall construction cost
30	Maintenance costs	1	2	3	4	Assumes doing nothing requries no maintenance Assumes checking transom clamps periodically results in the highest maintenance costs
	Totals	**78**	**65.5**	**74**	**82.5**	

Note:
Alternatives are ranked 1 to 4 with 1 having the least impact and 4 having the most impact except where noted.
Each row totals 10 points to ensure each criterion is weighted the same.

5.3 Repurposing of the Temporary Modular Panel Bridge

The question of what to do with the temporary modular panel bridge currently installed downstream of the Imperial Road site requires attention. One solution of re-purposing is to incorporate the temporary modular panel bridge into the design of the new bridge to be constructed at the Imperial Road site. The following letter investigates this alternative.

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS & PLANNERS

85 McIntyre Drive
Kitchener, ON N2R 1H6

Tel: 519-748-1199
Fax: 519-748-6100

June 10, 2019
Revised June 27, 2019

KSAL File No. 18-283

Brian Lima, P. Eng. Director of Engineering Services
Director of Engineering Services
County of Elgin
450 Sunset Drive
St. Thomas, Ontario
N5R 5V1

RE: PORT BRUCE BRIDGE REPLACEMENT
IMPERIAL ROAD AT CATFISH CREEK
COUNTY OF ELGIN
REPURPOSING OF TEMPORARY MODULAR BRIDGE

Dear Brian,

Per your request, we have considered a 5th possible replacement alternative as part of the Environmental Assessment process for this crossing. A temporary modular panel bridge was installed at Bank Street and Dexter Line to provide a crossing over Catfish Creek in the community of Port Bruce until the bridge at the Imperial Road site is constructed. This alternative would involve repurposing the temporary modular panel bridge currently installed at Bank Street and Dexter Line as the new bridge at the Imperial Road site.

ALTERNATIVE 5

We have been in contact with Acrow Bridge (Acrow), the supplier of the temporary panel bridge, regarding various panel bridge options such as configuration, overall width, inclusion of sidewalks, and approximate estimated pricing. In concert with both yourself and Acrow, it is understood the preferred bridge configuration is a three (3) span structure similar in length to Alternative 2 (i.e. 18.3, 39.6, 18.3) with a minimum deck width of 9.0m between curbs, and cantilevered sidewalks. Based on conversations with Acrow, the truss configurations would be triple-single with chord reinforcing and double-single for the centre and outside spans respectively. These configurations will result in a single panel high bridge (the temporary panel bridge is a double panel high bridge). Acrow is suggesting the traffic barrier across the bridge be box beam type.

The general methodology to construct this alternative would be to construct new abutments and piers at the Imperial Road site, close the roadway at the temporary panel bridge, disassemble the temporary panel bridge, transport components to the Imperial Road site, assemble the new bridge from a combination of recycled and new components, install the newly assembled panel bridge on the abutments and piers, and complete the remaining construction.

MODULAR PANEL BRIDGE VS STEEL GIRDER BRIDGE

The main advantage of repurposing the temporary panel bridge is that the question of what to do with the temporary panel bridge once a new bridge is constructed at the Imperial Road site is addressed. Another advantage of this alternative is the construction depth of the superstructure (i.e. distance between the underside of the truss and the top of the deck wearing surface) is less than the construction depth of a steel girder bridge alternative. This will result in less roadway reconstruction required to transition the newly constructed Imperial Road to adjacent Rush Creek Line and Dexter Line. Thirdly, the amount of time required for constructing this alternative is less when compared to a steel girder bridge alternative; modular bridges generally are quicker to construct since their components simply bolt together.

One disadvantage of this alternative is the need for expansion joints. Expansion joints expose load-carrying components of the structure to salt laden run-off, resulting in accelerated corrosion of said components which will ultimately require on-going maintenance and repairs. A traditional girder bridge at this site would be constructed without expansion joints. Another disadvantage of a panel bridge alternative is the need for additional foundations. A permanent modular bridge will need to be supported on abutments foundations consisting of two rows of driven piles, while a traditional girder bridge can be constructed of "integral abutment" style, which negates the need for multiple rows of piles at the abutment locations. As a result, the deep foundations for a panel bridge alternative require more materials and subsequent construction, resulting in longer in-water work and therefore risk. Consequently, the overall construction cost for the substructure of a panel bridge alternative is higher when compared to the substructure cost of a traditional girder bridge alternative. Thirdly, this bridge site is in an urban area and therefore aesthetics need to be considered at a higher degree compared to that of a bridge being constructed in a remote location. Panel bridges are considered by some as utilitarian and not necessarily appropriate for an urban community. A panel bridge alternative is inferior aesthetically when compared to a traditional girder bridge. The greatest disadvantage of this alternative is the need to close the temporary bridge in order to accommodate the repurposing. Acrow estimates the time required to disassemble the old bridge and assemble the new bridge is approximately two (2) weeks using approximately six (6) to ten (10) labourers. This estimate does not include the time required to construct ballast walls and reconstruct the roadway to the newly installed panel bridge. Based on our experience with a similar project, our estimate of time from closure of the roadway at the temporary bridge to opening of the roadway and bridge at the Imperial Road site is six (6) to ten (10) weeks.

The construction cost estimate for a three span modular panel bridge alternative is approximately $5,003,000 excluding HST. The construction cost estimate for a three span steel girder bridge alternative is approximately $4,988,000 excluding HST. Detailed cost estimates are attached to this letter. For comparison purposes, the construction cost of both alternatives can be considered the same.

CONCLUSION

When comparing the modular panel bridge alternative to the steel girder bridge alternative, it is our opinion that the steel girder bridge is superior. The cost of the two alternatives is relatively the same, however the steel girder bridge performs better when considering aesthetics and anticipated maintenance and repairs. When considering the local residents of the community of Port Bruce, the most important factor is maintaining a crossing of Catfish Creek in Port Bruce throughout the duration of the construction project, which will not be the case if the temporary modular panel bridge is repurposed. Therefore, we recommend the County of Elgin proceed with a steel girder bridge as the preferred replacement alternative. With respect to the temporary modular panel bridge, we would be pleased to present options for its future to the County under separate cover.

In lieu of closing the temporary bridge prior to opening of the bridge at the Imperial Road site, the modular panel bridge alternative can be assembled comprising of entirely new components, thus ensuring a crossing of Catfish Creek remains in Port Bruce throughout the construction process. However, the cost for this alternative is increased from the figures stated above.

Please confirm if the County agrees with our recommendation. If necessary, we would be happy to meet with you to further discuss the available alternatives.

If you have any questions or additional information is required, please contact the undersigned.

Yours truly,

Allan Garnham, P. Eng.
Project Manager

Port Bruce Bridge Replacement
Preliminary Construction Cost Estimate

Three Span Modular Panel Bridge

ITEM NO.	DESCRIPTION	EST. QUANT.	UNIT	UNIT PRICE	TOTAL AMOUNT
1	Mobilization/Demobilization	1	L.S.	$ 100,000.00	$ 100,000.00
2	Bonding and Insurance	1	L.S.	$ 75,000.00	$ 75,000.00
3	Traffic Control	1	L.S.	$ 20,000.00	$ 20,000.00
4	Clearing & Grubbing	1	L.S.	$ 5,000.00	$ 5,000.00
5	Earth Borrow	500	tonne	$ 20.00	$ 10,000.00
6	HL8 Asphalt on Roadway Approaches	950	tonne	$ 110.00	$ 104,500.00
7	HL4 Asphalt on Roadway Approaches	700	tonne	$ 110.00	$ 77,000.00
8	Milled Step Joint in Asphalt	6	each	$ 2,000.00	$ 12,000.00
9	Supply and Place Granular "A" for Road	900	tonne	$ 25.00	$ 22,500.00
10	Supply and Place Granular "B" for Road	350	tonne	$ 20.00	$ 7,000.00
11	Supply and Place Granular "B" Backfill to Structure	1	L.S.	$ 30,000.00	$ 30,000.00
12	150mm DIA HDPE Subdrain	40	m	$ 75.00	$ 3,000.00
13	Concrete Sidewalk	375	m^2	$ 100.00	$ 37,500.00
14	Concrete Curb	450	m	$ 100.00	$ 45,000.00
15	45° Concrete Gutter Outlet	2	each	$ 1,000.00	$ 2,000.00
16	600 x 600 Precast Concrete Catch Basin	2	each	$ 2,000.00	$ 4,000.00
17	Asphalt Removal Full Depth	4,500	m^2	$ 10.00	$ 45,000.00
18	Removal of Existing Structure	1	L.S.	$ 20,000.00	$ 20,000.00
19	Removal of Existing Pier Piles	1	L.S.	$ 110,000.00	$ 110,000.00
20	Rock Protection	250	m^3	$ 150.00	$ 37,500.00
21	Rip Rap Spillways	50	m^2	$ 100.00	$ 5,000.00
22	Permanent Pavement Marking – Yellow – 10cm Double Solid	550	m	$ 20.00	$ 11,000.00
23	Permanent Pavement Marking – White – 10cm Wide solid	1100	m	$ 20.00	$ 22,000.00
24	Permanent Pavement Marking – White – Stop Bar	4	each	$ 500.00	$ 2,000.00
25	MASH Steel Beam Guide Rail Type	110	m	$ 150.00	$ 16,500.00
26	SBEAT End Treatments	2	each	$ 4,500.00	$ 9,000.00
27	Topsoil from Stockpiles	40	m^3	$ 50.00	$ 2,000.00
28	Imported Topsoil (Provisional)	80	m^3	$ 80.00	$ 6,400.00
29	Hydraulic Seeding and Mulching	1	L.S.	$ 5,000.00	$ 5,000.00

Port Bruce Bridge Replacement
Preliminary Construction Cost Estimate

Three Span Modular Panel Bridge

ITEM NO.	DESCRIPTION	EST. QUANT.	UNIT	UNIT PRICE	TOTAL AMOUNT
30	Sod (Provisional)	600	m²	$ 15.00	$ 9,000.00
31	Erosion Control Blanket (Provisional)	600	m²	$ 5.00	$ 3,000.00
32	Light Duty Silt Fence Barrier	600	m	$ 150.00	$ 90,000.00
33	Straw Bale Flow Check Dams	4	each	$ 250.00	$ 1,000.00
34	Earth Excavation for New Structure, Dewatering, and Earth Backfill	1	L.S.	$ 300,000.00	$ 300,000.00
35	Piling - Mobilization and Demobilization	1	L.S.	$ 75,000.00	$ 75,000.00
36	Piling - HP310 x 110	2560	m	$ 250.00	$ 640,000.00
37	Concrete Working Slab - Abutments	1	L.S.	$ 19,000.00	$ 19,000.00
38	Concrete Working Slab - Piers	1	L.S.	$ 13,000.00	$ 13,000.00
39	Concrete in Abutment Footings	1	L.S.	$ 175,000.00	$ 175,000.00
40	Concrete in Pier Footings	1	L.S.	$ 110,000.00	$ 110,000.00
41	Concrete in Abutments & Wingwalls	1	L.S.	$ 175,000.00	$ 175,000.00
42	Concrete in Piers	1	L.S.	$ 130,000.00	$ 130,000.00
43	Concrete in Approach Slabs	1	L.S.	$ 30,000.00	$ 30,000.00
44	Steel Cutwater Assembly	1	L.S.	$ 7,500.00	$ 7,500.00
45	Reinforcing Steel Bar - Black	50	tonne	$ 2,500.00	$ 125,000.00
46	Mechanical Connections	1	L.S.	$ 7,500.00	$ 7,500.00
47	Modular Panel Superstructure - Supply	1	L.S.	$1,515,669.00	$ 1,515,669.00
48	Modular Panel Superstructure - Installation	1	L.S.	$ 250,000.00	$ 250,000.00
49	Ballast Wall Nosing Angle	1	L.S.	$ 5,000.00	$ 5,000.00
50	Locate Existing Buried Utility	30	each	$ 500.00	$ 15,000.00
51	Fish Salvage & Transfer	1	L.S.	$ 6,000.00	$ 6,000.00
52	Contingency (10%)	1	allow	$ 455,000.00	$ 455,000.00

TOTAL = $ 5,002,569.00
(excluding HST)

Port Bruce Bridge Replacement
Preliminary Construction Cost Estimate

Three Span Steel Girder Bridge

ITEM NO.	DESCRIPTION	EST. QUANT.	UNIT	UNIT PRICE	TOTAL AMOUNT
1	Mobilization/Demobilization	1	L.S.	$ 100,000.00	$ 100,000.00
2	Bonding and Insurance	1	L.S.	$ 75,000.00	$ 75,000.00
3	Traffic Control	1	L.S.	$ 20,000.00	$ 20,000.00
4	Clearing & Grubbing	1	L.S.	$ 5,000.00	$ 5,000.00
5	Earth Borrow	1400	tonne	$ 20.00	$ 28,000.00
6	HL8 Asphalt on Roadway Approaches	1450	tonne	$ 110.00	$ 159,500.00
7	HL4 Asphalt on Roadway Approaches	1050	tonne	$ 110.00	$ 115,500.00
8	HL4 Asphalt on Bridge Deck	180	tonne	$ 150.00	$ 27,000.00
9	Milled Step Joint in Asphalt	6	each	$ 2,000.00	$ 12,000.00
10	Supply and Place Granular "A" for Road	3200	tonne	$ 25.00	$ 80,000.00
11	Supply and Place Granular "B" for Road	3,500	tonne	$ 20.00	$ 70,000.00
12	Supply and Place Granular "B" Backfill to Structure	1	L.S.	$ 30,000.00	$ 30,000.00
13	150mm DIA HDPE Subdrain	40	m	$ 75.00	$ 3,000.00
14	Concrete Sidewalk	375	m^2	$ 100.00	$ 37,500.00
15	Concrete Curb	500	m	$ 100.00	$ 50,000.00
16	45° Concrete Gutter Outlet	2	each	$ 1,000.00	$ 2,000.00
17	600 x 600 Precast Concrete Catch Basin	2	each	$ 2,000.00	$ 4,000.00
18	Asphalt Removal Full Depth	6,600	m^2	$ 10.00	$ 66,000.00
19	Removal of Existing Structure	1	L.S.	$ 20,000.00	$ 20,000.00
20	Removal of Existing Pier Piles	1	L.S.	$ 110,000.00	$ 110,000.00
21	Rock Protection	250	m^3	$ 150.00	$ 37,500.00
22	Rip Rap Spillways	50	m^2	$ 100.00	$ 5,000.00
23	Permanent Pavement Marking – Yellow – 10cm Double Solid	800	m	$ 20.00	$ 16,000.00
24	Permanent Pavement Marking – White – 10cm Wide solid	1600	m	$ 20.00	$ 32,000.00
25	Permanent Pavement Marking – White – Stop Bar	4	each	$ 500.00	$ 2,000.00
26	MASH Steel Beam Guide Rail Type	110	m	$ 150.00	$ 16,500.00
27	SBEAT End Treatments	2	each	$ 4,500.00	$ 9,000.00
28	Topsoil from Stockpiles	110	m^3	$ 50.00	$ 5,500.00
29	Imported Topsoil	250	m^3	$ 80.00	$ 20,000.00

Port Bruce Bridge Replacement
Preliminary Construction Cost Estimate

Three Span Steel Girder Bridge

ITEM NO.	DESCRIPTION	EST. QUANT.	UNIT	UNIT PRICE	TOTAL AMOUNT
30	Hydraulic Seeding and Mulching	1	L.S.	$ 5,000.00	$ 5,000.00
31	Sod (Provisional)	1,750	m²	$ 15.00	$ 26,250.00
32	Erosion Control Blanket (Provisional)	600	m²	$ 5.00	$ 3,000.00
33	Light Duty Silt Fence Barrier	600	m	$ 15.00	$ 9,000.00
34	Straw Bale Flow Check Dams	4	each	$ 250.00	$ 1,000.00
35	Earth Excavation for New Structure, Dewatering, and Earth Backfill	1	L.S.	$ 300,000.00	$ 300,000.00
36	Piling - Mobilization and Demobilization	1	L.S.	$ 75,000.00	$ 75,000.00
37	Piling - HP310 x 110	1520	m	$ 250.00	$ 380,000.00
38	600mm DIA Hole Lined with Steel Pipe & Filled with Loose Sand After Driving Piles	36	m	$ 800.00	$ 28,800.00
39	Concrete Working Slab - Piers	1	L.S.	$ 11,000.00	$ 11,000.00
40	Concrete in Abutments & Wingwalls	1	L.S.	$ 190,000.00	$ 190,000.00
41	Concrete in Pier Footings	1	L.S.	$ 90,000.00	$ 90,000.00
42	Concrete in Piers	1	L.S.	$ 74,000.00	$ 74,000.00
43	Concrete in Deck & Diaphragms	1	L.S.	$ 520,000.00	$ 520,000.00
44	Concrete in Sidewalks	1	L.S.	$ 75,000.00	$ 75,000.00
45	Concrete in Approach Slabs	1	L.S.	$ 30,000.00	$ 30,000.00
46	Steel Cutwater Assembly	1	L.S.	$ 7,500.00	$ 7,500.00
47	Reinforcing Steel Bar - Black	75	tonne	$ 2,500.00	$ 187,500.00
48	Structural Steel	1	L.S.	$1,000,000.00	$ 1,000,000.00
49	Bridge Railing (ROW Fountain Street Bridge Type)	1	L.S.	$ 265,000.00	$ 265,000.00
50	Bridge Deck Waterproofing	1	L.S.	$ 40,000.00	$ 40,000.00
51	Form & Fill Grooves	40	m	$ 250.00	$ 10,000.00
52	Plain & Laminated Natural Rubber Bearings	1	L.S.	$ 25,000.00	$ 25,000.00
53	Locate Existing Buried Utility	30	each	$ 500.00	$ 15,000.00
54	Fish Salvage & Transfer	1	L.S.	$ 6,000.00	$ 6,000.00
55	Contingency (10%)	1	L.S.	$ 455,000.00	$ 455,000.00

TOTAL = $ 4,987,050.00
(excluding HST)

6. Refinement of the Preferred Alternative

6.1 Design Criteria

6.2 Railing Alternatives

6.3 Property Acquisition

6.4 Utility Relocations

6.1 Design Criteria

The following design criteria has been determined for this project:

Design Element	Existing Conditions	Design Standards	Proposed Standards
Highway Classification	RLU 50 ±	RLU50	RLU50
Minimum Stopping Sight (m)	65 ±	65	65
Curve "K" Value	-- (sag) 21.1 ± (crest)	12 (sag) 8 (crest)	18 (sag) 15 (crest)
Grades Maximum (%)	2.70	7-11	2.00
Minimum Radius (m)	111.5 ±	80	110
Number of Lanes	2	2	2
Lane Width (m)	4.00m ± (bridge) 3.68m ± (north app.)	3.0	3.5
Cycling Lane Width (m) (where denoted)	--	1.5	1.5
Shoulder Width (m) (where denoted)	1.0±	1.0	0.5
Rounding (m)	--	0.75	1.0
R.O.W. Width (m)	30 ±	30	30±
Posted Speed (km/h)	50	50	50
Traffic	AADT is estimated to be 1100		

Notes:

1. The work involves the construction of a three span girder bridge and reconstruction of the associated roadway approaches.

2. Circular curves with 6% maximum super elevation to be provided on Imperial Road.

3. Super elevation will be developed without transition (spiral) curves.

4. Curbs will be provided at the intersections, on Imperial Road between Dexter Line and Rush Creek Line, and on the inside of Imperial Road between Rush Creek line and Bank Street.

5. 1.5m wide sidewalk will be provided on Imperial Road between Dexter Line and Rush Creek Line. The sidewalk will terminate just past the curb 'drops'.

6. Paved shoulder cycling facilities will be provided on Dexter Line from the west limit of construction to the intersection with Imperial Road and on Imperial Road from the intersection of Dexter Line to the north limit of construction.

7. Roadside drainage is still to be determined but will be a combination of curb and gutter, catch basins, and roadside ditches.

8. Property acquisition is not required; the new construction can be contained within the existing right-of-way.

9. Construction staging is still to be determined. Staged construction will likely be required at the intersection of Imperial Road and Dexter Line, on Imperial Road south of the intersection, and Dexter Line west of the intersection.

10. There are buried and overhead utilities within the limits of construction. The buried utilities are likely fine, but the overhead utilities may need to be raised to provide acceptable vehicular clearances underneath these lines.

11. There are numerous entrances within the limits of construction which will require reconstruction to match the new roadways.

12. Steel beam guide rail will be erected adjacent to the shoulders where the vertical drop exceeds 3m and at the ends of the new bridge.

13. Steel beam guide rail ends will be protected with steel beam energy attenuating terminals (SBEAT).

6.2 Railing Alternatives

6.2.1 Railing Alternatives Letter

The following letter was submitted to the County outlining the bridge railing alternatives for this project:

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS

85 McINTYRE DRIVE
KITCHENER, ONTARIO N2R 1H6

TELEPHONE (519) 748-1199
FAX (519) 748-6100

May 6, 2019 File No. 18-283

Brian Lima, P. Eng. Director of Engineering Services
Director of Engineering Services
County of Elgin
450 Sunset Drive
St. Thomas, Ontario
N5R 5V1

RE: PORT BRUCE BRIDGE REPLACEMENT
IMPERIAL ROAD AT CATFISH CREEK
COUNTY OF ELGIN
RAILING OPTIONS

Dear Brian,

Further to the Imperial Road Port Bruce Bridge Replacement project, we request that the County of Elgin review the following railing options and select a preferred railing for the new structure.

The railing styles which may be considered for this structure are as follows:

Style 1 – Steel Box Beam (Picture 1)

This railing style is an MTO approved railing system constructed of standard and readily available structural elements. It offers a good performing lightweight and open railing compared to concrete parapet walls. It is well suited for vehicular/pedestrian applications and can be found throughout Ontario on bridges which span watercourses. It can terminate in either concrete end posts (shown on the picture) or transition to steel beam guide rail just off the structure.

Appearance wise, this railing style is usually supplied hot dipped galvanized which is silver/grey in colour. For a modest additional cost, this railing can be supplied painted (red, green, black, etc.) to improve the visual appeal.

Cost wise, this railing style is estimated at $950/m.

Style 2 – Concrete Parapet Wall With Single Tube Handrail (Picture 2)

This railing style is probably MTO's favourite and it is widely used throughout the Province of Ontario. It is normally designed to suit the traffic volumes specific to the site. This railing style is closed in nature, hence not allowing views of the river from the bridge. This railing terminates at the end of the bridge where it must transition into steel beam guide rail. A steel hand rail is added to the top of this railing to provide a grab rail for pedestrians.

Normally this railing style appears with form finish faces (i.e. smooth). To improve the aesthetics, patterns can be applied to the wet concrete during the construction to create different patterns. Most commonly brick or random stone patterns are used. Patterning will increase the price of the wall by a nominal amount.

Cost wise, this railing system is estimated at $950/m[1]

Style 3 –Concrete Parapet Wall with Aluminum Handrail (Picture 3)

This railing type is similar to Style 2, except the solid portion of wall (concrete) is shorter and the round handrail is replaced with an aluminum handrail. The design of the railing can be tailored to the specific requirements of the site by increasing or decreasing the reinforcing steel. This railing system would be classified as a semi-open railing style. The railing will terminate at the ends of the bridge and transitions well to steel beam guide rail.

This railing style will appear more open at the top compared to Style 2, but will still have smooth faces. Patterns can be applied to the inside faces, but such would increase the cost by a nominal amount. The aluminum handrail can also be painted to improve the aesthetics.

Cost wise, this railing style is estimated to be $1,000/m[1].

Style 4 –Concrete Parapet Wall with Double Tube Handrail (Picture 4)

This railing system is identical to Style 3, except the aluminum railing would be replaced with double round tubes.

This railing style will appear more open at the top, but will still have smooth faces. Patterns can be applied to the inside faces, but such would increase the cost by a nominal amount. Again, the handrails themselves could be painted to improve the aesthetics.

Cost wise, this railing style is estimated to be $1,000/m[1].

Style 5 –Concrete Parapet Wall with Box Beam Handrail (Picture 5)

This railing style is identical to Style 3, except the aluminum handrail would be replaced with rectangular steel tubes.

As with Style 3, patterns could be applied to the inside faces of the concrete and the rails could be painted. Such additions will increase the cost of the railing system.

Cost wise, this railing style is estimated to be $1,050/m[1].

Style 6 –Safety Shape Barrier with Steel Railing (New Jersey Style) (Picture 6)

This railing type is essentially concrete roadside barrier (similar to highway medians), heavily reinforced with steel rebar, and mounted on the side of the structure. It is generally reserved for high volume structures with no pedestrian traffic. It will terminate at the ends of the bridge and transition to steel beam guide rail. For this application, a steel rail would be added to the top for pedestrian use.

This railing will appear very substantial and utilitarian. It will not offer views of the river or flood plain.

This railing style is estimated to cost $1,100/m[1].

1. Cost provided does not include the cost of premium reinforcement (stainless steel or GFRP) contained within the concrete, but does include the cost of normal (black) reinforcing steel. Should the County of Elgin elect to use premium reinforcement, as the

railing system is vulnerable to salt-induced corrosion,, the additional cost is estimated to be $400/m.

Recommendation

The railing styles presented above are generally the most common types found within the Province of Ontario and are approved for use on MTO roadways. The County of Elgin may select one of these styles or choose a railing style which is not presented above. However, we strongly recommend the County select a railing style which has prior approval from MTO as these railings have been crash-tested and approved for use on Ontario roadways.

At this time, we are recommending Railing Style 1 as depicted on Picture 1. The openness of this railing system will maintain views of the river and landscape similar to the existing views. This railing style also maintains the use of steel along the edges of the bridge. We believe this particular railing will enhance the look of the new bridge and will be maintenance free for many years.

Please review the options and let us know if the County agrees with our recommendation. If necessary, we would be happy to meet with you to further discuss railing styles or present additional ideas.

If you have any questions or additional information is required, please contact the undersigned.

Yours truly,

Allan Garnham, P. Eng.
Project Manager

Railing Option 1 – Steel Box Beam

Railing Option 2 – Concrete Parapet Wall with Single Tube Handrail

Railing Option 3 – Concrete Parapet Wall with Aluminum Handrail

Railing Option 4 – Concrete Parapet Wall with Double Tube Handrail

Railing Option 5 – Concrete Parapet Wall with Box Beam Handrail

Railing Option 6 – Safety Shape Barrier with Steel Railing (New Jersey Style)

6.2.2 Railing Alternatives Memorandum

The following Technical Memorandum has been prepared to summarize the process used to determine the preferred railing alternative.

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS & PLANNERS
85 McIntyre Drive
Kitchener, ON N2R 1H6
Tel: 519-748-1199
Fax: 519-748-6100

Memorandum

The following memorandum has been prepared to summarize the process used to determine the preferred railing alternative.

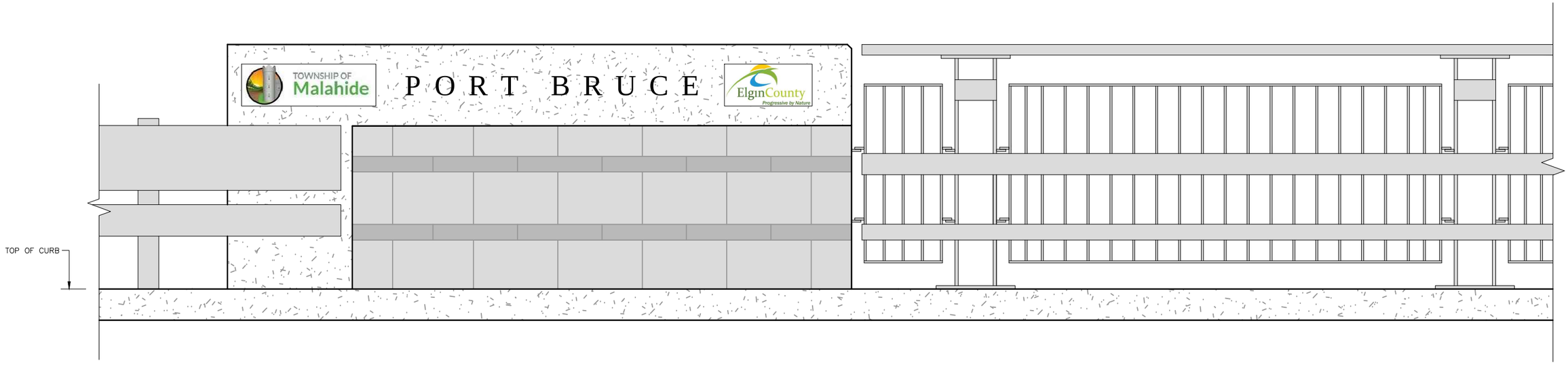
A letter outlining railing styles was submitted to the County of Elgin for review. Upon review of this letter, Railing Style 3 – Concrete Parapet Wall with Aluminum Handrail was selected. Further consultation between staff at the County of Elgin and Township of Malahide led to the consideration of a railing style that has been recently used on new bridges within the Region of Waterloo. This style of railing has been used on the following bridges:

- Fairway Road North Bridge over the Grand River
- Manitou Drive Bridge over Schneider's Creek
- Fountain Street South Bridge over the Grand River

Each of these bridges exhibits subtle differences within the railing style themselves, but generally the railing is of open style comprised of vertical steel posts complete with a pedestrian hand railing and steel panel with decorative horizontal wave pickets.

K. Smart Associates Limited reviewed the Region of Waterloo railing style to ensure this style is viable with the preferred bridge alternative. County of Elgin staff indicated that the decorative steel panel should be slightly modified to consist of only vertical and horizontal pickets. The following drawing showing a few options with this railing style was presented to the County of Elgin for review. Per the following drawing, the County of Elgin has decided to proceed with Option 2.

BRIDGE RAILING – OPTION 1
SCALE 1:10



BRIDGE RAILING – OPTION 2
SCALE 1:10

No.	REVISION	DATE
1.	ISSUED FOR CLIENT REVIEW	JULY 02/19

DESIGNED BY: A.G.
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

SCALE
1:150
1.5m 0 3.0m
(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

END POST ALTERNATIVES

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER EP ALT

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6.3 Property Acquisition

The following Technical Memorandum was prepared to summarize that no property acquisitions are required for this project and that all work will be contained within the existing right-of-way:

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS & PLANNERS
85 McIntyre Drive
Kitchener, ON N2R 1H6
Tel: 519-748-1199
Fax: 519-748-6100

Memorandum

The following memorandum has been prepared to confirm property acquisition IS NOT required to facilitate the preferred alternative.

Property line data prepared by Callon Dietz Incorporated, Ontario Land Surveyors has been inputted into our AutoCAD drawings. Based on 3-D modeling completed using AutoCAD Civil3D, match points were determined at routine intervals (stations) along Imperial Road, Dexter Line, and Rush Creek Line. These match points were then sketched onto the plan views and compared to the property lines. Overall, the match points are within County of Elgin property. Hence no additional property is required to contain the new structure and roadway approaches.

In addition, the preferred alternative is very similar in nature to the original 1962± structure. By means of simple deduction, if the pre-existing structure and roadway was contained with the County's right-of-way, then the proposed work should also be contained within the existing right-of-way.

Also of note, modeling completed using AutoCAD software indicate all storm water management structures (catchbasins, etc.), culverts, and roadside ditches will be constructed on County property.

In conclusion, property acquisition IS NOT required for the preferred alternative.

6.4 Utility Relocations

The following Technical Memorandum was prepared to summarize what utility relocations need to be completed for this project:

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS & PLANNERS
85 McIntyre Drive
Kitchener, ON N2R 1H6
Tel: 519-748-1199
Fax: 519-748-6100

Memorandum

The following memorandum has been prepared to summarize utility relocations required to facilitate the preferred alternative.

The preferred alternative will result in the need to relocate two hydro poles. Hydro poles and wires located within the project area are owned and maintained by Hydro One Networks Inc. (HONI), therefore all relocations will be coordinated with HONI. Most hydro poles within the project area are used for communication cable as well. Communication cable within the project area is owned and maintained by Eastlink, therefore all relocations will be coordinated with Eastlink as well.

1. The first hydro pole requiring relocation is located northwest of the intersection of Imperial Road and Dexter Line. At the current position, this hydro pole will be located in the middle of the proposed sidewalk. Therefore, a new hydro pole will be installed approximately 3m northwest of the current location.

2. There is a hydro pole located immediately north of Catfish Creek on the west side of Imperial Road. Excavation required to facilitate the construction of the north abutment will undermine this hydro pole, and therefore relocation or deep setting of this pole will be required.

7. Heritage and Archaeological Resources Assessment Checklists

Municipal Heritage Bridges
Cultural, Heritage and Archaeological
Resources Assessment Checklist
Revised April 11, 2014

This checklist was prepared in March 2013 by the Municipal Engineers Association to assist with determining the requirements to comply with the Municipal Class Environmental Assessment. View all 4 parts of the module on Structures Over 40 Years at www.municipalclassea.ca to assist with completing the checklist.

Project Name: Imperial Road Port Bruce Bridge

Location: Village of Port Bruce, Township of Malahide, County of Elgin

Municipality: County of Elgin

Project Engineer: Allan Garnham, P. Eng.

Checklist completed by: Allan Garnham, P. Eng.

Date: March 27, 2019

NOTE: Complete all sections of Checklist. Both Cultural Heritage and Archaeological Sections must be satisfied before proceeding.

Part A - Municipal Class EA Activity Selection

Description	Yes	No
Will the proposed project involve or result in construction of new water crossings? This includes ferry docks.	❒ Schedule B or C	☑ Next
Will the proposed project involve or result in construction of new grade separation?	❒ Schedule B or C	☑ Next
Will the proposed project involve or result in construction of new underpasses or overpasses for pedestrian recreational or agricultural use?	❒ Schedule B or C	☑ Next
Will the proposed project involve or result in construction of new interchanges between any two roadways, including a grade separation and ramps to connect the two roadways?	❒ Schedule B or C	☑ Next

Description	Yes	No
Will the proposed project involve or result in reconstruction of a water crossing where the structure is less than 40 years old and the reconstructed facility will be for the same purpose, use, capacity and at the same location? (Capacity refers to either hydraulic or road capacity.) This include ferry docks.	❒ Schedule A+	☑ Next
Will the proposed project involve or result in reconstruction of a water crossing, where the reconstructed facility will not be for the same purpose, use, capacity or at the same location? (Capacity refers to either hydraulic or road capacity). This includes ferry docks.	❒ Schedule B or C	☑ Next
Will the proposed project involve or result in reconstruction or alteration of a structure or the grading adjacent to it when the structure is over 40 years old where the proposed work will alter the basic structural system, overall configuration or appearance of the structure?	☑ Next	❒ Assess Archaeological Resources

Part B - Cultural Heritage Assessment

Description	Yes	No
Does the proposed project involve a bridge construction in or after 1956?	☑ Next	❒ Prepare CHER Undertake HIA
Does the project involve one of these four bridge types?	❒ Rigid frame Next ☑ Precast with Concrete Deck Next ❒ Culvert or Simple Span Next ❒ Steel Bean/ Concrete Deck Next	❒ Prepare CHER Undertake HIA

Description	Yes	No
Does the bridge or study area contain a parcel of land that is subject of a covenant or agreement between the owner of the property and a conservation body or level of government?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is listed on a register or inventory of heritage properties maintained by the municipality?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is designated under Part IV of the Ontario Heritage Act?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is subject to a notice of intention to designate issued by a municipality?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is located within a designated Heritage Conservation District?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is subject to a Heritage Conservation District study area by-law?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is included in the Ministry of Tourism, Culture and Sport's list of provincial heritage properties?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is part of a National Historic Site?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is part of a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site?	❒ Prepare CHER Undertake HIA	☑ Next

Description	Yes	No
Does the bridge or study area contain a parcel of land that is designated under the Heritage Railway Station Protection Act?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is identified as a Federal Heritage Building by the Federal Heritage Building Review Office (FHBRO)	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is the subject of a municipal, provincial or federal commemorative or interpretive plaque that speaks to the Historical significance of the bridge?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain a parcel of land that is in a Canadian Heritage River watershed?	❒ Prepare CHER Undertake HIA	☑ Next
Will the project impact any structures or sites (not bridges) that are over forty years old, or are important to defining the character of the area or that are considered a landmark in the local community?	❒ Prepare CHER Undertake HIA	☑ Next
Is the bridge or study area adjacent to a known burial site and/or cemetery?	❒ Prepare CHER Undertake HIA	☑ Next
Is the bridge considered a landmark or have a special association with a community, person or historical event in the local community?	❒ Prepare CHER Undertake HIA	☑ Next
Does the bridge or study area contain or is it part of a cultural heritage landscape?	❒ Prepare Cher Undertake HIA	☑ Assess Archaeological Resources

PART C - HERITAGE ASSESSMENT

Description	Yes	No
Does the Cultural Heritage Evaluation Report identify any Heritage Features on the project?	❒ Undertake HIA	❒ Part D - Archaeological Resources
Does the Heritage Impact Assessment determine that the proposed project will impact any of the Heritage Features that have been identified?	❒ Schedule B or C	❒ Part D - Archaeological Resources

PART D - ARCHAEOLOGICAL RESOURCES ASSESSMENT

Description	Yes	No
Will any activity, related to the project, result in land impacts/significant ground disturbance?	☑ Next	❒ Schedule A - proceed
Have all areas, to be impacted by ground disturbing activities, been subjected to recent extensive and intensive disturbances and to depths greater than the depths of the proposed activities?	❒ Schedule A - proceed	☑ Next
Has an archaeological assessment previously been carried out that includes all of the areas to be impacted by this project?	❒ Next	☑ Archaeological Assessment
Does the report on that previous archaeological assessment recommend that no further archaeological assessment is required within the limits of the project for which that assessment was undertaken, and has a letter been issued by the Ministry of Tourism, Culture and Sport stating that the report has been entered into the Ontario Public Register of Archaeological Reports?	❒ Schedule A - proceed	☑ Obtain satisfaction letter - proceed

**** Include Documentation Summary in Project File****

Project or Property Name
Imperial Road Port Bruce Bridge

Project or Property Location (upper and lower or single tier municipality)
Imperial Road at Catfish Creek, Village of Port Bruce, Township of Malahide, County of Elgin

Proponent Name
County of Elgin

Proponent Contact Information
County of Elgin c/o K. Smart Associates Limited, 85 McIntyre Drive, Kitchener, ON, N2R 1H6

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

8. Archaeological Assessment

8.1 Stage 1-2 Report

8.2 Stage 3 Report

Stage 1-2 Archaeological Assessment
Port Bruce Bridge Replacement

Lots 4 and 5, Concession 1,
Geographic Township of Malahide,
County of Elgin,
Port Bruce, Ontario

Submitted to:
K. Smart Associates Limited
85 McIntyre Drive
Kitchener, ON N2R 1H6

and

Ontario's Ministry of Tourism, Culture and Sport

Submitted by:

Detritus
CONSULTING LTD.
archaeology · heritage

69 Claremont Avenue, Kitchener Ontario, N2M 2P5
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Licensee: Garth Grimes
License Number: P017
PIF Number: P017-0715-2019
CP Number: 2018-199

ORIGINAL REPORT

August 19, 2019

Executive Summary

Detritus Consulting Ltd. ('Detritus') was retained by K. Smart Associates Limited ('the Proponent') to conduct a Stage 1-2 archaeological assessment on Lots 4 and 5, Concession 1, Geographical Township of Malahide, County of Elgin, Port Bruce, Ontario (Figure 1). This assessment was undertaken in advance of a proposed bridge replacement located at on Imperial Road from Bank Street in the north to approximately 100m south of Dexter Line. The assessment property ('Study Area') comprises portions of three roads, Imperial Road, Dexter Line, and Rush Creek Line, as well as their right-of-way, which measures 2.86 hectares (ha). At the time of the assessment, the Study Area comprised portions of Imperial Road, Dexter Line, and Rush Creek Line, their right-of-way as well as portions of private residential properties. Additionally, a tributary of Catfish Creek and Catfish Creek itself transect the Study Area along the northern edge and through the centre respectively.

The assessment was triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the condition, a Stage 1-2 assessment of the Study Area was conducted, during the pre-approval phase of the proposed bridge replacement, under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adheres to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

The Stage 1 background research indicated that the level ground portion of the manicured and overgrown grass components of the Study Area exhibited moderate to high potential for the identification and recovery of archaeological resources and were recommended for Stage 2 archaeological assessment (Figure 3). The existing asphalt roads, their concrete and gravel shoulders, as well as 15 gravel or asphalt laneways and parking areas and three areas where natural gas utilities are present, were evaluated as having no potential based on the identification of extensive and deep land alteration that has severely damaged the integrity of archaeological resources, as per Section 2.1, Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). These areas of disturbance, as confirmed during the Stage 2 field survey, were mapped and photo documented in accordance with Section 2.1, Standard 6 and Section 7.8.1, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011). Furthermore, a tributary of Catfish Creek, Catfish Creek itself and a ditch transect are also present within the Study Area. These areas were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). Additionally, steeply sloped overgrown grass, treed areas, overgrown weed areas and ditches are located throughout the Study Area. The permanently wet areas and steeply sloped areas, as confirmed during the Stage 2 field survey, were mapped and photo documented in accordance with Section 2.1, Standard 6 and Section 7.8.1, Standard 1a of the *Standards and Guidelines* (Government of Ontario 2011).

The subsequent Stage 2 assessment was conducted on May 27 and 31, 2019. This investigation consisted of a standard test pit survey at a five-metre interval and resulted in the identification and documentation of five archaeological sites; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7).

The Stage 2 assessment of M1 (AdHg-5) resulted in the documentation of 12 Euro-Canadian artifacts and 4 pre-contact Aboriginal artifacts from a single test pit and a single test unit located in the manicured grass area on the south side of Rush Creek Line, East of Imperial Road, in the northern portion of the Study Area. The Euro-Canadian component of the site comprises four cut nails, four recent material, two animal bones and two pieces of fence wire. The cut nails date from the middle to late 19th century. The presence of wire drawn nails, two brown beer bottle glass fragments, one piece of asphalt, and one plastic coffee cup lid extends this occupation into the

20th century. According to the background research presented above, M1 (AdHg-5) was located in the portion of Lot 5, Concession 1 that was owned by C. Monro in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of M1 (AdHg-5), however, the early community of Port Bruce is located to the south of the Study Area. Based on the results of the Stage 2 assessment, the Euro-Canadian component of M1 (AdHg-5) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of C. Monro.

The pre-contact Aboriginal component of the site comprised three thinning flakes and one secondary flake. Two of the thinning flakes are manufactured from Haldimand chert and one from Onondaga chert. The single secondary flake is manufactured on Onondaga chert. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Based on a complete absence of diagnostic artifacts, M1 (AdHg-5) has been interpreted as a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. The use of Onondaga and Haldimand chert, meanwhile, indicates that the people at M1 (AdHg-5) were largely relying on two sources of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 58km to the east of the site. Outcrops of Haldimand chert are found between Kohler and Hagersville, as well as in Cayuga, Ontario, which is approximately 85km to the northeast of the site.

M1 (AdHg-5) does not fulfill the criteria for further assessment as per Section 2.2, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011), however, given that there were only four archaeological sites registered within the Borden block AdHg prior to the current assessment and that M1 (AdHg-5) is located within the early community of Port Bruce, it was determined based on professional judgement that M1 (AdHg-5) retains CHVI. Additionally, as per Section 2.2 Guideline 1 of the *Standards and Guidelines* (Government of Ontario 2011) Detritus engaged with the COTTFN and it was determined that Stage 3 would be recommended in order to ensure there are no unaddressed Aboriginal archaeological interests connected with the land surveyed or sites identified. As a result, **M1 (AdHg-5) meets the criteria for a Stage 3 assessment** as per Section 2.2 Guidelines 1 to 3 of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

The Stage 2 assessment of M5 (AdHg-9) resulted in the documentation of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits located in the manicured grass area on the north side of Dexter Line, west of Imperial Road, and south of Catfish Creek. The Euro-Canadian component of the site comprises six structural artifacts, six household artifacts, one ceramic artifact and one piece of miscellaneous metal. The cut nails and ironstone fragment date from the middle to late 19th century. The remaining Euro-Canadian artifacts are non-diagnostic. According to the background research presented above, M5 (AdHg-9) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of M5 (AdHg-9). Based on the results of the Stage 2 assessment, M5 (AdHg-9) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that the Euro-Canadian component of M5 (AdHg-9) does not contain 20 artifacts dating to a period of use to before 1900 the site therefore retains no CHVI. As a result, **no Stage 3 assessment is recommended for the Euro-Canadian component of M5 (AdHg-9),** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The pre-contact Aboriginal component of the site comprises five thinning flakes, four of which are manufactured on Onondaga chert and one of an unknown chert type. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Given a complete absence of diagnostic artifacts the pre-contact Aboriginal component of M5 (AdHg-9) has been interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. Based on these results, the pre-contact component of M5 (AdHg-9) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, **the pre-contact component of M5 (AdHg-9) fulfills**

the criteria for a Stage 3 assessment as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

The Stage 2 assessment of P4 (AdHg-8) resulted in the documentation of 15 pre-contact Aboriginal artifacts and 7 Euro-Canadian artifacts from eight positive test pits located in the manicured grass area on the north side of Dexter Line, west of Imperial Road, south of Catfish Creek, and approximately 20m to the west of M5 (AdHg-9). The pre-contact Aboriginal component of the site comprises 11 thinning flakes, 3 secondary flakes and 1 flake fragment. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Given a complete absence of diagnostic artifacts the pre-contact Aboriginal component of P4 (AdHg-8) has been interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. Based on these results of the Stage 2 assessment, the pre-contact component of P4 (AdHg-8) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, **P4 (AdHg-8) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

The Euro-Canadian component of P4 (AdHg-8) comprises four cut nails, 1 bird bone, 1 ironstone fragment and 1 piece of window glass. The cut nails and ironstone fragment date from the middle to late 19th century. Given that the Euro-Canadian component of P4 (AdHg-8) does not contain 20 artifacts dating to a period of use to before 1900, the site therefore retains no CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011). The **Euro-Canadian component of P4 (AdHg-8) does not fulfill the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The Stage 2 assessment of H2 (AdHg-6) resulted in the documentation of 45 Euro-Canadian artifacts from two test pits, identified in the manicured grass area on the south side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The artifact assemblage is dominated by ceramic sherds, and in particular, ironstone pieces; a single RWE fragment was also recovered. The Stage 2 artifacts document a period of occupation spanning the middle to late 19th century, based primarily on the predominance of ironstone and RWE ceramic pieces, and machine cut nails. According to the background research presented above, H2 (AdHg-6) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of H2 (AdHg-6). Based on the results of the Stage 2 assessment, H2 (AdHg-6) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Based on the results of the Stage 2 assessment, H2 (AdHg-6) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that H2 (AdHg-6) contains at least 20 artifacts dating to a period of use to before 1900 and the site therefore retains CHVI. As a result, **H2 (AdHg-6) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The Stage 2 assessment of H3 (AdHg-7) resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits, identified in the manicured grass area on the north side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The artifact assemblage is dominated by ceramic sherds, and in particular, RWE pieces; ironstone, pearlware, and stoneware are also represented in lesser amounts. The Stage 2 artifacts document a period of occupation spanning the middle to late 19th century, based primarily on the predominance of RWE and ironstone ceramic pieces, cut nails, clear bottle glass, and white clay pipe fragments. A few earlier artifacts were observed in the Stage 2 assemblage, including nine window glass shards measuring less than 1.6mm and one piece of pearlware. Whereas the window glass might suggest the presence of an earlier structure, the early pearlware fragment is thought to represent an heirloom item.

According to the background research presented above, H3 (AdHg-7) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of H3 (AdHg-7). Based on the results of the Stage 2 assessment, H3 (AdHg-7) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Based on the results of the Stage 2 assessment, H3 (AdHg-7) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that H3 (AdHg-7) contains at least 20 artifacts dating to a period of use to before 1900 and the site therefore retains CHVI. As a result, **H3 (AdHg-7) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The Executive Summary highlights key points from the report only; for complete information and findings, the reader should examine the complete report.

Table of Contents

Project Personnel

Project Manager:	Garth Grimes, P017
Field Director:	Jon Cousins, R296
Field Technician:	Ryan Eden; Mathew Gibson, R1160; Laura Savoie, R1237
Artifact Analysis:	Jon Cousins, R296
Report Preparation:	Amanda Laprise, R470
Mapping and GIS:	Amanda Laprise, R470
Licensee Review:	Garth Grimes, P017

Acknowledgments

Generous contributions by the following individuals made this report possible.

- Mr. Daryl Schwartzentruber of K. Smart Associates Limited

1.0 Project Context

1.1 Development Context

Detritus Consulting Ltd. ('Detritus') was retained by K. Smart Associates Limited ('the Proponent') to conduct a Stage 1-2 archaeological assessment on Lots 4 and 5, Concession 1, Geographical Township of Malahide, County of Elgin, Port Bruce, Ontario (Figure 1). This assessment was undertaken in advance of a proposed bridge replacement located at on Imperial Road from Bank Street in the north to approximately 100m south of Dexter Line (the 'Study Area').

The assessment was triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the condition, a Stage 1-2 assessment of the Study Area was conducted, during the pre-approval phase of the proposed bridge replacement, under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adheres to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

The purpose of a Stage 1 Background Study is to compile all available information about the known and potential archaeological heritage resources within the Study Area and to provide specific direction for the protection, management and/or recovery of these resources. In compliance with the *Standards and Guidelines* (Government of Ontario 2011), the objectives of the following Stage 1 assessment are as follows:

- To provide information about the Study Area's geography, history, previous archaeological fieldwork and current land conditions;
- to evaluate in detail, the Study Area's archaeological potential which will support recommendations for Stage 2 survey for all or parts of the property; and
- to recommend appropriate strategies for Stage 2 survey.

To meet these objectives Detritus archaeologists employed the following research strategies:

- A review of relevant archaeological, historic and environmental literature pertaining to the Study Area;
- a review of the land use history, including pertinent historic maps; and
- an examination of the Ontario Archaeological Sites Database ('ASDB') to determine the presence of known archaeological sites in and around the Study Area.

The purpose of a Stage 2 Property Assessment was to provide an overview of any archaeological resources within the Study Area, and to determine whether any of the resources might be archaeological sites with cultural heritage value or interest ('CHVI'), and to provide specific direction for the protection, management and/or recovery of these resources. In compliance with the *Standards and Guidelines* (Government of Ontario 2011), the objectives of the following Stage 2 assessment are as follows:

- To document all archaeological resources within the Study Area;
- to determine whether the Study Area contains archaeological resources requiring further assessment; and
- to recommend appropriate Stage 3 assessment strategies for archaeological sites identified.

The licensee received permission from the Proponent to enter the land and conduct all required archaeological fieldwork activities, including the recovery of artifacts.

1.2 Historical Context

1.2.1 Post-Contact Aboriginal Resources

The earliest recorded history of southern Ontario began in 1626, when French Recollet Father Daillon travelled the entire length of the Grand River and documented 28 Neutral villages in the area (Harper 1950; White 1978). In 1647, the Seneca attacked one eastern group of the Neutral (White 1978) and, by 1653, the Neutral had been assimilated by the Five Nations (Jamieson 1992; Noble 1978). The Five Nations relinquished the Niagara Peninsula and northern Lake Ontario area before 1700.

The late 17th and early 18th centuries represent a watershed moment in the evolution of the post-contact Aboriginal occupation of southern Ontario. At this time, various Iroquoian-speaking communities began migrating into southern Ontario from New York State, followed by the arrival of Algonkian-speaking groups from northern Ontario (Konrad 1981; Schmalz 1991). This period also marks the arrival of the Mississaugas into southern Ontario and, in particular, the watersheds of the lower Great Lakes.

The oral traditions of the Mississaugas, as told by Chief Robert Paudash and recorded in 1904, suggest that the Mississaugas defeated the Mohawk Nation, who retreated to their homeland south of Lake Ontario. Following this conflict, a peace treaty was negotiated between the two groups and, at the end of the 17th century, the Mississaugas settled permanently in southern Ontario (Praxis Research Associates n.d.). Around this same time, members of the Three Fires Confederacy (Chippewa, Ottawa, and Potawatomi) began immigrating from Ohio and Michigan into southwestern Ontario (Feest and Feest 1978).

In 1722, the Five Nations adopted the Tuscarora in New York becoming the Six Nations (Pendergast 1995). Sir Frederick Haldimand, Governor of Québec, made preparations to grant a large plot of land in south-central Ontario to those Six Nations who remained loyal to the Crown during the American War of Independence (Weaver 1978). More specifically, Haldimand arranged for the purchase of the Haldimand Tract in south-central Ontario from the Mississaugas. The Haldimand Tract, also known as the 1795 Crown Grant to the Six Nations, was provided for in the Haldimand Proclamation of October 25th, 1784 and was intended to extend a distance of six miles on each side of the Grand River from mouth to source (Weaver 1978).

The Study Area first enters the Euro-Canadian historic record a few years later on May 19th 1790, as part of Treaty Number 2 made between the First Nation inhabitants of the area and the British, specifically Alexander McKee of the Indian Department (Surtees 1994). This treaty…

> *…was made with the Ottawas, Chippewas, Pottawatomys and Hurons May 19th, 1790, portions of which nations had established themselves on the Detroit River all of whom had been driven by the Iroquois from the northern and eastern parts of the Province, from the Detroit River easterly to Catfish Creek and south of the river La Tranche [Thames River] and Chenail Ecarte, and contains Essex County except Anderdon Township and Part of West Sandwich; Kent County except Zone Township, and Gores of Camden and Chatham; Elgin County except Bayham Township and parts of South Dorchester and Malahide. In Middlesex County, Del[a]ware and Westminster Townships and part of North Dorchester.*
>
> Morris 1943: 17

At this time, European squatters had already begun to settle along the banks of the Thames River, although their specific locations were not recorded until the first survey of the area was made after the First Nation land surrender in 1790 (Hamil 1951).

The size and nature of the pre-contact settlements and the subsequent spread and distribution of Aboriginal material culture in southern Ontario began to shift with the establishment of European settlers in southern Ontario.

Despite the inevitable encroachment of European settlers on previously established Aboriginal territories, "*written accounts of material life and livelihood, the correlation of historically recorded villages to their archaeological manifestations, and the similarities of those sites to more ancient sites have revealed an antiquity to documented cultural expressions that confirms a deep historical continuity to Iroquoian systems of ideology and thought*" (Ferris 2009:114). As Ferris observes, despite the arrival of a competing culture, First Nations communities throughout southern Ontario have left behind archaeologically significant resources that demonstrate continuity with their pre-contact predecessors, even if they have not been recorded extensively in historical Euro-Canadian documentation.

1.2.2 Euro-Canadian Resources

The current Study Area is located in the Geographic Township of Malahide, County of Elgin, Port Bruce, Ontario.

On July 24, 1788, Sir Guy Carleton, the Governor-General of British North America, divided the Province of Québec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (Archives of Ontario 2009). Further change came in December 1791 when the former Province of Québec was rearranged into Upper Canada and Lower Canada under the *Constitutional Act*. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada (Coyne 1895) and he introduced several initiatives to populate the province including the establishment of shoreline communities with effective transportation links between them.

In July 1792, Simcoe divided Upper Canada into 19 counties stretching from Essex in the west to Glengarry in the east. Later that year, the four districts originally established in 1788 were renamed as the Western, Home, Midland and Eastern Districts. The Study Area was situated in Norfolk County, which was part of the Western District (Archives of Ontario 2009).

As population levels in Upper Canada increased, smaller and more manageable administrative bodies were needed resulting in the establishment of many new counties and townships. As part of this realignment, the boundaries of the Home and Western Districts were shifted and the London and Niagara Districts were established. Under this new territorial arrangement, the Study Area was part of the London District (Archives of Ontario 2009).

The area of Elgin County was first settled by Lieutenant Thomas Talbot, the personal secretary of Lieutenant Governor Simcoe. After resigning from the military, Talbot sought to establish a small agricultural settlement at Kettle Creek, now Port Stanley. Given delays to this land grant, Simcoe requested 5,000 acres for future settlement along the north shore of Lake Erie on behalf of Talbot. In 1803, Talbot arrived from England and established a small settlement that he named Port Talbot. He then erected a log house on a hill facing the lake with a view of Talbot Creek valley. By 1808, he had constructed the settlements first water mill along Talbot Creek. He also provided new settlers with seed for wheat, barley, peas and oats. At the time, much of southwestern Ontario was owned by speculators, the Crown or the Anglican Church. Talbot, however, sought industrious settlers who demonstrated skill in infrastructure development, as opposed to land speculators. In addition to the settlement at Port Talbot, Talbot was granted 200 acres for every settler that he received. As part of this initiative, Talbot settled immigrants in Aldborough and Dunwich Townships, and eventually in Southwold, Yarmouth, Malahide, and Bayham Townships. By the middle of the 19th century, the population of Elgin County had risen to 12,000 settlers and over 60,000 acres had been cleared for cultivation.

The Township of Malahide received its name from Colonel Talbot, who sought to honour the Castle of Malahide in Ireland. The earliest settlers to the township were the five Davis brothers, American immigrants who arrived in 1810. Although Malahide did not grow significantly until much later, it boasted a population of some 800 people by 1817. At this time, nearly all of the first, eighth, and ninth concessions had been settled. The earliest businesses, including a general store

(est.1830), hotel, tailor and blacksmith shop (est. 1835), were established in the early to mid-1830s, although the County's first schoolhouse was erected in the township in 1816. Passage through the township was aided by the graveling of the Aylmer–Port Bruce Road, now known as Highway 73/Imperial Road, in 1855 (Page & Co. 1877).

Between 1837 and 1851, Elgin County was part of Middlesex County. In 1841, Middlesex County became part of Canada West in the new United Province of Canada. Following the abolition of the district system in 1849, the counties of Canada West were reconfigured once again. In 1851, Elgin County was severed from Middlesex County and was named for the Governor-General of the time, Lord Elgin. Throughout the reminder of the century, a number of schools, churches, businesses and industries were established throughout Elgin County, including a notable ship building industry at Port Burwell and fishing industries at Port Stanley and Port Burwell. Furthermore, at least five different railways eventually spanned the county, linking it to cities and ports in Canada and the United States, including the Michigan Central, the Pere Marquette, the London and Port Stanley, the Canadian National and the Canadian Pacific (McCallum 2016).

The *Illustrated Historical Atlas of the County of Elgin Ont.* ('*Historical Atlas';* Page & Co. 1877), demonstrates the extent to which Malahide Township had been settled by 1877 (Figure 2). Landowners are listed for every lot within the township. Many of the lots had been subdivided into smaller parcels to accommodate an increasing population throughout the late 19th century. Structures and orchards are prevalent throughout the township, almost all of which front early roads, such as Talbot Road.

According to the *Historical Atlas* map of Malahide Township, Lot 4, Concession 1 was divided into two parcels. C. Monro is listed as the owner of the parcel north of Catfish Creek. A structure, a school house and an orchard are located on Mr. Monro's property north of what is now known as Rush Creek Line. South of Rush Creek Line on Mr. Monro's parcel is a structure and an orchard. R. Wilson is illustrated as the owner of the parcel south of Catfish Creek. A single structure and an orchard are located on Mr. Wilson's property north of what is now known as Highway 24/Dexter Line, which transects Mr. Wilson's parcel from northeast to southwest. A portion of the early community of Port Bruce is located south of Catfish Creek on Mr. Wilson's property.

Furthermore, Mr. Monro also owned the northern parcel of Lot 5, Concession 1, north of Rush Creek Line. It is however unclear if Mr. Monro also owned the portion of Lot 5 south of Rush Creek Line and north of Catfish Creek. The early community of Port Bruce occupies that entire southern portion of Lot 5 south of Catfish Creek, as well as a portion of Lot 6. No orchards or structures are located on Lot 5, Concession 1. Significant and detailed landowner information is available on the historical atlas map of Malahide Township; however, it should be recognized that historical county atlases were produced primarily to identify factories, offices, residences and landholdings of subscribers and were funded by subscriptions fees. Therefore, landowners who did not subscribe were not always listed on the maps (Caston 1997). Moreover, associated structures were not necessarily depicted or placed accurately (Gentilcore and Head 1984).

1.3 Archaeological Context

1.3.1 Property Description and Physical Setting

The Study Area comprises portions of three roads, Imperial Road, Dexter Line, and Rush Creek Line, as well as their right-of-way, which measures 2.86 hectares (ha). At the time of the assessment, the Study Area comprised portions of Imperial Road, Dexter Line, and Rush Creek Line, their concrete and gravel shoulders, as well as portions of private residential properties, which comprised manicured and overgrown grass areas, treed areas, and overgrown weed areas and gravel or asphalt laneways and parking areas. Additionally, a tributary of Catfish Creek, Catfish Creek itself and a ditch are located in the central and northern portion of the Study Area.

The Study Area is located within the Norfolk Sand Plain physiographic region. The Norfolk Sand Plain has been classified as a wedge-shaped plain stretching from the Niagara Escarpment in a southwesterly direction to the north shore of Lake Erie. The sands and silts of this region were deposited as a delta in glacial Lakes Whittlesey and Warren, and was formed from west to east as the glacier withdrew (Chapman and Putnam 1984). These physiographic elements accumulated over grey shale and limestone bedrock belonging to the Middle Devonian Dundee formation (Davidson 1989). During pre-contact and early contact times, this area comprised a mixture of deciduous trees and open areas. In the late 18th century, Euro-Canadian settlers began to clear the forests for agricultural purposes, which have been ongoing in the vicinity of the Study Area for over 100 years.

The closest source of potable water is a tributary of Catfish Creek and Catfish Creek itself, which transect the Study Area along the northern edge and through the centre respectively.

1.3.2 Pre-Contact Aboriginal Land Use

This portion of southwestern Ontario has been demonstrated to have been occupied by people as far back as 11,000 years ago as the glaciers retreated. For the majority of this time, people were practicing hunter gatherer lifestyles with a gradual move towards more extensive farming practices. Table 1 provides a general outline of the cultural chronology of Malahide Township, based on Ellis and Ferris (1990).

Table 1: Cultural Chronology for Malahide Township

Time Period	Cultural Period	Comments
9500 – 7000 BC	Paleo Indian	first human occupation hunters of caribou and other extinct Pleistocene game nomadic, small band society
7500 - 1000 BC	Archaic	ceremonial burials increasing trade network hunter gatherers
1000 - 400 BC	Early Woodland	large and small camps spring congregation/fall dispersal introduction of pottery
400 BC – AD 800	Middle Woodland	kinship based political system incipient horticulture long distance trade network
AD 800 - 1300	Early Iroquoian (Late Woodland)	limited agriculture developing hamlets and villages
AD 1300 - 1400	Middle Iroquoian (Late Woodland)	shift to agriculture complete increasing political complexity large palisaded villages
AD 1400 - 1650	Late Iroquoian	regional warfare and political/tribal alliances destruction of Huron and Neutral

1.3.3 Previously Identified Archaeological Work

In order to compile an inventory of archaeological resources, the registered archaeological site records kept by the MTCS were consulted. In Ontario, information concerning archaeological sites stored in the ASDB (Government of Ontario n.d.) is maintained by the MTCS. This database contains archaeological sites registered according to the Borden system. Under the Borden system, Canada is divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13 kilometres (km) east to west and approximately 18.5km north to south. Each Borden Block is referenced by a four-letter designator and sites within a block are numbered sequentially as they are found. The study area under review is within Borden Block AdHg.

Information concerning specific site locations is protected by provincial policy, and is not fully subject to the *Freedom of Information and Protection of Privacy Act* (Government of Ontario 1990c). The release of such information in the past has led to looting or various forms of illegally

conducted site destruction. Confidentiality extends to all media capable of conveying location, including maps, drawings, or textual descriptions of a site location. The MTCS will provide information concerning site location to the party or an agent of the party holding title to a property, or to a licensed archaeologist with relevant cultural resource management interests.

According to the ASDB, a single archaeological site has been registered within 1km of the Study Area, Pineo 1 (AdHg-1). Pineo 1 (AdHg-1) is a multi-component site of which the pre-contact component dates from the Middle Archaic to the Late Woodland periods. To the best of Detritus' knowledge, no other assessments have been conducted adjacent to the Study Area, and no sites are registered within 50m of the Study Area.

1.3.4 Archaeological Potential

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. Detritus applied archaeological potential criteria commonly used by the MTCS (Government of Ontario 2011) to determine areas of archaeological potential within Study Area. These variables include proximity to previously identified archaeological sites, distance to various types of water sources, soil texture and drainage, glacial geomorphology, elevated topography, and the general topographic variability of the area.

Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and, considered alone, may result in a determination of archaeological potential. However, any combination of two or more other criteria, such as well-drained soils or topographic variability, may also indicate archaeological potential. When evaluating distance to water it is important to distinguish between water and shoreline, as well as natural and artificial water sources, as these features affect sites locations and types to varying degrees. The MTCS (Government of Ontario 2011) categorizes water sources in the following manner:

- Primary water sources: lakes, rivers, streams, creeks;
- secondary water sources: intermittent streams and creeks, springs, marshes and swamps;
- past water sources: glacial lake shorelines, relic river or stream channels, cobble beaches, shorelines of drained lakes or marshes; and
- accessible or inaccessible shorelines: high bluffs, swamp or marshy lake edges, sandbars stretching into marsh.

As was discussed above, the closest source of potable water is a tributary of Catfish Creek and Catfish Creek itself, which transect the Study Area along the northern edge and through the centre respectively.

Soil texture is also an important determinant of past settlement, usually in combination with other factors such as topography. The Study Area is situated within the Norfolk Sand Plain physiographic region. As was discussed earlier, the primary soils within the Study Area, have been documented as being suitable for pre-contact Aboriginal practices. Add to this discussion the presence of a single multi-component site within 1km of the Study Area and the Aboriginal archaeological potential is judged to be moderate to high.

For Euro-Canadian sites, archaeological potential can be extended to areas of early Euro-Canadian settlement, including places of military or pioneer settlements; early transportation routes; and properties listed on the municipal register or designated under the *Ontario Heritage Act* (Government of Ontario 1990b) or property that local histories or informants have identified with possible historical events.

As was discussed above, the *Historical Atlas* map (Page & Co. 1877; Figure 2) demonstrates the extent to which Malahide Township had been settled by 1877. Landowners are listed for most of the lots within the township, some of which had been subdivided into smaller parcels to accommodate an increasing population throughout the late 19th century. The Study Area is located in close proximity to historical roads, and the early community of Port Bruce. Considering

also the single multi-component site registered within 1km to the Study Area and the potential for post-contact Euro-Canadian archaeological resources is judged to be moderate to high.

Finally, despite the factors mentioned above, extensive land disturbance can eradicate archaeological potential within a Study Area (Wilson and Horne 1995). The existing asphalt roads, their concrete curbs and gravel shoulders, as well as 15 gravel or asphalt driveways were identified as areas that may have no potential based on the identification of extensive and deep land alteration that has severely damaged the integrity of archaeological resources, as per Section 1.3.2 of the *Standards and Guidelines* (Government of Ontario 2011).

These possible areas of previous disturbance were confirmed during a Stage 2 property inspection, conducted as per Section 2.1.8 of the *Standards and Guidelines* (Government of Ontario 2011). Based on the results of this inspection, the existing asphalt roads, their concrete and gravel shoulders, as well as 15 gravel or asphalt driveways, and areas disturbed by Natural Gas Utilities were excluded from the Stage 2 assessment, as per Section 2.1, Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). Additionally, the tributary of Catfish Creek and Catfish Creek itself transect the Study Area along the northern edge and through the centre respectively, as well as the steeply sloping overgrown grass, treed and weeded areas were excluded from the Stage 2 assessment, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). The remainder of the Study Area, comprising manicured and overgrown grass areas on level ground, which demonstrated no signs of visible disturbance and therefore retained archaeological potential and was recommended for assessment.

2.0 Field Methods

The current Stage 2 archaeological assessment was conducted on May 27 and 31, 2019 under archaeological consulting license P017 issued to Mr. Garth Grimes by the MTCS (P017-0715-2019). The limits of the Study Area were surveyed by the Proponent prior to assessment.

Assessment conditions were excellent and at no time were the field, weather, or lighting conditions detrimental to the recovery of archaeological material. Photos 1 to 58 demonstrate the land conditions at the time of the survey throughout the Study Area. Figure 3 provides an illustration of the Stage 2 assessment methods, as well as photograph locations and directions. Table 2 provides a summary of the weather and field conditions during the Stage 2 archaeological assessment.

Table 2: Field and Weather Conditions

Date	Activity	Weather	Field Conditions
May 27, 2019	Test Pit Survey	sunny, 15°C	soil dry and screens easily
May 31, 2019	Test Pit Survey	sunny, 15°C	soil dry and screens easily

Approximately 50% of the Study Area comprised existing asphalt roads, their concrete and gravel shoulders, as well as 15 gravel or asphalt laneways and parking areas and three areas where Natural Gas utilities are present. These areas were evaluated as having no potential based on the identification of extensive and deep land alteration that has severely damaged the integrity of archaeological resources, as per Section 2.1, Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). These disturbed areas were mapped and photo documented only (Photos 1 to 5, 7 to 21, 25, 27 to 46, 48 to 50) in accordance with Section 2.1, Standard 6 and Section 7.8.1, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

Approximately 25% of the Study Area comprised manicured and overgrown grass on level ground, which was inaccessible for ploughing. These areas were subject to a typical test pit survey at 5m intervals in accordance with Section 2.1.2 of the *Standards and Guidelines* (Government of Ontario 2011; Photos 1, 2, 6 to 11, 13 to 21, 28 to 36, 41 to 44, 46, 47, 50, 51, 55 to 58). All test pits were approximately 30 centimetres (cm) in diameter and were excavated 5cm into sterile subsoil. The soils were then examined for stratigraphy, cultural features, or evidence of fill. A single soil layer (topsoil) was observed. All soil from the test pits was screened through six-millimetre (mm) hardware cloth to facilitate the recovery of small artifacts and then used to backfill the pit. The test pit assessment resulted in the documentation of five archaeological sites; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7).

M1 (AdHg-5) was identified in the manicured grass area on the south side of Rush Creek Line, east of Imperial Road, in the northern portion of the Study Area. The Stage 2 assessment of M1 (AdHg-5) resulted in the documentation of four artifacts from a single test pit. Given the limited number of artifacts recovered a test unit was excavated as per Section 2.1.3 Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011) on top of the positive test pit, which produced 12 artifacts. The test unit was 30cm deep considering that the unit was excavated 5cm into the subsoil the topsoil layer was 25cm deep. Soil removed from the test unit was screened through six-millimetre (mm) hardware cloth, the test unit was examined for stratigraphy and settlement pattern and the test unit was backfilled.

M5 (AdHg-9) was identified in the manicured grass area on the north side of Dexter Line, west of Imperial Road, and south of Catfish Creek. The Stage 2 assessment of M5 (AdHg-9) resulted in the documentation of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits. No further archaeological methods were employed since the five positive test pits at M5 (AdHg-9) produced sufficient pre-contact Aboriginal resources to document and delineate the archaeological location and met the criteria for making a recommendation to conduct a Stage 3 archaeological assessment as per Section 2.1.3, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

P4 (AdHg-8) was identified in the manicured grass area on the north side of Dexter Line, west of Imperial Road, south of Catfish Creek, and approximately 20m to the west of M5 (AdHg-9). The Stage 2 assessment of P4 (AdHg-8) resulted in the documentation of 15 pre-contact Aboriginal artifacts and 7 Euro-Canadian artifacts from eight positive test pits. No further archaeological methods were employed since the eight positive test pits at P4 (AdHg-8) produced sufficient pre-contact Aboriginal resources to document and delineate the archaeological location and met the criteria for making a recommendation to conduct a Stage 3 archaeological assessment as per Section 2.1.3, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

H2 (AdHg-6) was identified in the manicured grass area on the south side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The Stage 2 assessment of H2 (AdHg-6) resulted in the documentation of 45 Euro-Canadian artifacts from two test pits. No further archaeological methods were employed since the two positive test pits at H2 (AdHg-6) produced sufficient archaeological resources to document and delineate the archaeological location and met the criteria for making a recommendation to conduct a Stage 3 archaeological assessment as per Section 2.1.3, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

H3 (AdHg-7) was identified in the manicured grass area on the north side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The Stage 2 assessment of H3 (AdHg-7) resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits. No further archaeological methods were employed since the 19 positive test pits at H3 (AdHg-7) produced sufficient archaeological resources to document and delineate the archaeological location and met the criteria for making a recommendation to conduct a Stage 3 archaeological assessment as per Section 2.1.3, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

All cultural material encountered was collected and recorded to the associated test pit or test unit and returned for laboratory analysis. UTM coordinates were recorded for all positive test pits as well as a fixed landmark using a Garmin eTrex 10 GPS unit with a minimum accuracy 1-2.5m (North American Datum 1983 ('NAD83') and Universal Transverse Mercator ('UTM') Zone 17T). These coordinates are presented in the Supplementary Documentation to this report.

Approximately 20% of the Study Area comprises steeply sloped overgrown grass, treed and weeded areas and ditches; these areas were evaluated as having no archaeological potential (see Section 1.3.4 above). These steeply sloped areas were mapped and photo documented (Photos 1 to 5, 7, 14, 15, 17 to 20, 24 to 27, 37, 38, 49) in accordance with Section 2.1 Standard 6; Section 7.8.1, Standard 1a; and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

The remaining 5% of the Study Area comprises a tributary of Catfish Creek and Catfish Creek itself; this area was evaluated as having no archaeological potential (see Section 1.3.4 above). These permanently wet areas were mapped and photo documented (Photos 16, 19, 22, 23, 24, 50) in accordance with Section 2.1 Standard 6; Section 7.8.1, Standard 1a; and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

3.0 Record of Finds

The Stage 2 archaeological assessment was conducted employing the methods described in Section 2.0 and resulted in the identification of five archaeological sites; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7). An inventory of the documentary record generated by fieldwork is provided in Table 3 below. Maps indicating the exact site location of the five archaeological sites and all UTM coordinates recorded during the assessment are included in the Supplementary Documentation to this report. A description of the locations and the recovered artifacts are provided in Sections 3.2 to 3.6.

Table 3: Inventory of Document Record

Document Type	Current Location of Document Type	Additional Comments
2 Page of Field Notes	Detritus office	Stored digitally in project file
1 Map provided by the Proponent	Detritus office	Stored digitally in project file
1 Field Map	Detritus office	Stored digitally in project file
154 Digital Photographs	Detritus office	Stored digitally in project file

All of the material culture collected during the Stage 2 survey is contained in one box and will be temporarily housed in the offices of Detritus until formal arrangements can be made for its transfer to Her Majesty the Queen in right of the Province of Ontario or another suitable public institution acceptable to the MTCS and the Study Area's owners.

3.1 Cultural Material

Five archaeological sites were documented during the Stage 2 assessment of the Study Area; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7).

M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8) comprised both Euro-Canadian artifacts. Chert types identified during the Stage 2 assessment are, Onondaga, Haldimand, and Bayport. Chert type identifications were accomplished visually using reference materials located online or in personal collections.

Bayport chert is found near Bayport in Huron County and is similar to Selkirk chert. Bayport chert is generally concentrically banded and occurs mainly in nodules, it is fine grained and dark blue-grey with light speckling caused by microfossil inclusions (Shott 1993).

Haldimand chert, also known as Bois Blanc chert, is a medium quality raw material that outcrops along the Bois Blanc formation between Kohler and Hagersville, as well as in Cayuga, Ontario. Dating to the Early Silurian, it derives from chalk-bearing limestones which give the material its characteristically white to light grey or buff colour and relatively low lustre (Eley and von Bitter 1989).

Onondaga formation chert is from the Middle Devonian age, with outcrops occurring along the north shore of Lake Erie between Long Point and the Niagara River (Eley and von Bitter 1989). Primary outcrops have also been reported along the banks of the Grand River (Ellis and Ferris. 1990). It is a high-quality raw material frequently utilized by pre-contact people and often found at archaeological sites in southern Ontario. Onondaga chert occurs in nodules or irregular thin beds. It is a dense non-porous rock that may be light to dark grey, bluish grey, brown or black and can be mottled with a dull to vitreous or waxy lustre (Eley and von Bitter 1989).

Furthermore, all pieces of chipping detritus were subject to morphological analysis following the classification scheme described by Lennox *et al.* (1986:79-81) and expanded upon by Fisher (1997: 41-49). Flake types identified during the morphological analysis of the chipping detritus assemblages include secondary, thinning, and fragmentary flakes. Cortical removal, primary and secondary flakes are produced during the initial reduction phases of raw material blanks and tend to exhibit minimal dorsal flake scarring. These flakes are also characterized by the presence of

cortex, or original unflaked area, on their dorsal surfaces and proximal ends. For cortical removal flakes, cortex makes up over half of the dorsal surface. For primary flakes, cortex makes up less than half of the dorsal surface, while secondary flakes may not contain any. Thinning flakes are produced during the latter stages of reduction when raw material blanks are shaped into preforms and formal tools. They are the result of precise flake removal through pressure flaking, where the maker applies direct pressure onto a specific part of the tool in order to facilitate flake removal. Pressure flaking generally produces smaller, thinner flakes than does percussion flaking. Thinning flakes also exhibit more flake scars on their dorsal surface than do primary or secondary flakes. Fragmentary flakes are flakes that may have some identifiable flake characteristic, but cannot be classified with certainty into a specific category.

3.2 M1 (AdHg-5)

M1 (AdHg-5) was identified in the manicured grass area on the south side of Rush Creek Line, East of Imperial Road, in the northern portion of the Study Area. The Stage 2 assessment of M1 (AdHg-5) resulted in the documentation of 16 artifacts from a single test pit and a single test unit (Table 4).

Table 4: M1 (AdHg-5) Artifact Summary

Artifact	Frequency	%
chipping detritus	4	25
cut nails	4	25
recent material	4	25
faunal remains, mammalian	2	12.5
fencing wire	2	12.5
Total	**16**	**100**

3.2.1 Euro Canadian Artifacts

A total of 12 Euro-Canadian artifacts were recovered during the Stage 2 assessment at M1 (AdHg-5) comprising, four cut nails, four pieces of recent material, two animal bones and two pieces of fence wire.

Cut Nails

Originally, all nails were hand wrought and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Cut (or square) nail manufacture began in the late 1790s. As the name implies, cut nails were created from flat sheets of iron that were cut by machines. As a result, they did not taper toward the bottom, but were even in thickness when viewed from the side. They were also characterised by flat, square heads. Cut nails became readily available in Upper Canada by the 1830s, at which time they helped to revolutionize house framing. Cut nails remained in use for a long period, from approximately 1830 to 1890, by which time they had been largely supplanted by wire drawn nails (Adams 1990). Wire drawn nails are identical to the type of nails used today, with their round heads and wire shafts. The four nails recovered during the Stage 2 assessment are cut nails. The predominance of machine cut nails suggests a middle to late 19th century occupation.

Recent Material

Four pieces of recent material were recovered including, two brown beer bottle glass fragments, one piece of asphalt, and one plastic coffee cup lid.

Faunal Remains

Two animal bones were recovered, both too fragmentary to identify a species, however, one does show evidence of butchering.

Fence Wire

Two pieces of metal fence wire were recovered.

3.2.2 Pre-Contact Aboriginal Artifacts

Due to the size of the Stage 2 assemblage, all pieces of chipping detritus were subject to morphological analysis (Table 5).

Table 5: Chipped Stone Debitage Analysis for M1 (AdHg-5)

Chert Type	Secondary		Thinning		Total Analyzed	
	n	%	n	%	n	%
Onondaga	1	25.00	1	25.00	2	50.00
Haldimand	0	0.00	2	50.00	2	50.00
Total	**1**	**25.00**	**3**	**75.00**	**4**	**100.00**

According to the morphological analysis presented above, 75% of the flakes recovered were thinning (n=3). The remaining specimen is a secondary flake (25%). The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities was undertaken at the site. Given the small sample size, however, it is difficult to draw any useful conclusions regarding site function.

The use of Onondaga and Haldimand chert, meanwhile, indicates that the people at M1 (AdHg-5) were largely relying on two sources of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 58km to the east of the site. Outcrops of Haldimand chert are found between Kohler and Hagersville, as well as in Cayuga, Ontario, which is approximately 85km to the northeast of the site.

3.2.3 M1 (AdHg-5) Artifact Catalogue

Table 6 provides a catalogue of the Stage 2 artifact assemblage recovered from M1 (AdHg-5). A sample of artifacts are depicted in Section 9.2 of this report.

Table 6: M1 (AdHg-5) Artifact Catalogue

Cat #	Context	Artifact	Frequency	Depth(m)	Comments
1	positive test pit 1	chipping detritus	1	0.36	Secondary, Onondaga Chert
2	positive test pit 1	chipping detritus	1	0.36	Thinning, Onondaga Chert
3	positive test pit 1	chipping detritus	2	0.36	Thinning, Haldimand Chert
4	Test unit (200E, 500N)	cut nails	4	0.3	
5	Test unit (200E, 500N)	faunal remains, mammalian	1	0.3	unknown, has butcher mark
6	Test unit (200E, 500N)	faunal remains, mammalian	1	0.3	unknown, small bone
7	Test unit (200E, 500N)	fencing wire	2	0.3	

8	Test unit (200E, 500N)	recent material	2	0.3	brown beer bottle glass
9	Test unit (200E, 500N)	recent material	1	0.3	asphalt
10	Test unit (200E, 500N)	recent material	1	0.3	plastic coffee cup lid

3.3 M5 (AdHg-9)

M5 (AdHg-9) was identified in the manicured grass area on the north side of Dexter Line, west of Imperial Road, and south of Catfish Creek. The Stage 2 assessment of M5 (AdHg-9) resulted in the documentation of 19 artifacts from five positive test pits (Table 7).

Table 7: M5 (AdHg-9) Artifact Summary

Artifacts	Frequency	%
structural	6	31.58
household	6	31.58
pre-contact Aboriginal	5	26.32
ceramic	1	5.26
miscellaneous metal	1	5.26
Total	19	100.00

3.3.1 Euro Canadian Artifacts

A total of 14 Euro-Canadian artifacts were recovered during the Stage 2 assessment at M5 (AdHg-9). The assemblage comprises six structural artifacts, six household artifacts, one ceramic artifact and one piece of miscellaneous metal.

Structural

Originally, all nails were hand wrought and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Cut (or square) nail manufacture began in the late 1790s. As the name implies, cut nails were created from flat sheets of iron that were cut by machines. As a result, they did not taper toward the bottom, but were even in thickness when viewed from the side. They were also characterised by flat, square heads. Cut nails became readily available in Upper Canada by the 1830s, at which time they helped to revolutionize house framing. Cut nails remained in use for a long period, from approximately 1830 to 1890, by which time they had been largely supplanted by wire drawn nails (Adams 1990). Wire drawn nails are identical to the type of nails used today, with their round heads and wire shafts. Three cut nails were recovered during the Stage 2 assessment, which suggests a middle to late 19th century occupation.

Window glass can be temporally diagnostic in a limited manner, but only if at least ten specimens are available. In the 1840s, window glass thickness changed dramatically, in large part due to the lifting of the English import tax on window glass in 1845. This tariff taxed glass by weight and encouraged manufacturers to produce thin panes. Most window glass manufactured before 1845 tended to be thinner, while later glass was thicker (Kenyon 1980). However, because window glass thickness varied even within a single pane, an assemblage of ten specimens is required to provide an adequate sample. Both shards of window glass recovered within the Stage 2 assemblage measured less than 1.6mm thick, suggestive of a pre-1845 occupation, however given the sample size a definitive date cannot be determined.

Lastly, a single red brick fragment was also recovered during the Stage 2 assessment.

Household

A total of six household artifacts were represented in the Stage 2 assemblage. Most of these (66.67%) were bottle glass fragments (n=4). Additionally, one animal bone and one piece of chimney lamp glass was represented in the Stage 2 assemblage.

Bottle glass fragments are generally not diagnostic and are often simply categorized according to colour. A total of 75% of the glass bottle pieces recovered during the Stage 2 assessment are clear (n=3). Uncommon prior to the 1870s, clear or colourless glass came into widespread use after the development of automatic bottle manufacturing machines in the early 20th century (Lindsey 2014). The remaining piece was violet tinge caused by the use of manganese additives to de-colourize glass. This process dates to 1880 (Adams 1994).

A single unknown animal bone fragment was recovered. No visible signs of the fragment bring burnt or butchered.

Ceramics

A single piece of undecorated ironstone was recovered. The fragment is from a flat vessel; however, the piece was too fragmentary to determine what type of vessel.

Somewhat concurrent with the development of pearlware and refined white earthenware ('RWE') was that of another refined white tableware commonly referred to as ironstone. Ironstone was designed by the Turner family in the late 1700s (Tharp 2017). Like its contemporaries, it featured a white surface, but with a bluish tint. Furthermore, ironstone vessels were usually thicker than earlier pearlware and RWE varieties with a dense, heavy paste. The impetus behind the development of ironstone was a desire among Staffordshire potters to find a cheap alternative to imported porcelain (The Potteries 2003). By 1813 James Mason had reworked and patented 'ironstone china'. The patent lasted only fourteen years; by then a variety of Staffordshire potteries were producing a similar product. Nevertheless, the Mason's brand name had become associated with all of the various stone china ceramics that were in production. Ironstone began to be imported from England to Canada during the 1840s and came to dominate the ceramic trade during the middle part of the century.

Miscellaneous Metal

A single metal ring was recovered during the Stage 2 assessment; the ring is not considered to be diagnostic.

3.3.2 Pre-Contact Aboriginal Artifacts

Five pieces of chipping detritus were recovered, including four Onondaga chert thinning flakes and one unknown chert type thinning flake. Due to the size of the Stage 2 assemblage, all pieces of chipping detritus were subject to morphological analysis. The flake type within the Stage 2 assemblage suggests that late stage of lithic reduction activities was undertaken at the site. Given the small sample size, however, it is difficult to draw any useful conclusions regarding site function.

The predominant use of Onondaga chert, meanwhile, indicates that the people at M5 (AdHg-9) were largely relying on two sources of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 56km to the east of the site.

3.3.3 M5 (AdHg-9) Artifact Catalogue

Table 8 provides a catalogue of the Stage 2 artifact assemblage recovered from M5 (AdHg-9). A sample of artifacts are depicted in Section 9.2 of this report.

Table 8: M5 (AdHg-9) Artifact Catalogue

Cat #	Context	Artifact	Freq.	Depth	Colour	Comments
1	positive test pit 1	chipping detritus	1	70 cm		unknown chert type thinning flake
2	positive test pit 1	glass bottle	1	70 cm	violet	
3	positive test pit 1	glass bottle	1	70 cm	clear	ribbed
4	positive test pit 1	glass bottle	2	70 cm	clear	formed
5	positive test pit 1	window glass	1	70 cm	clear	melted < 1.6 mm
6	positive test pit 1	cut nail	1	70 cm		
7	positive test pit 2	chipping detritus	1	15 cm		Onondaga chert thinning flake
8	positive test pit 2	window glass	1	15 cm	aqua	< 1.6 mm
9	positive test pit 3	chipping detritus	2	30 cm		Onondaga chert thinning flake
10	positive test pit 4	chipping detritus	1	20 cm		Onondaga chert thinning flake
11	positive test pit 5	ironstone	1	30 cm		flat, unknown function
12	positive test pit 5	metal ring	1	30 cm		
13	positive test pit 5	cut nail	2	30 cm		
14	positive test pit 5	glass chimney	1	30 cm	clear	molded
15	positive test pit 5	brick	1	30 cm	red	
16	positive test pit 5	faunal remains, mammalian	1	30 cm		unknown fragment

3.4 P4 (AdHg-8)

P4 (AdHg-8) was identified in the manicured grass area on the north side of Dexter Line, west of Imperial Road, south of Catfish Creek, and approximately 20m to the west of M5 (AdHg-9). The Stage 2 assessment of P4 (AdHg-8) resulted in the documentation of 22 artifacts from eight positive test pits (Table 9).

Table 9: P4 (AdHg-8) Artifact Summary

Artifacts	Frequency	%
chipping detritus	15	68.18
cut nail	4	18.18
faunal remains, avian	1	4.55
ironstone	1	4.55
window glass	1	4.55
Total	**22**	**100.00**

3.4.1 Pre-Contact Aboriginal Artifacts

Due to the size of the Stage 2 assemblage, all pieces of chipping detritus were subject to morphological analysis (Table 10).

Table 10: P4 (AdHg-8)

Chert Type	Secondary		Thinning		Fragment		Total Analyzed	
	n	%	n	%	n	%	n	%
Onondaga	2	13.33	7	46.67	0	0.00	9	60.00
Bayport	1	6.67	0	0.00	1	6.67	2	13.33
Unknown	0	0.00	2	13.33	0	0.00	2	13.33
Haldimand	0	0.00	2	13.33	0	0.00	2	13.33
Total	**3**	**20.00**	**11**	**73.33**	**1**	**6.67**	**15**	**100.00**

According to the morphological analysis presented above, over 70% of the flakes recovered were thinning (73.33%; n=11). The remaining specimens are secondary flakes (20%; n=3) and a flake fragment (6.67%; n=1). The variety of flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities was undertaken at the site. Given the small sample size, however, it is difficult to draw any useful conclusions regarding site function.

The predominant use of Onondaga chert, meanwhile, indicates that the people at P4 (AdHg-8) were largely relying on a single source of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 56km to the northeast of the site.

3.4.2 Euro Canadian Artifacts

A total of seven Euro-Canadian artifacts were recovered during the Stage 2 assessment. The assemblage comprises four cut nails, one window glass shard, one bird bone, and one piece of ironstone.

Originally, all nails were hand wrought and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Cut (or square) nail manufacture began in the late 1790s. As the name implies, cut nails were created from flat sheets of iron that were cut by machines. As a result, they did not taper toward the bottom, but were even in thickness when viewed from the side. They were also characterised by flat, square heads. Cut nails became readily available in Upper Canada by the 1830s, at which time they helped to revolutionize house framing. Cut nails remained in use for a long period, from approximately 1830 to 1890, by which time they had been largely supplanted by wire drawn nails (Adams 1990). Four cut nails were recovered during the Stage 2 assessment, which suggests a middle to late 19th century occupation.

Window glass can be temporally diagnostic in a limited manner, but only if at least ten specimens are available. In the 1840s, window glass thickness changed dramatically, in large part due to the lifting of the English import tax on window glass in 1845. This tariff taxed glass by weight and encouraged manufacturers to produce thin panes. Most window glass manufactured before 1845 tended to be thinner, while later glass was thicker (Kenyon 1980). However, because window glass thickness varied even within a single pane, an assemblage of ten specimens is required to provide an adequate sample. The window glass shard recovered within the Stage 2 assemblage measured less than 1.6mm thick, suggestive of a pre-1845 occupation, however given the sample size a definitive date cannot be determined.

A single unknown bird bone was recovered during the Stage 2 assessment. The fragment showed no evidence of burning or butchering.

Lastly, a single undecorated ironstone plate fragment was recovered. Somewhat concurrent with the development of pearlware and RWE was that of another refined white tableware commonly referred to as ironstone. Ironstone was designed by the Turner family in the late 1700s (Tharp 2017). Like its contemporaries, it featured a white surface, but with a bluish tint. Furthermore, ironstone vessels were usually thicker than earlier pearlware and RWE varieties with a dense,

heavy paste. The impetus behind the development of ironstone was a desire among Staffordshire potters to find a cheap alternative to imported porcelain (The Potteries 2003). By 1813 James Mason had reworked and patented 'ironstone china'. The patent lasted only fourteen years; by then a variety of Staffordshire potteries were producing a similar product. Nevertheless, the Mason's brand name had become associated with all of the various stone china ceramics that were in production. Ironstone began to be imported from England to Canada during the 1840s and came to dominate the ceramic trade during the middle part of the century.

3.4.3 P4 (AdHg-8) Artifact Catalogue

Table 11 provides a catalogue of the Stage 2 artifact assemblage recovered from P4 (AdHg-8). A sample of artifacts are depicted in Section 9.2 of this report.

Table 11: P4 (AdHg-8) Artifact Catalogue

Cat #	Context	Artifact	Freq.	Depth	Morphology	Chert Type	Comments
1	positive test pit 1	chipping detritus	2	35 cm	tool thinning	Onondaga	
2	positive test pit 1	chipping detritus	2	35 cm	tool thinning	Haldiman d	
3	positive test pit 1	chipping detritus	1	35 cm	secondary	Onondaga	
4	positive test pit 2	chipping detritus	1	35 cm	tool thinning	Onondaga	
5	positive test pit 2	chipping detritus	1	35 cm	fragment	Bayport	
6	positive test pit 3	chipping detritus	1	40 cm	tool thinning	unknown	
7	positive test pit 3	chipping detritus	1	40 cm	secondary	Onondaga	
8	positive test pit 3	ironstone	1	40 cm			plate fragment
9	positive test pit 3	cut nail	1	40 cm			
10	positive test pit 4	chipping detritus	1	35 cm	secondary	Bayport	
11	positive test pit 4	window glass	1	35 cm			< 1.6 mm
12	positive test pit 5	chipping detritus	3	41 cm	tool thinning	Onondaga	
13	positive test pit 5	cut nail	1	41 cm			
14	positive test pit 6	faunal remains, avian	1	35 cm			
15	positive test pit 7	chipping detritus	1	36 cm	tool thinning	unknown	
16	positive test pit 7	cut nail	1	36 cm			
17	positive test pit 8	chipping detritus	1	35 cm	tool thinning	Onondaga	
18	positive test pit 8	cut nail	1	35 cm			

3.5 H2 (AdHg-6)

H2 (AdHg-6) was identified in the manicured grass area on the south side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The Stage 2 assessment of H2 (AdHg-6) resulted in the documentation of 45 Euro-Canadian artifacts from two test pits (

Table 12).

Table 12: H2 (AdHg-6) Artifact Summary

Artifacts	Frequency	%
ceramics	34	75.56
structural	5	11.11
household	5	11.11
miscellaneous metal	1	2.22
Total	**45**	**100.00**

3.5.1 Ceramics

A total of 34 ceramic sherds were documented; the majority of these were from moulded ironstone vessels (97%, n=33). The remainder of the assemblage comprises a single piece of undecorated RWE (3%; n-1).

Ironstone

Somewhat concurrent with the development of pearlware and RWE was that of another refined white tableware commonly referred to as ironstone. Ironstone was designed by the Turner family in the late 1700s (Tharp 2017). Like its contemporaries, it featured a white surface, but with a bluish tint. Furthermore, ironstone vessels were usually thicker than earlier pearlware and RWE varieties with a dense, heavy paste. The impetus behind the development of ironstone was a desire among Staffordshire potters to find a cheap alternative to imported porcelain (The Potteries 2003). By 1813 James Mason had reworked and patented “ironstone china.” The patent lasted only fourteen years; by then a variety of Staffordshire potteries were producing a similar product. Nevertheless, the Mason’s brand name had become associated with all of the various stone china ceramics that were in production. Ironstone began to be imported from England to Canada during the 1840s and came to dominate the ceramic trade during the middle part of the century.

In terms of appearance, ironstone vessels were commonly left plain with infrequent applied surface decoration, although moulded designs were common. The entire ironstone assemblage is moulded.

RWE

Throughout the 19th century, potters in Staffordshire, England, sought to replicate Chinese porcelain resulting in the creation of many variations of RWE, including pearlware, whiteware., and ironstone.

In the 1820s, the blue-tinted pearlware glaze gave way to a whiter variety that some archaeologists have taken to calling whiteware; like pearlware, however, this term was not used by manufacturers. Miller (1980:18) suggests that the white appearance of whiteware was caused by reducing the amount of cobalt added to the glaze and adding it instead to the paste. It was manufactured by many different recipes and can be difficult to distinguish from other ceramics in

the period, including sherds of pearlware, especially when examining small sherds. As Miller states,

> *...if an assemblage of ceramics from the first half of the 19th century is placed before six archaeologists and they are asked for counts of creamware, pearlware, whiteware, and stone china wares, the results will probably be six different enumerations* (1980:2).

Accordingly, the term RWE is used in this report to identify whiteware sherds as well as any sherds that are too small to distinguish between whiteware, pearlware or ironstone (noting that this gives a conservative date to any pearlware sherds not correctly identified).

A single undecorated sherd of RWE was represented within the Stage 2 assemblage.

Ceramic Form and Function

All of the ceramic sherds were examined in order to describe the function of the item from which the ceramic sherd originated. However, for those sherds that were too fragmentary for a functional assignment, an attempt was made to at least provide a formal description, such as to which portion of an item the sherd belonged. For example, what used to be a porcelain teacup but now found in an archaeological context could be classified archaeologically in the artifact catalogue in a descending order of specificity depending on preservation and artifact size: a teacup (function), a cup (function), a hollowware (form), or a rim fragment (form). Flatware was differentiated based on the absence of curvature in the ceramic cross-section of each sherd. The classification system used here is based upon Beaudoin (2013:78-82). If Beaudoin's classifications could not be applied, then the broader definitions of Voss (2008:209) were used. Ultimately, if sherds were small enough that even a general functional or formal ware type could not be determined, then the sherd was simply classified as a rim fragment, a non-rim fragment, a base fragment, or indeterminate. The 33 moulded ironstone fragments are flat plate fragments. The single RWE fragment is an unknown flat vessel fragment.

3.5.2 Structural

Five structural artifacts were recovered including, three cut nails, one red brick and one window glass shard.

Originally, all nails were hand wrought and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Cut (or square) nail manufacture began in the late 1790s. As the name implies, cut nails were created from flat sheets of iron that were cut by machines. As a result, they did not taper toward the bottom, but were even in thickness when viewed from the side. They were also characterised by flat, square heads. Cut nails became readily available in Upper Canada by the 1830s, at which time they helped to revolutionize house framing. Cut nails remained in use for a long period, from approximately 1830 to 1890, by which time they had been largely supplanted by wire drawn nails (Adams 1990). Wire drawn nails are identical to the type of nails used today, with their round heads and wire shafts. The three nails recovered during the Stage 2 assessment are cut nails. The predominance of machine cut nails suggests a middle to late 19th century occupation.

Window glass can be temporally diagnostic in a limited manner, but only if at least ten specimens are available. In the 1840s, window glass thickness changed dramatically, in large part due to the lifting of the English import tax on window glass in 1845. This tariff taxed glass by weight and encouraged manufacturers to produce thin panes. Most window glass manufactured before 1845 tended to be thinner, while later glass was thicker (Kenyon 1980). However, because window glass thickness varied even within a single pane, an assemblage of ten specimens is required to provide an adequate sample. The window glass shard recovered within the Stage 2 assemblage measured less than 1.6mm thick, suggestive of a pre-1845 occupation, however given the sample size a definitive date cannot be determined.

3.5.3 Household

Five household artifacts were recovered including, three bird bones, one bottle glass fragment and one mason jar fragment.

Bottle glass fragments are generally not diagnostic and are often simply categorized according to colour. The glass bottle piece recovered is aqua. The three bird bone fragments are too fragmentary to determine species and show no evidence of burning or butchering.

3.5.4 Miscellaneous Metal

A single piece of miscellaneous metal was recovered and is not considered to be diagnostic.

3.5.5 H2 (AdHg-6) Artifact Catalogue

Table 13 provides a catalogue of the Stage 2 artifact assemblage recovered from H2 (AdHg-6). A sample of artifacts are depicted in Section 9.2 of this report.

Table 13: H2 (AdHg-6) Artifact Catalogue

Cat #	Context	Artifact	Freq.	Depth	Ceramic Form	Ceramic Function	Colour	Comments
1	positive test pit 1	ironstone moulded	33	35 cm	flat	plate		
2	positive test pit 1	RWE	1	35 cm	flat	unknown		
3	positive test pit 1	cut nails	3	35 cm				
4	positive test pit 1	faunal remains, avian	3	35 cm				
5	positive test pit 1	glass bottle	1	35 cm			aqua	
6	positive test pit 1	brick	1	35 cm			red	
7	positive test pit 2	misc. metal	1	35 cm				
8	positive test pit 2	glass mason jar	1	35 cm			aqua	large shard with embossed lettering " WO" "AM" over two parallel lines
9	positive test pit 2	window glass	1	35 cm				< 1.6 mm

3.6 H3 (AdHg-7)

H3 (AdHg-7) was identified in the manicured grass area on the north side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The Stage 2 assessment of H3 (AdHg-7) resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits (Table 14).

Table 14: H3 (AdHg-7) Artifact Summary

Artifacts	Frequency	%
structural	29	40.28
ceramics	25	34.72
household	11	15.28
miscellaneous metal	3	4.17
personal	3	4.17
horse tack	1	1.39
Total	**72**	**100.00**

3.6.2 Structural

A total of 29 structural artifacts were recovered including, 17 nails, 10 window glass shards, and 2 screws.

Originally, all nails were hand wrought and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Cut (or square) nail manufacture began in the late 1790s. As the name implies, cut nails were created from flat sheets of iron that were cut by machines. As a result, they did not taper toward the bottom, but were even in thickness when viewed from the side. They were also characterised by flat, square heads. Cut nails became readily available in Upper Canada by the 1830s, at which time they helped to revolutionize house framing. Cut nails remained in use for a long period, from approximately 1830 to 1890, by which time they had been largely supplanted by wire drawn nails (Adams 1990). Wire drawn nails are identical to the type of nails used today, with their round heads and wire shafts. In total, 16 cut nails and 1 wire nail were recovered. The predominance of machine cut nails suggests a middle to late 19th century occupation.

Window glass can be temporally diagnostic in a limited manner, but only if at least ten specimens are available. In the 1840s, window glass thickness changed dramatically, in large part due to the lifting of the English import tax on window glass in 1845. This tariff taxed glass by weight and encouraged manufacturers to produce thin panes. Most window glass manufactured before 1845 tended to be thinner, while later glass was thicker (Kenyon 1980). However, because window glass thickness varied even within a single pane, an assemblage of ten specimens is required to provide an adequate sample. A large majority of the window glass shard recovered within the Stage 2 assemblage measured less than 1.6mm thick (n=9), suggestive of a pre-1845 occupation.

3.6.3 Ceramics

A total of 25 ceramic sherds were documented including 17 RWE fragments, 6 ironstone fragments, 1 pearlware fragment, and 1 stoneware fragment. Table 15 provides a summary of the ceramic assemblage by fabric and Table 16, by decorative style.

Table 15: H3 (AdHg-7) Ceramic Assemblage by Fabric

Ceramics	Frequency	%
RWE	17	68
ironstone	6	24
pearlware	1	4
stoneware	1	4
Total	**25**	**100**

Table 16: H3 (AdHg-7) Ceramic Assemblage by Decorative Style

Ceramics	Frequency	%
RWE	12	48
ironstone	5	20
RWE transfer printed	5	20
ironstone transfer printed	1	4
pearlware	1	4
stoneware	1	4
Total	**25**	**100**

Ceramic Fabrics

RWE

Throughout the 19th century, potters in Staffordshire, England, sought to replicate Chinese porcelain resulting in the creation of many variations of RWE, including pearlware, whiteware., and ironstone.

In the 1820s, the blue-tinted pearlware glaze gave way to a whiter variety that some archaeologists have taken to calling whiteware; like pearlware, however, this term was not used by manufacturers. Miller (1980:18) suggests that the white appearance of whiteware was caused by reducing the amount of cobalt added to the glaze and adding it instead to the paste. It was manufactured by many different recipes and can be difficult to distinguish from other ceramics in the period, including sherds of pearlware, especially when examining small sherds. As Miller states,

> *...if an assemblage of ceramics from the first half of the 19th century is placed before six archaeologists and they are asked for counts of creamware, pearlware, whiteware, and stone china wares, the results will probably be six different enumerations* (1980:2).

Accordingly, the term RWE is used in this report to identify whiteware sherds as well as any sherds that are too small to distinguish between whiteware, pearlware or ironstone (noting that this gives a conservative date to any pearlware sherds not correctly identified).

A total of 17 sherds of RWE were represented within the Stage 2 assemblage; most of these (48%; n=12) were undecorated. The remaining five pieces are transfer printed. The remainder of the pieces were decorated using transfer printed technique, which will be discussed below.

Ironstone

Somewhat concurrent with the development of pearlware and RWE was that of another refined white tableware commonly referred to as ironstone. Ironstone was designed by the Turner family in the late 1700s (Tharp 2017). Like its contemporaries, it featured a white surface, but with a bluish tint. Furthermore, ironstone vessels were usually thicker than earlier pearlware and RWE varieties with a dense, heavy paste. The impetus behind the development of ironstone was a desire among Staffordshire potters to find a cheap alternative to imported porcelain (The Potteries 2003). By 1813 James Mason had reworked and patented “ironstone china.” The patent lasted only fourteen years; by then a variety of Staffordshire potteries were producing a similar product. Nevertheless, the Mason’s brand name had become associated with all of the various stone china ceramics that were in production. Ironstone began to be imported from England to Canada during the 1840s and came to dominate the ceramic trade during the middle part of the century.

In terms of appearance, ironstone vessels were commonly left plain with infrequent applied surface decoration, although moulded designs were common. Most of the ironstone sherds within

the assemblage are undecorated (20%; n=5). The remaining sherd was decorated using a transfer printed technique, which will be discussed below.

Pearlware

The term pearlware denotes an early variety of refined white tableware that was first produced in 1779 by Josiah Wedgewood; it remained popular on Euro-Canadian sites in Southern Ontario until the 1830s, when it was supplanted by later refined white tablewares such as RWE and ironstone (Adams 1994). Pearlware can be easily identified by a bluish glaze that appears along footing crevices due to the addition of cobalt to the glaze (Adams 1994) in an attempt to imitate Chinese porcelain. A single undecorated pearlware fragment was present within the Stage 2 assemblage.

Stoneware

Stoneware ceramics are made from a heavy, non-porous paste and, although naturally impermeable, were usually glazed with a grey or brown slip (Lamb 2003). Early 19th century varieties were manufactured in England, Germany and the United States and featured a salt glaze. Stoneware vessels were relatively infrequent in southern Ontario until the middle 1800s; by 1850, at least two potteries in Ontario (Brantford and Toronto) were producing stoneware. Because they were large and durable, stoneware vessels were typically utilitarian, functioning as food storage containers, beer jugs and tankards, butter crocks, and cream jars (Lamb 2003). A single stoneware fragment was present in the assemblage.

Decorative Techniques

Transfer Printing

The technique of transferring a pattern from an engraved metal plate to the surface of a ceramic vessel is thought to have developed in the middle of the 18th century (Jervis 1911); it became more widely used among Staffordshire potteries in the 1790s (Shaw 1829). In southern Ontario, transfer printing was popular throughout the first half of the 19th century before simpler techniques or no decoration whatsoever became more standard. It underwent a revival after 1870 until the end of the century (Majewski and O'Brien 1987). Blue was the most dominant colour before 1830 and after 1870, although transfer printed designs in blue were common throughout the 19th century on various wares. Brown and black transfer print wares were popular for a short span in the interim, between 1830 and 1870 (Adams 1994).

Six ceramic pieces in the Stage 2 assemblage demonstrated evidence of transfer printing, including five sherds RWE and one of ironstone. The transfer printed sherds featured designs in brown (n=2), blue (n=1), dark green (n=1), black (n=1), and green (n=1). Another four sherds of RWE featured a red design. Overall, the transfer printed sherds within the Stage 2 assemblage span the middle to late 19th century.

Ceramic Form and Function

All of the ceramic sherds were examined in order to describe the function of the item from which the ceramic sherd originated. However, for those sherds that were too fragmentary for a functional assignment, an attempt was made to at least provide a formal description, such as to which portion of an item the sherd belonged. For example, what used to be a porcelain teacup but now found in an archaeological context could be classified archaeologically in the artifact catalogue in a descending order of specificity depending on preservation and artifact size: a teacup (function), a cup (function), a hollowware (form), or a rim fragment (form). Flatware was differentiated based on the absence of curvature in the ceramic cross-section of each sherd. The classification system used here is based upon Beaudoin (2013:78-82). If Beaudoin's classifications could not be applied, then the broader definitions of Voss (2008:209) were used. Ultimately, if sherds were small enough that even a general functional or formal ware type could not be determined, then the sherd was simply classified as a rim fragment, a non-rim fragment, a base fragment, or indeterminate. Table 17 summarizes the ceramic assemblage by form; Table 18 summarizes the ceramic assemblage by function.

Table 17: Ceramic Assemblage by Form

Ceramics	Flat	Flat	Storage	Unknown
ironstone	5			
ironstone transfer printed	1			
pearlware	1			
RWE	6	1		5
RWE transfer printed	5			
stoneware			1	
Total	**18**	**1**	**1**	**5**

Table 18: Ceramic Assemblage by Function

Ceramics	Bowl	Plate	Unknown
ironstone	3	1	1
ironstone transfer printed		1	
pearlware			1
RWE	1	2	9
RWE transfer printed		1	4
stoneware			1
Total	**4**	**5**	**16**

3.6.4 Household

Eleven household artifacts were recovered including, six bottle glass fragments, and five animal bones.

Bottle glass fragments are generally not diagnostic and are often simply categorized according to colour. Of the 11 bottle glass fragments recovered four are clear, one is violet and one is blue. Uncommon prior to the 1870s, clear or colourless glass came into widespread use after the development of automatic bottle manufacturing machines in the early 20th century (Lindsey 2019). A single piece featured a violet tinge caused by the use of manganese additives to de-colourize glass. This process dates to 1880 (Adams 1994).

Of the five animal bones recovered, four are unknown, two of which show evidence of butchering; and one is a tooth.

3.6.5 Miscellaneous Metal

A total of two pieces of miscellaneous metal and a lead sheet fragment were present in the assemblage. None of these items were considered to be temporally diagnostic.

3.6.6 Personal Artifacts

Three personal items were observed within the Stage 2 assemblage including a white clap pipe bowl fragment, a white clay pipe stem fragment and a slate tablet fragment.

White clay pipes were popular throughout the 19th century, with a decline in use around 1880 due to the rise in popularity of briar pipes and cigarettes (Adams 1994). Most white clay pipes were manufactured in either Québec or Scotland, with occasional examples deriving from English, Dutch, French, and American manufacturers. The maker's name is commonly impressed on one side with the city of manufacture on the opposite side, although this did not become common practice until after 1840. Both pipe fragments within the Stage 2 assemblage are unmarked.

A single slate tablet fragment is present in the Stage 2 assemblage. The value of paper in the 1800s, especially writing quality paper, prevented its use for junior schoolwork and everyday household use. Instead, both adults and children commonly used slate boards and pencils. Boards comprised a flat sheet of fine quality slate, typically 2.5 millimetre (mm) thick, bound in a wooden frame. Slate pencils were typically 3 to 5mm thick and were composed of slate or shale that was softer than the slate board. Several methods existed for the production of slate pencils, including forcing slices of slate or shale through tubes as evidenced by flat facets along the pencil length. Slate pencils could also be formed by turning the slices of slate (Davies 2005), or grinding the slate or shale to a powder and compressing it in moulds (Evening Standard 1891). Given the expense of slate for roofing purposes, most thin slate fragments on historic sites are likely to be from writing boards.

3.6.7 Horse Tack

A single horseshoe nail was present in the Stage 2 assemblage.

3.6.8 H3 (AdHg-7) Artifact Catalogue

Table 19 provides a catalogue of the Stage 2 artifact assemblage recovered from H3 (AdHg-7). A sample of artifacts are depicted in Section 9.2 of this report.

Table 19: H3 (AdHg-7) Artifact Catalogue

Cat#	Context	Artifact	Freq.	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Notes
1	positive test pit 1	miscellaneous metal	1	30				
2	positive test pit 1	cut nail	1	30				
3	positive test pit 1	RWE	1	30	flat	plate	white	
4	positive test pit 1	ironstone transfer printed	1	30	flat	plate	green	makers mark unknown
5	positive test pit 1	ironstone	1	30	flat	bowl	white	
6	positive test pit 1	lead sheet	1	30				fragment
7	positive test pit 1	faunal remains, mammalian	1	30				tooth
8	positive test pit 2	wire nail	1	30				
9	positive test pit 2	cut nail	1	30				
10	positive test pit 2	glass bottle	1	30			clear	ribbed
11	positive test pit 2	RWE	1	30	flat	plate	white	
12	positive test pit 3	RWE	1	28	unknown	unknown		exfoliated
13	positive test pit 3	stoneware	1	28	hollow	unknown		small fragment; grey glaze
14	positive test pit 3	window glass	1	28			clear	< 1.6 mm
15	positive test pit 3	white clay pipe bowl	1	28				undecorated
16	positive test pit 3	white clay pipe stem	1	28				unglazed
17	positive test pit 3	screw	1	28				
18	positive test pit 4	RWE	1	26	flat	unknown	blue willow	
19	positive test pit 5	RWE transfer printed	1	30	flat	unknown	brown	
20	positive test pit 5	RWE	1	30	flat	unknown		
21	positive test pit 5	window glass	1	30				< 1.6 mm
22	positive test pit 5	glass bottle	1	30			violet	
23	positive test pit 6	ironstone	1	34	flat	plate		
24	positive test pit 6	RWE transfer printed	1	34	flat	unknown	blue	
25	positive test pit 6	RWE transfer printed	1	34	flat	unknown	dark green	

Cat#	Context	Artifact	Freq.	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Notes
26	positive test pit 6	RWE	1	34	flat	unknown	white	
27	positive test pit 6	glass bottle	1	34			blue	
28	positive test pit 6	cut nail	1	34				
29	positive test pit 7	miscellaneous metal	1	28				
30	positive test pit 7	RWE transfer printed	1	28	flat	plate	brown	
31	positive test pit 7	faunal remains, mammalian	1	28				unknown
32	positive test pit 8	cut nail	1	30				
33	positive test pit 9	cut nail	1	35				
34	positive test pit 9	window glass	1	35				< 1.6 mm
35	positive test pit 10	faunal remains, mammalian	1	40				unknown, butchered
36	positive test pit 10	ironstone	1	40	flat	unknown		
37	positive test pit 11	screw	1	35				
38	positive test pit 11	cut nail	1	35				
39	positive test pit 11	horseshoe nail	1	35				
40	positive test pit 11	RWE transfer printed	1	23	flat	unknown	black	
41	positive test pit 11	window glass	1	23				< 1.6 mm
42	positive test pit 11	cut nail	2	23				
43	positive test pit 12	cut nail	2	29				
44	positive test pit 12	RWE	3	29	unknown	unknown		
45	positive test pit 12	glass bottle	1	29			clear	
46	positive test pit 12	window glass	1	29				< 1.6 mm
47	positive test pit 12	slate tablet	1	29				fragment; for writing
48	positive test pit 13	pearlware	1	30	flat	unknown		
49	positive test pit 14	faunal remains, mammalian	2	32				unknown, butchered
50	positive test pit 14	cut nail	1	32				
51	positive test pit 14	window glass	1	32				< 1.6 mm

Cat#	Context	Artifact	Freq.	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Notes
52	positive test pit 14	RWE	1	32	flat	bowl		
53	positive test pit 14	glass bottle	1	32			clear	
54	positive test pit 15	window glass	2	30				< 1.6 mm
55	positive test pit 15	RWE	1	30	unknown	unknown		
56	positive test pit 16	cut nail	1	28				
57	positive test pit 17	window glass	1	32				> 1.6 mm
58	positive test pit 17	glass bottle	1	32			clear	
59	positive test pit 18	cut nail	1	28				
60	positive test pit 19	ironstone	2	40	flat	bowl		
61	positive test pit 19	cut nail	3	40				
62	positive test pit 19	window glass	1	40				< 1.6 mm
63	positive test pit 19	RWE	1	40	flat	unknown		

4.0 Analysis and Conclusions

Detritus was retained by the Proponent to conduct a Stage 1-2 archaeological assessment on Lots 4 and 5, Concession 1, Geographical Township of Malahide, County of Elgin, Port Bruce, Ontario (Figure 1). This assessment was undertaken in advance of a proposed bridge replacement located at on Imperial Road from Bank Street in the north to approximately 100m south of Dexter Line. The assessment property ('Study Area') comprises portions of three roads, Imperial Road, Dexter Line, and Rush Creek Line, as well as their right-of-way, which measures 2.86ha. At the time of the assessment, the Study Area comprised portions of Imperial Road, Dexter Line, and Rush Creek Line, their right-of-way as well as portions of private residential properties. Additionally, a tributary of Catfish Creek and Catfish Creek itself transect the Study Area along the northern edge and through the centre respectively.

The Stage 1 background research indicated that the level ground portion of the manicured and overgrown grass components of the Study Area exhibited moderate to high potential for the identification and recovery of archaeological resources and were recommended for Stage 2 archaeological assessment (Figure 3). The existing asphalt roads, their concrete and gravel shoulders, as well as 15 gravel or asphalt laneways and parking areas and three areas where natural gas utilities are present, were evaluated as having no potential based on the identification of extensive and deep land alteration that has severely damaged the integrity of archaeological resources, as per Section 2.1, Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). These areas of disturbance, as confirmed during the Stage 2 field survey, were mapped and photo documented in accordance with Section 2.1, Standard 6 and Section 7.8.1, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011). Furthermore, a tributary of Catfish Creek, Catfish Creek itself and a ditch transect are also present within the Study Area. These areas were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). Additionally, steeply sloped overgrown grass, treed areas, overgrown weed areas and ditches are located throughout the Study Area. The permanently wet areas and steeply sloped areas, as confirmed during the Stage 2 field survey, were mapped and photo documented in accordance with Section 2.1, Standard 6 and Section 7.8.1, Standard 1a of the *Standards and Guidelines* (Government of Ontario 2011).

The subsequent Stage 2 assessment was conducted on May 27 and 31, 2019. This investigation consisted of a standard test pit survey at a five-metre interval and resulted in the identification and documentation of five archaeological sites; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7).

4.1 M1 (AdHg-5)

The Stage 2 assessment of M1 (AdHg-5) resulted in the documentation of 12 Euro-Canadian artifacts and 4 pre-contact Aboriginal artifacts from a single test pit and a single test unit located in the manicured grass area on the south side of Rush Creek Line, East of Imperial Road, in the northern portion of the Study Area.

The Euro-Canadian component of the site comprises four cut nails, four recent material, two animal bones and two pieces of fence wire. The cut nails date from the middle to late 19th century. The presence of wire drawn nails, two brown beer bottle glass fragments, one piece of asphalt, and one plastic coffee cup lid extends this occupation into the 20th century. According to the background research presented above, M1 (AdHg-5) was located in the portion of Lot 5, Concession 1 that was owned by C. Monro in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of M1 (AdHg-5), however, the early community of Port Bruce is located to the south of the Study Area. Based on the results of the Stage 2 assessment, the Euro-Canadian component of M1 (AdHg-5) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of C. Monro.

The pre-contact Aboriginal component of the site comprised three thinning flakes and one secondary flake. Two of the thinning flakes are manufactured from Haldimand chert and one from Onondaga chert. The single secondary flake is manufactured on Onondaga chert. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Based on a complete absence of diagnostic artifacts, M1 (AdHg-5) has been interpreted as a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. The use of Onondaga and Haldimand chert, meanwhile, indicates that the people at M1 (AdHg-5) were largely relying on two sources of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 58km to the east of the site. Outcrops of Haldimand chert are found between Kohler and Hagersville, as well as in Cayuga, Ontario, which is approximately 85km to the northeast of the site.

M1 (AdHg-5) does not fulfill the criteria for further assessment as per Section 2.2, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011), however, given that there were only four archaeological sites registered within the Borden block AdHg prior to the current assessment and that M1 (AdHg-5) is located within the early community of Port Bruce, it was determined based on professional judgement that M1 (AdHg-5) retains CHVI. Additionally, as per Section 2.2 Guideline 1 of the *Standards and Guidelines* (Government of Ontario 2011) Detritus engaged with the COTTFN and it was determined that Stage 3 would be recommended in order to ensure there are no unaddressed Aboriginal archaeological interests connected with the land surveyed or sites identified. As a result, M1 (AdHg-5) meets the criteria for a Stage 3 assessment as per Section 2.2 Guidelines 1 to 3 of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

4.2 M5 (AdHg-9)

The Stage 2 assessment of M5 (AdHg-9) resulted in the documentation of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits located in the manicured grass area on the north side of Dexter Line, west of Imperial Road, and south of Catfish Creek.

The Euro-Canadian component of the site comprises six structural artifacts, six household artifacts, one ceramic artifact and one piece of miscellaneous metal. The cut nails and ironstone fragment date from the middle to late 19th century. The remaining Euro-Canadian artifacts are non-diagnostic. According to the background research presented above, M5 (AdHg-9) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of M5 (AdHg-9). Based on the results of the Stage 2 assessment, M5 (AdHg-9) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that the Euro-Canadian component of M5 (AdHg-9) does not contain 20 artifacts dating to a period of use to before 1900 and therefore retains no CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The pre-contact Aboriginal component of the site comprises five thinning flakes, four of which are manufactured on Onondaga chert and one of an unknown chert type. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Given a complete absence of diagnostic artifacts the pre-contact Aboriginal component of M5 (AdHg-9) has been interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. The predominant use of Onondaga chert, meanwhile, indicates that the people at M5 (AdHg-9) were largely relying on two sources of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 56km to the east of the site.

Based on these results, the pre-contact component of M5 (AdHg-9) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, M5 (AdHg-9) fulfills the criteria for a Stage 3 assessment as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

4.3 P4 (AdHg-8)

The Stage 2 assessment of P4 (AdHg-8) resulted in the documentation of 15 pre-contact Aboriginal artifacts and 7 Euro-Canadian artifacts from eight positive test pits located in the manicured grass area on the north side of Dexter Line, west of Imperial Road, south of Catfish Creek, and approximately 20m to the west of M5 (AdHg-9).

The pre-contact Aboriginal component of the site comprises 11 thinning flakes, 3 secondary flakes and 1 flake fragment. The flake types within the Stage 2 assemblage suggests that late stage of lithic reduction activities were undertaken at the site. Given a complete absence of diagnostic artifacts the pre-contact Aboriginal component of P4 (AdHg-8) has been interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction. The predominant use of Onondaga chert, meanwhile, indicates that the people at P4 (AdHg-8) were largely relying on a single source of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie between Long Point and the Niagara River, which is approximately 56km to the northeast of the site.

Based on these results, the pre-contact component of P4 (AdHg-8) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, P4 (AdHg-8) fulfills the criteria for a Stage 3 assessment as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

The Euro-Canadian component of P4 (AdHg-8) comprises four cut nails, 1 bird bone, 1 ironstone fragment and 1 piece of window glass. The cut nails and ironstone fragment date from the middle to late 19th century.

Based on these results, the Euro-Canadian component of P4 (AdHg-8) does not contain 20 artifacts dating to a period of use to before 1900 and therefore retains no CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

4.4 H2 (AdHg-6)

The Stage 2 assessment of H2 (AdHg-6) resulted in the documentation of 45 Euro-Canadian artifacts from two test pits, identified in the manicured grass area on the south side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The artifact assemblage is dominated by ceramic sherds, and in particular, ironstone pieces; a single RWE fragment was also recovered. The Stage 2 artifacts document a period of occupation spanning the middle to late 19th century, based primarily on the predominance of ironstone and RWE ceramic pieces, and machine cut nails.

According to the background research presented above, H2 (AdHg-6) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of H2 (AdHg-6). Based on the results of the Stage 2 assessment, H2 (AdHg-6) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that H2 (AdHg-6) contains at least 20 artifacts dating to a period of use to before 1900 and therefore

retains CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

4.5 H3 (AdHg-7)

The Stage 2 assessment of H3 (AdHg-7) resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits, identified in the manicured grass area on the north side of Dexter Line, East of Imperial Road, in the southern portion of the Study Area. The artifact assemblage is dominated by ceramic sherds, and in particular, RWE pieces; ironstone, pearlware, and stoneware are also represented in lesser amounts. The Stage 2 artifacts document a period of occupation spanning the middle to late 19th century, based primarily on the predominance of RWE and ironstone ceramic pieces, cut nails, clear bottle glass, and white clay pipe fragments. A few earlier artifacts were observed in the Stage 2 assemblage, including nine window glass shards measuring less than 1.6mm and one piece of pearlware. Whereas the window glass might suggest the presence of an earlier structure, the early pearlware fragment is thought to represent an heirloom item.

According to the background research presented above, H3 (AdHg-7) was located in the portion of Lot 5, Concession 1 that was part of the early community of Port Bruce in 1877. The *Historical Atlas* map depicts no structures or orchards in the vicinity of H3 (AdHg-7). Based on the results of the Stage 2 assessment, H3 (AdHg-7) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce.

Based on these results, H3 (AdHg-7) contains at least 20 artifacts dating to a period of use to before 1900 and therefore retains CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

4.6 Preliminary Indication of Sites Possibly Requiring Stage 4 Archaeological Mitigation

M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) have been recommended for Stage 3 archaeological assessment. A preliminary indication of whether the sites could be eventually recommended for Stage 4 archaeological mitigation is required under Section 7.8.3, Standard 2c of the *Standards and Guidelines* (Government of Ontario 2001). No firm recommendation for, or against, Stage 4 archaeological mitigation will be made until the forthcoming Stage 3 archaeological assessments have been conducted. Given that M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) met the minimum requirements for Stage 3 assessment, it not yet clear whether a Stage 4 archaeological mitigation will be recommended for these sites.

5.0 Recommendations

5.1 M1 (AdHg-5)

Based on the results of the Stage 2 assessment, the Euro-Canadian component of M1 (AdHg-5) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of C. Monro. Additionally, the pre-contact Aboriginal component of M1 (AdHg-5) has been interpreted as a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stages of lithic reduction.

M1 (AdHg-5) does not fulfill the criteria for further assessment as per Section 2.2, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011), however, given that there were only four archaeological sites registered within the Borden block AdHg prior to the current assessment and that M1 (AdHg-5) is located within the early community of Port Bruce, it was determined based on professional judgement that M1 (AdHg-5) retains CHVI. Additionally, as per Section 2.2 Guideline 1 of the *Standards and Guidelines* (Government of Ontario 2011) Detritus engaged with the COTTFN and it was determined that Stage 3 would be recommended in order to ensure there are no unaddressed Aboriginal archaeological interests connected with the land surveyed or sites identified. As a result, **M1 (AdHg-5) meets the criteria for a Stage 3 assessment as per Section 2.2 Guidelines 1 to 3 of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI**.

5.2 M5 (AdHg-9)

Based on the results of the Stage 2 assessment, M5 (AdHg-9) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that the Euro-Canadian component of M5 (AdHg-9) does not contain 20 artifacts dating to a period of use to before 1900 the site therefore retains no CHVI. As a result, **no Stage 3 assessment is recommended for the Euro-Canadian component of M5 (AdHg-9),** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

Based on these results, the pre-contact component of M5 (AdHg-9) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, **the pre-contact component of M5 (AdHg-9) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

5.3 P4 (AdHg-8)

Based on these results of the Stage 2 assessment, the pre-contact component of P4 (AdHg-8) has been interpreted as a small activity area of unknown function, occupied by unspecified Aboriginal people during the pre-contact period. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area during the Stage 2 assessment, **P4 (AdHg-8) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.a.ii(2) of the *Standards and Guidelines* (Government of Ontario 2011) and retains CHVI.

Furthermore, the Euro-Canadian component of P4 (AdHg-8) comprises a small number of middle to late 19th century artifacts. Given that the Euro-Canadian component of P4 (AdHg-8) does not contain 20 artifacts dating to a period of use to before 1900, the site therefore retains no CHVI as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011). The **Euro-Canadian component of P4 (AdHg-8) does not fulfill the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

5.4 H2 (AdHg-6)

Based on the results of the Stage 2 assessment, H2 (AdHg-6) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that H2 (AdHg-6) contains at least 20 artifacts dating to a period of use to before 1900 and the site therefore retains CHVI. As a result, **H2 (AdHg-6) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

5.5 H3 (AdHg-7)

Based on the results of the Stage 2 assessment, H3 (AdHg-7) has been interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. Given that H3 (AdHg-7) contains at least 20 artifacts dating to a period of use to before 1900 and the site therefore retains CHVI. As a result, **H3 (AdHg-7) fulfills the criteria for a Stage 3 assessment** as per Section 2.2 Standard 1.c. of the *Standards and Guidelines* (Government of Ontario 2011).

The Stage 3 archaeological assessments of M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) will be conducted according to Section 3.2.2 of the *Standards and Guidelines* (Government of Ontario 2011). Given that the five sites were documented during a test pit assessment, no CSP is required.

Given that it is not yet evident that the level of CHVI at the sites will result in a recommendation to proceed to Stage 4 (see Section 4.3), the Stage 3 assessments of M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) will consist of the hand excavation of 1m square test units every 5m in systematic levels and into the first 5cm of subsoil as per Table 3.1, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011). Additional 1m test units, amounting to 20% of the grid total, will be placed in areas of interest within the site extent as per Table 3.1, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). All excavated soil will be screened through six-millimetre mesh; all recovered artifacts will be recorded by their corresponding grid unit designation and collected for laboratory analysis. If a subsurface cultural feature is encountered, the plan of the exposed feature will be recorded and geotextile fabric will be placed over the unit before backfilling the unit. Finally, First Nations groups expressing interest in the archaeological resources of the area must also be engaged during the Stage 3 archaeological assessment.

6.0 Advice on Compliance with Legislation

This report is submitted to the Minister of Tourism and Culture as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest , and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological license.

7.0 Bibliography and Sources

Adams, Nick. 1994. *Field Manual for Avocational Archaeologists in Ontario*. Ontario Archaeological Society Inc., Archaeological Stewardship Project.

Archives of Ontario. 2009. *The Evolution of the District and County System, 1788-1899*. Electronic document: http://www.archives.gov.on.ca/en/maps/ontario-districts.aspx. Last accessed, August 11, 2019.

Beaudoin, Matthew A. 2013. *De-essentializing the Past: Deconstructing Colonial Categories in 19th-Century Ontario*. University of Western Ontario: Unpublished Ph.D. thesis.

Caston, Wayne A. 1997. Evolution in the Mapping of Southern Ontario and Wellington County. Wellington County History 10:91-106.

Chapman, L.J. and D.F. Putnam. 1984. *The Physiography of Southern Ontario*. Third Edition. Ontario Geological Survey. Special Volume 2. Toronto: Ontario Ministry of Natural Resources.

Coyne, J. H. 1895. The Country of the Neutrals (As Far as Comprised in the County of Elgin): From Champlain to Talbot. St. Thomas: Times Print.

Davidson, R.J. 1989. Foundations of the Land Bedrock Geology. In J.B. Theberge (editor) *The Natural History of Ontario*, pp. 36-47. Toronto: McClelland and Stewart Inc.

Davies, Peter. 2005. Writing Slates and Schooling in *Australian Historical Archaeology* vol. 23: 63-69.

Ellis, Chris J. and Neal Ferris (editors). 1990. T*he Archaeology of Southern Ontario to A.D. 1650*. Occasional Publication of the London Chapter, Ontario Archaeological Society, Number 5.

Eley, Betty, and Peter H. von Bitter, 1989. *Cherts of Southern Ontario*. Toronto: Royal Ontario Museum.

Evening Standard. 1891. How Slate Pencils Are Made in *Evening Standard* vol. 41, issue 70. Electronic Source: https://paperspast.natlib.govt.nz/newspapers/EP18910228.2.61. Last Accessed August 16, 2019.

Feest, Johanna E. and Christian F. Feest 1978. The Ottawa. *In* Trigger B.G. (editor) *Handbook of North American Indians*. *Vol.15 Northeast*, pp. 772-786. Washington: Smithsonian Institute.

Ferris, Neal. 2009. The Archaeology of Native-Lived Colonialism: Challenging History in the Great Lakes. Tucson: University of Arizona Press.

Fisher, Jacqueline A. 1997. *The Adder Orchard Site: Lithic Technology and Spatial Organization in the Broadpoint Late Archaic*. Occasional Publications of the London Chapter, OAS, Number 3, 1997.

Gentilcore, R. Louis and C. Grant Head. 1984. Ontario's History in Maps. Toronto: University of Toronto Press.

Government of Ontario. 1990a. Ontario Planning Act, R.S.O. 1990, CHAPTER P.13. Last amendment: 2018, c. 16, s. 8. Electronic document: https://www.ontario.ca/laws/statute/90p13. Last accessed August 16, 2019.

Government of Ontario. 1990b. Ontario Heritage Act, R.S.O. 1990, CHAPTER O.18. Last amendment: 2017, c. 34, Sched. 46, s. 37. Electronic document: https://www.ontario.ca/laws/statute/90o18. Last accessed August 16, 2019.

Government of Ontario. 1990c. Freedom of Information and Protection of Privacy Act, R.S.O. 1990, CHAPTER F.31. Last amendment: 2018, c. 17, Sched. 19. Electronic document: https://www.ontario.ca/laws/statute/90f31. Last accessed August 16, 2019.

Government of Ontario. 2011. *Standards and Guidelines for Consultant Archaeologists*. Toronto: Ministry of Tourism, Culture and Sport.

Government of Ontario. n.d. *Archaeological Sites Database Files*. Toronto: Culture Services Unit, Ministry of Tourism, Culture and Sport.

Hamil, Fred Coyne. 1951. The Valley of the Lower Thames, 1640 to 1850. Toronto: University of Toronto Press.

Harper, Russell. 1950. *The Early History of Haldimand County*. Caledonia: Grand River Sachem.

Jamieson, S. M. 1992 Regional Interaction and Ontario Iroquois Evolution. *Canadian Journal of Archaeology* 16:70-88.

Jervis, William Percival. 1911. *A Pottery Primer*. The O'Gorman Publishing Company, New York.

Kenyon, Ian. 1980. 19th Century Notes. *KEWA* (80-2).

Konrad, Victor. 1981. An Iroquois Frontier: the North Shore of Lake Ontario during the Late Seventeenth Century. *Journal of Historical Geography* 7(2):129-144.

Lamb, Lisa Nicole. 2003. *Historical Archaeology of the Indian Key* (8M015) warehouse: An analysis of nineteenth - Century ceramics. University of South Florida.

Lennox, Paul. 1983. *The Horner Creek Site: An Historic Neutral Encampment in Brant County*. Report on file with the Ministry of Tourism, Culture, and Sport, Toronto.

Lindsey, Bill. 2019. *Historic Glass Bottle Identification and Information Website*. Electronic document: http://www.sha.org/bottle/index.htm. Last accessed on August 16, 2019.

Majewski Teresita and Michael J. O'Brien. 1987. "The Use and Misuse of Nineteenth-Century English and American Ceramics in Archaeological Analysis." In *Advances in Archaeological Method and Theory, Volume 11*, edited by Michael Schiffer, 98-209. Academic Press, New York.

Miller, George L. 1980a. *Ceramics - The ACO Guide to 19th C. Sites*. Ontario Ministry of Culture and Recreation, Historical Planning and Research Branch. London, Ontario.

Morris, J.L. 1943. *Indians of Ontario*. 1964 reprint. Toronto: Department of Lands and Forests, Government of Ontario.

Noble, William. 1978. The Neutral Indians. In *Essays in Northeastern Anthropology in Memory of Marian E. White*, Occasional Publications in Northeastern Anthropology 5, pp. 152-164. William Engelbrecht and Donald Grayson, editors. Rindge, NH: Department of Anthropology, Franklin Pierce College.

Page, H.R. & Co. 1877 *Illustrated Historical Atlas of the County of Elgin, Ontario*. Toronto: H.R. Page & Co.

Potteries, The. 2003. Ironstone. In *Stoke on Trent: Resources on the North Staffordshire Pottery Industry*. Electronic document: http://www.thepotteries.org/types/ironstone.htm. Last accessed August 14, 2019.

Praxis Research Associates. n.d. *The History of the Mississaugas of the New Credit First Nation. Hagersville: Lands, Research and Membership, Mississaugas of the New Credit First Nation*.

Schmalz, Peter S. 1991. *The Ojibwa of Southern Ontario*. Toronto: University of Toronto Press.

Shaw, Simeon. 1829. *History of the Staffordshire Potteries and the Rise and Progress of the Manufacture of Pottery and Porcelain; with Reference to Genuine Specimens and Notices of Eminent Potters*. Reprinted 1968 by Beatrice C. Weinstock, Great Neck, New York.

Shott, Michael J. *The Leavitt Site: A Parkhill Phase Paleo-Indian Occupation in Central Michigan*. Memoirs. Vol. 25. Ann Arbor: Museum of Anthropology, University of Michigan, 1993.

Surtees, Robert J. 1994. Land Cessations, 1763-1830. In *Aboriginal Ontario: Historical Perspectives on the First Nations*, pp. 92-121. Edward Rogers and Donald B. Smith (editors). Toronto: Dundurn Press.

Tharp, Lars. 2017. The Origin of Ironstone. In *Stoke on Trent: Resources on the North Staffordshire Pottery Industry*. http://www.thepotteries.org/features/ironstone.htm. Last accessed August 14, 2019.

Voss, Barbara L. 2008. *The Archaeology of Ethnogenesis: Race and Sexuality in Colonial San Francisco*. Berkeley: University of California Press.

Weaver, Sally. 1978. Six Nations of the Grand River, Ontario. In *Handbook of North American Indians. Volume 15: Northeast*, pp. 525-536. Bruce G. Trigger, editor. Washington: Smithsonian Institution Press.

White, Marian. 1978. Neutral and Wenro. In *Handbook of North American Indians Volume 15: Northeast*, pp. 407-411. Bruce G. Trigger, editor. Washington: Smithsonian Institution Press.

Wilson, J.A. and M. Horne 1995. City of London Archaeological Master Plan. London: City of London, Department of Planning and Development.

8.0 Maps

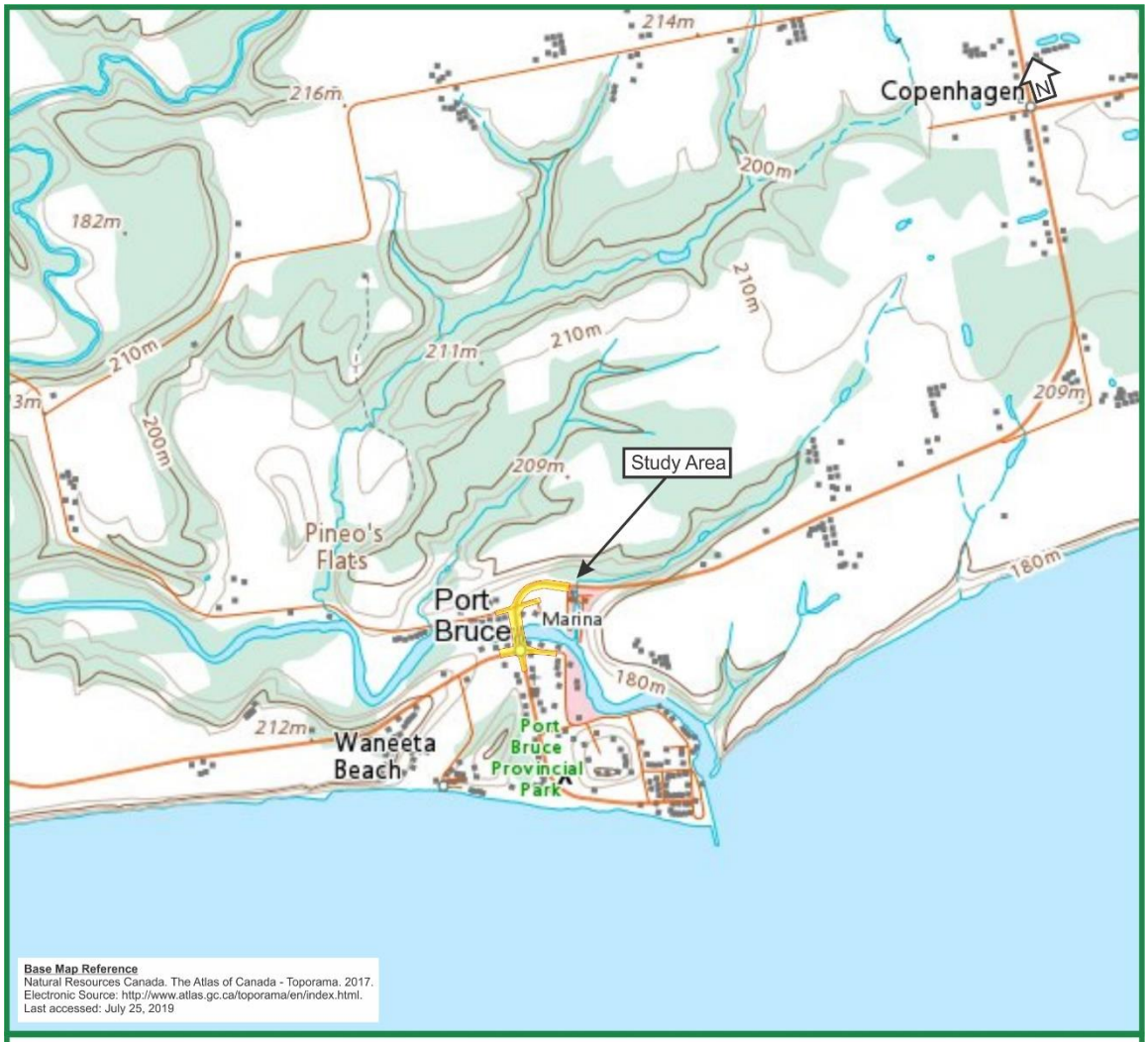

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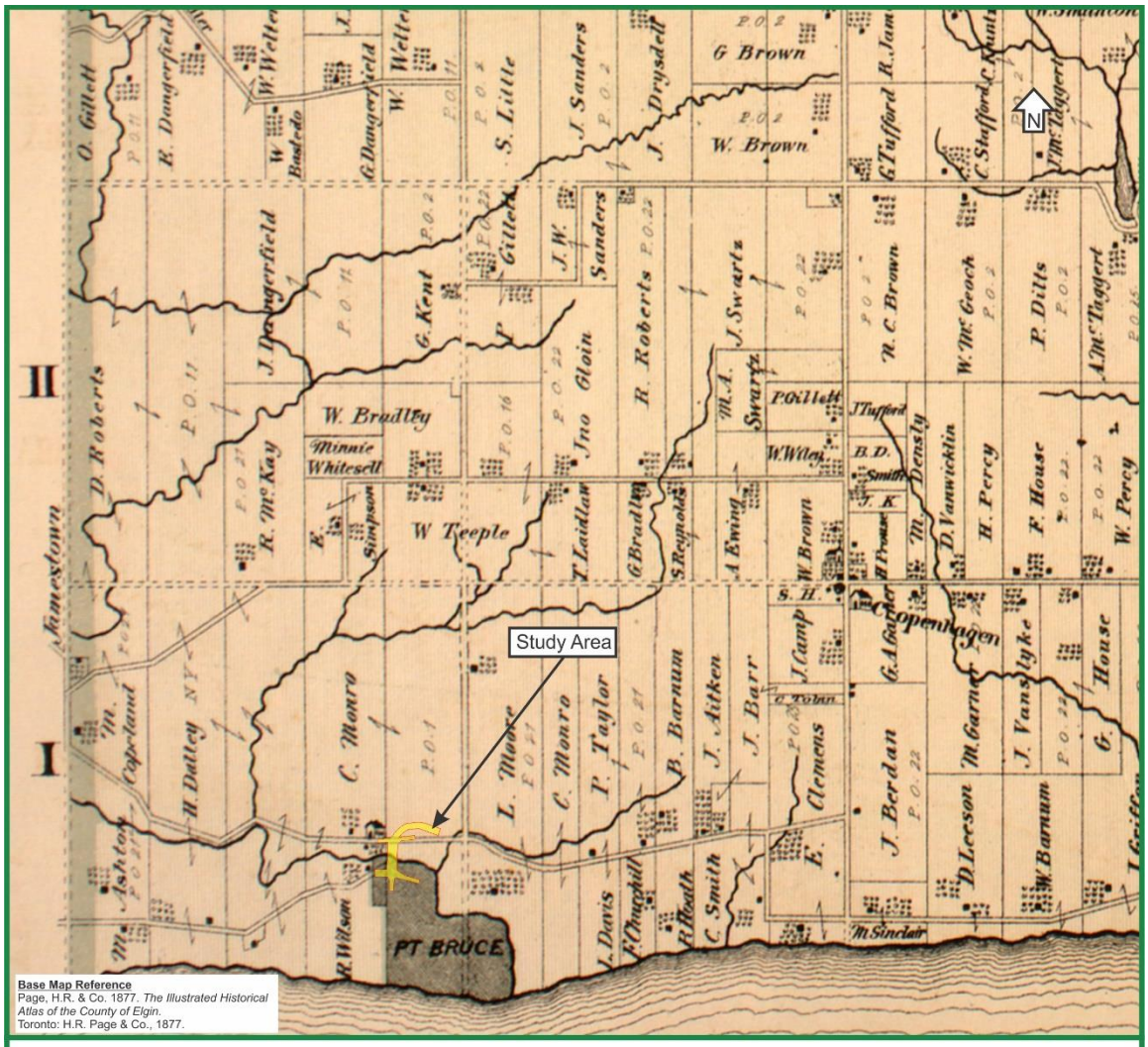
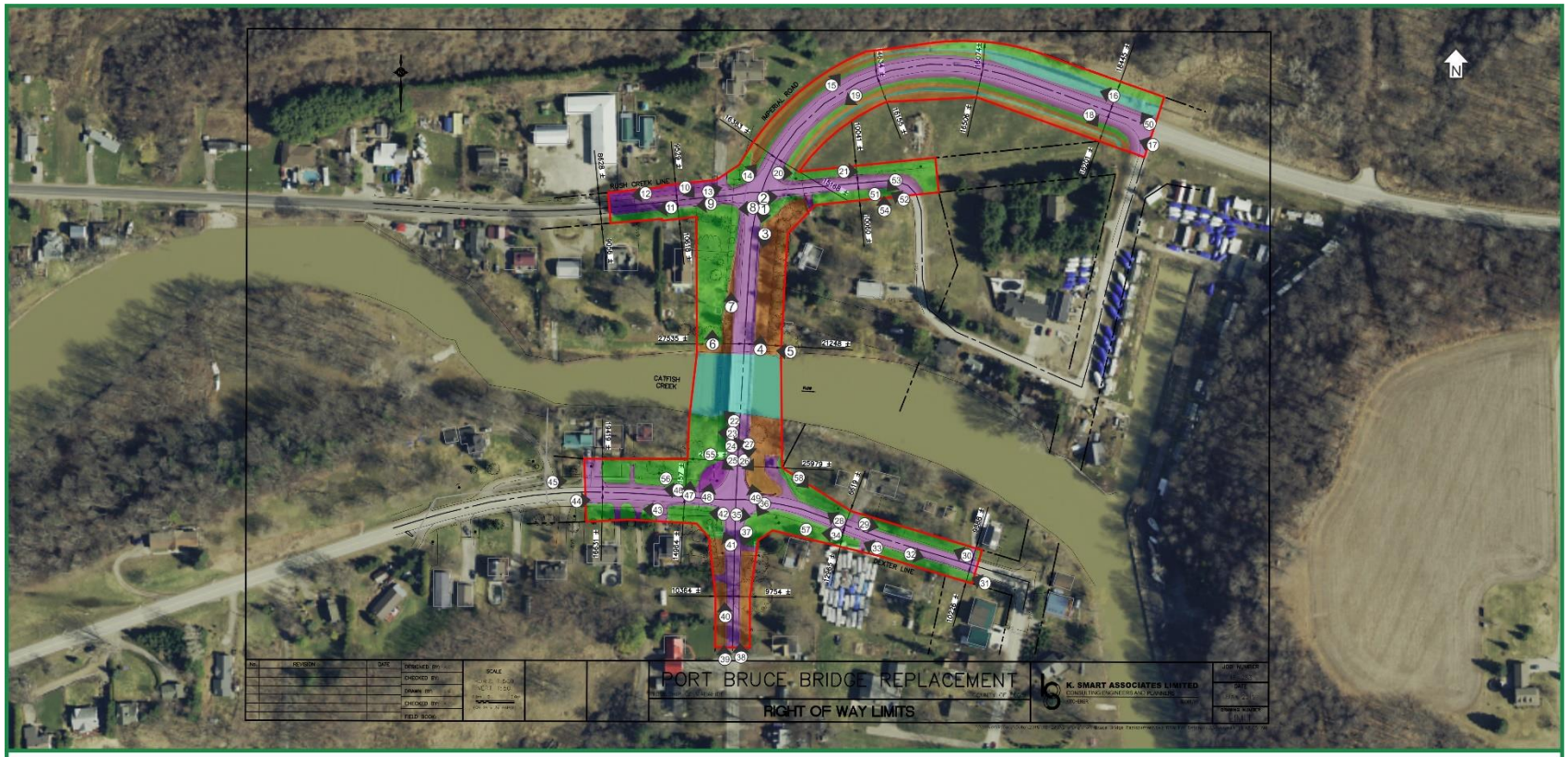
Figure 1: Study Area



Not to Scale

Figure 2: Portion of the 1877 *Historical Atlas* Map of Malahide Township



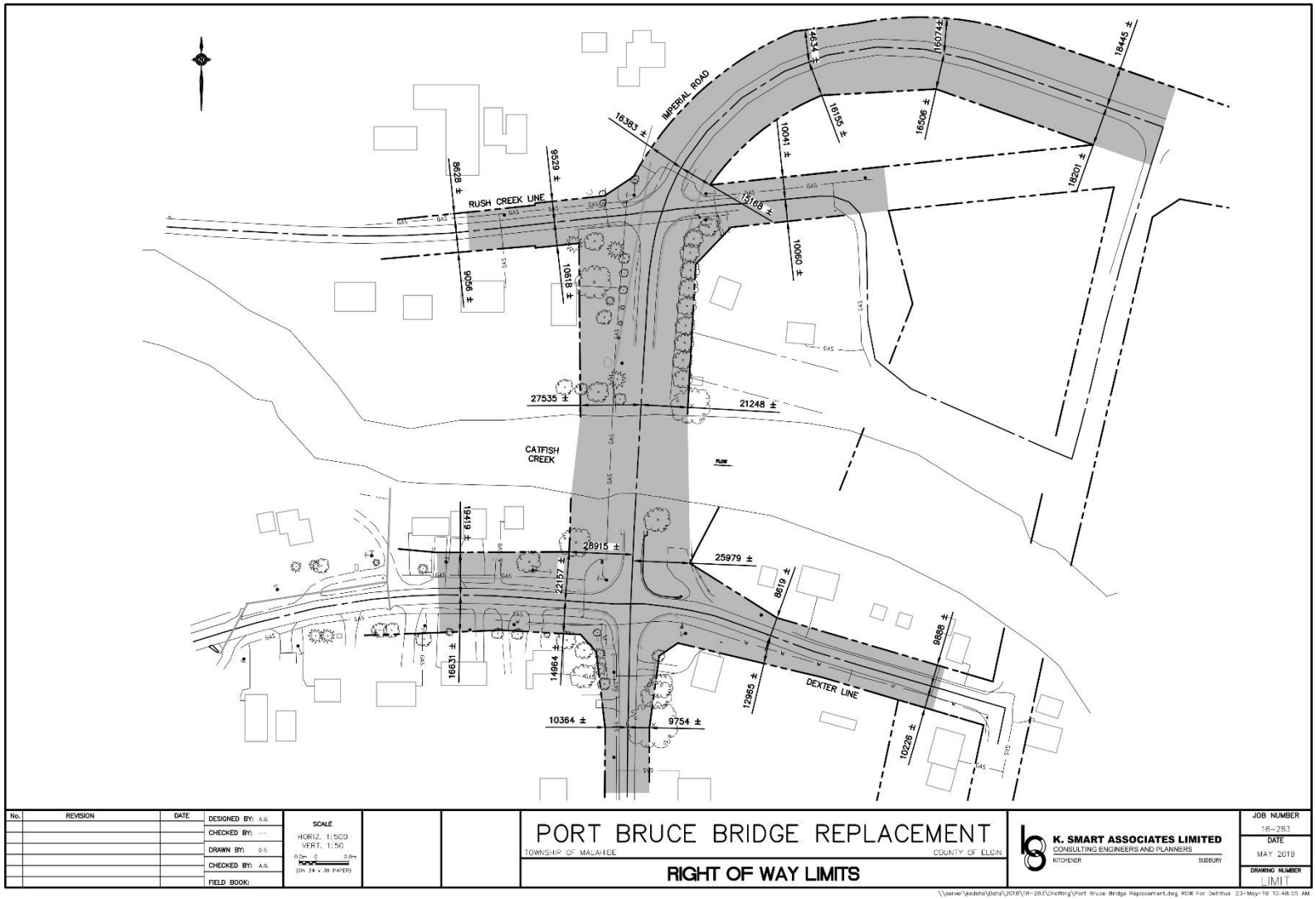
Legend

- Study Area
- Photo Location and Direction
- Test Pit Survey at 5m Intervals
- Previously Disturbed, Not Assessed
- Steeply Sloped, Not Assessed
- Permanently Wet, Not Assessed

0 50 100m

Figure 3: Stage 2 Survey Methods

Figure 4: Development Map



9.0 Images

Photo 1: Level Ground of Overgrown Grass Test Pit Survey at 5m Intervals; Steeply Sloped Overgrown Grass and Treed Area; and Disturbed Asphalt Road and Concrete Shoulder Not Assessed, facing south

Photo 2: Level Ground of Overgrown Grass Test Pit Survey at 5m Intervals; Steeply Sloped Overgrown Grass and Treed Area; and Disturbed Asphalt Road, Concrete Shoulder, and Gravel Laneway Not Assessed, facing east

Photo 3: Steeply Sloped Overgrown Grass and Treed Area; and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing south

Photo 4: Steeply Sloped Overgrown Grass and Treed Area; and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing north

Photo 5: Steeply Sloped Overgrown Grass and Treed Area; and Disturbed Former Bridge Location Not Assessed, facing west

Photo 6: Manicured Grass Test Pit Survey at 5m Intervals, facing north

Photo 7: Manicured Grass Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing north

Photo 8: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing west

Photo 9: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing west

Photo 10: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing southeast

Photo 11: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing west

Photo 12: Disturbed Manicured Grass Due to the Presence of a Natural Gas Line, Asphalt Road, and Gravel Shoulder Not Assessed, facing west

Photo 13: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing east

Photo 14: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing northeast

Photo 15: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Trees Area and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing northeast

Photo 16: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Permanently Wet Unnamed Tributary of Catfish Creek and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing northwest

Photo 17: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing northwest

Photo 18: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing southeast

Photo 19: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass, Permanently Wet Ditch, and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing southwest

Photo 20: Manicured Grass on Level Ground Test Pit Survey at 5m Intervals; Steeply Sloped Manicured Grass and Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing east

Photo 21: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing east

Photo 22: Overgrown Grass Test Pit Survey at 5m Intervals; Permanently Wet Catfish Creek Not Assessed, facing northwest

Photo 23: Overgrown Grass Test Pit Survey at 5m Intervals; Permanently Wet Catfish Creek Not Assessed, facing west

Photo 24: Steeply Sloped Overgrown Weed and Tree Area and Permanently Wet Catfish Creek Not Assessed, facing northeast

Photo 25: Disturbed Manicured Grass Due to the Presence of a Natural Gas Line Not Assessed, facing southwest

Photo 26: Steeply Sloped Overgrown Weed and Tree Area and Disturbed Gravel Laneway and Parking Area Not Assessed, facing southeast

Photo 27: Steeply Sloped Overgrown Weed and Tree Area and Disturbed Asphalt Road, Gravel Shoulder, Laneway and Parking Area Not Assessed, facing south

Photo 28: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road, Gravel Shoulder, Laneway and Parking Area Not Assessed, facing northwest

Photo 29: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Laneway, Road and Gravel Shoulder Not Assessed, facing southeast

Photo 30: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Road and Gravel Shoulder Not Assessed, facing northwest

Photo 31: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Road and Gravel Shoulder Not Assessed, facing northwest

Photo 32: Formerly Grass Area Test Pit Survey at 5m Intervals; Disturbed Road and Gravel Shoulder Not Assessed, facing southeast

Photo 33: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Laneway and Road, Gravel Shoulder Not Assessed, facing northwest

Photo 34: Manicured Lawn Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing west

Photo 35: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Road and Gravel Shoulder Not Assessed, facing east

Photo 36: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Road and Gravel Shoulder Not Assessed, facing southwest

Photo 37: Steeply Sloped Ditch, Disturbed Asphalt Laneway and Road, and Gravel Shoulder Not Assessed, facing north

Photo 38: Steeply Sloped Ditch, Disturbed Asphalt Road, and Gravel Shoulder Not Assessed, facing north

Photo 39: Disturbed Ditch with Presence of a Natural Gas Line, Asphalt Laneway, Road, and Gravel Shoulder Not Assessed, facing north

Photo 40: Disturbed Ditch with Presence of a Natural Gas Line, Asphalt Laneway, Road, and Gravel Shoulder Not Assessed, facing north

Photo 41: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road and Concrete Shoulder Not Assessed, facing northwest

Photo 42: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road Not Assessed, facing west

Photo 43: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road, Gravel Shoulder and Laneway Not Assessed, facing west

Photo 44: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road, Gravel Shoulder and Laneway Not Assessed, facing east

Photo 45: Overview of Western End of the Study Area, facing east

Photo 46: Manicured Grass Test Pit Survey at 5m Intervals; Disturbed Asphalt Road, Gravel Shoulder and Laneways Not Assessed, facing west

Photo 47: Manicured Grass Test Pit Survey at 5m Intervals, facing north

Photo 48: Disturbed Manicured Grass Due to the Presence of a Natural Gas Line; Disturbed Asphalt Road and Gravel Shoulder Not Assessed, facing northeast

Photo 49: Steeply Sloping Overgrown Grass and Disturbed Asphalt Road and Gravel Shoulder, facing northwest

Photo 50: Overgrown Grass Test Pit Surveyed at 5m Intervals, Permanently Wet Unnamed Tributary of Catfish Creek Not Assessed, facing northwest

Photo 51: Typical Test Pit at M1 (AdHg-5)

Photo 52: Test Unit Excavation at M1 (AdHg-5), facing northwest

Photo 53: Test Unit Excavation at M1 (AdHg-5), facing southwest

Photo 54: Typical Stratigraphy at M1 (AdHg-5), facing north

Photo 55: Typical Test Pit at M5 (AdHg-9)

Photo 56: Typical Test Pit at P4 (AdHg-8)

Photo 57: Typical Test Pit at H2 (AdHg-6)

Photo 58: Typical Test Pit at H3 (AdHg-7)

Stage 3 Archaeological Assessment Five Locations, Port Bruce Bridge Replacement

Lot 5, Concession 1,
Geographic Township of Malahide,
County of Elgin,
Port Bruce, Ontario

Submitted to:
K. Smart Associates Limited
85 McIntyre Drive
Kitchener, ON N2R 1H6

and

Ontario's Ministry of Tourism, Culture and Sport

Submitted by:

Detritus
CONSULTING LTD.
archaeology · heritage

69 Claremont Avenue, Kitchener Ontario, N2M 2P5
Mobile/Office: 519-744-7018
e-mail: garth@golden.net www.detcon.net

Licensee: Garth Grimes
License Number: P017
PIF Numbers: M1 (AdHg-5) (P017-0722-2019)
M5 (AdHg-9) (P017-0725-2019)
P4 (AdHg-8) (P017-0723-2019)
H2 (AdHg-6) (P017-0724-2019)
H3 (adHg-7) (P017-0726-2019)
CP Number: 2018-199

ORIGINAL REPORT

September 19, 2019

Executive Summary

Detritus Consulting Ltd. ('Detritus') was retained by K. Smart Associates Limited ('the Proponent') to conduct Stage 3 Site Specific Assessments for five archaeological sites located on Lot5, Concession 1, within the Geographical Township of Malahide and historical County of Elgin, Port Bruce, Ontario (Figure 1). These assessments were undertaken in advance of a proposed bridge replacement on Imperial Road, from Bank Street in the north to a point approximately 100 metres (m) south of Dexter Line (the 'Study Area'; Figure 1).

The investigations were triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (Government of Ontario 1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the conditions of this legislation, Stage 3 assessments were conducted at archaeological sites M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adhere to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

An initial Stage 1-2 assessment of the Study Area was conducted by Detritus in May, 2019 (Detritus 2019; P017-0715-2019). The Study Area was irregularly shaped and measured approximately 2.86 hectares (ha). At the time of the assessment, it consisted of portions of Imperial Road, Dexter Line, and Rush Creek Line; their rights-of-way; and several residential properties along all three roads. Additionally, Catfish Creek and one its tributaries transect the Study Area along the northern edge.

The Stage 1 background research noted that by 1877 Lot 4, Concession 1 was divided into two halves. C. Monro owned the parcel north of Catfish Creek and R. Wilson, the parcel south of Catfish Creek. Mr. Monro also owned the northern parcel of Lot 5, Concession 1, north of Rush Creek Line. Most of Lot 5 south of Catfish Creek was occupied by the early community of Port Bruce. It is unclear if Mr. Monro owned the portion of Lot 5 north of Catfish Creek.

Based on the results of the Stage 1 investigation, the overgrown and manicured grassy areas throughout the Study Area exhibited archaeological potential and were recommended for Stage 2 field assessment. Approximately half of the Study Area was determined to be previously disturbed. These areas of disturbance included the existing asphalt road surfaces, their concrete and gravel shoulders, a number of gravel or asphalt laneways and parking areas, and three Natural Gas utility lines. The remainder of the Study Area comprised areas that were either steeply sloped or permanently wet due to the presence of Catfish Creek and its tributary.

The Stage 2 assessment of the Study Area was conducted on May 27 and 31, 2019 and consisted of a test pit survey at 5m intervals. This investigation resulted in the documentation of five archaeological locations, identified as M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7).

M1 (AdHg-5) comprised a single positive test pit and a single Stage 2 test unit in the manicured grass area on the south side of Rush Creek Line, east of Imperial Road, in the northern portion of the Study Area. The Stage 2 investigation of the site produced 12 Euro-Canadian artifacts and 4 pre-contact Aboriginal artifacts. The Euro-Canadian component of the site was interpreted as a small middle to late 19th century domestic site, possibly related to the occupation of C. Monro, with 20th century contamination. The pre-contact Aboriginal component, meanwhile, comprised three thinning flakes and one secondary flake. Based on these results M1 (AdHg-5) did not fulfill any of the criteria for additional assessment.

Given the fact that M1 (AdHg-5) was located just north of the early community of Port Bruce and that only four archaeological sites had been registered within the Borden block AdHg prior to the

Stage 2 assessment, Detritus determined that M1 (AdHg-5) retained cultural heritage value or interest ('CHVI'). Furthermore, through consultation of with the Chippewas of the Thames First Nation (COTTFN), additional assessment was requested to ensure there are no unaddressed Aboriginal archaeological interests connected with the site. Therefore, M1 (AdHg-5) was recommended for Stage 3 assessment.

M5 (AdHg-9) was discovered in the grassy area north of Dexter Line, west of Imperial Road, and south of Catfish Creek on the portion of Lot 5 that was once part of the early community of Port Bruce. The Stage 2 assessment of the site resulted in the documentation of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits covering an area of approximately 9m by 5m.

Based on the results of this investigation, the Euro-Canadian component of the site interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. The Euro-Canadian component of M5 (AdHg-9) was determined to retain no further CHVI. The pre-contact Aboriginal component of the site, meanwhile, was interpreted a small activity area occupied briefly during the pre-contact period, and characterised by late stage lithic reduction activities. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey are, the pre-contact Aboriginal component of M5 (AdHg-9) was recommended for Stage 3 assessment.

P4 (AdHg-8) was discovered in the manicured grass area on the north side of Dexter Line, west of Imperial Road, south of Catfish Creek, and approximately 20m to the west of M5 (AdHg-9). The Stage 2 assessment of the site produced 15 pre-contact Aboriginal artifacts and 7 Euro-Canadian artifacts. As was the case with nearby M5 (AdHg-5), the Euro-Canadian component of P4 (AdHg-8) was interpreted as a small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. The Euro-Canadian component of P4 (AdHg-9) was determined to retain no further CHVI.

Given a complete absence of diagnostic artifacts, the pre-contact Aboriginal component of P4 (AdHg-8) was interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stage lithic reduction activities. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey are, the pre-contact Aboriginal component of P4 (AdHg-8) was recommended for Stage 3 assessment.

H2 (AdHg-6) was discovered in the manicured grass area on the south side of Dexter Line, East of Imperial Road, within the limits of historical Port Bruce. The Stage 2 assessment of the site produced 45 Euro-Canadian artifacts from two test pits. Based on the results of the Stage 2 assessment, H2 (AdHg-6) was interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. A Stage 3 assessment was recommended.

H3 (AdHg-7) was identified in the manicured grass area on the north side of Dexter Line, opposite H2 (AdHg-6). The Stage 2 assessment of the site resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits. Based on the results of the Stage 2 assessment, H3 (AdHg-7) was interpreted as small middle to late 19th century domestic site, possibly related to the occupation of the early community of Port Bruce. A Stage 3 assessment was recommended.

The Stage 3 assessments of M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6) and H3 (AdHg-7) were conducted by Detritus between June 21 and July 18, 2019 under archaeological consulting license P017 issued to Mr. Garth Grimes by the MTCS.

The Stage 3 assessment of M1 (AdHg) yielded 16 Euro-Canadian artifacts from a line of three test units spanning the original positive Stage 2 test pit. Artifact yields were very low, ranging from three to seven, and documented a period of occupation generally spanning the middle to late 19th century. No midden area was observed. Additionally, the westernmost unit, 195E, 500N, revealed evidence of deep disturbance that truncated the site on that side. This evidence, when considered with the Stage 2 results, suggests that the Euro-Canadian component of M1 (AdHg-5) was a small area of late 19th to 20th century debris that may have been associated with the occupation of C. Monro.

Given the absence of pre-contact Aboriginal material encountered during the Stage 3 assessment, it is impossible to build upon the Stage 2 conclusions, which identified the pre-contact Aboriginal component of the site as a small activity area occupied seasonally by pre-contact Aboriginal.

Based on the results of the Stage 3 assessment, and the period of occupation represented within the artifact assemblage, M1 (AdHg-5) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the site is not recommended.**

The Stage 3 test unit excavations at M5 (AdHg-9) and P4 (AdHg-8) determined that the two sites were nodes of a larger parent site, later identified as M5/P4 (AdHg-9).

The Stage 3 assessment of the combined M5/P4 (AdHg-9) produced 316 Euro-Canadian artifacts and 180 pre-contact Aboriginal artifacts from 14 test units. The distribution of Euro-Canadian artifacts at the combined site was more reminiscent of smaller isolated deposits than a singular midden area. The predominance of thick window glass pieces, machine cut and wire drawn nails, and machine manufactured bottle glass within the Stage 3 assemblage is suggestive of a middle of the 19th to early 20th century occupation. This range is supported by the Stage 3 ceramic assemblage, which featured primarily undecorated ironstone sherds. The presence of horse tack, meanwhile, suggests that the occupants of the site were wealthy enough to stable a horse. Finally, A small modern fence post observed in Test Unit 215E, 503N and the modern fence wire recovered from 230E, 510N suggests that a 20th century fence may have spanned the southern edge of the site.

The Euro-Canadian component of M5/P4 (AdHg-9) has been interpreted as small pockets of late 19th to early 20th artifacts along the edge of a larger midden area that may extend to the northwest beyond the limits of the Study Area. Based on the results of the Stage 3 assessment, and the occupation range represented in the artifact assemblage, the Euro-Canadian component of M5/P4 (AdHg-9) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the Euro-Canadian component of the site is not recommended.**

The pre-contact Aboriginal component of M5/P4 (AdHg-9) comprised 180 artifacts, including a single piece of Aboriginal pottery. The remainder of the assemblage consisted of pieces of chipping detritus. Five of the test units from P4 (AdHg-8) and two from M5 (AdHg-9) produced over ten pre-contact Aboriginal artifacts each and formed a single activity area in the middle of the merged site, measuring approximately 14m east to west by 9m north to south. Morphological analysis of the flake assemblage suggests that late stage lithic reduction was undertaken most actively at M5/P4 (AdHg-9) prior to European settlement. The presence of Aboriginal pottery, meanwhile suggests that this earlier occupation belongs to the Woodland period. Whereas no other features that are considered typical for Woodland period sites were observed, it is possible that both sites form the edge of a much larger Woodland period site that extends to the northwest beyond the limits of the Study Area. Based on the results of the Stage 3 assessment, wherein seven test units yielded 10 or more pre-contact artifacts, including a single piece of Aboriginal pottery, **the pre-contact Aboriginal component of M5/P4 (AdHg-9) fulfills the criteria for a Stage 4 mitigation of impacts** as per Section 3.4.1, Standards 1a and 1c of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

The Stage 3 assessment of H2 (AdHg-6) resulted in the documentation of 162 primarily Euro-Canadian artifacts from four test units. Three of these units formed a straight line between the edge of the Study Area to the south, and the two positive Stage 2 test pits to the north. A service pipe observed in Test Unit 200E, 500N suggested that the east side of the site was disturbed. Likewise, Test Unit 193E, 502N, excavated directly on one of the Stage 2 test pits, revealed disturbance layers.

Although disturbed, Test Unit 193E, 502N produced the highest number artifacts on the site, and most of these from the surviving portion of the undisturbed topsoil layer. Given that the next highest yielding unit produced only 32 artifacts, it is proposed here that H2 (AdHg-6) represents the edge of a larger site that extends north into the disturbed area to the north. The ceramic

assemblage was dominated by RWE and ironstone, suggestive of a middle to late 19th century occupation. This occupation range is supported by the predominance of machine cut nails, and thick window glass. The presence of wire drawn nails and machine manufactured bottle glass may extend this period of occupation into the 20th century. Based on the results of the Stage 3 assessment, the Euro-Canadian component of H2 (AdHg-6) has been interpreted as the southern edge of a larger middle 19th to early 20th century midden area. Given the absence of any definitive 20th century material culture in the Stage 3 assemblage, **H2 (AdHg-6) fulfills the criterion for a Stage 4 mitigation of impacts**, as outlined in Section 3.4.2, Standard 1a of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

One piece of pre-contact Aboriginal chipping detritus was also represented in the Stage 3 assemblage at H2 (AdHg-6). This one flake represents less than 1% of the Stage 3 artifact assemblage at H2 (AdHg-6), and is thought to be residual. This conclusion is supported by the absence of pre-contact Aboriginal artifacts in the Stage 2 assemblage.

The Stage 3 assessment of H3 (AdHg-7) the resulted in the documentation of 284 Euro-Canadian artifacts and ten pieces of pre-contact Aboriginal chipping detritus from five Stage 3 test units. Three of these units were positioned along the edge of the Study Area for the length of the Stage 2 site limits, and produced 30, 100 and 5 Euro-Canadian artifacts respectively. Two additional units positioned to the northeast and northwest of the highest yielding grid unit produced an additional 69 and 80 Euro-Canadian artifacts.

Seven hand painted RWE sherds within the Stage 3 assemblage were suggestive of a late 19th century occupation. This range is supported also by the presence of ironstone, clear and aqua bottle glass pieces, cut nails, clay pipe fragments, and thick window glass pieces. The presence of wire drawn nails and three 20th century coins extend the period of occupation. Whereas a few earlier ceramic pieces were recovered, including three pieces of pearlware, these were interpreted as heirloom items. The Euro-Canadian component of H3 (AdHg-7) has been interpreted as middle of the 19th to early 20th century midden area that extends primarily to the north of the Study Area. Based on the results of the Stage 3 assessment, and the period of occupation represented within the artifact assemblage, the Euro-Canadian component of H3 (AdHg-7) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the Euro-Canadian component of H3 (AdHg-7) is not recommended.**

The ten pre-contact Aboriginal artifacts within the Stage 3 assemblage were recovered from two of the five units. Given an absence of cultural features, formal tools, or diagnostic material, the pre-contact Aboriginal component of the site has been interpreted as a small activity area within the limits of the larger Euro-Canadian midden area. Based on the results of the Stage 3 assessment, wherein no test units yielded 10 or more pre-contact artifacts, the pre-contact Aboriginal component of H3 (AdHg-7) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011). One of the Stage 3 test units at the site, however, produced eight pieces of chipping detritus. Given a dearth of registered archaeological sites within the AdHg Borden Block as a whole, the presence of eight pre-contact Aboriginal artifacts within a single unit was considered a rare occurrence. As a result, **the pre-contact Aboriginal component of H3 (AdHg-7) fulfills the criterion for a Stage 4 mitigation of impacts**, as outlined in Section 3.4.1, Guideline 1a of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

The MTCS prefers that sites recommended for Stage 4 mitigation be avoided and protected rather than excavated, as per Section 7.9.4, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). Options to reduce or eliminate impacts to archaeological sites include redesigning the Study Area, excluding the archaeological site area from the Study Area, or incorporating the area of the archaeological site into the Study Area but without alteration, as outlined in Section 3.5 of the *Standards and Guidelines* (Government of Ontario 2011a). If these options are not feasible, Stage 4 archaeological mitigation by hand excavation is an alternative. In consultation with the Proponent, the Stage 4 mitigation of M5/P4 (AdHg-9), H2 (AdHg-6), and H3 (AdHg-7) by avoidance and protection was a viable option. For more details regarding the avoidance and protection recommendations at each site, please refer to Section 5.0 of the accompanying

The Executive Summary highlights key points from the report only; for complete information and findings, the reader should examine the complete report.

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Project Personnel

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Acknowledgments

Generous contributions by the following individuals and agencies made this report possible.

- Mr. Daryl Schwartzentruber of K. Smart Associates Limited

1.0 Project Context

1.1 Development Context

Detritus Consulting Ltd. ('Detritus') was retained by K. Smart Associates Limited ('the Proponent') to conduct Stage 3 Site Specific Assessments for five archaeological sites located on Lot5, Concession 1, Geographical Township of Malahide, historical County of Elgin, Port Bruce, Ontario (Figure 1). These assessments were undertaken in advance of a proposed bridge replacement on Imperial Road, from Bank Street in the north to a point approximately 100 metres (m) south of Dexter Line (the 'Study Area'; Figure 2).

The investigations were triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (Government of Ontario 1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the conditions of this legislation, Stage 3 assessments were conducted at archaeological sites M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adhere to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

The purpose of a Stage 3 Site Specific Assessment is to assess the cultural heritage value or interest ('CHVI') of a site through a controlled collection of material. This information is used to support a determination of whether the site has been sufficiently documented or if further measures are required to protect or document it fully. In compliance with the *Standards and Guidelines* (Government of Ontario 2011), the objectives of the following Stage 3 assessments are:

- To collect a representative sample of artifacts;
- to determine the extent of each archaeological site and the characteristics of the artifacts;
- to assess the CHVI of each archaeological site; and
- to determine the need for mitigation of development impacts and recommend appropriate strategies for mitigation and future conservation.

The licensee received permission from the Proponent to enter the land and conduct all required archaeological fieldwork activities, including the recovery of artifacts.

1.2 Historical Context

1.2.1 Post-Contact Aboriginal Resources

The earliest recorded history of southern Ontario began in 1626, when French Recollet Father Daillon travelled the entire length of the Grand River and documented 28 Neutral villages in the area (Harper 1950; White 1978). In 1647, the Seneca attacked one eastern group of the Neutral and, by 1653, the Neutral had been assimilated by the Five Nations (White 1978; Noble 1978; Jamieson 1992). The Five Nations relinquished the Niagara Peninsula and northern Lake Ontario area before 1700.

The late 17th and early 18th centuries represent a turning point moment in the evolution of the post-contact Aboriginal occupation of southern Ontario. At this time, various Iroquoian-speaking communities began migrating into southern Ontario from New York State, followed by the arrival of Algonkian-speaking groups from northern Ontario (Konrad 1981; Schmalz 1991). This period also marks the arrival of the Mississaugas into southern Ontario and, in particular, the watersheds of the lower Great Lakes.

The oral traditions of the Mississaugas, as told by Chief Robert Paudash and recorded in 1904, suggest that the Mississaugas defeated the Mohawk Nation, who retreated to their homeland south of Lake

Ontario. Following this conflict, a peace treaty was negotiated between the two groups and, at the end of the 17th century, the Mississaugas settled permanently in southern Ontario (Praxis Research Associates n.d.). Around this same time, members of the Three Fires Confederacy (Chippewa, Ottawa, and Potawatomi) began immigrating from Ohio and Michigan into southwestern Ontario (Feest and Feest 1978).

In 1722, the Five Nations adopted the Tuscarora in New York becoming the Six Nations (Pendergast 1995). Sir Frederick Haldimand, Governor of Québec, made preparations to grant a large plot of land in south-central Ontario to those Six Nations who remained loyal to the Crown during the American War of Independence (Weaver 1978). More specifically, Haldimand arranged for the purchase of the Haldimand Tract in south-central Ontario from the Mississaugas. The Haldimand Tract, also known as the 1795 Crown Grant to the Six Nations, was provided for in the Haldimand Proclamation of October 25th, 1784 and was intended to extend a distance of six miles on each side of the Grand River from mouth to source (Weaver 1978).

The Study Area first enters the Euro-Canadian historic record a few years later on May 19th 1790, as part of Treaty Number 2 made between the First Nation inhabitants of the area and the British, specifically Alexander McKee of the Indian Department (Surtees 1994). According to Morris, this treaty,

> *...was made with the Ottawas, Chippewas, Pottawatomys and Hurons May 19th, 1790, portions of which nations had established themselves on the Detroit River all of whom had been driven by the Iroquois from the northern and eastern parts of the Province, from the Detroit River easterly to Catfish Creek and south of the river La Tranche [Thames River] and Chenail Ecarte, and contains Essex County except Anderdon Township and Part of West Sandwich; Kent County except Zone Township, and Gores of Camden and Chatham; Elgin County except Bayham Township and parts of South Dorchester and Malahide. In Middlesex County, Del[a]ware and Westminster Townships and part of North Dorchester.*
>
> Morris 1943: 17

At this time, European squatters had already begun to settle along the banks of the Thames River, although their specific locations were not recorded until the first survey of the area was made following the First Nation land surrender in 1790 (Hamil 1951).

The size and nature of the pre-contact settlements and the subsequent spread and distribution of Aboriginal material culture in southern Ontario began to shift with the establishment of European settlers in southern Ontario. Despite the inevitable encroachment of European settlers on previously established Aboriginal territories, "*written accounts of material life and livelihood, the correlation of historically recorded villages to their archaeological manifestations, and the similarities of those sites to more ancient sites have revealed an antiquity to documented cultural expressions that confirms a deep historical continuity to Iroquoian systems of ideology and thought*" (Ferris 2009:114). As Ferris observes, despite the arrival of a competing culture, First Nations communities throughout southern Ontario have left behind archaeologically significant resources that demonstrate continuity with their pre-contact predecessors, even if they have not been recorded extensively in historical Euro-Canadian documentation.

1.2.2 Euro-Canadian Resources

The five sites being considered in this report are located in the Geographic Township of Malahide and historical County of Elgin, Port Bruce, Ontario.

On July 24, 1788, Sir Guy Carleton, the Governor-General of British North America, divided the Province of Québec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (Archives of Ontario 2009). Further change came in December 1791 when the Province of Québec was rearranged into Upper Canada and Lower Canada under the Constitutional Act. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada; he initiated several initiatives to populate the province including the establishment of shoreline communities with effective transportation links between them (Coyne 1895:33).

In July 1792, Simcoe divided Upper Canada into 19 counties stretching from Essex in the west to Glengarry in the east. Later that year, the four districts originally established in 1788 were renamed as the Western, Home, Midland and Eastern Districts. As population levels in Upper Canada increased, smaller and more manageable administrative bodies were needed resulting in the establishment of many new counties and townships. As part of this realignment, the boundaries of the Home and Western Districts were shifted and the London and Niagara Districts were established. Under this new territorial arrangement, the sites became part of the London District (Archives of Ontario 2009).

The area of Elgin County was first settled by Lieutenant Thomas Talbot, the personal secretary of Lieutenant Governor Simcoe. After resigning from the military, Talbot sought to establish a small agricultural settlement at Kettle Creek, now Port Stanley. Given delays to this land grant, Simcoe requested 5,000 acres for future settlement along the north shore of Lake Erie on behalf of Talbot. In 1803, Talbot arrived from England and established a small settlement that he named Port Talbot. He erected a log house on a hill facing the lake with a view of Talbot Creek valley. By 1808, he had constructed the settlement's first water mill along Talbot Creek. He also provided new settlers with seed for wheat, barley, peas, and oats (McCallum 2016).

At the time, much of southwestern Ontario was owned by speculators, the Crown or the Anglican Church. Talbot, however, sought industrious settlers who demonstrated skill in infrastructure development, as opposed to land speculators. In addition to the settlement at Port Talbot, Talbot was granted 200 acres for every settler that he received. As part of this initiative, Talbot settled immigrants in Aldborough and Dunwich Townships, and eventually in Southwold, Yarmouth, Malahide, and Bayham Townships. By the middle of the 19th century, the population of Elgin County had risen to 12,000 settlers and over 60,000 acres had been cleared for cultivation (McCallum 2016).

Between 1837 and 1851, Elgin County was part of Middlesex County. In 1841, Middlesex County became part of Canada West in the new United Province of Canada. Following the abolition of the district system in 1849, the counties of Canada West were reconfigured once again. In 1851, Elgin County was severed from Middlesex County and was named for the Governor-General of the time, Lord Elgin. Throughout the reminder of the century, a number of schools, churches, businesses and industries were established throughout Elgin County, including a notable ship building industry at Port Burwell and fishing industries at Port Stanley and Port Burwell. Furthermore, at least five different railways eventually spanned the county, linking it to cities and ports in Canada and the United States, including the Michigan Central, the Pere Marquette, the London and Port Stanley, the Canadian National and the Canadian Pacific (McCallum 2016).

The Township of Malahide also received its name from Talbot, who sought to honour the Castle of Malahide in Ireland. The earliest settlers to the township were the five Davis brothers, American immigrants who arrived in 1810. Although Malahide did not grow significantly until much later, it boasted a population of approximately 800 people by 1817. At this time, nearly all of the first, eighth, and ninth concessions had been settled. The earliest businesses, including a general store, hotel, tailor and blacksmith shop, were established in the early to middle 1830s; the county's first schoolhouse was erected in Malahide township earlier in 1816. Passage through the township was aided by the graveling of the Aylmer–Port Bruce Road, now known as Highway 73/Imperial Road, in 1855 (Page & Co. 1877).

The *Illustrated Historical Atlas of the County of Elgin Ont.* ('*Historical Atlas';* Page & Co. 1877), demonstrates the extent to which Malahide Township had been settled by 1877 (Figure 3). Landowners are listed for every lot within the township. Many of the lots had been subdivided into smaller parcels to accommodate an increasing population throughout the late 19th century. Structures and orchards are prevalent throughout the township, almost all of which front early roads, such as Talbot Road.

All five of the sites detailed in this report are located on Lot 5, Concession 1. The majority of Lot 5, like Lot 4 to the west, was owned by C. Monroe. The Monroe Estate included the portions of both lots located north of Catfish Creek, and was traversed by what is now Rush Creek Line. A house and orchard are depicted on either side of Rush Creek Line in Lot 4; a school house occupies the southeast corner.

Most of Lot 5 south of Catfish Creek was occupied by the early community of Port Bruce. It is unclear who owned the portion of the lot east of Port Bruce and south of Catfish Creek, although it may have been an extension of the L. Moore's property, which included all of Lot 6 to the east. R. Wilson is listed as the owner of Lot 4, Concession 1, south of Catfish Creek.

Although significant and detailed landowner information is available on the *Historical Atlas* map of Malahide Township, it should be recognized that historical county atlases were produced primarily to identify factories, offices, residences and landholdings of subscribers and were funded by subscriptions fees. Therefore, landowners who did not subscribe were not always listed on the maps (Caston 1997). Moreover, associated structures were not necessarily depicted or placed accurately (Gentilcore and Head 1984).

1.2.3 Land Registry Record

According to the Land Registry Records for Malahide Township (Government of Ontario 2018), the Crown Patent for Lot 5 Concession 1 was granted to Honourable John Hale by the Crown on June 4, 1817. The next transaction took place in October of 1854 when a plan for Port Bruce was registered for portions of Lots 4, 5, and 6. The grantor is listed as J.P. Ball P.L.L. Mr. Ball granted these lots to three people, Lindley Moore, Amasa Lewis, and Elijah Bens. In November 1855 John A. Hogan sold a portion of his lot to John Hutchison. In December 1855, Edward Hale, the eldest son of Honourable John Hale deeded a portion of the lot to Amasa Lewis. It is unclear from the records how Mr. Hogan acquired the land he sold to Mr. Hutchinson. Throughout the remainder of the 19th century many small portions of land within Port Bruce were sold by Mr. Moore, Mr. Lewis, and Mr. Bens, to various people. Given the illegibility of the comments in the records it is difficult to associate any of the transactions with the particular portions of Lot 5 in which the current Stage 3 sites are located.

1.2.4 Recent Reports

Archaeological sites M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) were discovered during a Stage 1-2 assessment of the Study Area, conducted by Detritus in May 2019 (P017-0715-2019) and documented in the following assessment report;

> *Stage 1-2 Archaeological Assessment, Port Bruce Bridge Replacement. Lots 4 and 5, Geographical Township of Malahide, County of Elgin, Port Bruce, Ontario* (Detritus 2019).

The results of this investigation will be discussed in greater detail below in Section 1.3.4.

1.3 Archaeological Context

1.3.1 Property Description and Physical Setting

The Stage 2 Study Area was irregularly shaped and measured approximately 2.86 hectares (ha). At the time of the assessment, it consisted of portions of Imperial Road, Dexter Line, and Rush Creek Line; their rights-of-way; and several residential properties along all three roads. Additionally, Catfish Creek and one its tributaries transect the Study Area along the northern edge. Four of the five sites were located in the southern portion of the Study Area, near the intersection of Dexter Line and Imperial Road. M1 (AdHg) was situated just south of Rush Creek Line, east of Imperial Road.

Prior to the industrialization and commercial development of the area, the majority of the region surrounding the five sites has been subject to European-style agricultural practices for over 100 years, having been settled by Euro-Canadian farmers from the early 19th century. Much of the region continues to be used for agricultural purposes.

All five sites are situated within the Norfolk Sand Plain physiographic region. The Norfolk Sand Plain has been classified as a wedge-shaped plain stretching from the Niagara Escarpment in a southwesterly direction to the north shore of Lake Erie. The sands and silts of this region were deposited as a delta in glacial Lakes Whittlesey and Warren, and was formed from west to east as the glacier withdrew (Chapman and Putnam 1984). These physiographic elements accumulated over grey shale and limestone bedrock belonging to the Middle Devonian Dundee formation (Davidson 1989). During pre-contact and early contact times, this area comprised a mixture of deciduous trees and open areas. In the late 18th century, Euro-Canadian settlers began to clear the forests for agricultural purposes, which have been ongoing in the vicinity of the Study Area for over 100 years.

The closest source of potable water is Catfish Creek, which traverses the middle of the Study Area to the north of Dexter Line and four of the five documented sites. A tributary of Catfish Creek traverses the northern edge of the Study Area, to the northeast of M1 (AdHg-5)

1.3.2 Pre-Contact Aboriginal Land Use

This portion of southwestern Ontario has been occupied by people as far back as 11,000 years ago as the glaciers retreated. For the majority of this time, people were practicing hunter gatherer lifestyles with a gradual move towards more extensive farming practices. Table 1 provides a general outline of the cultural chronology of Malahide Township, based on Ellis and Ferris (1990).

Table 1: Cultural Chronology for Malahide Township

Time Period	Cultural Period	Comments
9500 – 7000 BC	Paleo Indian	first human occupation hunters of caribou and other extinct Pleistocene game nomadic, small band society
7500 - 1000 BC	Archaic	ceremonial burials increasing trade network Hunter gatherers
1000 - 400 BC	Early Woodland	large and small camps spring congregation/fall dispersal introduction of pottery
400 BC – AD 800	Middle Woodland	kinship based political system incipient horticulture long distance trade network
AD 800 - 1300	Early Iroquoian (Late Woodland)	limited agriculture developing hamlets and villages
AD 1300 - 1400	Middle Iroquoian (Late Woodland)	shift to agriculture complete increasing political complexity large palisaded villages
AD 1400 - 1650	Late Iroquoian	regional warfare and political/tribal alliances destruction of Huron and Neutral

1.3.3 Previous Identified Archaeological Work

In order to compile an inventory of archaeological resources in the vicinity of the archaeological sites documented in this report, the registered archaeological site records kept by the MTCS were consulted. In Ontario, information concerning archaeological sites stored in the ASDB (Government of Ontario n.d.) is maintained by the MTCS. This database contains archaeological sites registered according to the Borden system. Under the Borden system, Canada is divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13km east to west and approximately 18.5km north to south. Each Borden Block is referenced by a four-letter designator and sites within a block are numbered sequentially as they are found. The five sites currently under review are situated in Borden Block AdHg.

Information concerning specific site locations is protected by provincial policy, and is not fully subject to the *Freedom of Information and Protection of Privacy Act* (Government of Ontario 1990c). The release of such information in the past has led to looting or various forms of illegally conducted site destruction. Confidentiality extends to all media capable of conveying location, including maps, drawings, or textual descriptions of a site location. The MTCS will provide information concerning site location to the party or an agent of the party holding title to a property, or to a licensed archaeologist with relevant cultural resource management interests.

According to the ASDB, a single archaeological site has been registered within 1km of the Study Area. Pineo 1 (AdHg-1) is a multi-component site of which the pre-contact component dates from the Middle Archaic to the Late Woodland periods. To the best of Detritus' knowledge, no other assessments have been conducted adjacent to the Study Area, and no sites are registered within 50m of the Study Area.

1.3.4 Summary of Previous Investigations

An initial Stage 1-2 assessment of the Study Area was conducted by Detritus in May, 2019 (Detritus 2019; P017-0715-2019). At the time of the assessment, the Study Area consisted of portions of Imperial Road, Dexter Line, and Rush Creek Line; their rights-of-way; and several residential properties along all three roads. Additionally, Catfish Creek transected the centre of the Study Area and one its tributaries, the northern edge (Figure 2).

Based on the results of the Stage 1 investigation, the overgrown and manicured grassy areas throughout the Study Area exhibited archaeological potential and were recommended for Stage 2 field assessment. Approximately half of the Study Area was determined to be previously disturbed. The areas of disturbance included the existing asphalt road surfaces, their concrete and gravel shoulders, 15 gravel or asphalt laneways and parking areas, and three Natural Gas utility lines. The remainder of the Study Area comprised areas that were either steeply sloped or permanently wet due to the presence of Catfish Creek and its tributary. The previously disturbed steeply sloped, and permanently wet areas were mapped and photographed only.

The Stage 2 assessment of the Study Area was conducted on May 27 and 31, 2019 and consisted of a test pit survey at 5m intervals across the non-sloping grass areas. This investigation resulted in the documentation of five archaeological locations, identified as M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7). All five of the sites were located on Lot 5, Concession 1.

The Stage 2 assessment of M1 (AdHg-5) resulted in the documentation of 12 Euro-Canadian artifacts and 4 pre-contact Aboriginal artifacts from a single test pit and a single test unit located in the manicured grass area on the south side of Rush Creek Line, east of Imperial Road, in the northern portion of the Study Area. Half of the Euro-Canadian assemblage comprised four cut nails and two animal bone fragments, suggestive of a middle to late 19th century occupation. The other half consisted of two modern beer bottle fragments, two pieces of fence wire, one piece of asphalt, and one plastic coffee cup lid, all of which was interpreted as 20th century debris. The Euro-Canadian component of M1 (AdHg-5) was interpreted as small middle to late 19th century domestic site, possibly related to the occupation of C. Monro, with 20th century contamination. Based on the results of the Stage 2 assessment, the Euro-Canadian component of M1 (AdHg-5) did not meet the criteria for additional assessment.

The pre-contact Aboriginal component of the site comprised three thinning flakes and one secondary flake. Two of the thinning flakes were manufactured from Haldimand chert; the other thinning flake and the secondary flake were manufactured from Onondaga chert. Given an absence of diagnostic artifacts, the pre-contact Aboriginal component of M1 (AdHg-5) was interpreted as a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stage lithic reduction. Based on the results of the Stage 2 assessment, wherein only four non-diagnostic artifacts were recovered, the pre-contact Aboriginal component of M1 (AdHg-5) did not fulfill any of the criteria for further assessment outlined in Section 2.2, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

Detritus also noted, however, that M1 (AdHg-5) was identified just north of the early community of Port Bruce within a Borden Block that had produced only four registered archaeological sites prior to Detritus' Stage 2 assessment. Additionally, the Chippewas of the Thames First Nation (COTTFN) requested additional assessment to ensure there are no unaddressed Aboriginal archaeological interests connected with the site. Therefore, despite a paucity of artifacts observed during the Stage 2 assessment, the pre-contact Aboriginal component of M1 (AdHg-5) was recommended for Stage 3 assessment, as per Section 2.2, Guidelines 1 and 2 of the *Standards and Guidelines* (Government of Ontario 2011).

M5 (AdHg-9) was discovered on the northwest corner of Dexter Line and Imperial Road, to the south of Catfish Creek, in the northwest corner of historical Port Bruce according to the 1877 *Historical Atlas* map. The Stage 2 assessment of M5 (AdHg-9) resulted in the documentation of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits covering an area of approximately 9m by 5m. The Euro-Canadian component of the site comprised four glass bottle pieces, three cut nails, two thin window glass shards, a single sherd of undecorated ironstone, a red brick fragment, an animal bone, a piece of chimney glass, and an unidentified metal ring. Based on the results of the Stage 2 assessment, the site was interpreted as small middle to late 19th century domestic site related to the occupation of the early community of Port Bruce. Based on the results of the Stage 2 assessment of M5 (AdHg-9), wherein less

than 20 artifacts were observed dating to a period of use to before 1900, the Euro-Canadian component of M5 (AdHg-9) was determined to retain no further CHVI.

The pre-contact Aboriginal component of M5 (AdHg-9) consisted of five pieces of chipping detritus, all of which were identified as thinning flakes. Four of these were manufactured from Onondaga chert, and the other from an unknown chert type. Given an absence of diagnostic artifacts, the pre-contact Aboriginal component of M5 (AdHg-9) was interpreted a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stage lithic reduction. Given that at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area, the pre-contact Aboriginal component of M5 (AdHg-9) was recommended for Stage 3 assessment.

P4 (AdHg-8) was identified in the manicured grass area approximately 20m to the southwest of M5 (AdHg-9). The Stage 2 assessment of the site resulted in the documentation of 15 pre-contact Aboriginal artifacts and 7 Euro-Canadian artifacts from eight positive test pits covering an area of approximately 8m east to west by 6m north to south. The pre-contact Aboriginal component of the site comprised 11 thinning flakes, 3 secondary flakes, and 1 flake fragment. Given an absence of diagnostic artifacts, the pre-contact Aboriginal component of P4 (AdHg-8) was interpreted as a small activity area occupied briefly by Aboriginal people during the pre-contact period, and characterised by late stage lithic reduction. Based on the results of the Stage 2 assessment, wherein at least five non-diagnostic artifacts were recovered from a 10m by 10m test pit survey area, the pre-contact Aboriginal component of P4 (AdHg-8) was recommended for a Stage 3 assessment.

The Euro-Canadian component of P4 (AdHg-8) comprised four cut nails, one bird bone, one ironstone fragment, and one piece of window glass. The cut nails and ironstone fragment date from the middle to late 19th century. Given their small quantity, however, these artifacts were considered at the time to be misplaced from nearby M5 (AdHg-9) to the northeast. Based on the results of the Stage 2 assessment, the Euro-Canadian component of P4 (AdHg-8) did not fulfill the criteria for a Stage 3 assessment and was determined to retain no additional CHVI.

H2 (AdHg-6) was discovered to the east of Imperial Road on the south side of Dexter Line within historical Port Bruce. The Stage 2 assessment of the site resulted in the documentation of 45 Euro-Canadian artifacts from two test pits, 6m apart. The artifact assemblage was dominated by ceramic sherds and documented a period of occupation spanning the middle to late 19th century, based primarily on the predominance of ironstone ceramic pieces and machine cut nails. H2 (AdHg-6) was interpreted as a middle to late 19th century domestic site related to the early community of Port Bruce. Based on the results of the Stage 2 assessment, wherein at least 20 artifacts dating to a period of use to before 1900 were observed, H2 (AdHg-6) was recommended for Stage 3 assessment.

H3 (AdHg-7) was discovered on the north side of Dexter Line, opposite H2 (AdHg-6), but still within the limits of historical Port Bruce. The Stage 2 assessment of the site resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits covering an area of 21m northwest to southeast by 7m northeast to southwest. The artifact assemblage was dominated by sherds of refined white earthenware ('RWE'), although ironstone, pearlware, and stoneware were also represented. Given the presence also of cut nails, clear bottle glass, and white clay pipe fragments, H3 (AdHg-7) was interpreted as a small middle to late 19th century domestic site related to the occupation of the early occupation of Port Bruce. Based on the results of the Stage 2 assessment, wherein at least 20 artifacts dating to a period of use to before 1900 were observed, H3 (AdHg-7) was recommended for Stage 3 assessment.

1.3.5 Archaeological Potential

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. Detritus applied archaeological potential criteria commonly used by the MTCS (Government of Ontario 2011) to determine areas of archaeological potential throughout Study Area, focusing on the vicinity of archaeological sites M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7). These variables include proximity to previously identified archaeological sites, distance to various types of water sources, soil texture and drainage, glacial geomorphology, elevated topography, and the general topographic variability of the area.

Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and, when considered alone, may result in a determination of

archaeological potential. However, any combination of two or more other criteria, such as well-drained soils or topographic variability, may also indicate archaeological potential. When evaluating distance to water it is important to distinguish between water and shoreline, as well as natural and artificial water sources, as these features affect sites locations and types to varying degrees. The MTCS (Government of Ontario 2011) categorizes water sources in the following manner:

- Primary water sources: lakes, rivers, streams, creeks;
- secondary water sources: intermittent streams and creeks, springs, marshes and swamps;
- past water sources, glacial lake shorelines, relic river or stream channels, cobble beaches, shorelines of drained lakes or marshes; and
- accessible or inaccessible shorelines: high bluffs, swamp or marshy lake edges, sandbars stretching into marsh.

The closest source of potable water is Catfish Creek, which traverses the middle of the Study Area to the north of Dexter Line and four of the five documented sites. A tributary of Catfish Creek traverses the northern edge of the Study Area, to the northeast of M1 (AdHg-5), the only site documented along Rush Creek Line. Additional ancient, relic, or seasonal water courses may have been present in the past but are not depicted on modern or historic mapping.

Soil texture is also an important determinant of past settlement, usually in combination with other factors such as topography. The Study Area is situated within the Norfolk Sand Plain physiographic region. The soils within this region are well-drained, and suitable for pre-contact and post contact Aboriginal agricultural. Considering also the length of occupation of Malahide Township prior to the arrival of Euro-Canadian settlers, as evidenced by the multi-component site registered within 1km of the Stage 2 Study Area, and the potential for pre-contact and post-contact Aboriginal archaeological material at the five sites site is judged to be moderate to high.

For Euro-Canadian sites, archaeological potential can be extended to areas of early Euro-Canadian settlement, including places of military or pioneer settlements; early transportation routes; and properties listed on the municipal register or designated under the *Ontario Heritage Act* (Government of Ontario 1990b) or property that local histories or informants have identified with possible historical events.

The *Historical Atlas* map demonstrate the extent to which Malahide Township was occupied by 1877. Landowners are listed for every lot in the township, many of which have been subdivided multiple times to accommodate a growing population in the second half of the 19th century. Structures and orchards are prevalent throughout the township, almost all of which front early roads, such as Talbot Road.

All five of the sites detailed in this report are located on Lot 5, Concession 1. Four of these fall within the limits of the early community of Port Bruce. M1 (AdHg-5) was located just to the north of Port Bruce along what is now Rush Creek Line on a large property owned by C. Monro. The southern end of the Monroe Estate was traversed by what is now Rush Creek Line. A house and orchard are depicted on either side of Rush Creek Line in neighbouring Lot 4; a school house occupies the southeast corner. Considering also the multi-component site registered within 1km of the Stage 2 Study Area and the potential for post-contact Euro-Canadian archaeological resources at the five sites is judged to be moderate to high.

Finally, despite the factors mentioned above, extensive land disturbance can eradicate archaeological potential within a Study Area (Wilson and Horne 1995). At the time of the Stage 2 assessment, approximately half of the Study Area was determined to have been previously disturbed. These areas of disturbance included the existing asphalt road surfaces, their concrete and gravel shoulders, 15 gravel or asphalt laneways and parking areas and three areas of Natural Gas utilities. The remainder of the Study Area comprised areas that were either steeply sloped or permanently wet due to the presence of Catfish Creek and its tributary. The previously disturbed steeply sloped and permanently wet areas were mapped and photographed only.

The five sites under review were all located in the undisturbed grassy areas adjacent to the roadways. Given that the sites themselves appear to be undisturbed, the potential for pre-contact and post-contact archaeological resources at the five sites is judged to be moderate to high

2.0 Field Methods

The Stage 3 assessments of M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) were conducted between June 21 and July 18, 2018 under archaeological consulting license P017 issued to Mr. Garth Grimes by the MTCS.

During the assessment, the weather was warm and sunny. The soil was dry and screened easily. At no time during the investigation were field or weather conditions detrimental to the recovery of archaeological material, as outlined in Section 3.2, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). Lighting and soil conditions were suitable and visibility was excellent, as required by Section 7.11.1, Standard 1a of the *Standards and Guidelines* (Government of Ontario 2011). Table 2 provides a summary of the weather and field conditions during the Stage 3 archaeological assessment; Photos 1 to 29 illustrate field conditions.

Table 2: Field and Weather Conditions

Date	Site	Weather	Field Conditions
June 21, 2019	M1 (AdHg-5)	warm, 20° C	soil dry and screens easily
	H2 (AdHg-6)		
July 10, 2019	H2 (AdHg-6)	hot, 25° C	soil dry and screens easily
	H3 (AdHg-7)		
July 12, 2019	P4 (AdHg-8)	warm, 20 ° C	soil dry and screens easily
July 18, 2019	P4 (AdHg-8)	warm, 25 ° C	soil dry and screens easily
	M5 (AdHg-9)		

The Stage 3 investigations began with a review of all relevant reports of previous fieldwork on the property as per Section 3.2, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011). Upon arrival at the site, geographic reference markers that were established during the Stage 2 archaeological assessment of the property were relocated using a Garmin eTrex 10 handheld GPS unit, with a minimum accuracy 1-2.5m (North American Datum 1983 and Universal Transverse Mercator ('UTM') Zone 17T) in tandem with an optical theodolite. Two permanent datum stakes were placed in the ground at each site, as per Section 3.2.2, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). All coordinates taken during the Stage 3 assessment are listed in the Supplementary Documentation that accompanies this report.

For archaeological sites documented through a pedestrian survey of open ploughed fields, a Stage 3 field investigation typically begins with a CSP, conducted as per Section 3.2.1 of the *Standards and Guidelines* (Government of Ontario 2011). Given that all five sites in the current assessment were documented during a test pit assessment, no CSP was conducted. The Stage 3 assessment at each site consisted solely of the hand excavation of 1m test units, conducted as per Section 3.2.2 of the *Standards and Guidelines* (Government of Ontario 2011)

A 5m by 5m grid was established across the limits of each site as identified through the Stage 2 test pit survey, as per Section 3.2.3 of the *Standards and Guidelines* (Government of Ontario 2011). The grids were established using hand tapes and an optical theodolite.

In total, the Stage 3 assessments at M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) included the hand excavation of 26 1m square test units strategically positioned to test the nature and density of the subsurface artifact distribution at each site. Given the absence of CSP data, it was not yet evident that the level of CHVI at any of the five sites would result in a recommendation to proceed to Stage 4. As a result, 1m square test units initially placed at 5m intervals across the Stage 2 limits of each site, as per Table 3.1, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

All test units were excavated in systematic levels as per Section 3.2.2, Standard 4 of the *Standards and Guidelines* (Government of Ontario 2011). Those that did not contain a cultural feature were excavated into the first five centimetres (cm) of subsoil, as per Section 3.2.2, Standard 5 of the *Standards and*

Guidelines (Government of Ontario 2011). The subsoil surface was then shovel shined, trowelled and examined for any evidence of subsurface cultural features prior to backfilling.

A single post hole was observed at P4 (AdHg-8). The subsoil surface of this unit was shovel shined, but not excavated below the level of the feature. Although it was later concluded that the post hole represented a modern fence post (see Section 3.4.7 below), the exposed plan of the feature was recorded, and geotextile cloth was placed over the unit floor prior to back filling as per Section 3.2.2, Standard 6 of the *Standards and Guidelines* (Government of Ontario 2011).

Each test unit contained a topsoil layer (Layer 1) directly sealing the subsoil. Additional disturbance layers were documented at M1 (AdHg-5) and H2 (AdHg-6) (see Sections 3.2.4 and 3.5.8 below). All of the soil from the Stage 3 units was screened through six-millimetre (mm) hardware cloth to facilitate the recovery of small artifacts, as per Section 3.2.2, Standard 7 of the *Standards and Guidelines* (Government of Ontario 2011). All artifacts recovered during the Stage 3 excavations were retained for analysis and description; they were catalogued with reference to their corresponding site, grid unit designator, and soil layer when applicable. Photographs of the Stage 3 test unit excavations are provided in Section 9.1 of this report. Details regarding the grid layout at each site follows below.

At M1 (AdHg-5), two Stage 3 test units were excavated 5m apart, one on either side of the positive Stage 2 test pit, as per Table 3.1, Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011). An additional unit amounting to 50% of the grid total was then excavated between them, directly on top of the positive test pit, as per Table 3.1, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). A single topsoil layer (Layer 1) was observed in all units; a disturbance layer was observed in Test Unit 195E, 500N (see Section 3.2.4 below). The test units at M1 (AdHg-5) ranged in depth from 21cm to 60cm; taking into account that each test unit had been excavated 5cm into subsoil, Layer 1 ranged in depth from 16cm to 55cm. Artifact yields ranged from three to seven. The limits of the Stage 3 grid were based on repetitive low yields in all units.

At M5 (AdHg-9), it became clear over the course of the grid unit excavation that the level of CHVI would result in a recommendation to proceed to Stage 4. As a result, the test unit placement strategy was revised and three test units were positioned at 10m intervals across the site as per Table 3.1, Standard 3 of the *Standards and Guidelines* (Government of Ontario 2011). Following this, three additional units amounting to 100.0% of the grid unit total were excavated, focusing on areas of interest within the site extent as per Table 3.1, Standard 4 of the *Standards and Guidelines* (Government of Ontario 2011). A final Stage 3 unit was excavated 10m to the north of the site, to test the periphery on that side. A single topsoil layer (Layer 1) was observed in all units. The test units at M5 (AdHg-9) ranged in depth from 20cm to 48cm; taking into account that each test unit had been excavated 5cm into subsoil, Layer 1 ranged in depth from 15cm to 43cm. Artifact yields among the Stage 3 test units ranged from 1 to 33 for Euro-Canadian artifacts and 0 to 31 for pre-contact Aboriginal artifacts. The limits of the Stage 3 excavation grid were based on low artifact yields to the north and northeast, the limits of the Study Area to the northwest, and an area of disturbance to the southeast. To the southwest, M5 (AdHg-9) merged with the Stage 3 grid at P4 (AdHg-8) (see Section 3.4.7 below).

At P4 (AdHg-8), test unit placement was restricted by the presence of a driveway to the west of the site, weeping bed and a large tree in the northwest corner, and a natural gas utility line to the south. A single test unit was excavated within the area of the weeping bed, revealing a sewer pipe and few artifacts. Another unit was excavated adjacent to the south side of the weeping bed. Five additional units were clustered to the east of the weeping bed, nestled between the Study Area boundary to the north, the natural gas line to the south, and M5 (AdHg-9) to the east.

Over the course of the Stage 3 test unit excavation, it became clear that the level of CHVI at P4 (AdHg-8) would result in a recommendation to proceed to Stage 4. Furthermore, it was determined later that P4 (AdHg-8) and M5 (AdHg-9) were two loci of the same site. In order to meet the conditions outlined in Table 3.1, Standards 3 and 4 of the *Standards and Guidelines* (Government of Ontario 2011), while still maintaining a single grid between the neighbouring sites, the two test units at P4 (adHg-8) excavated at 205E and 215E, just south of the 505N grid line have been assigned as grid units. The two test units excavated to the north of these were also assigned to the excavation grid, albeit at reduced intervals given the physical constraints of the site. The remaining three test units, amounting to 75% of the grid total, were identified as infill units, focusing on areas of interest within the site extent.

A single topsoil layer (Layer 1) was observed in all units. The test units at P4 (AdHg-8) ranged in depth from 23cm to 46cm; taking into account that each test unit had been excavated 5cm into subsoil, Layer 1 ranged in depth from 18cm to 41cm. Artifact yields among the Stage 3 test units ranged from 11 to 54 for Euro-Canadian artifacts and 0 to 42 for pre-contact Aboriginal artifacts.

At H2, it became clear over the course of the grid unit excavation that the level of CHVI would result in a recommendation to proceed to Stage 4. Test unit placement at the site was restricted, however, by the presence of a sidewalk and an electrical utility line within the site limits, as well as Dexter Line and the Study Area limits to the north and south respectively. Additionally, a test unit excavated on top of one of the positive Stage 2 test pits revealed disturbance layers (Layers 2 and 3; see Section 3.5.8 below). As a result, the test unit placement strategy was revised and three test units were positioned in a straight line along the undisturbed area between the positive test pits to the north and the Study Area boundary to the south. For the sake of convenience, and to meet the conditions outlined in Table 3.1, Standards 3 and 4 of the *Standards and Guidelines* (Government of Ontario 2011), the two outside units have been designated grid units at a slightly larger interval given the physical constraints of the site. The two units excavated between the utility line and the side walk, which account for 100% of this grid total, were identified as infill units, focusing on areas of interest within the site extent.

A single topsoil layer (Layer 1) was observed in all four units. The test unit excavated at 193E, 502N on top of the positive Stage 2 test pit featured two disturbance layers (Layers 2 and 3) truncating Layer 1 (see Section 3.5.8 below). Overall, the test units ranged in depth from 44 to 55cm; taking into account that each test unit had been excavated 5cm into subsoil, Layer 1 ranged in depth from 39cm to 48cm among the undisturbed units; 11cm to 15cm of Layer 1 was preserved in the disturbed unit. Artifact yields among the Stage 3 test units ranged from 3 to 116 Euro-Canadian artifacts; a single piece of pre-contact Aboriginal chipping detritus was also observed in the easternmost unit of the site. The limits of the Stage 3 excavation grid were based on low artifact yields to the east and west, an area of disturbance and the Dexter Line right-of-way to the north, and the Study Area limits to the south.

At H3 (AdHg-6), it became clear over the course of the Stage 3 grid unit excavation, that the level of CHVI at the site would result in a recommendation to proceed to Stage 4. It was also determined that the site extended farther north beyond the limits of the Study Area. As a result, the test unit placement strategy was revised and three test units were positioned at 10m intervals along the Study Area boundary, across the widest portion of the site as per Table 3.1, Standard 3 of the *Standards and Guidelines* (Government of Ontario 2011). Two additional units amounting to 67% of the original grid total were excavated, focusing on areas of interest within the site extent as per Table 3.1, Standard 3 of the *Standards and Guidelines* (Government of Ontario 2011). Artifact yields among the Stage 3 test units ranged from 5 to 100 Euro-Canadian artifacts; ten pieces of pre-contact Aboriginal chipping detritus was also recovered between two units of the five. The limits of the Stage 3 excavation grid were based on the Study Area boundary to the northeast, low artifact yields to the southeast, and areas of disturbance on all other sides. The test units at H3 (AdHg-6) ranged in depth from 18cm to 34cm; taking into account that each test unit had been excavated 5cm into subsoil, the plough zone ranged in depth from 13cm to 29cm.

3.0 Record of Finds

The record of finds is presented for five archaeological sites; M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7). Figures 4 to 7 illustrate the results of these investigations, as well as photograph locations and directions. Maps indicating the exact location of the sites, as well as all UTM coordinates recorded during the Stage 3 assessments, are included in the Supplementary Documentation to this report. An inventory of the documentary record generated by the fieldwork is provided in Table 3 below.

Table 3: Inventory of Document Record

Document Type	Current Location of Document Type	Additional Comments
9 Page of Field Notes	Detritus office	stored digitally in project file
1 Map Provided by the Proponent	Detritus office	stored digitally in project file
5 Field Maps	Detritus office	stored digitally in project file
278 Digital Photographs	Detritus office	stored digitally in project file

All of the material culture collected during the Stage 3 assessments of M1 (AdHg-5), M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6), and H3 (AdHg-7) is contained in one box and will be temporarily housed in a Detritus office until formal arrangements can be made for its transfer to Her Majesty the Queen in right of the Province of Ontario or another suitable public institution acceptable to the MTCS and the site's owners.

3.1 Cultural Material

A summary of the cultural material recovered at each of the five sites currently under review is provided below in Sections 3.2 to 3.6. More detailed descriptions of the artifact types are provided in the Appendices at the end of the report. A sample of the recovered artifacts is depicted in Section 9.2.

Four of the five sites produced lithic artifacts in the form of chipping detritus manufactured from Onondaga, Haldimand, and Bayport chert. Chert type identifications were accomplished visually using reference materials located online and in personal collections.

Onondaga formation chert derives from the Middle Devonian age, with outcrops occurring along the north shore of Lake Erie between Long Point and the Niagara River. It is a high-quality raw material frequently utilized by pre-contact Aboriginal people and often found at archaeological sites in southern Ontario. Onondaga chert occurs in nodules or irregular thin beds. It is a dense non-porous rock that may be light to dark grey, bluish grey, brown or black and can be mottled with a dull to vitreous or waxy lustre (Eley and von Bitter 1989).

Haldimand chert, also known as Bois Blanc chert, is a medium quality raw material that outcrops along the Bois Blanc formation between Kohler and Hagersville, as well as in Cayuga, Ontario. Dating to the Early Silurian, it derives from chalk-bearing limestones which give the material its characteristically white to light grey or buff colour and relatively low lustre (Eley and von Bitter 1989).

Bayport chert is a medium to fine grain chert type that varies from light brown to medium gray with white quartz inclusions forming white clouds or bull's eye formations. It derives from Saginaw Bay, near Bayport, in Huron County, Michigan. Bayport chert typically occurs as nodules and blocks along river banks throughout the northeastern region if southern Michigan. Examples of Bayport chert have been documented throughout the lower Michigan peninsula and into central Indiana, northwestern Ohio, and southwestern Ontario (University of West Florida 2008).

Additionally, all pieces of chipping detritus were subject to morphological analysis following the classification scheme described by Lennox *et al.* (1986:79-81) and expanded upon by Fisher (1997: 41-49). Flake types identified during the morphological analysis of the chipping detritus assemblages included cortex removal, primary, secondary, thinning, and broken flakes as well as shatter. Cortex removal, primary, and secondary flakes are produced during the initial reduction phases of raw material and tend to exhibit minimal dorsal flake scarring. Cortex removal and primary flakes are also characterized by the

presence of cortex, or original, unflaked material on their dorsal surfaces and proximal ends; secondary flakes contain little to no cortex. Thinning flakes are produced during the latter stages of reduction when raw material in the form of blanks and bifaces are shaped into preforms and formal tools. They are the result of precise flake removal through pressure flaking, where the maker applies direct pressure onto a specific part of the tool in order to facilitate flake removal. Pressure flaking generally produces smaller, thinner flakes than does percussion flaking. Thinning flakes also exhibit more flake scars on their dorsal surface than do primary or secondary flakes.

Finally, all of the sites currently under review yielded 19th century ceramic pieces. As part of their analysis, all ceramic sherds were examined in order to describe the function of the item from which the ceramic sherd originated. For those sherds that were too fragmentary for a functional assignment, an attempt was made to at least provide a formal description, such as to which portion of an item the sherd belonged. For example, what used to be a porcelain teacup but now found in an archaeological context could be classified archaeologically in the artifact catalogue in a descending order of specificity depending on preservation and artifact size: a teacup (function), a cup (function), a hollowware (form), or a rim fragment (form). Hollowwares and flatwares were differentiated based on the presence or absence, respectively, of curvature in the ceramic cross-section of each sherd. The classification system used here is based upon Beaudoin (2013:78-82), but teas were differentiated as teacups and tea saucers as necessary. If Beaudoin's classifications could not be applied, then the broader definitions of Voss (2008:209) were used. Ultimately, if sherds were small enough that even a general functional or formal ware type could not be determined, and then the sherd was simply classified as a rim fragment, a non-rim fragment, a base fragment, or indeterminate.

3.2 M1 (AdHg-5)

The Stage 3 assessment of M1 (AdHg-5) produced 16 Euro-Canadian artifacts, including eight cut nails, four ceramic sherds, three pieces of bottle glass, and one animal bone (Table 4). No pre-contact Aboriginal artifacts, subsurface features, or fire cracked rock were observed.

Table 4: M 1 (AdHg-5) Artifact Summary

Artifacts	Frequency	%
Structural	8	50.00%
Ceramics	4	25.00%
Household	4	25.00%
Total	**16**	**100.00%**

3.2.1 Structural Artifacts (see Appendix 10.2.5)

All of the structural artifacts within the Stage 3 assemblage from M1 (AdHg-5) were nails, and all were machine cut. The absence of earlier hand wrought and later wire drawn varieties is suggestive of a middle to late 19th century occupation.

3.2.2 Ceramics (see Appendices 10.2.1 and 10.2.2)

The four ceramic sherds within the Stage 3 assemblage from M1 (AdHg-5) included two ironstone sherds and two refined white earthenware (RWE) sherds. One of the two RWE sherds featured a flow transfer printed design in blue. The other three sherds were undecorated. Although admittedly a small sample size, these sherds support a middle to late 19th century occupation.

The two ironstone sherds from M1 (AdHg-5) were identified as body sherds from a plate. The two RWE sherds were too fragmentary to determine form or function.

3.2.3 Household Artifacts (see Appendix 10.2.3)

Four household items were observed in the Stage 3 assemblage from M1 (AdHg-5), including three bottle glass pieces and one animal bone fragment. Two of the bottle pieces were blue and the other aqua. The animal bone, meanwhile, was too fragmentary to be classified and demonstrated no evidence of

butchering or cooking. Whereas the aqua bottle glass fragment suggests a pre-1880 occupation, the sample size is far too small to draw any definitive conclusions.

3.2.4 Artifact Distribution and Settlement Pattern

The Stage 2 assessment of M1 (AdHg-5) resulted in the identification of 12 Euro-Canadian artifacts and four pieces of pre-contact Aboriginal chipping detritus from a single test pit. The Stage 3 assessment yielded an additional 16 Euro-Canadian artifacts from a line of three test units, one of which was positioned on top of the original Stage 2 test pit.

All three units featured Layer 1 directly sealing the subsoil. Layer 1 was a medium brown gray sandy silt with a few gravel inclusions. A second layer (Layer 2) was observed in the western half of Test Unit 195E, 500N, just below the sod. Excavation of the test unit revealed Layer 2 to be a deep disturbance fill cutting through Layer 1 and into the subsoil below (Photo 30). This fill was a semi-compact clayey silt with no inclusions. Furthermore, all of the artifacts were recovered from Layer 1.

Artifact yields among the three units were very low, ranging from three to seven artifacts. No midden area was observed. This evidence, when considered with the Stage 2 results, supports the previous conclusion that the Euro-Canadian component of M1 (AdHg-5) was a small area of late 19th to 20th century debris that may have been associated with the occupation of C. Monro.

Likewise, no pre-contact Aboriginal artifacts, fire-cracked rock, or cultural features were encountered during the Stage 3 assessment.

3.3 M5 (AdHg-9)

The Stage 3 assessment of M5 (AdHg-9) produced 188 primarily Euro-Canadian artifacts, including 45 structural artifacts, 33 ceramic sherds, 28 household artifacts, 6 pieces of miscellaneous metal and horse tack, 3 personal items, and 3 pieces of recent material. The remainder of the assemblage comprised 69 pieces of chipping detritus and a single piece of Aboriginal pottery (Table 5). No subsurface features or fire cracked rock were observed.

Table 5: M5 (AdHg-9) Artifact Summary

Artifacts	Frequency	%
Pre-Contact Aboriginal	70	37.23
Structural	45	23.94
Ceramics	33	17.55
Household	28	14.89
Miscellaneous Metal and Horse Tack	6	3.19
Personal	3	1.60
Recent Material	3	1.60
Total	**188**	**100.00**

Euro-Canadian Artifacts

3.3.1 Structural Artifacts (see Appendix 10.2.5)

A total of 45 structural artifacts were represented in the Stage 3 assemblage from M5 (AdHg-9), most of which were window glass pieces. The remainder of the structural assemblage comprises nails and brick fragments (Table 6).

Table 6: Structural Artifact Summary

Artifact	Frequency	%
window glass	29	64.44
brick fragments	7	15.56
wire nails	6	13.33
cut nails	3	6.67
Total	**45**	**100.00**

Just over half of the window glass pieces (51.7%; n=15) recovered from M5 (AdHg-9) measured greater than 1.6mm thick, suggestive of a post-1845 occupation. This date is supported by the predominance of machine cut and wire drawn nails, which extend this period of occupation into the early 20th century. The remainder of the structural assemblage comprises five red and two yellow brick fragments, none of which are temporally diagnostic.

3.3.2 Ceramics (see Appendix 10.2.1 and 10.2.2)

A total of 33 Euro-Canadian ceramic sherds were recovered during the Stage 3 assessment of M5 (AdHg-9). Just over half of these were pieces of ironstone (51.5%; n=17). The remainder of the ceramic assemblage comprised 11 sherds of RWE, 3 of pearlware, and 2 of utilitarian wares. Table 7 provides a summary of the ceramic assemblage by ware type and Table 8, by surface decoration technique

Table 7: Ceramic Assemblage by Ware Type (see Appendix 10.2.1)

Artifact	Frequency	%
ironstone	17	51.52
RWE	11	33.33
pearlware	3	9.09
utilitarian	2	6.06
Total	**33**	**100.00**

Table 8: Ceramic Assemblage by Decorative Technique (see Appendix 10.2.2)

Artifact	Frequency	%
ironstone	15	45.45
RWE	5	15.15
RWE, transfer printed	4	12.12
pearlware	3	9.09
ironstone, moulded	2	6.06
stoneware	1	3.03
RWE, painted	1	3.03
RWE, banded	1	3.03
yellow earthenware	1	3.03
Total	**33**	**100.00**

The predominance of undecorated ironstone in the Stage 3 ceramic assemblage suggests a middle to late 19th century occupation. The presence earlier pieces, including three sherds of pearlware and one of banded RWE, may extend this occupation back into the earlier 19th century, but it is more likely that they represent heirloom items.

In addition to the banded sherd, three additional RWE sherds featured either sprig or floral transfer printed designs in blue; another was hand painted, also featuring a blue design. Given the extensive use of the colour blue on transfer printed and hand painted wares throughout the 19th century, it is difficult to refine this occupation range further using decorated sherds.

In terms of function, most of the ceramic pieces from M5 (AdHg-9) were identified as tableware vessels, including 18 bowls sherds, 4 saucer sherds, and 1 plate sherd. The remainder of the ceramic assemblage comprised two basin fragments, to ceramic vessel fragments, and one storage jar fragment; four sherds were too fragmentary to be classified according to form or function. Table 9 provides a summary of the ceramic assemblage by farm and Table 10, by function.

Table 9: Ceramic Assemblage by Form

Artifact	Flat	Hollow	Unknown	Total
ironstone	1	14		15
ironstone, moulded		2		2
pearlware	3			3
RWE		3	2	5
RWE, banded			1	1
RWE, painted			1	1
RWE, transfer printed	1	3		4
stoneware		1		1
yellow earthenware		1		1
Total	**5**	**24**	**4**	**33**

Table 10: Ceramic Assemblage by Function

Artifact	Basin	Bowl	Cosmetics	Plate	Saucer	Storage	Unknown	Total
ironstone		14		1				15
ironstone, moulded	2							2
pearlware					3			3
RWE		2				1	2	5
RWE, banded							1	1
RWE, painted							1	1
RWE, transfer printed		1	2		1			4
stoneware						1		1
yellow earthenware		1						1
Total	**2**	**18**	**2**	**1**	**4**	**2**	**4**	**33**

3.3.3 Household Artifacts (see Appendix 10.2.3)

A total of 28 household artifacts were recovered during the Stage 3 assessment of M5 (AdHg-9), most of which were pieces of bottle glass (Table 11).

Table 11: Household Artifact Summary

Artifact	Frequency	%
bottle glass	17	60.71
faunal remains	5	17.86
brass fitting	1	3.57
brass tack	1	3.57
copper spoon	1	3.57
meat hook	1	3.57
scissors	1	3.57
coal	1	3.57
Total	**28**	**100.00**

Over half of the bottle glass pieces in the Stage 3 assemblage were clear (52.9%; n=9), suggestive of a late 19th or early 20th century occupation; the two aqua tinged pieces support a pre-1880 date. The remaining

pieces include four blue medicine bottle pieces, one green soda bottle piece, and one a possible light purple bottle or tumbler.

Among the faunal remains, four were identified as cow rib bones and demonstrated evidence for butchering; the other was a burnt deer long bone. None of the remaining household items are considered to be diagnostic, although they are typical for 19th century domestic assemblages.

3.3.4 Miscellaneous Metal and Horse Tack

Three horseshoe nails, two spikes, and one identified iron item were recovered during the Stage 3 assessment of M5 (AdHg-9). Whereas none of these artifacts are considered to be diagnostic, the presence of horseshoe nails suggests that the residents of M5 (AdHg-9) were wealthy enough to stable a horse.

3.3.5 Personal Items

Three personal items were represented in the Stage 3 artifact assemblage including the soundboard from a harmonica, a metal shoe grommet, and a shell casing. None of these items are considered to be diagnostic.

3.3.6 Recent Material

Three artifacts were recovered during the Stage 3 assessment of M5 (adHg-9) that can be securely dated to the 20th century, including a plastic pencil sharpener, a plastic fishing rod tip, and a piece of recent fence wire.

Pre-Contact Aboriginal Artifacts (see Appendix 10.3)

Just over one third of the Stage 3 artifact assemblage from M5 (AdHg-9) comprised pre-contact Aboriginal artifacts including 79 pieces of chipping detritus and a single sherd of Aboriginal pottery.

According to Ellis and Ferris, pottery is not introduced on sites in Southern Ontario until the Early Woodland Period, and is one of several characteristics associated with a permanent village site (Ellis and Ferris 1990). Others include the presence of subsurface cultural features, and a large concentration of artifacts, including an abundance of formal tools and projectile points. The remainder of the pre-contact Aboriginal artifacts from M5 (AdHg-9) comprised 69 pieces of chipping detritus.

Due to the size of the assemblage, all pieces of chipping detritus were subject to morphological analysis following the classification scheme described above in Section 3.1 above (Table 12).

Table 12: Chipping Detritus by Flake Type

Chert Type	Secondary		Thinning		Total	
	n	%	n	%	n	%
Onondaga	10	14.49	53	76.81	63	91.30
Haldimand	1	1.45	4	5.80	5	7.25
Bayport	0	0	1	1.45	1	1.45
Total	**11**	**15.94**	**58**	**84.06**	**69**	**100.00**

Most of the flakes represented in the Stage 3 assemblage from M5 (AdHg-9) were thinning flakes. Secondary flakes were also represented, albeit in a much smaller amount. The predominance of thinning flakes suggests that the occupants of M5 (AdHg-9) were actively undertaking late stage lithic reduction, likely for the production and maintenance of projectile points and formal tools. The complete absence of cortex removal and primary flakes, meanwhile, suggests that early stage reduction practices were restricted to an off-site location.

The predominant use of Onondaga chert indicates that the people at M5 (adHg-9) were largely relying on a single source of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie, located approximately 56km to the east of the Study Area.

These conclusions are supported by the results of the Stage 2 assessment, which produced five additional thinning flakes, four of which were manufactured from Onondaga chert; the remaining flake was of an unknown chert type.

3.3.7 Artifact Distribution and Settlement Pattern

The Stage 2 assessment of M5 (AdHg-9) resulted in the identification of 14 Euro-Canadian artifacts and 5 pre-contact Aboriginal artifacts from five positive test pits covering an area of approximately 9m by 5m.

The Stage 3 assessment yielded an additional 118 Euro-Canadian artifacts and 70 pre-contact Aboriginal artifacts from seven test pits covering an expended area of approximately 20m north to south and 11m east to west. Euro-Canadian artifact yields ranged from 1 to 33 and increased towards the southwest corner of the site. Likewise, the pre-contact Aboriginal artifact yields ranged from 0 to 31. Most of these artifacts (75.7%; n=53), including the single sherd of Aboriginal pottery, derived from test units 226E, 511N and 225E, 505N in the southwest corner. No fire-cracked rock or cultural features were encountered anywhere on site.

Based on the results of the Stage 3 assessment, M5 (AdHg-9) represents the edge of a possible 19th century midden area, superimposed upon an earlier pre-contact Aboriginal activity. This earlier component may date to the Woodland period, given the presence of Aboriginal pottery. However, no other features that are considered typical for Woodland period sites were observed, such as a distinct midden area, cultural features, or a plethora of formal tools. Furthermore, both components of the site appear to extend into neighbouring site P4 (AdHg-8) to the southwest (see Section 3.4.7 below).

3.4 P4 (AdHg-8)

The Stage 3 assessment of P4 (AdHg-8) produced 308 artifacts from seven test units. Almost two-thirds of these (64.3%; n=198) were Euro-Canadian artifacts including 81 household artifacts, 63 structural artifacts, 31 ceramic pieces, 18 pieces of miscellaneous metal and horse tack, 3 personal items, and 2 recent items. The remainder of the assemblage comprised 110 pieces of pre-contact Aboriginal chipping detritus (Table 13). No subsurface features or fire cracked rock were observed.

Table 13: P4 (AdHg-8) Artifact Summary

Artifact	Freq.	%
Pre-Contact Aboriginal	110	35.71
Household	81	26.30
Structural	63	20.45
Ceramics	31	10.06
Metal Tools and Horse tack	18	5.84
Personal	3	0.97
Recent Material	2	0.65
Total	**308**	**100.00**

Euro-Canadian Artifacts

3.4.1 Household Artifacts (see Appendix 10.2.3)

Bottle glass fragments comprised most of the household artifacts recovered during the Stage 3 assessment of P4 (AdHg-8), and over one third of the Euro-Canadian assemblage as a whole (35.4%). The remainder of the assemblage comprised animal bones and coal fragments (Table 14).

Table 14: Household Artifact Summary

Artifact	Freq.	%
bottle glass	70	86.42
faunal remains	8	9.88
coal	3	3.70
Total	**81**	**100.00**

Most of the bottle glass pieces (77.1%; n=54) were dark green, and derived from the same unit (205E, 504N). Four of the fragments featured a seam, which suggests that all 54 pieces belonged to the same bottle, likely a 20th century alcohol container. Another 14 pieces were clear, also suggestive of a 20th century occupation; 11 of these were recovered from the same unit (213E, 505N). The remaining two shards were aqua and dark blue, and are more reminiscent of the late 19th century.

The faunal remains, meanwhile, consisted of four cow bones, and four bones that were too fragmentary to be classified. None of the specimens demonstrated evidence of cooking or butchering. The coal pieces were small and not considered to be diagnostic.

3.4.2 Structural Artifacts (see Appendix 10.2.5)

Structural artifacts were also well represented at P4 (AdHg-8), comprising almost one third (31.8%) of the Euro-Canadian assemblage, and 20.5% of the Stage 3 assemblage as a whole. Over half of the structural assemblage were nails (54.0%); the remainder comprised window glass pieces and brick fragments (Table 15).

Table 15: Structural Artifact Summary

Artifact	Freq.	%
cut nail	21	33.33
window glass	19	30.16
wire nail	13	20.63
brick fragment	10	15.87
Total	**63**	**100.00**

The predominance of cut and wire nails suggest a middle 19th to early 20th century occupation. This occupation range is supported by the predominance of window glass pieces measuring greater than 1.6mm thick (73.7%). The brick fragments were all red, but too fragmentary to be considered diagnostic.

3.4.3 Ceramics (see Appendix 10.1.1)

Euro-Canadian ceramic pieces made up only 15.7% of the Euro-Canadian assemblage, and 10.1% of the Stage 3 assemblage as a whole. Most of the ceramic assemblage comprised undecorated ironstone sherds (80.7%; n=25), one of which was moulded. The remainder of the assemblage consisted of two sherds each of pearlware, RWE and red earthenware. Table 16 provides a summary of the ceramic assemblage by ware type and Table 17, by surface decoration technique.

Table 16: Ceramic Assemblage by Ware Type

Artifact	Freq.	%
ironstone	25	80.65
pearlware	2	6.45
red earthenware	2	6.45
RWE	2	6.45
Total	**31**	**100.00**

Table 17: Ceramic Assemblage by Decorative Technique

Artifact	Freq.	%
ironstone	24	77.42
pearlware	2	6.45
red earthenware	2	6.45
ironstone moulded	1	3.23
RWE	1	3.23
RWE, transfer printed	1	3.23
Total	**31**	**100.00**

The predominance of ironstone is suggestive of a middle to late 19th century occupation. The two pearlware sherds may suggest an earlier occupation range. Considering the Stage 3 assemblage as a whole, however, it seems more likely that these specimens represent heirloom items.

Furthermore, only one of the ceramic pieces from P4 (AdHg-8) is decorated. More specifically, one of the two sherds of RWE featured a blue transfer printed design. Given the predominance of the colour blue among transfer printed wares throughout the 19th century, this specimen could not refine the occupation range further.

In terms of function, over half of the sherds (54.8%; n=17) in the Stage 3 assemblage from P4 (AdHg-8) were identified as plates; most of these were ironstone sherds that derived from the same unit (215E, 503N). Three bowl fragments and two storage vessel pieces were also recovered. The remaining ceramic pieces were too fragmentary to determine form of function. Table 18 provides a summary of the ceramic assemblage by form and Table 19, by function.

Table 18: Ceramic Assemblage by Form

Artifact	Flat	Hollow	Unknown	Total
ironstone	14	2	8	24
ironstone, moulded		1		1
pearlware	2			2
red earthenware		2		2
RWE			1	1
RWE, transfer printed	1			1
Total	**17**	**5**	**9**	**31**

Table 19: Artifact Assemblage by Function

Artifact	Bowl	Plate	Storage	Unknown	Total
ironstone	2	14		8	24
ironstone, moulded	1				1
pearlware		2			2
red earthenware			2		2
RWE				1	1
RWE, transfer printed		1			1
Total	**3**	**17**	**2**	**9**	**31**

3.4.4 Miscellaneous Metal Tools and Horse Tack

Also included within the Stage 3 assemblage were 18 miscellaneous metal items (Table 20). Whereas none of the metal items are considered diagnostic, the presence of one horseshoe, five horseshoe nails, and two haying fork pieces suggest that the residents of P4 (AdHg-8) were wealthy enough to stable a horse.

Table 20: Metal Tools and Horse Tack

Artifact	Freq.	%
horseshoe nail	5	27.78
spike	5	27.78
haying fork	2	11.11
horseshoe	1	5.56
iron clamp	1	5.56
anchor chain	1	5.56
sheet metal	1	5.56
metal wire	1	5.56
misc. metal	1	5.56
Total	**18**	**100.00**

3.4.5 Personal (see Appendix 10.2.4)

Three personal items were observed in the Stage 3 assemblage including a shotgun shell, a slate writing tablet fragment, and piece of a shoe sole. None of the three items are diagnostic.

3.4.6 Recent Material

Two artifacts in the Stage 3 assemblage could be dated to the 20th century, including a recent brown beer bottle shard and a piece of safety glass.

Pre-Contact Aboriginal Artifacts (see Appendix 10.3)

Approximately one third of the Stage 3 assemblage from P4 (AdHg-8) were pieces of Aboriginal chipping detritus, most of which were manufactured from Onondaga chert.

Due to the size of the assemblage, all pieces of chipping detritus were subject to morphological analysis following the classification scheme described above in Section 3.1 (Table 21).

Table 21: Chipping Detritus by Flake Type

Chert Type	Cortex Removal		Secondary		Thinning		Micro		Total	
	n	%	n	%	n	%	n	%	n	%
Onondaga	2	1.82	7	6.36	91	82.73	3	2.73	103	93.64
Haldimand	0	0.00	0	0.00	5	4.55	0	0.00	5	4.55
Bayport	0	0.00	0	0.00	1	0.91	0	0.00	1	0.91
Unknown	0	0.00	0	0.00	1	0.91	0	0.00	1	0.91
Total	**2**	**1.82**	**7**	**6.36**	**98**	**89.09**	**3**	**2.73**	**110**	**100.00**

By far, most of the specimens were thinning or micro flakes (91.8%; n=101). This evidence suggests that the pre-contact occupants of P4 (AdHg-8) were actively undertaking late stage lithic reduction, likely for the production and maintenance of projectile points and formal tools. The dearth of cortex removal and primary flakes, meanwhile, suggests that early stage reduction practices were restricted to an off-site location. This conclusion is supported by the results of the Stage 2 assessment, which produced an

additional 15 chert flakes, 11 of which were thinning flakes; no primary or cortical removal flakes were observed.

The predominant use of Onondaga chert, meanwhile, suggests that the people at P4 (AdHg-8) were largely relying on a single source of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie, located approximately 56km to the east of the Study Area.

3.4.7 Artifact Distribution and Settlement Pattern

The Stage 2 assessment of P4 (AdHg-8) resulted in the identification of seven Euro-Canadian artifacts and 15 pieces of pre-contact Aboriginal chipping detritus from eight test pits covering an area of approximately 8m east to west by 6m north to south. The Stage 3 assessment yielded an additional 198 Euro-Canadian artifacts and 110 pre-contact Aboriginal artifacts from seven test units covering an expended area of approximately 16m east to west and 7m north to south. The site is limited by the limits of the Study Area to the north, a natural gas utility line to the south, a driveway and weeping bed to the west, and site M5 (AdHg-9) to the east.

Euro-Canadian artifact yields ranged from 11 to 54 and increased towards the southwest corner of the site. The highest count occurs in Test Unit 205E, 504N, on the edge of the site. All 54 artifacts in this unit, however, were the dark green machine-made bottle pieces discussed above, that likely represent a single bottle. Likewise, the 36 Euro-Canadian artifacts from Test Unit 213E, 505N featured 11 clear bottle glass pieces; and the 41 Euro-Canadian artifacts from Test Unit 215E, 503N, the 12 ironstone plate sherds. Given the relatively low artifact counts, the Euro-Canadian component of P4 (AdHg-8), along with the Euro-Canadian component of M5 (AdHg-9), represent small pockets of artifacts along the edge of a larger midden area that appears to extend to the northwest beyond the limits of the Study Area.

A small square post hole was observed in test unit 215E, 503N. Considering both the uniform shape of the post and the late 19th to 20th century occupation range represented by the Stage 3 assemblage, this post was considered to be a 20th century fence post, possibly associated with the recent fence wire documented in neighbouring M5 (AdHg-9).

The pre-contact Aboriginal artifact yields ranged from 0 to 42, with the highest count occurring in the centre of the site in Test Unit 213E, 505N. Only five artifacts were produced from the test units on the western edge of the site. All five of the units on the east side of the site produced over 10 lithic artifacts, confirming that P4 (AdHg-8) and M5 (AdHg-9) were a single site.

Combined, the five test units from P4 (AdHg-8) and the two test units from M5 (AdHg-9) that produced over 10 pre-contact Aboriginal artifacts each form a single Pre-contact Aboriginal activity area spanning both sites measuring approximately 14m east to west by 9m north to south. Given the presence of Aboriginal pottery at M5 (AdHg-9), it is possible that both sites form the edge of a much larger Woodland period site that extends to the northwest beyond the limits of the Study Area.

3.5 H2 (AdHg-6)

The Stage 3 assessment of H2 (AdHg-6) produced 162 artifacts from four test units. Most of these were Euro-Canadian artifacts, including 70 ceramic pieces, 42 structural artifacts, 23 household items, 17 miscellaneous metal objects, 8 personal objects, and 1 20th century bottle cap. A single piece of pre-contact Aboriginal chipping detritus was also observed in the Stage 3 assemblage (Table 22). No subsurface features or fire cracked rock were observed.

Table 22: H2 (AdHg-6) Artifact Summary

Artifacts	Freq.	%
Ceramics	70	43.21
Structural	42	25.93
Household	23	14.20
Miscellaneous Metal	17	10.49

Artifacts	Freq.	%
Personal	8	4.94
Recent Material	1	0.62
Pre-Contact Aboriginal	1	0.62
Total	**162**	**100.00**

3.5.1 Ceramics (see Appendix 10.2.1)

Just under half of the Stage 3 assemblage from H2 (AdHg-6) were ceramic pieces (43.2%). Most of these were pieces of RWE or ironstone vessels. Two sherds of stoneware and another of pearlware were also represented. Table 23 provides a summary of ceramic assemblage by ware type and Table 24, by surface decoration technique.

Table 23: Ceramic Assemblage by Ware Type (see Appendix 10.2.1)

Ceramics	Freq.	%
RWE	43	61.43
ironstone	24	34.29
stoneware	2	2.86
pearlware	1	1.43
Total	**70**	**100.00**

Table 24: Ceramic Assemblage by Decorative Technique (see Appendix 10.2.2)

Ceramics	Freq.	%
RWE	36	51.43
ironstone	23	32.86
RWE, transfer printed	3	4.29
stoneware	2	2.86
RWE, banded	2	2.86
ironstone, moulded	1	1.43
pearlware	1	1.43
RWE, edged	1	1.43
RWE, hand painted	1	1.43
Total	**70**	**100.00**

The predominance of undecorated RWE and ironstone within the ceramic assemblage suggests a middle to late 19th century occupation. The single piece of pearlware, along with the two pieces of banded RWE, more likely represent heirloom items than they do an earlier period of occupation at H2 (AdHg-6).

Seven RWE sherds within the Stage 3 assemblage were decorated, including the two banded pieces mentioned above. Another sherd of featured an edged design with a blue chicken claw pattern. An absence of scallops suggests a post-1840 occupation. Three more sherds were transfer printed, two in blue and one in brown. The final decorated sherd was hand painted with a green design.

In terms of function, most of the ceramic pieces were identified as tableware vessels, including 35 plates, 29 bowls, and 1 serving dish. The two stoneware pieces were both identified as storage vessels. The remaining three sherds were too fragmentary to identify form or function. Table 25 provides a summary of the ceramic assemblage by form and Table 26, by function.

Table 25: Ceramic Assemblage by Form

Ceramics	Flat	Hollow	Unknown
ironstone	23		
ironstone, moulded		1	
pearlware		1	
RWE	11	24	1
RWE, banded		2	
RWE, edged	1		
RWE, hand painted		1	
RWE, transfer printed		1	2
stoneware		2	
Total	**35**	**32**	**3**

Table 26: Ceramic Assemblage by Function

Ceramics	Bowl	Plate	Serving	Storage	Unknown
ironstone		23			
ironstone, moulded	1				
pearlware	1				
RWE	24	11			1
RWE, banded	2				
RWE, edged		1			
RWE, hand painted	1				
RWE, transfer printed			1		2
stoneware				2	
Total	**29**	**35**	**1**	**2**	**3**

3.5.2 Structural Artifacts (see Appendix 10.2.5)

Over half of the structural artifacts in the Stage 3 assemblage are nails (69.0%; n=29). The remainder of the assemblage comprised window glass and brick pieces (Table 27).

Table 27: Structural Artifact Summary

Structural	Freq.	%
cut nails	21	50.00
window glass	11	26.19
wire nail	8	19.05
brick fragment	2	4.76
Total	**42**	**100.00**

The exclusive presence of machine cut nails in the Stage 3 assemblage suggests a middle to late 19th century occupation. This date is supported by the window glass pieces, just over half of which (54.6%; n=6) measured greater than 1.6mm. Additionally, one of the two red brick fragments was frogged, indicative of a post 1830 manufacture date.

3.5.3 Household Artifacts (see Appendix 10.2.3)

A total of 23 household artifacts were recovered from H2 (AdHg-6). Over half of these (56.5%; n=13) were faunal remains. The remainder of the household assemblage comprises bottle glass fragments and a single piece of coal (Table 28).

Table 28: Household Artifact Summary

Household	Freq.	%
bottle glass	9	52.17
faunal remains, mammalian	8	39.13
faunal remains, avian	5	4.35
coal	1	4.35
Total	**23**	**100.00**

Over half of the bottle glass pieces (n=5) were blue body shards that derived from a single unit, 193E, 502N. The remaining bottle glass assemblage comprised four body fragments: two green, one blue, and one clear. The clear shard and one of the green shards revealed evidence of 20th century machine manufacturing in the form of seams.

As for the faunal remains, eight were identified as mammal, including five cow bones, one of which showed evidence of burning. The other three were too fragmentary to be classified, although one was burnt. Four of the five avian remains were chicken bones, and the other unclassified. None revealed evidence of cooking or butchering.

The piece of coal is not diagnostic, but common in domestic assemblages.

3.5.4 Miscellaneous Metal

Approximately 10% of the Stage 3 artifact assemblage from H2 (AdHg-6) were miscellaneous metal items (Table 29). None of the metal artifacts are considered diagnostic.

Table 29: Miscellaneous Metal Artifact Summary

Artifact	Freq.	%
miscellaneous metal	6	35.29
sheet metal	4	23.53
spike	4	23.53
fencing wire	1	5.88
bolt	1	5.88
metal strapping	1	5.88
Total	**17**	**100.00**

3.5.5 Personal Items (see Appendix 10.2.4)

Eight personal items were identified in the Stage 3 assemblage from P2 (AdHg-6), including four slate tablet pieces, three white clay pipe fragments, and a metal belt buckle (Table 30).

Slate writing tablets and white clay pipes were commonly in use throughout the 19th century, with a decline near the turn of the century. Furthermore, none of the clay pipe pieces are stamped, which would allow for more precise dating. The belt buckle was heavily corroded, and equally non-diagnostic.

Table 30: Personal Item Summary

Personal	Freq.
slate tablet	4

Personal	Freq.
white clay pipe bowl	2
white clay pipe stem	1
metal belt buckle	1
Total	**8**

3.5.6 Recent Material

A single bottle cap was recovered during the Stage 3. Bottle caps were used on glass bottles with crown finishes, which were common in the 20th century (Lindsey 2019).

3.5.7 Chipping Detritus

One piece of pre-contact Aboriginal chipping detritus was represented in the Stage 3 assemblage. Morphological analysis revealed the specimen to be a thinning flake manufactured from Onondaga chert. This one flake represents less than 1% of the Stage 3 artifact assemblage, and is thought to be residual.

3.5.8 Artifact Distribution and Settlement Pattern

The Stage 2 assessment of H2 (AdHg-6) resulted in the identification of 45 Euro-Canadian artifacts from two test pits, 6m apart. An additional 162 primarily Euro-Canadian artifacts were recovered from four test units excavated during the Stage 3 assessment. A single topsoil layer (Layer 1) was observed in all four test units, directly sealing the subsoil below. Layer 1 was a fairly compact, medium grey brown sandy silt with frequent gravel inclusions.

Layer 1 was the only soil layer observed within the test units excavated along the 500N grid line, to the south of the two positive Stage 2 test pits. This layer ranged in thickness from 44 to 53cm between the three test units, and was covered with grass and gravel. A service pipe was observed in the floor of test unit 200E, 500N at a depth of 53 cm, suggesting that the unit was disturbed.

In Test Unit 193E, 502N, located on one of the two positive Stage 2 test pits to the north of this line of units, two disturbance layers were observed truncating Layer 1. Directly below the grass surface within this test unit was Layer 3, a band of dark silty sand that was similar to Layer 1, but contained little gravel and was sterile of artifacts. Separating Layer 3 from Layer 1 below was a thin band of fine, light brown builder's sand measuring 5cm to 11cm in thickness. Both Layers 2 and 3 were determined represent more recent disturbance.

Most of the artifacts within the Stage 3 assemblage derived from Layer 1 (80.9%; n=131); only four artifacts were recovered from Test Unit 200E, 500N at the east end of the site, supporting the conclusion that this unit was disturbed during the installation of the observed service pipe. The remaining 31 artifacts were recovered from the layer of builder's sand in Test Unit 200E, 500N, and likely originally originated in Layer 1 below. The main disturbance layer, Layer 3, was sterile.

Although disturbed, Test Unit 193E, 502N produced by far the highest number artifacts (71.6%; n=116) on the site, and most of these from Layer 1 (n=85), the surviving portion of the undisturbed topsoil layer. Given that the next highest yielding unit produced only 32 artifacts, it is proposed here that H2 (AdHg-6) represents the edge of a larger midden area that extends into the disturbed area to the north.

3.6 H3 (AdHg-7)

The Stage 3 assessment of H3 (AdHg-8) produced 294 primarily Euro-Canadian artifacts from five Stage 3 test units; ten pieces of pre-contact Aboriginal chipping detritus was also represented in the assemblage (Table 31).

Table 31: H3 (AdHg-7) Stage 3 Artifact Summary

Artifact	Freq.	%
Structural	140	47.62
Ceramics	81	27.55
Household	40	13.61
Personal	13	4.42
Miscellaneous Metal and Horse Tack	10	3.40
Pre-Contact Aboriginal	10	3.40
Total	**294**	**100.00**

3.6.1 Structural Artifacts (see Appendix 10.2.5)

Almost half of the artifacts in the Stage 3 assemblage from H3 (AdHg-7) were structural, including 84 nails, 48 window glass pieces, 5 red brick fragments, 1 piece of concrete, 1 metal hinge, and 1 piece of mortar (Table 32).

Table 32: Structural Artifact Summary

Structural	Freq.	%
cut nails	80	57.14
window glass	48	34.29
brick fragment	5	3.57
wire nail	4	2.86
concrete	1	0.71
metal hinge	1	0.71
mortar	1	0.71
Total	**140**	**100.00**

The predominance of cut nails and thick window glass pieces (n=35) suggests a middle to late 19th century occupation. The presence of wire drawn nails and concrete extends the period of occupation into the early 20th century, as does the metal hinge, which looks to have been machine made. The brick and mortar pieces were very fragmentary and are not considered to be diagnostic.

3.6.2 Ceramics

Just over one quarter of the Stage 3 assemblage from H3 (AdHg-7) were ceramic pieces (27.6%; n=81); over two thirds of these were identified as RWE. Ironstone, utilitarian wares, pearlware and yellowware were also represented, albeit in lesser amounts. Table 33 provides a summary of the ceramic assemblage by ware type and Table 34, by surface decoration technique.

Table 33: Ceramic Assemblage by Ware Type (see Appendix 10.2.1)

Ceramics	Freq.	%
RWE	55	67.90
ironstone	12	14.81
utilitarian	8	9.88
pearlware	3	3.70
yellowware	3	3.70
Total	**81**	**100.00**

Table 34: Ceramic Assemblage by Decorative Technique (see Appendix 10.2.2)

Ceramics	Freq.	%
RWE	34	41.98
RWE, transfer printed	14	17.28
ironstone	9	11.11
RWE, hand painted	7	8.64
red earthenware	4	4.94
stoneware	4	4.94
ironstone, moulded	3	3.70
pearlware	3	3.70
yellowware	3	3.70
Total	**81**	**100.00**

The predominance of undecorated RWE sherds in the assemblage makes dating the occupation of the site difficult. The seven hand painted RWE sherds featured a variety of colours, including blue green and red in polychromatic designs, suggestive of a late 19th century occupation. This range is supported by the nine ironstone sherds also observed in the assemblage.

Another 14 sherds of RWE were transfer printed. Half of these featured blue designs that were common throughout the 19th century. Another four featured brown designs, more common for a long period spanning the middle of the century. The two mulberry pieces may date a bit earlier, as may the three yellowware pieces. These slightly earlier fragments, however, as well as the pearlware fragments, more likely represent heirloom items. The utilitarian wares were not diagnostic, but are typical in a domestic assemblage.

Most of the ceramic pieces in the assemblage were tableware vessels including 26 plates, 21 bowls, 5 cups and 1 tea cup. Another four sherds, including three of the four red earthenware pieces, were identified as storage vessels. The other red earthenware sherd was identified as an ink well. The remaining 23 sherds were too fragmentary to determine form or function. Table 35 provides a summary of the ceramic assemblage by form and Table 36, by function.

Table 35: Ceramic Assemblage by Form

Ceramics	Flat	Hollow	Unknown
ironstone	5	3	1
ironstone, moulded		3	
pearlware	3		
red earthenware		4	
RWE	13	11	10
RWE, hand painted		5	2
RWE, transfer printed	4	2	8
stoneware		2	2
yellowware	1	2	
Total	**26**	**32**	**23**

Table 36: Ceramic Assemblage by Function

Ceramics	Bowl	Cup	Ink Well	Plate	Storage	Tea Cup	Unknown
ironstone	3			5			1
ironstone, moulded	3						

Ceramics	Bowl	Cup	Ink Well	Plate	Storage	Tea Cup	Unknown
pearlware				3			
red earthenware			1		3		
RWE	10	1		13			10
RWE, hand painted		4				1	2
RWE, transfer printed	2			4			8
stoneware	1				1		2
yellowware	2			1			
Total	**21**	**5**	**1**	**26**	**4**	**1**	**23**

3.6.3 Household Artifacts (see Appendix 10.2.3)

Forty household artifacts were identified in the Stage assemblage from H3 (AdHg-7). Over half of these were faunal remains. The remainder of the household assemblage consisted of pieces of window glass and coal (Table 37).

Table 37: Household Artifact Summary

Household	Freq.	%
faunal remains	23	57.50
bottle glass	13	32.50
coal	4	10.00
Total	**40**	**100.00**

Almost half of the bottle glass pieces were purple, and are not considered to be diagnostic. Of the remaining pieces, four were clear, suggestive of a post 1870 occupation. Another three were aqua tinged, more suggestive of a pre-1880 occupation.

Among the faunal remains, most (n=15) were too fragmentary to be classified. The remaining pieces included three cow ribs pieces and a cow tooth, as well as two chicken cranium fragments and one chicken rib fragment. None of the faunal remains demonstrated evidence of butchering or cooking.

The four coal fragments were not considered to be diagnostic, but are common in domestic assemblages.

3.6.4 Personal Items (see Appendix 10.2.4)

Thirteen personal items were represented in the Stage 3 artifact assemblage. Over half of these were clay pipe fragments. The remainder of the assemblage comprised three coins two slate writing tablet fragments, and a button (Table 38).

Table 38: Personal Item Summary

Personal	Freq.
coin	3
white clay pipe bowl	3
white clay pipe stem	3
slate	2
brown clay pipe stem	1
button	1
Total	**13**

One of the white clay pipe stems (Cat#101) featured maker's marks identifying it as a Murray variety, manufactured in Glasgow between 1830 and 1861 (Adams 1994). One of the bowls (Cat#103) featured a

bird of paradise design, but was not considered to be diagnostic. This 19th century occupation range is supported also by the presence of a prosser-style button, typical of a post 1840 occupation. The three coins dated significantly later, and included a 1903 American Indian Head penny (Cat#100) and two American quarters dating to 1964 and 1966 respectively (Cat# 5).

None of the remaining personal items are considered to be diagnostic.

3.6.5 Miscellaneous Metal and Horse Tack

Ten miscellaneous metal items were included in the Stage 3 assemblage from H3 (AdHg-7), including six horseshoe nails. The remaining pieces included two metal can pieces, an iron bracket, and a possible gun part. Whereas none of these items are considered to be diagnostic, the presence of horseshoe nails suggests that the occupants of H3 (AdHg-7) could afford to stable a horse.

3.6.6 Pre-Contact Aboriginal

Included in the Stage 3 assemblage from H3 (AdHg-7) are ten pieces of pre-contact Aboriginal chipping Detritus manufactured from Onondaga chert. Due to the size of the assemblage, all pieces of chipping detritus were subject to morphological analysis following the classification scheme described above in Section 3.1 above.

Eight of the ten specimens were identified as thinning flakes. The remaining flakes consisted of a single cortex removal flake and a single secondary flake. The predominance of thinning flakes suggests that the pre-European occupants of the site were actively undertaking late stage lithic reduction, possibly for the production and maintenance of projectile points and formal tools. The predominant use of Onondaga chert, meanwhile, indicates that the occupants of H3 (adHg-7) were largely relying on a single source of raw material. Outcrops of Onondaga chert are found along the north shore of Lake Erie, located approximately 56km to the east of the Study Area. The lithic artifacts comprised less than 5% of the Stage 3 assemblage, however, and none whatsoever were encountered during the Stage 2. Given the small sample size, no conclusions may be drawn regarding pre-contact site function.

3.3.7 Artifact Distribution and Settlement Pattern

The Stage 2 assessment of H3 (AdHg-7) resulted in the documentation of 72 Euro-Canadian artifacts from 19 test pits covering an area of 21m northwest to southeast by 7m northeast to southwest. The Stage 3 assessment of the resulted in the recovery of an additional 284 Euro-Canadian artifacts and ten pieces of pre-contact Aboriginal chipping detritus from five Stage 3 test units. Three of these units were positioned along the edge of the Study Area for the length of the Stage 2 site limits, and produced 30, 100 and 5 Euro-Canadian artifacts respectively. Two additional units positioned to the northeast and northwest of the highest yielding grid unit produced an additional 69 and 80 Euro-Canadian artifacts. The limits of the site were bound by the edge of the Study Area to the north, low artifact yields to the east, and areas of disturbance on all other sides. Based on the results of the Stage 3 assessment, the site has been interpreted as a large Euro-Canadian midden that extends primarily to the north of the Study Area. The southern edge appears to be truncated by the disturbance.

The ten pre-contact Aboriginal artifacts within the Stage 3 assemblage were recovered from two of the five units. Two of the flakes were recovered from the highest yielding test unit at 205E, 505N. The other eight derived from the unit to the southeast. Given an absence of cultural features, formal tools, or diagnostic material, the pre-contact Aboriginal component of the site has been interpreted as a small activity area within the limits of the larger Euro-Canadian midden area. Given the areas of disturbance that limit the site, it is unknown if this pre-contact Aboriginal activity area extends beyond the limits of the site to the south.

4.0 Analysis and Conclusions

Detritus was retained by the Proponent to conduct Stage 3 Site Specific Assessments for five archaeological sites located in the Town of Port Bruce in advance of a in advance of a proposed bridge replacement on Imperial Road.

4.1 M1 (AdHg-5)

The Stage 3 assessment of M1 (AdHg-5) yielded 16 Euro-Canadian artifacts from a line of three test units spanning the original positive Stage 2 test pit. Artifact yields among the three units were very low, ranging from three to seven artifacts, and documented a period of occupation generally spanning the middle to late 19th century. No midden area was observed. Additionally, the westernmost unit, 195E, 500N, revealed evidence of deep disturbance that truncated the site on that side.

This evidence, when considered with the Stage 2 results, suggests that the Euro-Canadian component of M1 (AdHg-5) was a small area of late 19th to 20th century debris that may have been associated with the occupation of C. Monro.

Likewise, no pre-contact Aboriginal artifacts, fire-cracked rock, or cultural features were encountered during the Stage 3 assessment. Given the complete absence of pre-contact Aboriginal material encountered during the Stage 3 assessment, it is impossible to build upon the Stage 2 conclusions, which identified the pre-contact Aboriginal component of the site as a small activity area occupied seasonally by pre-contact Aboriginal, and possibly characterized primarily by all stages of lithic reduction with a propensity for formal tool preparation, and tool maintenance. This conclusion, however, is based on only four pieces of chipping detritus documented during the previous assessment.

4.2 M5 (AdHg-9) & P4 (AdHg-8)

The test unit excavations at M5 (AdHg-9) and P4 (AdHg-8) determined that the two sites were nodes of a larger parent site, identified as M5/P4 (AdHg-9) for the remainder of this report.

The Stage 3 assessment of the combined M5/P4 (AdHg-9) produced 316 Euro-Canadian artifacts and 180 pre-contact Aboriginal artifacts from 14 test units covering an area of 32m east to west by 12m north to south, not counting the test unit excavated at 235E, 525N to test the northern periphery of the site. All other sides of the site were limited by areas of disturbance and the boundaries of the Study Area. The distribution of Euro-Canadian artifacts at the site was more reminiscent of smaller isolated deposits than a larger midden area.

Household (n=109) and structural artifacts (n=108) were represented most often within the combined Euro-Canadian assemblage M5/P4 (AdHg-9). The household assemblage was dominated by bottle glass pieces (n=87) and faunal remains (n=15). The structural artifacts comprised entirely window glass pieces (n=48), nails (n=43) and red brick fragments (n-=17). The predominance of thick window glass pieces, machine cut and ware drawn nails, and machine manufactured bottle glass is suggestive of a middle of the 19th to early 20th century occupation.

This occupation range is supported by the Stage 3 ceramic assemblage, which featured primarily undecorated ironstone sherds (65.6%; n=42). Only five sherds of RWE featured surface decoration, including a possible early 19th century banded example. This specimen, in addition to the five earlier pearlware pieces, more likely represent heirloom items. The presence of horse tack, meanwhile, suggests that the occupants of the site were wealthy enough to stable a horse. Finally, A small modern fence post observed in Test Unit 215E, 503N and the modern fence wire recovered from 230E, 510N suggests that a 20th century fence may have spanned the southern edge of the site.

Based on the results of the Stage 3 assessment, the Euro-Canadian component of M5/P4 (AdHg-9) has been interpreted as small pockets of late 19th to early 20th artifacts along the edge of a larger midden area that may extend to the northwest beyond the limits of the Study Area.

The pre-contact Aboriginal component of the site comprised 180 primary lithic artifacts, including a single piece of Aboriginal pottery. The remainder of the pre-contact Aboriginal artifacts consisted of pieces of chipping detritus (99.4%; n=179). As was noted above, the five test units from P4 (AdHg-8) and the two test units from M5 (AdHg-9) that produced over ten pre-contact Aboriginal artifacts each formed a single activity area measuring approximately 14m east to west by 9m north to south.

Morphological analysis of the flake assemblage suggested that late stage lithic reduction was undertaken most actively at M5/P4 (AdHg-9) prior to European settlement. The presence of Aboriginal pottery suggests that this earlier occupation belongs to the Woodland period. Whereas no other features that are considered typical for Woodland period sites were observed, it is possible that both sites form the edge of a much larger Woodland period site that extends to the northwest beyond the limits of the Study Area.

4.3 H2 (AdHg-6)

The Stage 3 assessment of H2 (AdHg-6) resulted in the documentation of 162 primarily Euro-Canadian artifacts from four test units. Three of these units formed a straight line between the edge of the Study Area to the south, and the two positive Stage 2 test pits to the north. A service pipe observed in the floor of test unit 200E, 500N at a depth of 53 cm suggested that the east side of the site was disturbed. Likewise, Test Unit 193E, 502N, excavated directly on one of the Stage 2 test pits, revealed disturbance layers.

Although disturbed, Test Unit 193E, 502N produced by far the highest number artifacts on the site, and most of these from the surviving portion of the undisturbed topsoil layer. Given that the next highest yielding unit produced only 32 artifacts, it is proposed here that H2 (AdHg-6) represents the edge of a larger site that extends north into the disturbed area to the north.

The ceramic assemblage was dominated by RWE and ironstone, suggestive of a middle to late 19th century occupation. This occupation range is supported by the predominance of machine cut nails, and thick window glass. The presence of wire drawn nails and machine manufactured bottle glass may extend this period of occupation into the 20th century. Based on the results of the Stage 3 assessment, the Euro-Canadian component of H2 (AdHg-6) has been interpreted as the southern edge of a larger middle 19th to early 20th century midden area.

One piece of pre-contact Aboriginal chipping detritus was represented in the Stage 3 assemblage. Morphological analysis revealed the specimen to be a thinning flake manufactured from Onondaga chert. This one flake represents less than 1% of the Stage 3 artifact assemblage, and is thought to be residual. This conclusion is supported by the absence of pre-contact Aboriginal artifacts in the Stage 2 assemblage.

4.4 H3 (AdHg-7)

The Stage 3 assessment of H3 (AdHg-7) the resulted in the documentation of 284 Euro-Canadian artifacts and ten pieces of pre-contact Aboriginal chipping detritus from five Stage 3 test units. Three of these units were positioned along the edge of the Study Area for the length of the Stage 2 site limits, and produced 30, 100 and 5 Euro-Canadian artifacts respectively. Two additional units positioned to the northeast and northwest of the highest yielding grid unit produced an additional 69 and 80 Euro-Canadian artifacts. The limits of the site were bound by the edge of the Study Area to the north, low artifact yields to the east, and areas of disturbance on all other sides.

The predominance of undecorated RWE sherds in the Euro-Canadian assemblage makes dating the assemblage difficult. Seven hand painted RWE sherds were suggestive of a late 19th century occupation. This range is supported also by the presence of ironstone, clear and aqua bottle glass pieces, cut nails, clay pipe fragments, and thick window glass pieces.

Three coins recovered from the site dated significantly later, and included a 1903 American Indian Head penny and two American quarters dating to 1964 and 1966 respectively. The presence of wire drawn nails may also extend the period of occupation at H3 (AdHg-7) into the 20th century. Whereas a few earlier pieces, including three pieces of pearlware, appear to document an earlier occupation range, it is more likely that these artifacts represent heirloom items.

Based on the results of the Stage 3 assessment, the Euro-Canadian component of H3 (AdHg-7) has been interpreted as middle of the 19th to early 20th century midden area that extends primarily to the north of the Study Area. The southern edge of the site appears to be truncated by disturbance.

The ten pre-contact Aboriginal artifacts within the Stage 3 assemblage were recovered from two of the five units. Two of the flakes were recovered from the highest yielding test unit at 205E, 505N. The other eight derived from the unit to the southeast. Given an absence of cultural features, formal tools, or diagnostic material, the pre-contact Aboriginal component of the site has been interpreted as a small activity area within the limits of the larger Euro-Canadian midden area. Given the areas of disturbance that limit the site, it is unknown if this pre-contact Aboriginal activity area extends beyond the limits of the site to the south.

5.0 Recommendations

5.1 M1 (AdHg-5)

Based on the results of the Stage 3 assessment, and the period of occupation represented within the artifact assemblage, M1 (AdHg-5) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the site is not recommended.**

5.2 M5/P4 (AdHg-9)

Based on the results of the Stage 3 assessment, and the occupation range represented in the artifact assemblage, the Euro-Canadian component of M5/P4 (AdHg-9) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the Euro-Canadian component of the site is not recommended.**

Based on the results of the Stage 3 assessment, wherein seven test units yielded 10 or more pre-contact artifacts, including a single piece of Aboriginal pottery, **the pre-contact Aboriginal component of M5/P4 (AdHg-9) fulfills the criteria for a Stage 4 mitigation of impacts** as per Section 3.4.1, Standards 1a and 1c of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

5.3 H2 (AdHg-6)

Based on the results of the Stage 3 assessment, and the absence of any definitive 20th century material culture in the Stage 3 assemblage, **H2 (AdHg-6) fulfills the criterion for a Stage 4 mitigation of impacts**, as outlined in Section 3.4.2, Standard 1a of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

5.4 H3 (AdHg-7)

Based on the results of the Stage 3 assessment, and the period of occupation represented within the artifact assemblage, the Euro-Canadian component of H3 (AdHg-7) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011) and retains no further CHVI. **A Stage 4 archaeological mitigation of impacts for the Euro-Canadian component of H3 (AdHg-7) is not recommended.**

Based on the results of the Stage 3 assessment, wherein no test units yielded 10 or more pre-contact artifacts, the pre-contact Aboriginal component of H3 (AdHg-7) does not fulfill any of the criteria for further archaeological investigation as per Section 3.4 of the *Standards and Guidelines* (Government of Ontario 2011). One of the Stage 3 test units at the site, however, produced eight pieces of chipping detritus. Given a dearth of registered archaeological sites within the AdHg Borden Block as a whole, the presence of eight pre-contact Aboriginal artifacts within a single unit was considered a rare occurrence. As a result, **the pre-contact Aboriginal component of H3 (AdHg-7) fulfills the criterion for a Stage 4 mitigation of impacts**, as outlined in Section 3.4.1, Guideline 1a of the *Standards and Guidelines* (Government of Ontario 2011) and retains further CHVI.

5.5 Summary

As was noted above, four of the five sites subject to Stage 3 assessment have been recommended for Stage 4 mitigation of impacts, including M5 (AdHg-9), P4 (AdHg-8), H2 (AdHg-6) and H3 (AdHg-7). Furthermore, M5 (AdHg-9) and P4 (AdHg-8) have been merged into a single site, registered with the MTCS as M5/P4 (AdHg-9). The MTCS prefers that sites recommended for Stage 4 mitigation be avoided and protected rather than excavated, as per Section 7.9.4, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). Options to reduce or eliminate impacts to archaeological sites include redesigning the Study Area, excluding the archaeological site area from the Study Area, or incorporating the area of the archaeological site into the Study Area but without alteration, as outlined in Section 3.5 of the *Standards and Guidelines* (Government of Ontario 2011a). If these options are not feasible, Stage 4 archaeological mitigation by hand excavation is an alternative.

In consultation with the Proponent, the Stage 4 mitigation of M5/P4 (AdHg-9), H2 (AdHg-6), and H3 (AdHg-7) by avoidance and protection was a viable option.

In order to meet the standards for avoidance, as outlined in Section 4.1.1 of the *Standards and Guidelines* (Government of Ontario 2011), it is recommended that **a temporary fence be installed around M5/P4 (AdHg-9), H2 (AdHg-6), and H3 (AdHg-7) and their protective buffers during construction, and that any ground disturbance activities in this vicinity be monitored by a licensed archaeological consultant in order to prevent any impacts to the sites.** If any of M5/P4 (AdHg-9), H2 (AdHg-6), or H3 (AdHg-7) will be impacted by development, the archaeological sites and their protective buffers will be protected and no construction impacts will be allowed. The protective buffers will extend 10m past the limits of each site wherever possible as per Section 4.1, Standards 2b and 2c of the *Standards and Guidelines* (Government of Ontario 2011; Tiles 4 and 5 of the Supplementary Documentation). 'No-go' instructions will be issued to all on-site construction crews, engineers, architects and any others involved in day-to-day decisions during construction. The locations of the areas to be avoided will marked be on all contract drawings, when applicable, and will include explicit instructions to avoid them.

In order to meet the requirements for long term protection, as outlined in 4.1.4 of the *Standards and Guidelines* (Government of Ontario 2011), the Proponent has agreed to have a covenant registered on title for M5/P4 (AdHg-9), H2 (AdHg-6), and H3 (AdHg-7) and their 10m protective buffers that will prohibit any activities that might alter these archaeological sites in any way, either temporarily or permanently. As per Section 4.1.4, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011), such activities include, but are not limited to, demolition, tree removal, minor landscaping, or utilities installation.

As per Section 7.8.5, Standard e of the *Standards and Guidelines* (Government of Ontario 2011), a development map outlining the extents of M5/P4 (AdHg-9), H2 (AdHg-6), and H3 (AdHg-7) and their protective buffers will be provided as part of this report package, in addition to written confirmation of the proponent's commitment to implementing the avoidance strategy outlined above. This letter includes a construction monitoring schedule for all ground disturbance activity in the vicinity of the sites and their protective buffers, as well as a timeline for completing the remaining archaeological fieldwork.

If in the future, it is decided to conduct a Stage 4 mitigation by hand excavation at M5/P4 (AdHg-9), H2 (AdHg-6), or H3 (AdHg-7), this investigation will be conducted according to the procedures outlined in Section 4.2 of the *Standards and Guidelines* (Government of Ontario 2011).

At M5/P4 (AdHg-9) and H3 (AdHg-7), the Stage 4 excavation will consist of hand excavated blocks of 1m units surrounding the Stage 3 units that produced the most pre-contact Aboriginal artifacts. At M5/P4 (AdHg-9), this block will include the seven test units that produced at least ten pre-contact Aboriginal artifacts. At H3 (AdHg-7), the Stage 4 block will surround the highest yielding Stage 3 unit at 210E, 500N. At H2 (AdHg-6), 1m units will be excavated around the two highest yielding Stage 3 test units at 191E, 500N and 193E, 502N. The extent of each block excavation will be determined in accordance with Table 4.1 of the *Standards and Guidelines* (Government of Ontario 2011b).

Soil from all units will be screened through 6mm hardware cloth to facilitate the recovery of any artifacts that may be present. All artifacts will be bagged and tagged by provenience. The exposed subsoil surface will be cleaned by shovel or trowel and will be examined for cultural features. If any subsurface cultural

features are encountered, they will be recorded and excavated by hand in accordance with Section 4.2.2 of the *Standards and Guidelines* (Government of Ontario 2011b). Block excavation will continue to 2m beyond any cultural feature identified in accordance with Section 4.2.2, Standard 7c of the *Standards and Guidelines* (Government of Ontario 2011b).

Finally, according to Section 4.2.7, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011), the Stage 4 mitigation of archaeological sites that mostly date after 1830 must include mechanical topsoil removal ('MTR') following the hand excavation of all midden areas. As a result, the hand excavation at H2 (AdHg-6) will be followed by MTR to identify any potential cultural features or evidence of original architecture relating to the earliest occupation of the property. The Stage 4 MTR must be completed in accordance with Section 4.2.3 and Table 4.1 of the *Standards and Guidelines* (Government of Ontario 2011). The entire limits of the site, as determined by the previous Stage 2 and Stage 3 assessments, must be subject to MTR employing a straight-edged ditching bucket that pulls the soil away from the exposed surface. The subsoil surface will then be immediately shovel shined and examined for any evidence of subsurface cultural features. If any subsurface cultural features are encountered, they will be recorded and excavated by hand in accordance with Section 4.2.2, Standard 7 of the Standards and Guidelines (Government of Ontario 2011).

The recommendations above apply to the portions of M1 (AdHg-5), M5/P4 (AdHg-9) and H3 (AdHg-7) that occur within the current Study Area, and which were subject to both Stage 2 and Stage 3 archaeological assessment. Given the narrow constraints of the Study Area, it is possible that any of the five sites could extend beyond the limits of the Study Area. **If in the future, the properties adjacent to the five sites documented in this report will be impacted by development, then a Stage 1 archaeological assessment is required**, conducted according to Section 1.1 of the *Standards and Guidelines* (Government of Ontario 2011). This investigation will assess the development area's potential for the recovery of archaeological resources and will provide specific direction for the protection, management and/or recovery of these resources, as per Sections 1.3 and 1.4 of the *Standards and Guidelines* (Government of Ontario 2011).

6.0 Advice on Compliance with Legislation

This report is submitted to the Minister of Tourism and Culture as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of the Ontario Heritage Act and may not be altered, or have artifacts removed from them, except by a person holding an archaeological license.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest , and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

7.0 Bibliography and Sources

Adams, Nick. 1994. *Field Manual for Avocational Archaeologists in Ontario*. Ontario Archaeological Society Inc., Archaeological Stewardship Project.

Archives of Ontario. 2009. *The Evolution of the District and County System, 1788-1899*. Electronic document: http://www.archives.gov.on.ca/english/on-line-exhibits/maps/ontario-district-maps.aspx. Last accessed, November 30, 2018.

Beaudoin, Matthew A. 2013. *De-essentializing the Past: Deconstructing Colonial Categories in 19th-Century Ontario*. University of Western Ontario: Unpublished Ph.D. thesis.

Caston, Wayne A. 1997. Evolution in the Mapping of Southern Ontario and Wellington County. *Wellington County History* 10:91-106.

Chapman, L.J. and D.F. Putnam. 1984. *The Physiography of Southern Ontario*. Third Edition. Ontario Geological Survey. Special Volume 2. Toronto: Ontario Ministry of Natural Resources.

Coyne, J. H. 1895. *The Country of the Neutrals (As Far as Comprised in the County of Elgin): From Champlain to Talbot*. St. Thomas: Times Print.

Davidson, R.J. 1989. Foundations of the Land Bedrock Geology. In J.B. Theberge (editor), *The Natural History of Ontario*, pp. 36-47. Toronto: McClelland and Stewart Inc.

Davies, Peter. 2005. Writing Slates and Schooling. *Australian Historical Archaeology* Vol. 23: 63-69.

Detritus. 2019. *Stage 1-2 Archaeological Assessment, Port Bruce Bridge Replacement. Lots 4 and 5, Geographical Township of Malahide, County of Elgin, Port Bruce, Ontario*. Report on file with the Ministry of Tourism, Culture and Sport, Toronto.

Eley, Betty, and Peter H. von Bitter, 1989. *Cherts of Southern Ontario*. Toronto: Royal Ontario Museum.

Ellis, Chris J. and Neal Ferris (editors). 1990. T*he Archaeology of Southern Ontario to A.D. 1650*. Occasional Publication of the London Chapter, Ontario Archaeological Society, Number 5.

Evening Standard. 1891. "How Slate Pencils Are Made," in *Evening Standard vol. 41, Issue 70*. https://paperspast.natlib.govt.nz/newspapers/EP18910228.2.61. Last accessed December 7, 2017.

Feest, Johanna E. and Christian F. Feest 1978. "The Ottawa." In B.G. Trigger (editor), *Handbook of North American Indians. Vol.15 Northeast*, edited by, 772-786. Washington: Smithsonian Institute.

Ferris, Neal. 2009. *The Archaeology of Native-Lived Colonialism: Challenging History in the Great Lakes*. Tucson: University of Arizona Press.

Fisher, Jacqueline A. 1997. The Adder Orchard Site: Lithic Technology and Spatial Organization. In *The Broadpoint Late Archaic*. Occasional Publications of the London Chapter, Ontario Archaeological Society, Number 3.

Gentilcore, R. Louis and C. Grant Head. 1984. *Ontario's History in Maps*. Toronto: University of Toronto Press.

Government of Ontario. 1990a. *Ontario Planning Act*, R.S.O. 1990, CHAPTER P.13. Last amendment: 2016, c. 25, Sched. 4. Electronic documents https://www.ontario.ca/laws/statute/90p13. Last accessed December 17, 2018.

Government of Ontario. 1990b. *Ontario Heritage Act, R.S.O. 1990, CHAPTER O.18*. Last amendment: 2009, c. 33, Sched. 11, s. 6. Electronic document: https://www.ontario.ca/laws/statute/90o18. Last accessed December 17, 2018.

Government of Ontario. 1990c. *Freedom of Information and Protection of Privacy Act, R.S.O. 1990, CHAPTER F.31*. Last amendment: 2017, c. 2, Sched. 12, s. 4. Electronic document: https://www.ontario.ca/laws/statute/90f31. Last accessed December 17, 2018.

Government of Ontario. 2011. *Standards and Guidelines for Consultant Archaeologists*. Toronto: Ministry of Tourism, Culture and Sport.

Government of Ontario. 2018. *Ontario Land Registry Access*. Electronic Source: https://www.onland.ca/ui/. Last accessed July 31, 2019.

Government of Ontario. n.d. *Archaeological Sites Database Files*. Toronto: Culture Services Unit, Ministry of Tourism, Culture and Sport.

Hamil, Fred Coyne. 1951. *The Valley of the Lower Thames, 1640 to 1850*. Toronto: University of Toronto Press.

Harper, Russell. 1950. *The Early History of Haldimand County*. Caledonia: Grand River Sachem.

Hunter, Robert and George L. Miller. 2009.Suitable for Framing: Decorated Shell-Edged Earthenware. *Early American Life* August: 8-19.

Jamieson, S. M. 1992 Regional Interaction and Ontario Iroquois Evolution. *Canadian Journal of Archaeology* 16:70-88.

Jervis, William Percival. 1911. *A Pottery Primer*. New York: The O'Gorman Publishing Company.

Kenyon, Ian. 1980. 19th Century Notes. *KEWA* (80-2).

Konrad, Victor. 1981. An Iroquois Frontier: The North Shore of Lake Ontario during the Late Seventeenth Century. *Journal of Historical Geography* 7(2): 129-144.

Lamb, Lisa Nicole. 2003. *Historical Archaeology of the Indian Key (8M015) warehouse: An analysis of nineteenth - Century ceramics*. University of South Florida.

Lennox, P., C. Dodd and C. Murphy. 1986. *The Wiacek Site: A Late Middleport Component, Simcoe County*. London: Ontario Ministry of Transportation and Communications.

Lindsey, Bill. 2014. *Historic Glass Bottle Identification and Information Website*. Electronic document: http://www.sha.org/bottle/index.htm. Last accessed on December 17, 2018.

Majewski Teresita and Michael J. O'Brien. 1987. The Use and Misuse of Nineteenth-Century English and American Ceramics in Archaeological Analysis. In Michael Schiffer (editor), *Advances in Archaeological Method and Theory, Volume 11*, 98-209. New York: Academic Press.

McCallum, James L. 2016. *Discovering Your Roots in Elgin: A Guide to the Genealogical Resources in Elgin County, Ontario*. Electronic document: https://elgin.ogs.on.ca/wp-content/uploads/2016/02/Discovering-Your-Roots-in-Elgin.pdf. Last accessed May 10, 2017.

Miller, George L. 1980a. *Ceramics - The ACO Guide to 19th C. Sites*. Ontario Ministry of Culture and Recreation, Historical Planning and Research Branch. London, Ontario.

Miller, George L. 1980b. Classification and Economic Scaling of 19th Century Ceramics. *Historical Archaeology* 14: 1-40.

Morris, J.L. 1943. *Indians of Ontario*. 1964 reprint. Toronto: Department of Lands and Forests, Government of Ontario.

Noble, William. 1978 The Neutral Indians. In William Engelbrecht and Donald Grayson (editors), *Essays in Northeastern Anthropology in Memory of Marian E. White*, Occasional Publications in Northeastern Anthropology 5, pp. 152-164. Rindge, NH: Department of Anthropology, Franklin Pierce College.

Page, H.R. & Co. 1877. *Illustrated Historical Atlas of the County of Elgin, Ontario*. Toronto: H.R. Page & Co.

Pendergast, James. 1995. The Identity of Jacques Cartier's Stadaconans and Hochelagans: The Huron-Iroquois Option. In André Bekerman and Gary Warrick (editors), *Origins of the People of the Longhouse: Proceedings of the 21st Annual Symposium of the Ontario Archaeological Society*, pp. 106-118. North York: Ontario Archaeological Society.

Praxis Research Associates. n.d. *The History of the Mississaugas of the New Credit First Nation*. Hagersville: Lands, Research and Membership, Mississaugas of the New Credit First Nation.

Schmalz, Peter S. 1991. *The Ojibwa of Southern Ontario*. University of Toronto Press, Toronto.

Shaw, Simeon. 1829 (1968 reprint). *History of the Staffordshire Potteries and the Rise and Progress of the Manufacture of Pottery and Porcelain; with Reference to Genuine Specimens and Notices of Eminent Potters*. New York: Great Neck.

Sprague, Roderick. 2002. China or Prosser Button Identification and Dating. *Historical Archaeology* 36(2):111-127.

Surtees, Robert J. 1994. Land Cessations, 1763-1830. In Edward Rogers and Donald B. Smith (editors), *Aboriginal Ontario: Historical Perspectives on the First Nations*, pp. 92-121. Toronto: Dundurn Press.

Tharp, Lars. 2017. The Origin of Ironstone. In *Stoke on Trent: Resources on the North Staffordshire Pottery Industry*. http://www.thepotteries.org/features/ironstone.htm. Last accessed July 28, 2017.

The Potteries.org. 2003. *Ironstone*. Electronic document: http://www.thepotteries.org/types/ironstone.htm. Last accessed July 30, 2019.

University of West Florida. 2008. *Bayport Chert*. Electronic document: http://www.projectilepoints.net/Materials/Bayport%20Chert.html. Last accessed September 11, 2019.

Venovcevs, Anatolijs. 2013. Dressed for Life and Death: The Archaeology of Common Nineteenth-Century Buttons. Paper presented at *Forward into the Past* conference, Wilfrid Laurier University, Waterloo, Ontario, 6 April 2013. Electronic Document: http://www.fitp.ca/articles/FITPXXIII/Dress_for_Life_and_Death_Paper.pdf. Last accessed September 13, 2019.

Voss, Barbara L. 2008. *The Archaeology of Ethnogenesis: Race and Sexuality in Colonial San Francisco*. Berkeley: University of California Press.

Weaver, Sally. 1978. "Six Nations of the Grand River, Ontario." In Bruce G. Trigger (editor) *Handbook of North American Indians. Volume 15: Northeast*, edited by, 525-536. Smithsonian Institution Press, Washington.

White, Marian. 1978. Neutral and Wenro. In Bruce G. Trigger (editor), *Handbook of North American Indians Volume 15: Northeast*, pp. 407-411. Washington: Smithsonian Institution Press.

Wilson, J.A. and M. Horne 1995. *City of London Archaeological Master Plan*. London: City of London, Department of Planning and Development.

8.0 Maps

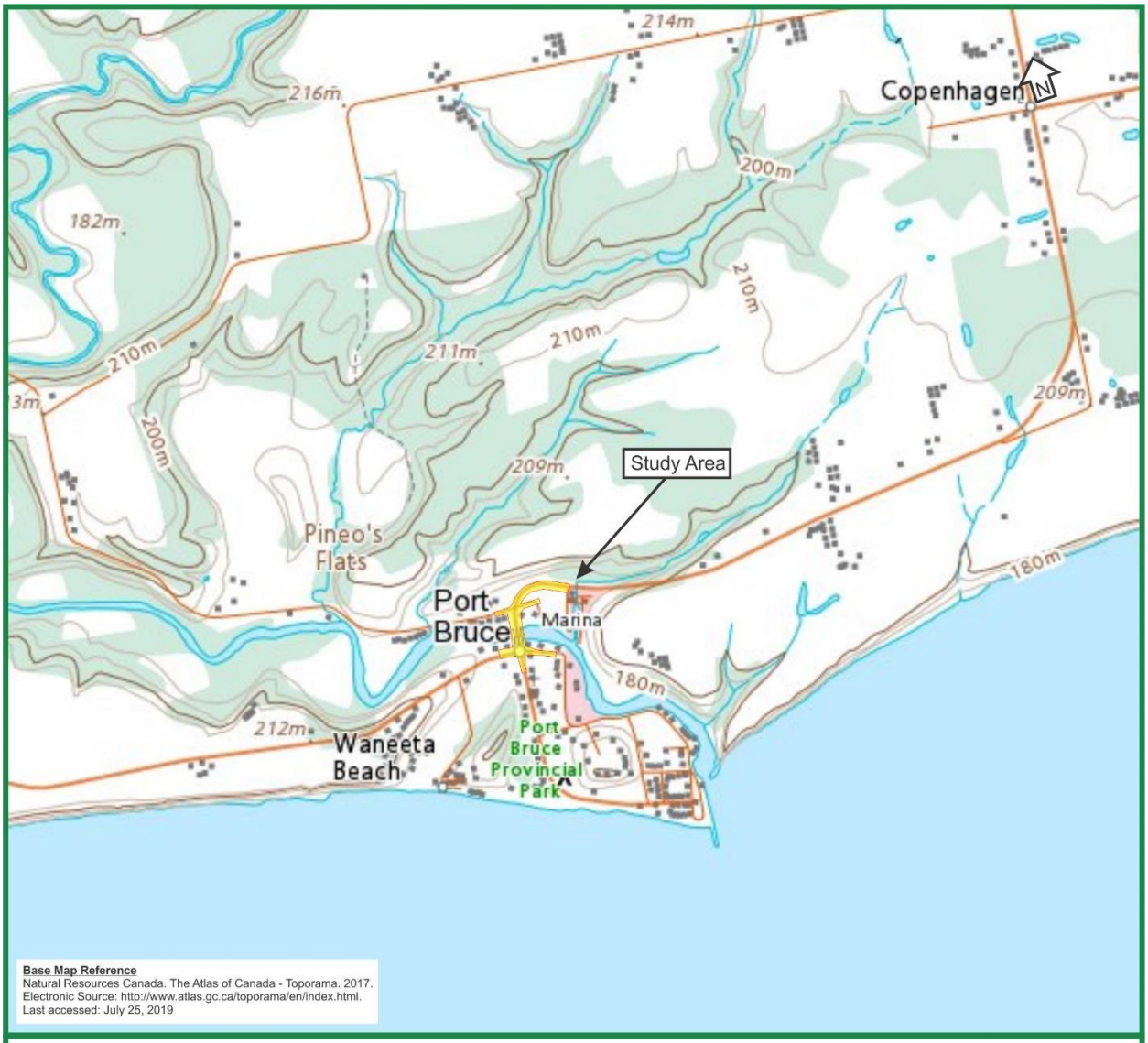

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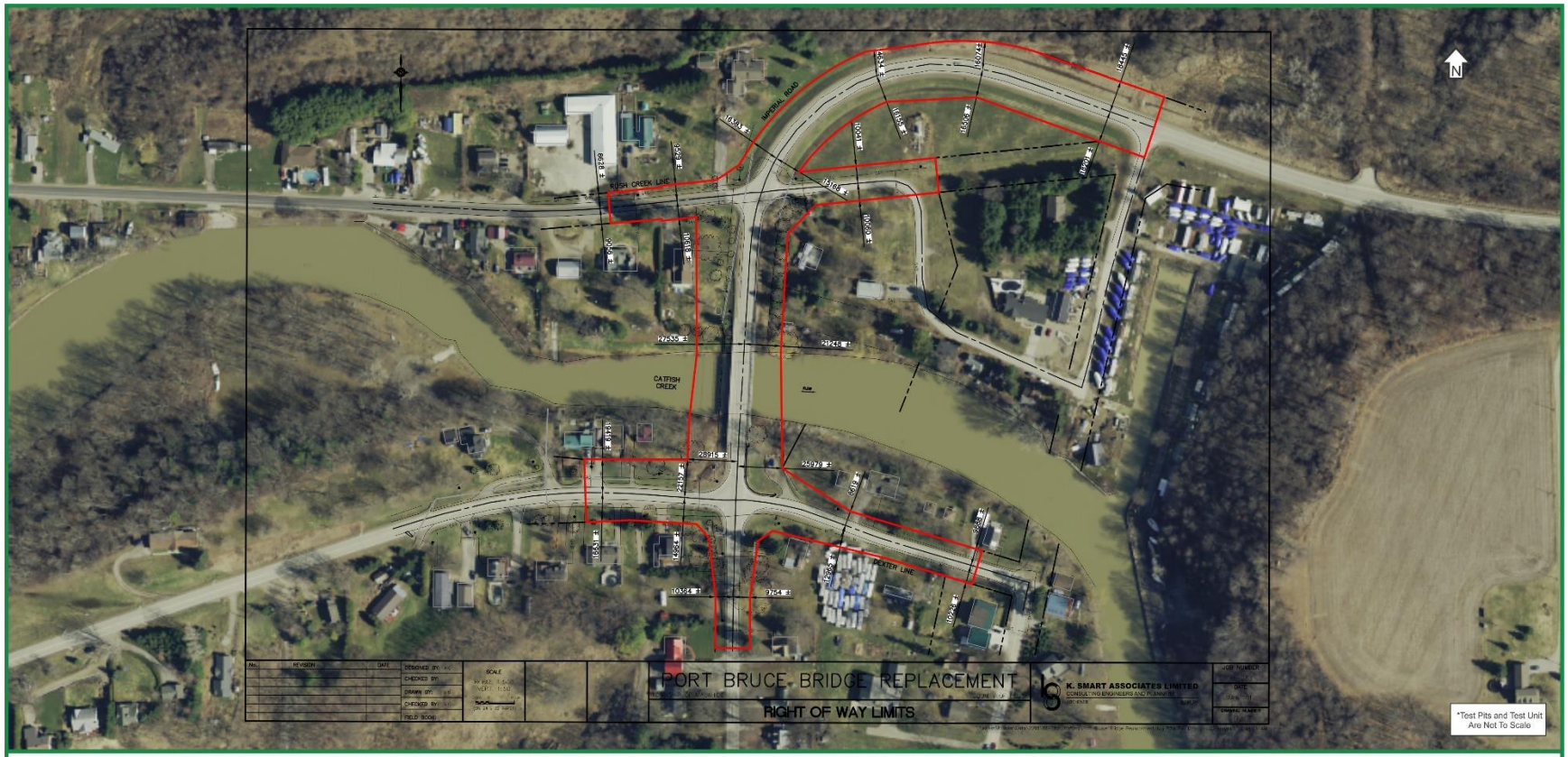
Figure 1: Study Area

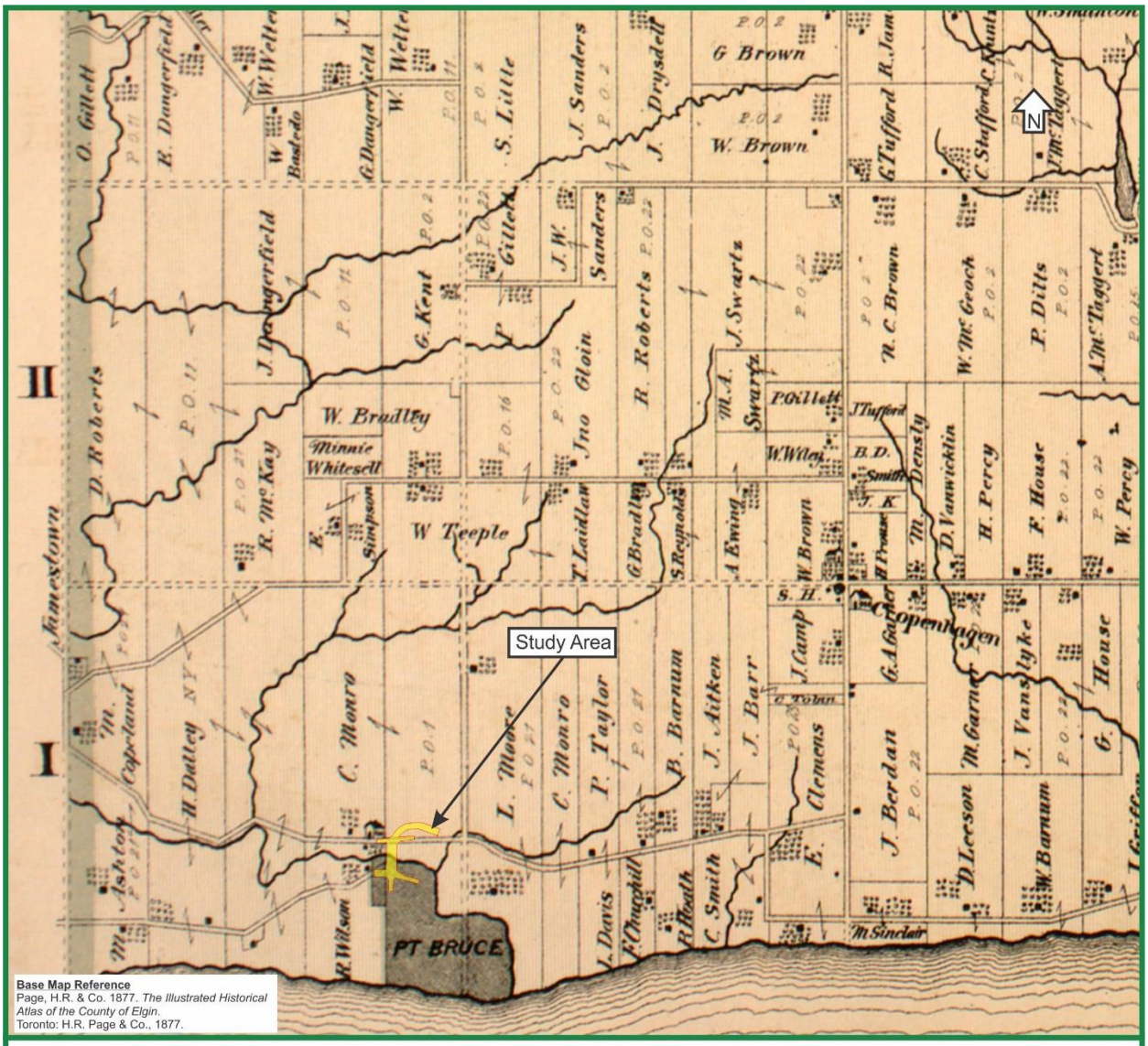


Legend

Study Area (Stage 1-2 Assessment; Detritus 2019)

0 50 100m

Figure 2: Previous Archaeological Assessment



Not to Scale

Figure 3: Portion of the 1877 *Historical Atlas* Map of Malahide Township

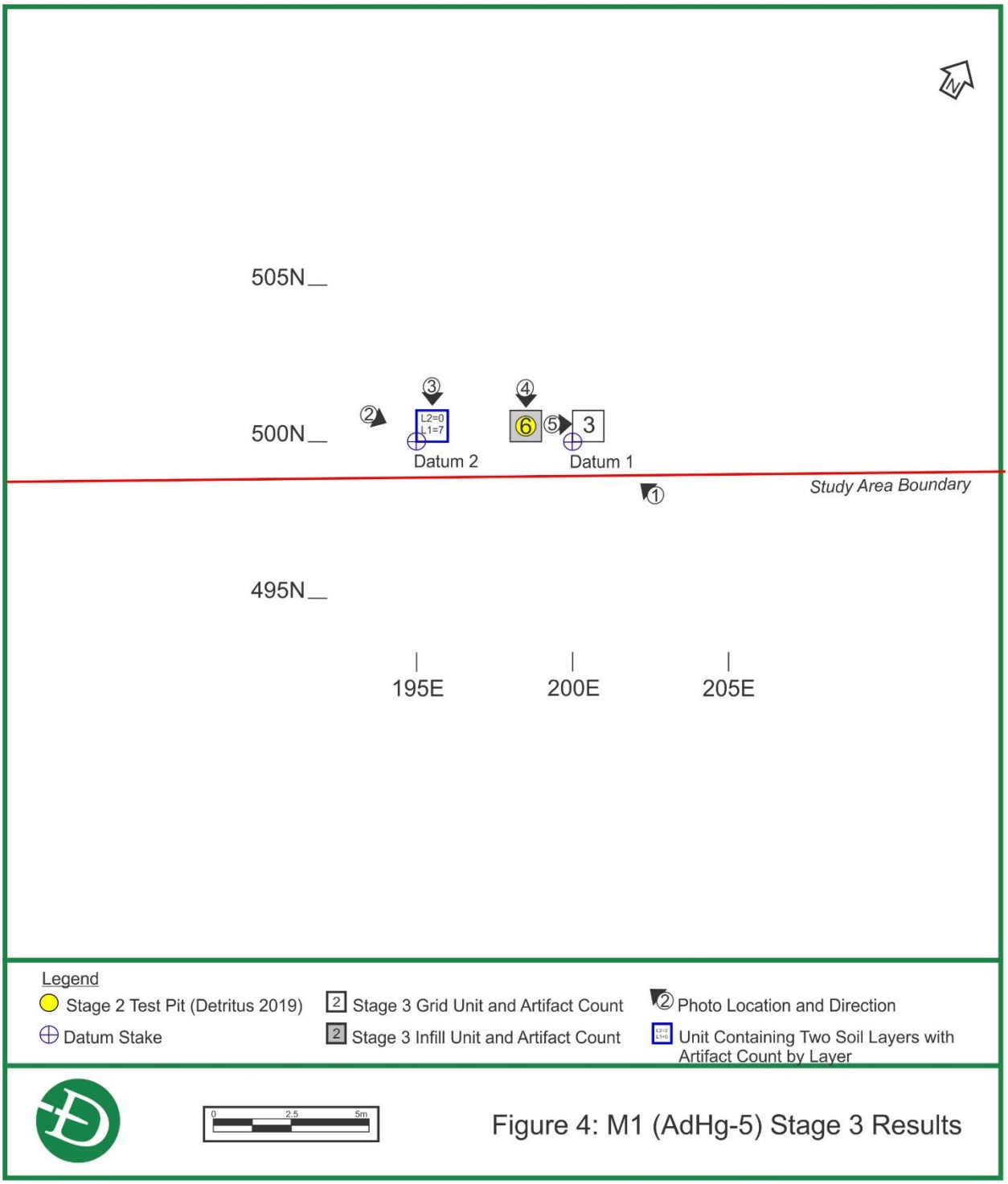


Figure 4: M1 (AdHg-5) Stage 3 Results

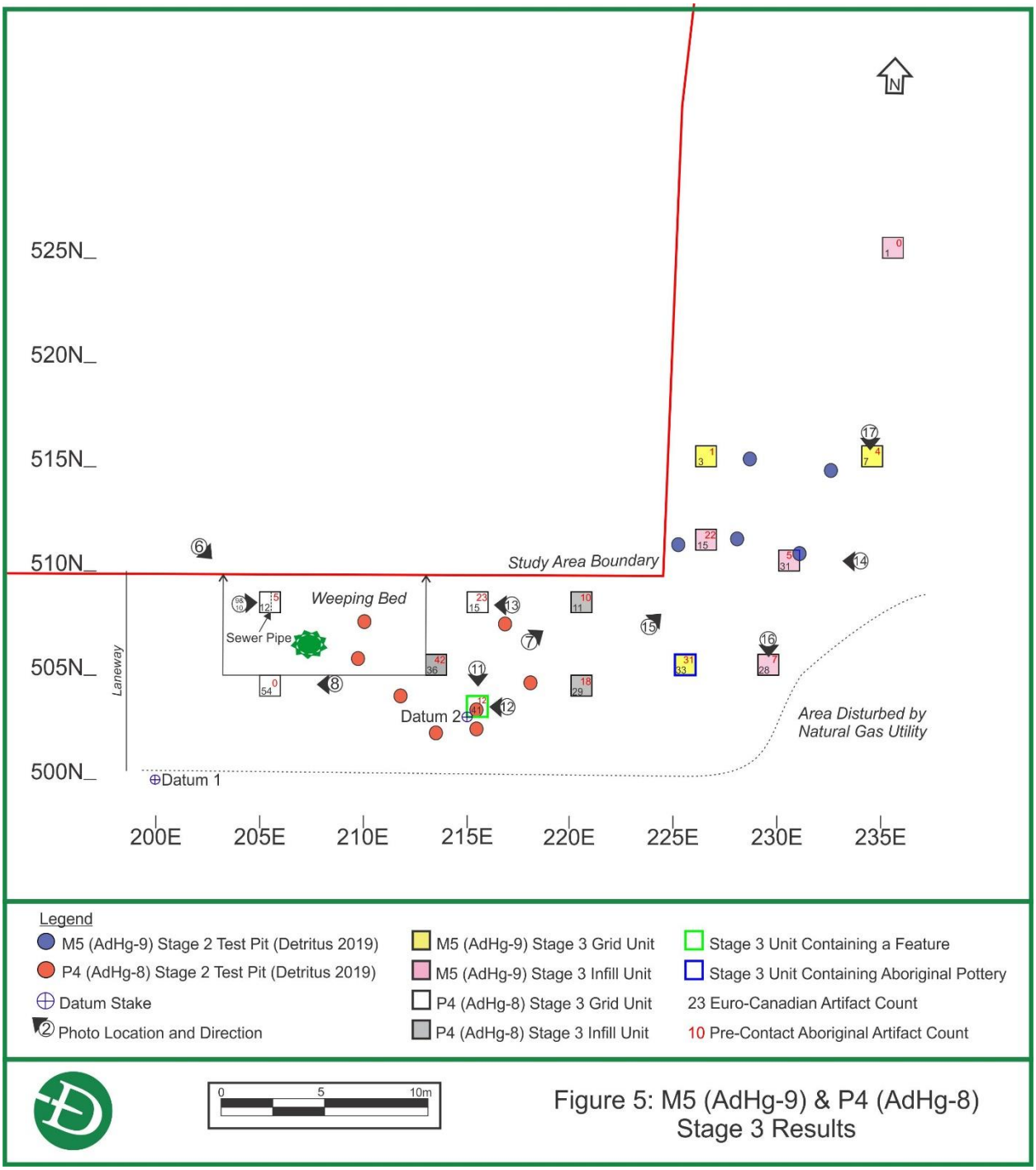


Figure 5: M5 (AdHg-9) & P4 (AdHg-8) Stage 3 Results

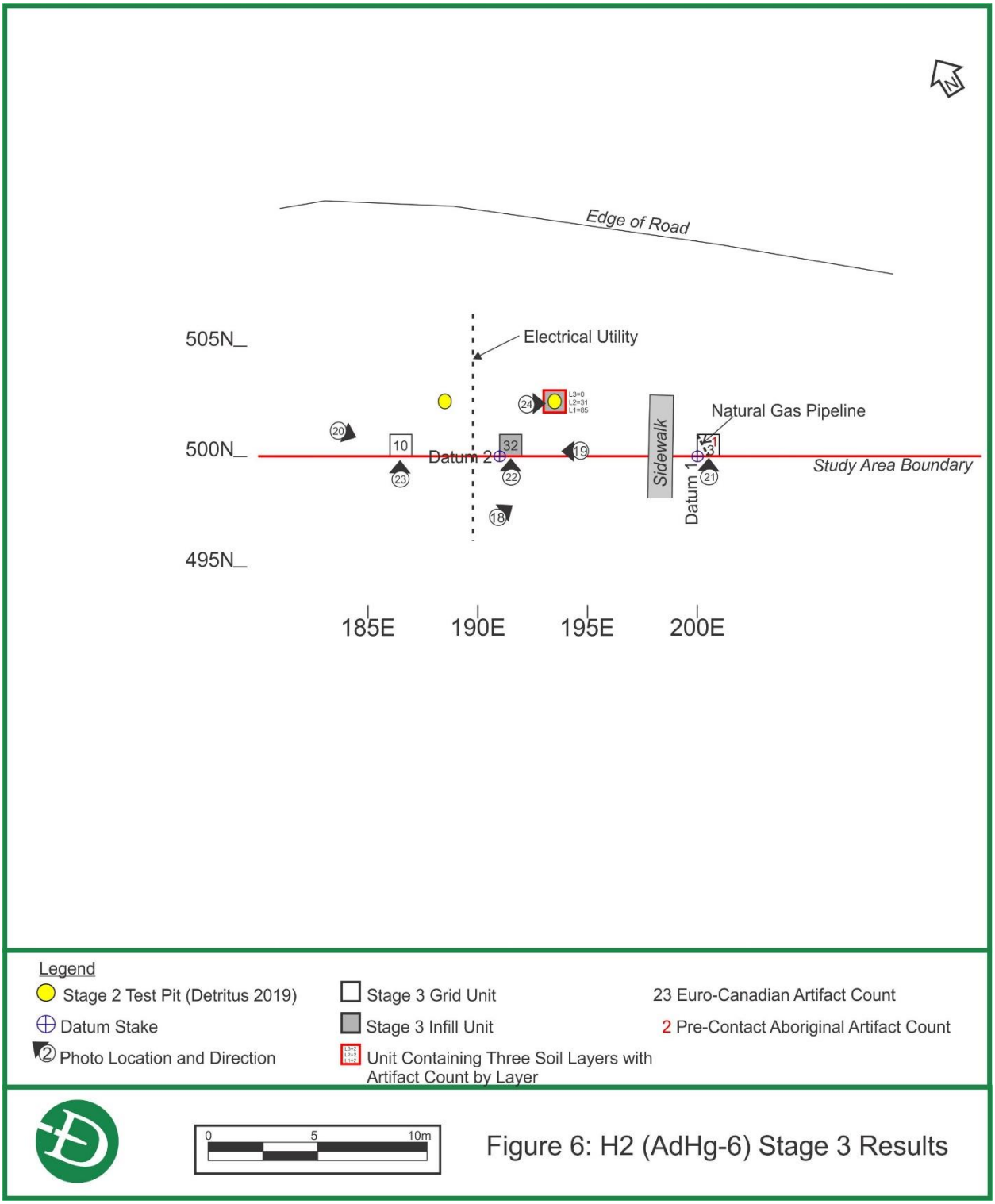


Figure 6: H2 (AdHg-6) Stage 3 Results

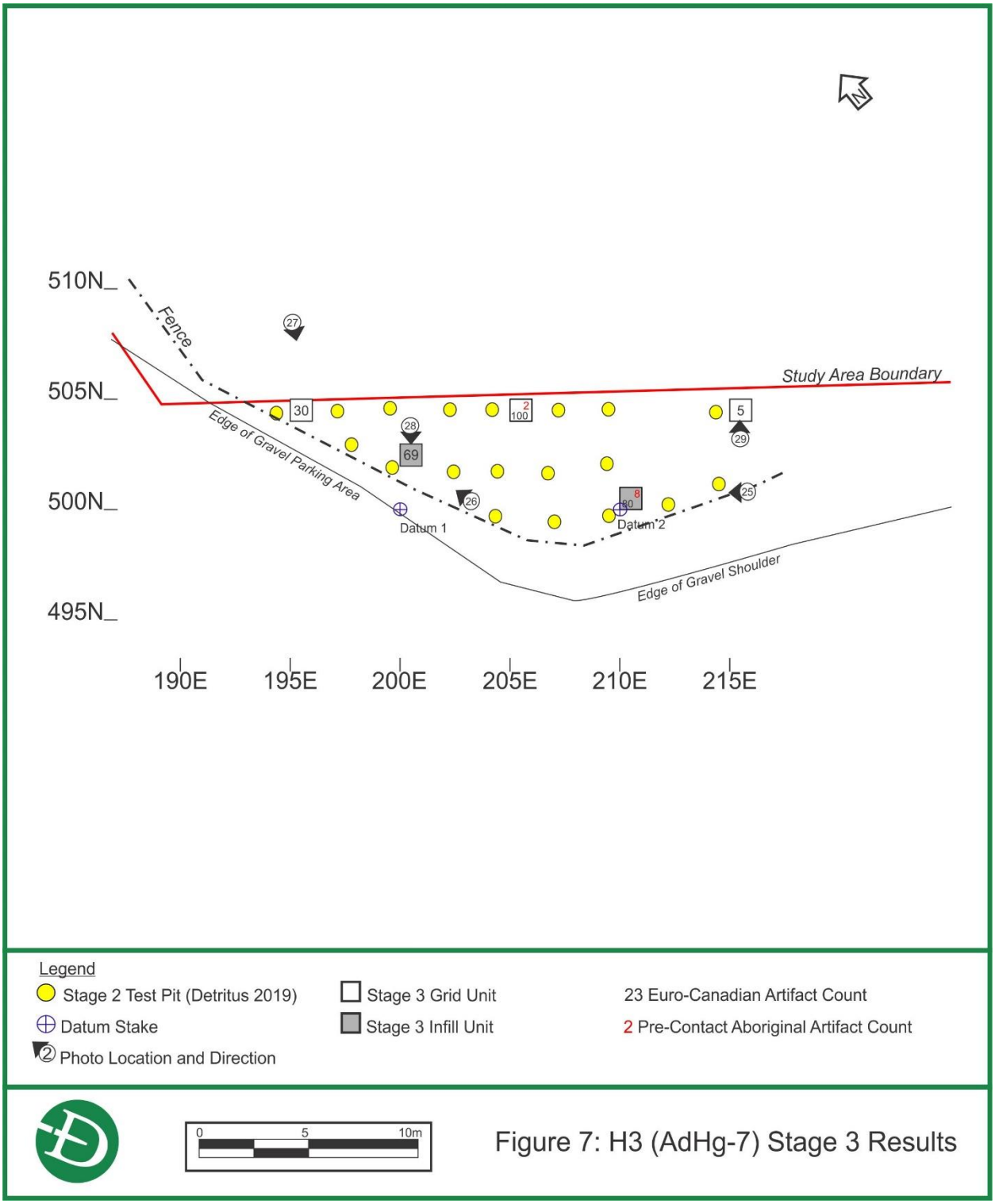


Figure 7: H3 (AdHg-7) Stage 3 Results

9.0 Images

9.1 Field Photos

Photo 1: Stage 3 Unit Excavation at M1 (AdHg-5), facing west

Photo 2: Stage 3 Unit Excavation at M1 (AdHg-5), facing east

Photo 3: Two Soil Layers in Stage 3 Unit 195E, 500N at M1 (AdHg-5), facing grid south

Photo 4: Stage 3 Unit 198E, 500N at M1 (AdHg-5), facing grid south

Photo 5: Stage 3 Unit 200E, 500N at M1 (AdHg-5), facing grid east

Photo 6: Stage 3 Unit Excavation at P4 (AdHg-8), facing southeast

Photo 7: Stage 3 Unit Excavation at P4 (AdHg-8), facing northeast

Photo 8: Stage 3 Unit Excavation at P4 (AdHg-8), facing west

Photo 9: Stage 3 Unit 205E, 508N Containing a Sewer Pipe at P4 (AdHg-8), facing east

Photo 10: Stratigraphy of Stage 3 Unit 205E, 508N Containing a Sewer Pipe at P4 (AdHg-8), facing east

Photo 11: Stage 3 Unit 215E, 503N Containing a Feature at P4 (AdHg-8), facing west

Photo 12: Stratigraphy of Stage 3 Unit 215E, 503N at P4 (AdHg-8), facing west

Photo 13: Stratigraphy of Stage 3 Unit 215E, 508N at P4 (AdHg-8), facing west

Photo 14: Stage 3 Unit Excavation at M5 (AdHg-9), facing west

Photo 15: Stage 3 Unit Excavation at M5 (AdHg-9), facing northeast

Photo 16: Stratigraphy of Stage 3 Unit 229E, 505N at M5 (AdHg-9), facing grid south

Photo 17: Stratigraphy of Stage 3 Unit 234E, 515N at M5 (AdHg-9), facing grid south

Photo 18: Stage 3 Unit Excavation at H2 (AdHg-6), facing east

Photo 19: Stage 3 Unit Excavation at H2 (AdHg-6), facing northwest

Photo 20: Stage 3 Unit Excavation at H2 (AdHg-6), facing southeast

Photo 21: Natural Gas Line in Stage 3 Unit 200E, 500N at H2 (AdHg-6), facing grid west

Photo 22: Single Layer Stratigraphy of Stage 3 Unit 191E, 500N at H2 (AdHg-6), facing grid north

Photo 23: Single Layer Stratigraphy of Stage 3 Unit 191E, 500N at H2 (AdHg-6), facing grid north

Photo 24: Three Layer Stratigraphy of Stage 3 Unit 193E, 502N at H2 (AdHg-6), facing grid east

Photo 25: Stage 3 Unit Excavation at H3 (AdHg-7), facing northwest

Photo 26: Stage 3 Unit Excavation at H3 (AdHg-7), facing north

Photo 27: Stage 3 Unit Excavation at H3 (AdHg-7), facing southwest

Photo 28: Stratigraphy of Stage 3 Unit 200E, 503N at H3 (AdHg-7), facing grid south

Photo 29: Stratigraphy of Stage 3 Unit 215E, 504N at H3 (AdHg-7), facing grid north

Photo 30: Drawing of the Stratigraphy in Stage 3 Unit 195E, 500N at M1 (AdHg-5)

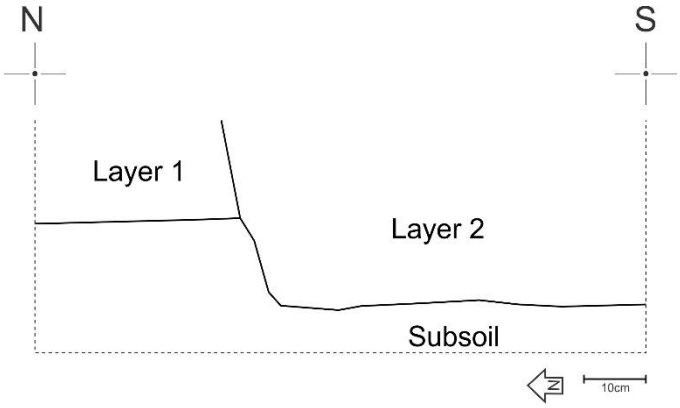
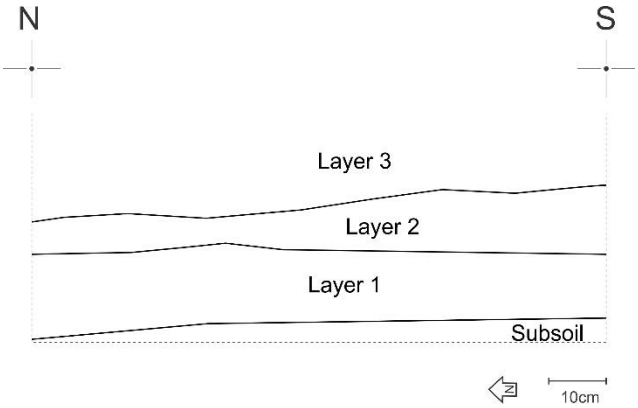


Photo 31: Drawing of the Stratigraphy in Stage 3 Unit 193E, 502N at H2 (AdHg-6)



9.2 Artifact Photos

Plate 1: Cut Nails Recovered from M1 (AdHg-5)

Plate 2: Bottle Glass Recovered from M1 (AdHg-5)

Plate 3: Chipping Detritus and Aboriginal Pottery Recovered from M5 (AdHg-9)

Plate 4: Two Blue Transfer Printed Fragments and 1 Blue Hand Painted RWE Fragment Recovered from M5 (AdHg-9)

Plate 5: Scissor Handle Fragment and a Sound Board from a Harmonica Recovered from M5 (AdHg-9)

Plate 6: Chipping Detritus Recovered from P4 (AdHg-8)

Plate 7: (left to right) Moulded Ironstone, Red Earthenware, Transfer Printed RWE, Ironstone Recovered from P4 (AdHg-8)

Plate 8: Shoe Sole and Shotgun Shell Recovered from P4 (AdHg-8)

Plate 9:Edged and Transfer Printed RWE Recovered from H2 (AdHg-6)

Plate 10: Bottle Glass Recovered from H2 (AdHg-6)

Plate 11:Slate Tablet Recovered from H2 (AdHg-6)

Plate 12: White Clay Pipe Stem and Bowl Fragments Recovered from H2 (AdHg-6)

Plate 13:Cut Nails Recovered from H3 (AdHg-7)

Plate 14: (left to right) Blue Transfer Printed, Brown Transfer Printed, Green Hand Painted, Blue and Red Hand Painted RWE Fragments Recovered from H3 (AdHg-7)

Plate 15: Bottle Glass Recovered from H3 (AdHg-7)

Plate 16: Bird of Paradise Design on White Clay Pipe Bowl Fragment and Murray Glasgow Pipe Stem Fragment Recovered from H3 (AdHg-7)

Plate 17: 1903 American Indian Head Penny Recovered from H3 (AdHg-7)

Plate 18: Prosser Button Recovered from H3 (AdHg-7)

Plate 19: Chipping Detritus Recovered from H3 (AdHg-7)

10.0 Appendices

10.1 Artifact Catalogues

10.1.1 M1 (AdHg-5) Stage 3 Artifact Catalogue

Cat#	Unit Easting	Unit Northing	Depth (m)	Layer	Artifact	Freq.	Ceramic Form	Ceramic Function	Colour	Comments
1	200	500	0.60	1	glass bottle	1			blue	melted
2	200	500	0.60	1	ironstone	2	flat	plate	white	body sherds
3	195	500	0.53	1	glass bottle	1			blue	body shard, medicine bottle, "CO" lettering embossed
4	195	500	0.53	1	cut nails	4				framing nails
5	198	500	0.21	1	cut nails	3				framing nails
6	198	500	0.21	1	glass bottle	1			aqua	body shard
7	198	500	0.21	1	faunal remains - mammalian	1				unknown fragment
8	198	500	0.21	1	RWE – flow transfer printed	1	unknown	unknown	blue	small fragment
9	195	500	0.53	1	RWE	1	unknown	unknown		small fragment
10	195	500	0.53	1	cut nail	1				framing nail

10.1.2 M5 (AdHg-9) Stage 3 Artifact Catalogue

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
1	225	505	0.34	wire nail	1						framing nail
2	225	505	0.34	brick fragment	1					red	
3	225	505	0.34	brick fragment	1					yellow	
4	225	505	0.34	recent material	1						possible plastic fishing rod tip
5	225	505	0.34	coal	1						
6	225	505	0.34	metal shoe grommet	1						single hole
7	225	505	0.34	Aboriginal pottery	1						small body sherd
8	225	505	0.34	chipping detritus	1	thinning	Haldimand				
9	225	505	0.34	chipping detritus	24	thinning	Onondaga				
10	225	505	0.34	chipping detritus	5	secondary	Onondaga				

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
11	225	505	0.34	ironstone, moulded	1			hollow	basin		rim sherd
12	225	505	0.34	ironstone, moulded	1			hollow	basin		body sherd
13	225	505	0.34	ironstone	1			hollow	bowl		rim sherd
14	225	505	0.34	ironstone	6			hollow	bowl		body sherds
15	225	505	0.34	RWE, painted	1			unknown	unknown	blue	body sherd
16	225	505	0.34	stoneware	1			hollow	storage	dark brown	body sherd
17	225	505	0.34	window glass	1						<1.6 mm
18	225	505	0.34	window glass	3						<1.6 mm
19	225	505	0.34	window glass	2						>1.6 mm
20	225	505	0.34	bottle glass	3					clear	wine glass
21	225	505	0.34	bottle glass	1					green	soda bottle
22	225	505	0.34	bottle glass	1					light blue	square sided, medicine bottle, "NTE"
23	225	505	0.34	bottle glass	3					light blue	rounded, medicine bottle
24	225	505	0.34	bottle glass	1					aqua	glass fragment
25	225	505	0.34	bottle glass	1					clear	glass fragment
26	226	515	0.28	recent material	1						plastic pencil sharpener
27	226	515	0.28	copper spoon	1						large spoon, "HOH" stamped on back of handle
28	226	515	0.28	chipping detritus	1	thinning	Onondaga				
29	226	515	0.28	ironstone	1			flat	plate		body sherd
30	235	525	0.3	yellow earthenware	1			hollow	bowl	dark brown	body sherd
31	229	505	0.42	spike	1						hand made
32	229	505	0.42	cut nail	1						finishing nail
33	229	505	0.42	meat hook	1						hand forged, single eye
34	229	505	0.42	miscellaneous metal	1						iron, indeterminate use
35	229	505	0.42	chipping detritus	7	thinning	Onondaga				
36	229	505	0.42	brick fragment	1					red	
37	229	505	0.42	brick fragment	1					yellow	

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
38	229	505	0.42	bottle glass	1					clear	soda bottle
39	229	505	0.42	bottle glass	1					aqua	wine glass
40	229	505	0.42	window glass	4						<1.6 mm
41	229	505	0.42	window glass	1						<1.6 mm
42	229	505	0.42	window glass	1						>1.6 mm
43	229	505	0.42	window glass	3						>1.6 mm
44	229	505	0.42	RWE, transfer printed	1			flat	saucer	blue	Sprig pattern with clouds. Shoulder sherd
45	229	505	0.42	ironstone	2			hollow	bowl		rim sherds
46	229	505	0.42	ironstone	5			hollow	bowl		body sherds
47	229	505	0.42	pearlware	1			flat	saucer		body sherd
48	229	505	0.42	pearlware	1			flat	saucer		rim sherd
49	229	505	0.42	pearlware	1			flat	saucer		shoulder
50	234	515	0.2	chipping detritus	4	thinning	Onondaga				
51	234	515	0.2	RWE, transfer printed	2			hollow	cosmetics	blue	flower pattern, mendable
52	234	515	0.2	bottle glass	1					clear	wine glass
53	234	515	0.2	window glass	1						<1.6 mm
54	234	515	0.2	window glass	1						>1.6 mm
55	234	515	0.2	window glass	2						>1.6 mm
56	226	511	0.48	faunal remains	1						deer long bone, burnt
57	226	511	0.48	brick fragment	1					red	
58	226	511	0.48	shell casing	1						no markings, rim fired, pistol or rifle round
59	226	511	0.48	scissors	1						handle
60	226	511	0.48	brass tack	1						
61	226	511	0.48	horseshoe nail	1						
62	226	511	0.48	cut nail	1						framing nail
63	226	511	0.48	window glass	2						<1.6 mm
64	226	511	0.48	window glass	1						<1.6 mm, melted

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
65	226	511	0.48	bottle glass	1					clear	wine glass
66	226	511	0.48	chipping detritus	3	thinning	Haldimand				
67	226	511	0.48	chipping detritus	1	secondary	Haldimand				
68	226	511	0.48	chipping detritus	4	secondary	Onondaga				
69	226	511	0.48	chipping detritus	14	thinning	Onondaga				
70	226	511	0.48	RWE, banded	1			unknown	unknown	blue, black	body sherd
71	226	511	0.48	RWE	1			unknown	unknown	white	salt glazed, body sherd
72	226	511	0.48	RWE	1			unknown	unknown	brown	exfoliated, body sherd
73	226	511	0.48	RWE	1			hollow	storage	dark brown	body sherd
74	230	510	0.36	fencing wire	1						
75	230	510	0.36	wire nail	1						framing nail
76	230	510	0.36	wire nail	4						roofing nails
77	230	510	0.36	cut nail	1						framing nail
78	230	510	0.36	horseshoe nail	2						
79	230	510	0.36	spike	1						bent to form hook
80	230	510	0.36	musical instrument	1						sound board from harmonica
81	230	510	0.36	brass fitting	1						unknown purpose, some illegible text, then "PATENT JUNE" no date visible
82	230	510	0.36	brick fragment	2					red	
83	230	510	0.36	RWE	1			hollow	bowl	white	rim sherd
84	230	510	0.36	RWE	1			hollow	bowl	white	body sherd
85	230	510	0.36	RWE, transfer printed	1			hollow	bowl	blue	sprig pattern, body sherd
86	230	510	0.36	chipping detritus	1	thinning	Bayport				
87	230	510	0.36	chipping detritus	3	thinning	Onondaga				
88	230	510	0.36	chipping detritus	1	secondary	Onondaga				
89	230	510	0.36	window glass	1						<1.6 mm
90	230	510	0.36	window glass	1						>1.6 mm
91	230	510	0.36	window glass	5						>1.6 mm

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
92	230	510	0.36	bottle glass	2					clear	wine glass
93	230	510	0.36	bottle glass	1					light purple	tumbler
94	230	510	0.36	faunal remains	4						Bos. Taurus, ribs, butchered

10.1.3 P4 (AdHg-8) Stage 3 Artifact Catalogue

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
1	220	508	0.23	miscellaneous metal	1						possible bolt, heavily corroded
2	220	508	0.23	cut nail	1						finishing nail
3	220	508	0.23	cut nail	2						framing nails, heavily corroded
4	220	508	0.23	chipping detritus	1	micro	Onondaga				
5	220	508	0.23	chipping detritus	8	thinning	Onondaga				
6	220	508	0.23	chipping detritus	1	thinning	Bayport				
7	220	508	0.23	brick fragment	2					red	
8	220	508	0.23	recent material	1					brown	modern beer bottle glass
9	220	508	0.23	slate	1						writing slate
10	220	508	0.23	coal	1						
11	220	508	0.23	window glass	1						>1.6 mm
12	220	508	0.23	window glass	1						<1.6 mm
13	215	503	0.38	wire nail	2						finishing nails
14	215	503	0.38	wire nail	1						framing nail
15	215	503	0.38	cut nail	4						framing nails
16	215	503	0.38	horseshoe nail	1						
17	215	503	0.38	spike	2						framing spikes
18	215	503	0.38	spike	1						handmade
19	215	503	0.38	haying fork	1						two prongs
20	215	503	0.38	wire	1						bent wire
21	215	503	0.38	horseshoe	1						heavy gauge
22	215	503	0.38	haying fork	1						three prongs

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
23	215	503	0.38	shotgun shell	1						all metal body, "Kynochs No 10 Patent"
24	215	503	0.38	brick fragment	1					red	
25	215	503	0.38	chipping detritus	2	thinning	Haldimand				
26	215	503	0.38	chipping detritus	10	thinning	Onondaga				
27	215	503	0.38	faunal remains, mammalian	3						Bos. Taurus, femur fragments
28	215	503	0.38	faunal remains, mammalian	1						Bos. Taurus, shoulder fragment
29	215	503	0.38	ironstone	3			flat	plate		base with foot ring
30	215	503	0.38	ironstone	9			flat	plate		body sherds
31	215	503	0.38	window glass	1						<1.6 mm, melted
32	215	503	0.38	window glass	6						>1.6 mm
33	215	503	0.38	window glass	1						>1.6 mm
34	215	508	0.36	cut nail	3						framing nails
35	215	508	0.36	wire nail	1						finishing nail
36	215	508	0.36	wire nail	4						framing nails
37	215	508	0.36	iron clamp	1						handmade, possibly for boat
38	215	508	0.36	shoe sole	1						vulcanized rubber
39	215	508	0.36	bottle glass	1					clear	
40	215	508	0.36	window glass	1					aqua	>1.6 mm
41	215	508	0.36	pearlware	1			flat	plate		rim sherd
42	215	508	0.36	pearlware	1			flat	plate		body sherd
43	215	508	0.36	RWE, transfer printed	1			flat	plate	blue	rim sherd, unknown pattern
44	215	508	0.36	chipping detritus	1	outer cortex	Onondaga				
45	215	508	0.36	chipping detritus	18	thinning	Onondaga				
46	215	508	0.36	chipping detritus	2	micro	Onondaga				
47	215	508	0.36	chipping detritus	2	thinning	Haldimand				
48	220	504	0.38	horseshoe nail	1						
49	220	504	0.38	cut nail	4						framing nails
50	220	504	0.38	cut nail	1						finishing nail

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
51	220	504	0.38	wire nail	3						framing nails
52	220	504	0.38	faunal remains, mammalian	2						unknown, small fragments
53	220	504	0.38	sheet metal	1						tin
54	220	504	0.38	coal	2						
55	220	504	0.38	brick fragment	6					red	
56	220	504	0.38	window glass	1						>1.6 mm
57	220	504	0.38	window glass	1						>1.6 mm, melted
58	220	504	0.38	bottle glass	1					aqua	
59	220	504	0.38	bottle glass	1					clear	
60	220	504	0.38	bottle glass	1					clear	very thin
61	220	504	0.38	red earthenware	1			hollow	storage	red/brown	body sherd
62	220	504	0.38	red earthenware	1			hollow	storage	brown	body sherd
63	220	504	0.38	ironstone	1			hollow	bowl		shoulder
64	220	504	0.38	ironstone	1			unknown	unknown		flake
65	220	504	0.38	chipping detritus	18	thinning	Onondaga				
66	205	508	0.40	spike	1						
67	205	508	0.40	spike	1						
68	205	508	0.40	cut nail	3						framing nails
69	205	508	0.40	ironstone	1			flat	plate	white	
70	205	508	0.40	brick fragment	1					red	
71	205	508	0.40	bottle glass	1					blue	medicine bottle body shard
72	205	508	0.40	recent material	1					clear	safety glass
73	205	508	0.40	window glass	2						>1.6 mm
74	205	508	0.40	window glass	1						>1.6 mm melted
75	205	508	0.40	chipping detritus	1	outer cortex	Onondaga				
76	205	508	0.40	chipping detritus	1	secondary	Onondaga				
77	205	508	0.40	chipping detritus	3	thinning	Onondaga				
78	213	505	0.40	chipping detritus	5	thinning	Onondaga				subsoil

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Freq.	Morphology	Chert Type	Ceramic Form	Ceramic Function	Colour	Comments
79	213	505	0.40	chipping detritus	2	secondary	Onondaga				subsoil
80	213	505	0.40	RWE	1			unknown	unknown		subsoil
81	213	505	0.40	cut nail	3						framing nails, topsoil
82	213	505	0.40	wire nail	2						framing nails, topsoil
83	213	505	0.40	horseshoe nail	3						topsoil
84	213	505	0.40	anchor chain	1						2 links, topsoil
85	213	505	0.40	chipping detritus	4	secondary	Onondaga				topsoil
86	213	505	0.40	chipping detritus	1	thinning	Haldimand				topsoil
87	213	505	0.40	chipping detritus	1	thinning	Unknown				topsoil
88	213	505	0.40	chipping detritus	29	thinning	Onondaga				topsoil
89	213	505	0.40	faunal remains, mammalian	2						unknown, very small fragments
90	213	505	0.40	ironstone, moulded	1			hollow	bowl		rim sherd
91	213	505	0.40	ironstone	1			hollow	bowl		body sherd
92	213	505	0.40	ironstone	1			flat	plate		rim sherd
93	213	505	0.40	ironstone	7			unknown	unknown		body sherds
94	213	505	0.40	bottle glass	2					clear	base shards, orange peel finish on bottom
95	213	505	0.40	bottle glass	1					clear	neck, topsoil
96	213	505	0.40	bottle glass	7					clear	body shards
97	213	505	0.40	bottle glass	1					clear	wine glass
98	213	505	0.40	window glass	2						<1.6 mm
99	213	505	0.40	window glass	1						<1.6 mm
100	205	504	0.46	bottle glass	2					forest green	neck, rim, seam
101	205	504	0.46	bottle glass	2					forest green	shoulder, seam
102	205	504	0.46	bottle glass	50					forest green	body shards

10.1.4 H2 (AdHg-6) Stage 3 Artifact Catalogue

Cat#	Context	Unit Easting	Unit Northing	Layer	Artifact	Frequency	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Comments
1	unit excavation	193	502	2	miscellaneous metal	1	6 to 12				wrought iron fence
2	unit excavation	193	502	2	cut nails	3	6 to 12				heavily corroded
3	unit excavation	193	502	2	RWE	15	6 to 12	hollow	bowl		body sherds
4	unit excavation	193	502	2	RWE, banded	1	6 to 12	hollow	bowl	blue	body sherd
5	unit excavation	193	502	2	ironstone	3	6 to 12	flat	plate		body sherds, burnt
6	unit excavation	193	502	2	ironstone, moulded	1	6 to 12	hollow	bowl		body sherd, burnt
7	unit excavation	193	502	2	RWE, edged	1	6 to 12	flat	plate	blue	straight rim sherd, chicken claw
8	unit excavation	193	502	2	faunal remains, mammalian	1	6 to 12				Bos. Taurus, unknown, burnt
9	unit excavation	193	502	2	brick fragment	1	6 to 12			buff	
10	unit excavation	193	502	2	window glass	2	6 to 12				>1.6 mm
11	unit excavation	193	502	2	bottle glass	2	6 to 12			blue	body shards
12	unit excavation	186	500	1	bolt	1	48				large iron bolt
13	unit excavation	186	500	1	cut nails	5	48				heavily corroded
14	unit excavation	186	500	1	coal	1	48				
15	unit excavation	186	500	1	faunal remains, avian	1	48				unknown
16	unit excavation	186	500	1	bottle glass	1	48			green	thick, heavy body shard, seam visible
17	unit excavation	186	500	1	bottle glass	1	48			blue	bubbles present
18	unit excavation	191	500	1	metal strapping	1	44				heavily corroded
19	unit excavation	191	500	1	metal belt buckle	1	44				heavily corroded
20	unit excavation	191	500	1	cut nails	4	44				heavily corroded
21	unit excavation	191	500	1	wire nail	2	44				heavily corroded
22	unit excavation	191	500	1	miscellaneous metal	3	44				heavily corroded
23	unit excavation	191	500	1	faunal remains, mammalian	1	44				unknown, burnt
24	unit excavation	191	500	1	faunal remains, avian	1	44				G. gallus, femur
25	unit excavation	191	500	1	slate tablet	2	44				
26	unit excavation	191	500	1	window glass	2	44				<1.6 mm
27	unit excavation	191	500	1	window glass	1	44				<1.6 mm

Cat#	Context	Unit Easting	Unit Northing	Layer	Artifact	Frequency	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Comments
28	unit excavation	191	500	1	window glass	2	44				>1.6 mm
29	unit excavation	191	500	1	window glass	2	44				<1.6 mm
30	unit excavation	191	500	1	bottle glass	1	44			green	heavy glass, bubbles
31	unit excavation	191	500	1	bottle glass	1	44			clear	machine finish
32	unit excavation	191	500	1	RWE	1	44	flat	plate		rim sherd
33	unit excavation	191	500	1	RWE	2	44	flat	plate		body sherds
34	unit excavation	191	500	1	RWE, hand painted	1	44	hollow	bowl	green	body sherd
35	unit excavation	191	500	1	stoneware	2	44	hollow	storage	brown	body sherds
36	unit excavation	191	500	1	RWE, transfer printed	2	44	unknown	unknown	blue	body sherds, burnt
37	unit excavation	200	500	1	chipping detritus	1	53				Onondaga Thinning Flake
38	unit excavation	200	500	1	faunal remains, avian	1	53				G. gallus, pelvic fragment
39	unit excavation	200	500	1	RWE, banded	1	53	hollow	bowl	purple	body sherd
40	unit excavation	200	500	1	ironstone	1	53	flat	plate		base sherd
41	unit excavation	193	502	1	brick fragment	1	11 to 15			red	frog present
42	unit excavation	193	502	1	slate tablet	2	11 to 15				
43	unit excavation	193	502	1	faunal remains, mammalian	2	11 to 15				Bos. Taurus, pelvic
44	unit excavation	193	502	1	faunal remains, avian	1	11 to 15				G. gallus, knee joint
45	unit excavation	193	502	1	faunal remains, mammalian	2	11 to 15				Bos. Taurus, rib
46	unit excavation	193	502	1	faunal remains, mammalian	2	11 to 15				unknown
47	unit excavation	193	502	1	faunal remains, avian	1	11 to 15				G. gallus, femur
48	unit excavation	193	502	1	window glass	2	11 to 15				>1.6 mm
49	unit excavation	193	502	1	bottle glass	3	11 to 15			blue	body shards
50	unit excavation	193	502	1	white clay pipe bowl	2	11 to 15				plain, mendable
51	unit excavation	193	502	1	white clay pipe stem	1	11 to 15				unmarked
52	unit excavation	193	502	1	RWE	2	11 to 15	hollow	bowl		rim sherds
53	unit excavation	193	502	1	RWE	2	11 to 15	flat	plate		rim sherds
54	unit excavation	193	502	1	RWE	2	11 to 15	flat	plate		footring
55	unit excavation	193	502	1	RWE	7	11 to 15	hollow	bowl		body sherds

Cat#	Context	Unit Easting	Unit Northing	Layer	Artifact	Frequency	Depth(cm)	Ceramic Form	Ceramic Function	Colour	Comments
56	unit excavation	193	502	1	RWE	4	11 to 15	flat	plate		body sherds
57	unit excavation	193	502	1	RWE	1	11 to 15	unknown	unknown		exfoliated
58	unit excavation	193	502	1	pearlware	1	11 to 15	hollow	bowl		body sherd
59	unit excavation	193	502	1	RWE, transfer printed	1	11 to 15	hollow	serving	brown	rim sherd, large serving bowl, light cable pattern
60	unit excavation	193	502	1	ironstone	1	11 to 15	flat	plate		rim sherd
61	unit excavation	193	502	1	ironstone	1	11 to 15	flat	plate		exfoliated
62	unit excavation	193	502	1	ironstone	17	11 to 15	flat	plate		body sherds
63	unit excavation	193	502	1	wire nail	6	11 to 15				heavily corroded
64	unit excavation	193	502	1	spike	2	11 to 15				heavily corroded, bent
65	unit excavation	193	502	1	fencing wire	1	11 to 15				heavily corroded
66	unit excavation	193	502	1	spike	2	11 to 15				heavily corroded
67	unit excavation	193	502	1	cut nails	9	11 to 15				heavily corroded
68	unit excavation	193	502	1	recent material	1	11 to 15				bottle cap
69	unit excavation	193	502	1	sheet metal	4	11 to 15				heavily corroded, heavy gauge
70	unit excavation	193	502	1	miscellaneous metal	2	11 to 15				heavily corroded

10.1.5 H3 (AdHg-7) Stage 3 Artifact Catalogue

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Frequency	Ceramic Form	Ceramic Function	Colour	Comments
1	205	504	0.25	cut nails	22				framing nails
2	205	504	0.25	horseshoe nail	2				
3	205	504	0.25	cut nails	10				finishing nails
4	205	504	0.25	metal hinge	1				3 holes punched through
5	205	504	0.25	coin	2				U.S.A. 25 cent pieces, dated 1964 & 1966
6	205	504	0.25	faunal remains, mammalian	1				unknown, long bone fragment
7	205	504	0.25	slate	1				flake
8	205	504	0.25	chipping detritus	1				Onondaga Chert secondary flake
9	205	504	0.25	chipping detritus	1				Onondaga chert thinning flake
10	205	504	0.25	white clay pipe bowl	1				small fragment, plain

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Frequency	Ceramic Form	Ceramic Function	Colour	Comments
11	205	504	0.25	white clay pipe stem	1				unmarked
12	205	504	0.25	brown clay pipe stem	1				unmarked
13	205	504	0.25	pearlware	1	flat	plate		foot ring
14	205	504	0.25	yellowware	1	flat	plate	yellow	body sherd
15	205	504	0.25	RWE	2	unknown	unknown		small fragments
16	205	504	0.25	RWE, transfer printed	1	unknown	unknown	blue	sprig pattern
17	205	504	0.25	RWE, transfer printed	1	unknown	unknown	blue	burnt
18	205	504	0.25	RWE, transfer printed	1	unknown	unknown	blue	unknown pattern
19	205	504	0.25	RWE, transfer printed	1	hollow	bowl	mulberry	unknown pattern
20	205	504	0.25	RWE, transfer printed	1	flat	plate	brown	thin cable pattern
21	205	504	0.25	RWE, transfer printed	1	flat	plate	brown	wing pattern
22	205	504	0.25	RWE, transfer printed	1	flat	plate	brown	light strokes trailed across surface
23	205	504	0.25	RWE	5	unknown	unknown		exfoliated
24	205	504	0.25	RWE, hand painted	4	hollow	cup	green, blue	leaf pattern, late palette
25	205	504	0.25	RWE	1	hollow	cup		rim sherd
26	205	504	0.25	ironstone	1	unknown	unknown		foot ring
27	205	504	0.25	ironstone	3	hollow	bowl		body sherds
28	205	504	0.25	ironstone, moulded	2	hollow	bowl		body sherds
29	205	504	0.25	ironstone, moulded	1	hollow	bowl		rim sherd
30	205	504	0.25	stoneware	2	unknown	unknown	dark brown	body sherds
31	205	504	0.25	window glass	5				<1.6 mm
32	205	504	0.25	window glass	3				>1.6 mm
33	205	504	0.25	window glass	15				>1.6 mm
34	205	504	0.25	bottle glass	1			purple	lamp chimney rim
35	205	504	0.25	bottle glass	1			purple	lamp chimney body shard
36	205	504	0.25	bottle glass	1			clear	
37	205	504	0.25	bottle glass	1			aqua	
38	205	504	0.25	bottle glass	1			clear	melted

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Frequency	Ceramic Form	Ceramic Function	Colour	Comments
39	200	502	0.33	wire nail	2				framing nails
40	200	502	0.33	cut nails	13				framing nails
41	200	502	0.33	cut nails	4				finishing nails
42	200	502	0.33	horseshoe nail	1				
43	200	502	0.33	miscellaneous metal	1				lid or base of metal can
44	200	502	0.33	miscellaneous metal	1				body of metal can
45	200	502	0.33	white clay pipe stem	1				unmarked
46	200	502	0.33	button	1				Prosser Type, 4 holes, round
47	200	502	0.33	coal	1				
48	200	502	0.33	brick fragment	3			red	
49	200	502	0.33	concrete	1				painted yellow
50	200	502	0.33	yellowware	2	hollow	bowl	yellow	body sherds
51	200	502	0.33	RWE, hand painted	1	hollow	tea cup	green	late palette, leaf pattern, rim sherd
52	200	502	0.33	RWE, hand painted	1	unknown	unknown	red	body sherd
53	200	502	0.33	RWE, hand painted	1	unknown	unknown	red, blue	body sherd
54	200	502	0.33	RWE, transfer printed	2	unknown	unknown	mulberry	body sherds
55	200	502	0.33	RWE, transfer printed	1	flat	plate	blue	geometric pattern, rim sherd
56	200	502	0.33	RWE, transfer printed	1	unknown	unknown	blue	unknown pattern
57	200	502	0.33	RWE, transfer printed	1	hollow	bowl	brown	light cable pattern, rim sherd
58	200	502	0.33	pearlware	1	flat	plate		rim sherd
59	200	502	0.33	RWE	1	flat	plate		body sherd, burnt
60	200	502	0.33	RWE	1	hollow	bowl		foot ring
61	200	502	0.33	RWE	2	hollow	bowl		body sherds
62	200	502	0.33	RWE	9	flat	plate		body sherds
63	200	502	0.33	window glass	3				>1.6 mm
64	200	502	0.33	window glass	5				<1.6 mm
65	200	502	0.33	bottle glass	1				wine glass, body shard
66	200	502	0.33	faunal remains, mammalian	1				G. gallus, rib fragment

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Frequency	Ceramic Form	Ceramic Function	Colour	Comments
67	200	502	0.33	faunal remains, mammalian	3				Bos. Taurus, rib fragments
68	200	502	0.33	faunal remains, mammalian	3				unknown
69	210	500	0.26	cut nail	13				framing nail
70	210	500	0.26	wire nail	1				framing nail
71	210	500	0.26	cut nails	14				finishing nails
72	210	500	0.26	miscellaneous metal	1				large iron bracket
73	210	500	0.26	chipping detritus	1				Onondaga chert outer cortex flake
74	210	500	0.26	chipping detritus	7				Onondaga chert thinning flake
75	210	500	0.26	slate	1				small flake
76	210	500	0.26	coal	3				
77	210	500	0.26	mortar	1				
78	210	500	0.26	brick fragment	1			red	
79	210	500	0.26	window glass	2				<1.6 mm
80	210	500	0.26	window glass	2				>1.6 mm
81	210	500	0.26	window glass	9				>1.6 mm
82	210	500	0.26	bottle glass	4			purple	body shards
83	210	500	0.26	bottle glass	1			clear	body shards
84	210	500	0.26	bottle glass	1			clear	body shards, very thin
85	210	500	0.26	bottle glass	1			aqua	body shards
86	210	500	0.26	faunal remains, mammalian	1				Bos. Taurus, tooth
87	210	500	0.26	faunal remains, mammalian	2				G. gallus, cranium
88	210	500	0.26	faunal remains, mammalian	1				G. gallus, pelvis
89	210	500	0.26	faunal remains, mammalian	6				unknown, small fragments
90	210	500	0.26	RWE, transfer printed	2	unknown	unknown	blue	willow pattern, small body sherds
91	210	500	0.26	RWE	3	unknown	unknown		exfoliated sherds
92	210	500	0.26	RWE	3	hollow	bowl		body sherds
93	210	500	0.26	ironstone	5	flat	plate		body sherds
94	210	500	0.26	stoneware	1	hollow	bowl	olive green	body sherd

Cat#	Unit Easting	Unit Northing	Depth(m)	Artifact	Frequency	Ceramic Form	Ceramic Function	Colour	Comments
95	210	500	0.26	red earthenware	1	hollow	ink well	red, green	neck sherd
96	195	504	0.34	cut nails	3				framing nails
97	195	504	0.34	wire nail	1				framing nail
98	195	504	0.34	horseshoe nail	3				
99	195	504	0.34	miscellaneous metal	1				possible gun part
100	195	504	0.34	coin	1				1903 U.S.A. Indian Head penny
101	195	504	0.34	white clay pipe stem	1				"Murray" "Glasgow" embossed on sides
102	195	504	0.34	white clay pipe bowl	1				plain
103	195	504	0.34	white clay pipe bowl	1				bird of paradise design
104	195	504	0.34	faunal remains, mammalian	4				unknown, fragments
105	195	504	0.34	window glass	1				<1.6 mm
106	195	504	0.34	window glass	1				>1.6 mm
107	195	504	0.34	window glass	1				>1.6 mm
108	195	504	0.34	red earthenware	3	hollow	storage	buff	body sherds
109	195	504	0.34	stoneware	1	hollow	storage	dark brown	body sherd
110	195	504	0.34	RWE	3	hollow	bowl		body sherds
111	195	504	0.34	RWE	3	flat	plate		body sherds
112	195	504	0.34	RWE	1	hollow	bowl		body sherd, burnt
113	215	504	0.18	pearlware	1	flat	plate		foot ring
114	215	504	0.18	cut nail	1				framing nail
115	215	504	0.18	brick fragment	1			red	
116	215	504	0.18	faunal remains, mammalian	1				unknown, fragment
117	215	504	0.18	window glass	1			aqua	>1.6 mm

10.2 Euro Canadian Artifact Descriptions

10.2.1 Ceramic Ware Types

Pearlware

The term pearlware denotes an early variety of refined white tableware that was first produced in 1779 by Josiah Wedgewood; it remained popular on Euro-Canadian sites in Southern Ontario until the 1830s, when it was supplanted by later RWE varieties such as whiteware and ironstone (Adams 1994). Pearlware can be easily identified by a bluish glaze that appears along footing crevices due to the addition of cobalt to the glaze (Adams 1994) in an attempt to imitate Chinese porcelain.

RWE

In the 1820s, the blue-tinted pearlware glaze gave way to a whiter variety that some archaeologists have taken to calling whiteware; like pearlware, however, this term was not used by manufacturers. According to Miller (1980a:18), the white appearance of whiteware was caused by reducing the amount of cobalt added to the glaze and adding it instead to the paste. It was manufactured by many different recipes, however, and can be difficult to distinguish from other ceramics in the period, including sherds of pearlware, especially when examining small sherds. As Miller suggests,

> *...if an assemblage of ceramics from the first half of the 19th Century is placed before six archaeologists and they are asked for counts of creamware, pearlware, whiteware, and stone china wares, the results will probably be six different enumerations*
>
> Miller 1980a:2

Accordingly, the term RWE is used in this report to identify whiteware sherds as well as any sherds that are too small to distinguish between whiteware, pearlware or ironstone (noting that this gives a conservative date to any pearlware sherds not correctly identified).

Ironstone

Ironstone was a variety of RWE designed by the Turner family in the late 1700s (Tharp 2017). Like its contemporaries, it featured a white surface, but with a bluish tint. Furthermore, ironstone vessels were usually thicker than earlier whiteware varieties with a dense, heavy paste. The impetus behind their development was a desire among Staffordshire potters to find a cheap alternative to imported porcelain. By 1813 James Mason had reworked and patented “ironstone china.” The patent lasted only fourteen years; by that time a variety of Staffordshire potteries were producing a similar product. Nevertheless, the Mason’s brand name had become associated with all of the various stone china ceramics that were in production. Ironstone began to be imported from England to Canada during the 1840s and came to dominate the ceramic trade during the middle part of the century (The Potteries.org 2003). In terms of appearance, ironstone vessels were commonly left plain with infrequent applied surface decoration, although moulded designs were common (Adams 1994).

Red and Yellow Earthenware

Red and yellow earthenware are utilitarian wares that are fired at a lower temperature than more RWE varieties, and are made from a coarser, more porous paste. Earthenwares cannot be used to date an archaeological assemblage since they were in use throughout the entirety of the 19th century. Their frequency on sites began to decline slowly from the 1850s onwards with the importation of stoneware from the United States and then dramatically after 1890 when they were replaced by glass jars (Miller 1980b:9). Earthenware vessels were also less expensive than other, more refined tablewares. As a result, an abundance of earthenware pieces relative to other ware types, especially on a late 19th century site, may indicate lower economic status.

Stoneware

Stoneware ceramics are made from a heavy, non-porous paste and, although naturally impermeable, were usually glazed with a grey or brown slip (Lamb 2003). Early 19th century varieties were manufactured in England, Germany and the United States and featured a salt glaze. Stoneware vessels were relatively infrequent in Southern Ontario until the mid-1800s; by 1850, at least two potteries in Ontario (Brantford and Toronto) were producing stoneware. Because they were large and durable, stoneware vessels were typically utilitarian, functioning as food storage containers, beer jugs and tankards, butter crocks, and cream jars (Lamb 2003).

Yellowware

Yellowware is a type of coarse earthenware that was produced in England in the late 18th century. It first appeared on sites in Southern Ontario in the 1840s, and remained popular throughout the remainder of the 19th century. In addition to the distinctive mustard-yellow glaze, yellowware vessels can be identified by their porous, buff-coloured fabric. They were often slip decorated and commonly used for utilitarian kitchen bowls (Adams 1994).

10.2.2 Ceramic Decorative Styles

Banding

Banding is one of several terms that denotes the use of an applied coloured slip to decorate the edge of a vessel; others include annular ware and slip-decorated ware. As the name implies, simple bands of colour were a common motif among banded vessels, but the term also includes dendritic (or mocha), cabling, and cat's eye designs, as well as machine-turned impressed patterns. Banding was common on ceramic vessels throughout the 19th century. As the century progressed, the patterns tended to become simpler and blue the most dominant colour (Adams 1994).

Edging

Edging is used to describe ceramics where decoration is concentrated on moulding or colouring the rim of the vessel, most commonly plates and other flatware. The earliest edged vessels bore asymmetrical, rococo shell-edging and date from roughly 1775. Over time, the style of the edge design changed, becoming symmetrical scalloping from around 1800, to straight-edged with feathering by 1840 and non-embossed, straight edges by 1860 (Hunter and Miller 2009). Dates vary somewhat for the popularity of the dominant colours – blue and green – but blue scalloped edged vessels date from 1820 to 1840, blue unscalloped edged vessels from after 1860.

Hand Painting

Hand painted floral tea and dinner ware sets were a staple ceramic item in the 1800s. From 1785 to 1815, potters used metal oxide colours that produced subdued, earth tones including brownish orange, olive-green, raw umber, and a limited use of blue. Cobalt blue, often referred to as Early Palette Blue, was the most dominant colour observed between 1815 and 1830, and typically featured large brushstrokes. Between 1830 and 1870, a growing variety of chrome colours, often referred to as Late Palette colours, were popular for RWE and ironstone dinner and tea sets (Adams 1994). By the end of the century, blue had once again emerged as the post popular colour for hand painted vessels.

Transfer Printing

The technique of transferring a pattern from an engraved metal plate to the surface of a ceramic vessel is thought to have developed in the mid-18th century (Jervis 1911); it became more widely used among Staffordshire potteries in the 1790s (Shaw 1829). In Southern Ontario, transfer printing was popular through the first half of the 19th Century before simpler techniques or no decoration whatsoever became popular. It underwent a revival after 1870 until the end of the Century (Majewski and O'Brien 1987). Blue transfer print ware was a popular decorated ceramic ware manufactured throughout the 19th century on various wares and it was the dominant colour available for printed wares before 1830. Brown and black transfer print wares were popular for a long span roughly between 1830 and 1870 (Adams 1994).

Flow Transfer Printing

Flow transfer printing was similar to regular transfer printing, with the exception that designs were allowed to bleed into the glaze giving them a misty appearance. Flow transfer printing was popular in the late 1840s and 1850s and was later revived in the 1890s. Traditionally, blue is the most predominant colour used in flow-transfer printing, although examples in black do exist (Adams 1994).

10.2.3 Household Artifacts

Bottle Glass

Bottle glass fragments are generally not diagnostic and are often simply categorized according to colour. Clear, or colourless glass was uncommon prior to the 1870s. Until 1880, clear glass bottles often displayed an aqua tinge that resulted from the iron additives used to de-colourise it. Clear or colourless glass came into much more widespread use after the development of automatic bottle manufacturing machines in the early 20th century (Lindsey 2019).

10.2.4 Personal Artifacts

Buttons

The patent for the Prosser method provides a *terminus post quem* of 1840. They were the most inexpensive buttons available in the 19th century, remained popular through to the 1920s and were produced in France until the 1960s (Venovcevs 2013). The method involves pressure moulding powdered minerals common in the recipe of ceramics, such as clay, flint and feldspar, before firing at high temperatures to achieve a vitrified finish. While the buttons were moulded in various patterns, embossed and decorated with transfer and hand-painted glazes, the most common are simple white, sew-though, dish type buttons used on men's shirts (Sprague 2002).

White Clay Pipes

White clay pipes were popular throughout the 19th century, with a decline in use around 1880 due to the rise in popularity of briar pipes and cigarettes (Kenyon 1980). Most white clay pipes were manufactured in either Québec or Scotland, with occasional examples from English, Dutch, French, and American manufacturers. The maker's name is commonly impressed on one side of the stem with the city of manufacture on the opposite side, although this did not become common practice until after 1840.

Slate

The value of paper, especially writing quality paper, in the 1800s prevented its use for junior schoolwork and everyday household use. Instead, both adults and children commonly used slate boards and pencils. Boards comprised a flat sheet of fine quality slate (typically 2.5mm thick) bounded in a wood frame. The pencils were typically 3-5mm thick and composed of slate or shale softer than the board. There were several methods of pencil manufacture, from reducing slices it by forcing them through tubes (the evidence of which can be seen as flat facets along the pencil length); turning slices of slate (Davies 2005), or by grinding slate or shale to a powder to then compress it in moulds (Evening Standard 1891). Given the expense of slate for roofing purposes, most thin slate fragments on historic sites are likely to be from writing boards.

10.2.5 Structural Artifacts

Bricks

Baked red and yellow clay bricks were commonly used throughout the 19th century, and occurred in a variety of different shapes and sizes depending on the use of the brick. Generally, early 19th century bricks were handmade and were thin, flat and rectangular. Throughout the middle of the century, bricks became thicker and often featured badly impressed ovals or 'frogs'. By the end of the century, brick manufacturing had become mechanised. As a result, bricks from this period are uniform in size, shape and colour with sharp edges and well-defined impressed frogs, often featuring the manufacturer's name in raised letters (Adams 1994).

Nails

Originally, all nails were handmade (wrought) and required skill, as well as a forge. As a result, nails were relatively expensive and methods were sought to have them machine made. Whereas cut, or square nail manufacture began in the late 1790s, cut nails only become readily available in Upper Canada by the 1830s. Cut nails revolutionized house framing and were common for a long period, from approximately 1830 to 1890 by which time they had been largely supplanted by wire nails. Wire drawn nails are identical to the type of nails used today, with their round heads and wire shafts (Adams 1994).

Window Glass

Window glass can be temporally diagnostic in a limited manner, but only if at least ten specimens are available. In the 1840s, window glass thickness changed dramatically, in large part due to the lifting of the English import tax on window glass in 1845. This tariff taxed glass by weight and encouraged manufacturers to produce thin panes. Most window glass manufactured before 1845 tended to be thinner, while later glass was thicker. However, because window glass thickness varied even within a single pane, an assemblage of ten specimens is required to provide an adequate sample (Kenyon 1980).

10.3 Pre-Contact Aboriginal Artifacts

Aboriginal Pottery

In Ontario the use of pottery began approximately 2,800 years ago (Adams 1994). The clay used to make pots is a plastic medium, therefore, it can be shaped and decorated to the preference of the potter. Once the pottery is fired these preferences are fixed into the clay. As the cultural and artistic preferences, and the function of the vessels changed over time, the decorative techniques changed as well. A wide variety of decorative techniques were used in Ontario by pre-contact Aboriginal people.

Chipping Detritus

Chipping detritus is the waste product from the production of stone tools and is the most frequently recovered artifact on pre-contact Aboriginal sites in southern Ontario. Chipping detritus has a low significance and interpretive value when it is not associated with any diagnostic material, therefore they cannot be used to determine the cultural affiliation or time period of the occupation of a site.

9. Environmental Screening Study

MEMORANDUM

To: K. Smart Associated Limited
From: Dean Fitzgerald & Jessica Zadori, ELM Inc.
Subject: Environmental Screening for the Proposed Port Bruce Bridge Replacement
Date: September, 2019

1.0 INTRODUCTION

Environmental Liability Management Inc. (ELM) was retained by K. Smart Associates Limited (KSAL) to complete environmental screening studies for the proposed replacement of the Port Bruce Bridge located on Imperial Rd, Aylmer, County of Elgin, Ontario N5H 2R2 (Hereafter, the Site, Figure 1). The Port Bruce bridge extends across Catfish Creek, a tributary of Lake Erie. It is the understanding of ELM that the Port Bruce Bridge requires replacing following extreme flooding events in Catfish Creek, which caused a washout of the bridge in early 2018. Currently, a temporary structure has been implemented approximately 150 metres downstream, as means for local vehicular traffic to cross Catfish Creek.

For environmental management, the Site exists within the jurisdiction of the Ontario Ministry of Natural Resources and Forestry (MNRF) and Catfish Creek Conservation Authority (CCCA). These agencies recommended environmental screening be completed to document the existing environmental features upstream and downstream from the original location of the Port Bruce Bridge and the location of the temporary bridge in order to provide recommendations for environmental management during future construction. For this Site, ELM assessed existing land use, adjacent land use, past land use, distance to water, vegetation cover, and other facets. A key consideration for this assessment was the evaluation of possible presence of Species At Risk (SAR) using a public database (i.e., Natural Heritage Information Centre – NHIC), maintained by MNRF. It is essential to screen for possible presence of SAR and possible SAR habitat on-site and in proximity to the location of the proposed bridge replacement. This approach to screen for SAR and SAR habitat is required under Ontario's Endangered Species Act (ESA, Ontario, 2007) as proposed activities are intended to avoid disturbance of SAR specimens and their habitats.

Figure 1: View of the Site located along Imperial Rd, Aylmer, County of Elgin, Ontario N5H 2R2. The approximate footprint of the project is located within the red rectangle. The location of the temporary bridge is located approximately 150 m downstream, within the blue rectangle. Aerial imagery was obtained from a public database (i.e. Google Earth).

1.1 Species at Risk

It is appropriate to proceed with the proposed replacement of Port Bruce Bridge with the goal to ideally avoid but minimally reduce environmental disturbance. When environmental disturbance is reduced or avoided, it represents a strategy to reduce possible consequences on plant and wildlife communities. Such strategies also have the added benefit to also reduce and/or avoid disturbance of SAR specimens and associated habitat that may possibly exist. Southern Ontario represent an area potentially rich with SAR specimens, including SAR turtles, snakes, migratory birds, and bats. Within this group, over the past decade, many freshwater turtles have become protected under the ESA. As a result of habitat degradation, poaching and the introduction of invasive species, many freshwater turtles have reached Threatened or Special Concern status in the province of Ontario (COSEWIC, 2018). Therefore, it is vital to screen for the potential presence of turtles and/or turtle habitat on or in proximity to the Site. Habitat for turtles is largely dependent on the specific species, however, generally consists of relatively shallow, slow flowing water, often rich in vegetation and organic substrates. Potential habitats can include, ponds, swamps, marsh, bog, etc. (COSEWIC, 2018). This Site is also located in an area known in the past to be home to SAR snake species. A variety of Ontario snakes have become protected under the ESA over the past decade as a result of road expansion and habitat degradation/development (COSEWIC, 2014). Snakes often can live in a variety of macrohabitats across Ontario, however, always require microhabitats in the area suitable for hibernation, gestation and foraging (COSEWIC, 2014). In general, habitats with large rocks or rocky outcrops are preferred by most snake species however Milksnake (*Lampropeltis triangulum*) may also populate open meadowed areas and rural infrastructure. Therefore, barns and sheds should be considered candidate habitat for SAR snakes (COSEWIC, 2014). It is also prudent to discuss the possible presence of migratory SAR birds in proximity to the Site. In recent years, many species of migratory birds have become protected under the ESA. Therefore, it is essential to screen for the possible presence of birds, nests or candidate nesting habitat in proximity to the Site.

It is also vital that tree removal activities be completed outside of the bird breeding season. Additionally, during the last decade, some migratory bat species and the habitat they use became protected under the ESA, due primarily to the arrival of a disease to North America (COSEWIC, 2013). Due to the prevalence of this disease, the current management strategy is to protect candidate habitat used by migratory and resident SAR bats and this habitat includes large trees (COSEWIC 2013), defined by a Diameter at Breast Height (DBH) $\geq$ 10 cm. Thus, if trees with DBH $\geq$ 10 cm exist in a proximity to the bridges, then justification exists to assess these trees for cavities that could be used by bats. In conjunction with this assessment of tree cover, it is suitable to complete follow-up studies to identify strategies to avoid disturbance of large trees. Hence, if large mature trees are retained, direct benefits result for wildlife species generally as well as SAR bats, if they exist in an area. Thus, the assessment approach used to screen the proposed bridge replacement considers a suite of environmental factors and human-built features.

2.0 METHODS

Information on the environmental features of the Site was assessed using a three-step process by staff from ELM, described within this Memorandum, as follows:

1. Complete a desktop screening of environmental features on-Site, including inspection of aerial photographs as well as review information on SAR in NHIC database as well as consult other databases with natural heritage information;
2. Completed preliminary communications with Catfish Creek Conservation Authority (CCCA), Elgin County, and Ontario's Ministry of Natural Resources and Forestry (MNRF);
3. Conduct a site visit(s) to document environmental features, if justified by the findings from the desktop study. Representative photographs to be collected during the visit; and
4. Share professional opinion on insights for follow-up study requirements based on existing habitat features and other considerations after the visit.

3.0 RESULTS

3.1 Aerial Photographs

For this study, Staff from ELM initially evaluated the Site of the proposed bridge replacement relative to available aerial photographs from 2006 and 2018 (Figure 2). Inspection of aerial photography led to the determination that the area along the banks of Catfish Creek is predominantly urban with associated infrastructure such as, driveways, sheds and laneways. Banks of the creek appear to be utilized to dock and store boats when not in use in Lake Erie. A key difference between the photographs from 2006 and 2018 is that Port Bruce Bridge no longer crosses Catfish Creek in 2018 where it previously did in 2006. This is due to the washout of the bridge in 2018 following extreme flooding events. This is what ultimately prompted the replacement of the Port Bruce Bridge in 2019. Currently a temporary bridge has been implemented approximately 150 metres downstream of the original bridge. It is prudent to mention the presence of small groups of trees in proximity to the corners of the original and the temporary bridge. In addition, it also appears that woodlands exist towards the north and east of the Site. It is likely this area includes vegetation such as small (DBH < 10 cm) and mature (DBH > 20 cm) trees. Areas beyond these woodlands are mainly composed of agricultural land and associated homes, barns, shed and laneways. The presence of these varied features led to the determination that a field inspection was justified, to confirm the spatial

distribution of the features. Thus, staff from ELM conducted an evaluation to identify environmental features of concern at or near the proposed bridge replacement.

Figure 2: Plate 1 displays an aerial view of the Site in 2006. Plate 2 displays an aerial view from 2018.

3.2 Desktop Review

Following the evaluation of the aerial photographs, the Site was then screened for records of SAR using the NHIC database and other natural heritage screening databases, such as the Ontario Reptiles and Amphibian Atlas, inaturalist.com and ebird.com. This desktop review identified candidate wildlife habitat in proximity to the Site. It is prudent to mention that species identified during natural heritage screening observed prior to 1989 (30 years ago) are generally considered to no longer be present in the area.

When the Site was screened through the NHIC database, the proposed location of the bridge replacement falls within the center of database square 17MH9823. This square identifies this area as part of the Catfish Creek Till. In addition, this square identifies that this area contained Eastern Stiff-leaved Goldenrod (*Solidago rigida ssp. rigida*) in the past, last observed in 1908. Located directly west of the Site is NHIC database square 17MH9723, which also identifies this area as part of the Catfish Creek Till. Located north of the Site is NHIC database square 17MH9824, this square identifies a variety of potential SAR species in

proximity to Port Bruce Bridge. These species include, Virginia Bluebells (*Mertensia virginica*), American Chestnut (*Castanea dentata*), Stiff Gentian (*Gentianella quinquefolia*), Acadian Flycatcher (*Empidonax virescens*), Striped Cream Violet (*Viola striata*), Appendaged Waterleaf (*Hydrophyllum appendiculatum*), Harbinger-of-spring (*Erigenia bulbosa*) and Lowland Brittle Fern (*Cystopteris protrusa*). The majority of these species were last observed in 1993 with the exception of American Chestnut, which was last observed in 2014, and Acadian Flycatcher which was last observed in 1983. Located east of the Site is square 17MH9923, which identifies Eastern Stiff-rod Goldenrod and Henslow's Sparrow (*Ammodramus henslowii*). These species were last observed in the area in 1908 and 1930, respectively. Located south of the Site is square 17MH9822, which again identifies similar species to these NHIC database squares However, this square also identifies Bank Swallow (*Riparia riparia*) in the area, last observed in 2017.

When the Site was screened through the Ontario Reptiles and Amphibian Atlas (ORAA), the proposed location of the bridge replacement is near the east edge of ORAA database square 17MH92. Square 17MH92 identifies three SAR species in the area. These species include Snapping Turtle (*Chelydra serpentina*), Midland Painted Turtle (*Chrysemys picta marginata*) and Milksnake (*Lampropeltis triangulum*). These species were most recently observed in 2017, 2016 and 2010, respectively. Since the Site exists in proximity near Square 17MH92, ELM also screened for SAR species that may be present east of the Site. Square 17NH02, identifies similar species to square 17MH92, however also identifies Blanding's Turtle (*Emydoidea blandingii*). Blanding's Turtle was most recently observed 2011.

When the Site was screened through ebird.com, a natural heritage database focused on recording observations of migratory birds, no SAR were reported in the area.

Further screening of the Site through natural heritage databases, such as inaturalist.com, identified Peregrine Falcon (*Falco peregrinus*). This bird was most recently observed in 2009, off the coast of Lake Erie. It is also important to note that Pink Heelsplitter (*Potamilus alatus*) was observed in 2016 approximately 10.0 KM west of the proposed bridge replacement, off the shores of Lake Erie. Although Pink Heel-Splitter is not considered a Species at Risk in Ontario, its presence identifies this area as potential candidate habitat for other SAR freshwater mussels.

The review also identified that myotis (i.e., bats) may exist near the Site, including Little Brown Myotis (*Myotis lucifugu*) and Northern Myotis (*Myotis septentrionalis*). Specifically, Little Brown Myotis prefers to roost during the day within the cavities of large trees, caves, or abandoned mine shafts; these same habitats are also used as winter hibernacula (COSEWIC, 2013). Foraging at night usually involves a diet primarily of flying insects with foraging activities concentrated over natural areas, agricultural fields, water, and human settlements (EC, 2015). Similarly, Northern Myotis prefers to roost during the day within the cavities of large trees, caves, or abandoned mine shafts; these same habitats are also used as winter hibernacula (COSEWIC, 2013). Foraging at night usually involves a diet primarily of flying insects with foraging activities concentrated over natural areas, agricultural fields, water, and urban areas (EC, 2015).

Table 1: Summary of SAR determined by natural heritage database screening to be potentially present within 1000 m of Imperial Rd, Port Bruce, County of Elgin, Ontario. Species listed are designated as Special Concern (SC), Threatened (THR) or Endangered (END) in Ontario after COSEWIC.

Common Name	Scientific Name	Conservation Rank (Reported Year of Last Observation)
Eastern Sand Darter	*Ammocrypta pellucida*	END (1946)
Midland Painted Turtle	*Chrysemys picta marginata*	SC (2016)
Snapping Turtle	*Chelydra serpentina*	SC (2017)
Blanding's Turtle	*Emydoidea blandingii*	END (2011)
Milksnake	*Lampropeltis triangulum*	SC (2010)
Henslow's Sparrow	*Ammodramus henslowii*	END (1930)
Bank Swallow	*Riparia riparia*	THR (2017)
Peregrine Falcon	*Falco peregrinus*	SC (2009)
Acadian Flycatcher	*Empidonax virescens*	END (1983)
American Chestnut	*Castanea dentata*	END (2014)
Black Ash	*Fraxinus nigra*	THR (2018)*

*-designation of Black Ash Fraxinus nigra as THR confirmed during July, 2018 by COSEWIC (2018)

3.3 Communications with Government Agencies

Staff from ELM initially communicated with Tony Difazio, Resource Planning Coordinator at CCCA, during March 2019. This communication resulted in follow-up communications between CCCA and ELM during March 2019. The message from CCCA was that they had communicated with Elgin County and MNRF and were very concerned about this process identifying an environmental plan that would avoid disturbance of Catfish Creek with particular reference to wildlife and plants, including both non-SAR and SAR. Species of particular concern included varied birds, fish, turtles, and mussels that may migrate from Lake Erie to Catfish Creek seasonally or are resident in Catfish Creek. That is, CCCA identified it was necessary to protect SAR and non-SAR species during the proposed activities.

During late March 2019, ELM requested guidance from MNRF regarding a list of SAR of concern for the Site. A response to the request was received on 4 September 2019. The simple explanation provided for the timing on the response was due to the transition of the responsibilities for the ESA from MNRF to Ministry of Environment, Conservation and Parks (MECP) during March, 2019. A list of SAR of concern for the Site provided by MECP identified only aquatic species, similar to the list identified during the ELM literature review, as:

- Eastern Sand Darter (Endangered);
- Barn Swallow (Threatened);
- Northern Map Turtle (Special Concern); and
- Snapping Turtle (Special Concern).

With the information provided by MECP during September, 2018 and other technical literature, it is inferred all candidate SAR from the Site have been identified, and the records review can be regarded as complete. Copies of select correspondence with government agencies included within Appendix A.

Correspondence from CCCA and a review of technical literature (e.g., Scott and Crossman, 1973) confirms fish are resident in Catfish Creek during the entire calendar year or migrate from Lake Erie during the spring or autumn and then spawn in Catfish Creek. This list of fish includes:

Walleye	Channel Catfish
Yellow Perch	Smallmouth Bass
Logperch	Largemouth Bass
Darters (e.g., Iowa, Johnny, Rainbow)	Pumpkinseed
Common White Sucker	Bluegill
Northern Hognose Sucker	Rock Bass
Bowfin	Creek Chub
Freshwater Drum	Common Shiner
Quillback	Striped Shiner
Gizzard Shad	Rosyface Shiner
Rainbow Trout	Bluntnose Minnow
Chinook Salmon	Fathead Minnow
Brown Bullhead	Mimic Shiner
Stonecat	Brook Stickleback

Path Forward

Communications from CCCA and MECP confirm that careful environmental management is required to avoid disturbance of habitats used by non-SAR fishes. In addition, SAR turtles like Blanding's Turtle (*Emydoidea blandingii*) and SAR fish like Eastern Sand Darter (*Ammocrypta pellucida*) also require careful management. Concerning Eastern Sand Darter, the last confirmed specimens were collected during 1941 but this fish could still possibly exist in Catfish Creek, as this species is small and difficult to capture in deep sandy habitats (COSEWIC, 2009). Hence, future activities for the Site need to be framed within an approach that will avoid possible disturbance of Eastern Sand Darter, if they possibly exist upstream and or downstream of the proposed bridge area. In addition, management of the runoff within the work area also needs to be carefully managed. For Blanding's Turtle, activities need to avoid disturbance of specimens and habitats, and this will also convey protection to other turtles that could possibly be in the area.

3.4 Field Studies

Field inspections were completed on May 6, 2019 after the communications with CCCA. Weather on-Site was mainly cloudy with periodic showers throughout the afternoon. This inspection process allowed for the prevailing environmental features and land use on-Site to be documented. This inspection confirmed that land use in proximity to both the original Port Bruce Bridge and the temporary bridge is predominantly urban. A large number of these properties appear to be used seasonally, mainly inhabited during the spring and summer months of the year. Private homes were documented to exist on all four corners of both bridges. Representative photographs of the Site are provided in Appendix B.

Port Bruce Bridge

Inspection of the original bridge location confirmed that two abutments were still present on-Site following the collapse of the Port Bruce Bridge in 2018. Vegetation between the southern abutment and Catfish Creek has since begun to regenerate. A number of species common to Southern Ontario were documented, including: Riverbank Grape (*Vitis riparia*), Common Strawberry (*Fragaria virginiana*), Canada Goldenrod (*Solidago canadensis*) and Common Milkweed (*Asclepias syriaca*). Additionally, a number of invasive species were noted to be growing in proximity to the southern abutment. These species include: Garlic Mustard (*Alliaria petiolata*), Great Burdock (*Arctium lappa*) and Common Mullein (*Verbascum thapsus*). Similar species were seen from across the creek growing in proximity to the northern abutment. The substrate along the banks, in proximity to the existing abutments, appeared to be a mixture of course sand, gravel and larger rocks. This area represents candidate habitat for nesting SAR turtles.
It is prudent to note the presence of a drainage path on the western side of the southern abutment. Drainage appears to run downhill from the roadside of Dexter Line towards Catfish Creek. The path of drainage was readily apparent due to the presence of moisture tolerant plant species, such as Smooth Solomon's Seal (*Polygonatum biflorum*) and assorted species of sedges. Erosion along this path is not evident, likely as a result of the thick, vegetative ground cover. Towards the western edge of the drainage path, a number of mature trees are growing. These trees include two larger (DBH > 20 cm) specimens that may be considered candidate habitat for SAR bats. These trees were determined to be Black Walnut (*Juglans nigra*) and Buroak (*Quercus macrocarpa*). A number of smaller Common Alder (*Alnus glutinosa*) and Red-Osier Dogwood (*Cornus sericea*) trees were also observed growing in the treeline extending from of Dexter Line towards Catfish Creek. Similar vegetation species were documented in proximity to the northern abutment, however a large Weeping Willow (*Salix babylonica*) tree was also on the northern bank of Catfish Creek.

The presence of a small, sandy parking area was documented on the eastern side of the southern abutment. This area displayed evidence of extreme erosion leading from the parking area towards Catfish Creek. It is also of key importance to note the presence of a mature Sugar Maple (*Acer saccharum*) tree, located between the parking area and the southern abutment. This tree represents candidate habitat for SAR bats.

Temporary Bridge

Inspection of the temporary bridge documented the presence of additional candidate habitat for wildlife and SAR specimens. A number of mature woody specimens were documented at each corner of the temporary bridge. A large Red Spruce (*Picea rubens*) was documented in proximity to the eastern corner of the southern abutment while a mature Crack Willow (*Salix fragilis*) tree was documented on the bank of the western side of the southern abutment of the temporary bridge. In proximity to the northern abutment of the temporary bridge, a mature Norway Maple (*Acer platanoides*) tree was observed growing in proximity to the northeastern corner of the bridge, while a number of mature Eastern Cottonwood (*Populus deltoides*) trees and a European Linden (*Tilia x europaea L*) tree were documented near the northwestern corner. It is prudent to note that another mature Red Spruce was observed on the neighbouring property northwest of the temporary bridge. These trees were all documented to have DHB > 20 cm and may therefore be considered as candidate habitat for SAR bats.

Slopes on all four corners of the temporary bridge appear to be stable and do not show any visible signs of erosion. This is likely a result of the rockfill installed in proximity to Catfish Creek and the presence of grasses covering the remaining slopes. Other vegetation, such as Stinging Nettle (*Urtica dioica*) and White Clover (*Trifolium repens*), were also observed on the slopes. Sediment fencing was seen surrounding rockfill on the northern bank of the temporary bridge. This was likely installed to stop potential erosion from entering neighbouring properties.

A key consideration of this inspection was to determine the presence or absence of Barn Swallow nests on the underside of the bridge. Based on this inspection, no Barn Swallow nests were present. While this bridge offers a pristine location for nesting, the bridge was observed to rattle loudly during vehicle use. This offers insight as to why no Barn Swallow have nested within the beams. However, nests were documented in the trusses of the top of the temporary bridge. These were likely the nests of another, more common bird species observed during the field inspection.

Incidental Wildlife Observations

A number of bird species were observed during inspections of both bridges. Some of these birds include: Chipping Sparrow (*Spizella passerina*), American Goldfinch (*Spinus tristis*), Blue Jay (Cyanocitta cristata), House Sparrow **(***Passer domesticus*), Eastern Kingbird (*Tyrannus tyrannus*), Common Grackle (*Quiscalus quiscula*) and Barn Swallow. While the majority of these birds are species known to be common in Ontario, Barn Swallow is currently designated as Threatened in Ontario. Since no nests were observed on the underside of the temporary bridge, it is likely these birds are nesting on nearby urban structures, such as sheds, garages and cottages. In addition to the birds observed during the field inspection, an Eastern Cottontail Rabbit (*Sylvilagus floridanus*) was on the slope of southeastern corner of the temporary bridge.

3.5 Invasive Species

A number of non-native plants exist in Southern Ontario that are considered harmful to the native vegetation communities. One such non-native plant observed on-Site was Common Mullein. Common Mullein invades disturbed areas and achieves high densities to the detriment of native plants (Gross and Werner, 1978). Other non-native plants that can also compete with native plants identified during the inspection on-Site included Garlic Mustard and Great Burdock.

4.0 DISCUSSION

This study used a combination of desktop review followed by a focal field inspection to develop an inventory of existing biological, physical, and environmental features within proximity to the Port Bruce Bridge. These inventories documented soil features, creek attributes, vegetation communities, aquatic species, wildlife occurrence, and SAR presence-absence along with potential habitat for use by SAR. This information provides the basis to identify key features of the Port Bruce Bridge replacement. With the identification of these features, it has resolved the possible effects of the proposed infrastructure replacement on SAR and non-SAR species. To provide the basis for environmental recommendations, it is prudent to resolve the status of SAR upstream, at, and downstream of the bridge. This resolution allows for the identification of Best Management Practices (BMPs) to enhance environmental management through effects avoidance as well as to mitigate unavoidable disturbance from the proposed activity.

4.1 Species At Risk

Observations from the desktop study documented potential habitat on-Site for use by a suite of SAR specimens. This documentation led to the completion of the field inspection to evaluate possible presence of potential habitat for SAR plants and animals. Inspections documented that the Site of the proposed bridge replacement area and the Site of the temporary bridge are both highly disturbed as a result of surrounding urban areas along with recent and historical development along the entire creek. Given the highly disturbed and urban nature of this Site, it is unlikely that SAR vegetation or tree species exist within the proximity of the bridge replacement. Furthermore, the majority of these SAR plant species reported to exist in the area are approaching 30 years since the last observation, therefore it is common practice to assume these species no longer exist within the area. For these reasons, plant SAR should be considered absent from the Site.

Aquatic Species

A number of aquatic SAR are known to exist in Catfish Creek, regardless of the urban dominance within the watershed. This habitat is known to support SAR fish and SAR turtles. The location of both the temporary bridge and area of the bridge replacement both exist within close proximity to Lake Erie, and this identifies SAR found in Lake Erie could migrate to Catfish Creek. Other SAR are regarded as resident to this creek. For example, Eastern Sand Darter was reported to historically exist upstream and downstream of the Site and represents a priority for current environmental management in Catfish Creek (COSEWIC, 2009). Hence, future management actions need to involve activities that avoid the possible disturbance of SAR Eastern Sand Darter and other SAR fishes that may migrate to these habitats or are residents

This study demonstrated the natural substrates along the shoreline of Catfish Creek represent an area suitable for turtle nesting, particularly areas facing south. For these reasons, this section of Catfish Creek should be regarded as candidate habitat for Midland Painted Turtle, Snapping Turtle and Blanding's Turtle. For these reasons, avoidance measures to exclude interactions with turtles on-Site also represents a priority for environmental management.

Although no freshwater mussel shells were observed during the field inspection, shells of common (not SAR) freshwater mussels were reported in Lake Erie near the Site, during the desktop review. This report of common non-SAR freshwater mussels in the area indicates candidate mussel habitat is present in the lake and possibly Catfish Creek. While the temporary bridge and former bridge area both exist within close proximity to Lake Erie, no shells or mussels were observed during the field inspection, suggesting that freshwater mussels are likely absent from the Site.

Other SAR

The desktop review identified Milksnake near the Site during 2010. This snake species uses rock piles and bedrock outcrops for gestation and overwinter hibernacula (COSEWIC, 2014). No rock piles or bedrock outcrops were observed on-Site of the temporary bridge or within the area of the bridge replacement. Due to the absence of rock habitat and the past disturbance regime on-Site, possible presence Milksnake, is considered low.

For other animal SAR, a suite of species previously observed in proximity to Catfish Creek included a number of birds, during the last 30 years. The exception to this pattern of recent observations concerns two bird species: Acadian Flycatcher seen during 1983 and Henslow's Sparrow seen during 1930. Due to the extended period since the last observations of these two birds, it is inferred they are now absent from Catfish Creek near the Site. For the remaining reported SAR animals along with SAR bats, it is possible they still exist near the Site. Each of these candidate SAR animals are now considered for possible presence.

Downstream of the bridge location, steep slopes appear before Catfish Creek opens into Lake Erie. This area represents candidate habitat for both Bank Swallow and Peregrine Falcon. No nests from either bird species were observed during 2018, however, due to the slope's distance downstream from either bridge, it is unlikely that the proposed activities will disturb this candidate SAR habitat. Specifically, Bank Swallow develop nests within suitable substrates often associated with creek shorelines or aggregate / sand piles (COSEWIC, 2016). In contrast, Peregrine Falcon often develop stick nests on tall trees or human structures such as tall buildings or towers (COSEWIC, 2015). No such stick nests were observed on-Site or in proximity to the Site. Although Barn Swallow (*Hirundo rustica*) was reported as possibly evident on-Site in the area during the desktop review, this species ranges widely in proximity to the north shore of Lake Erie. Hence, it is prudent to note that no Barn Swallow nests or specimens were observed on the temporary bridge or on the houses in proximity to the proposed bridge replacement. For these reasons, it is inferred that it is unlikely these three SAR birds actively use habitats near the Site.

Due to the presence of mature trees with DBH > 10 cm as well as human structures near the temporary bridge and area of bridge replacement, it is possible that SAR bats exist in the area. No bats were observed during the field inspection, but they could possibly exist in the area. For these reasons, a conservative approach is to infer SAR bats could exist in the area and should be considered during the planning.

In summary, due to the noted habitat features, the following SAR can be identified as likely absent in proximity to the Site with particular reference to the proposed bridge replacement and surrounding habitats:

- SAR trees such as American Chestnut and Black Ash confirmed as absent within 100 m of Site;
- SAR migratory birds such as Henslow's Sparrow, Acadian Flycatcher, Bank Swallow, Barn Swallow, and Peregrine Falcon;
- SAR snakes such as Milksnake; and
- SAR freshwater mussels.

Candidate SAR species that may exist near the temporary bridge and area of bridge replacement includes:

- Eastern Sand Darter;
- Midland Painted Turtle, Snapping Turtle and Blanding's Turtle; and
- Little Brown Myotis and Northern Myotis.

Future environmental management strategies need to attempt to avoid disturbance of candidate SAR that may exist in Catfish Creek upstream and/or downstream of the Site. This approach of avoidance is preferred over mitigation of disturbance. In addition, the protection of SAR is inferred to result in a high degree of protection for non-SAR species also found in the area.

4.2 Invasive Plants

A number of non-native plants exist on-Site that can compete with native plants. This list includes Bull Thistle (*Cirsium vulgare*), Great Burdock (*Arctium lappa*) as well as Common Mullein. Some of these species, especially Great Burdock and Common Mullein can achieve high densities to the severe detriment of native plants (Gross and Werner, 1978; Zimdahl, 2018). For these reasons, ELM recommends that during span of this project, these plants be removed when encountered on-Site. Active removal of invasive plants represents a Best Management Practice (BMP), as it will limit the expansion of these non-native plants and reduce the need for future plant control efforts on-Site. A challenge with both Great Burdock and Common Mullein identification is that the plant looks different during the first and second years. During the first year, these plants show a vegetative form with no seeds and large leaves. Then the plant produces a fruiting body with seeds and looks different from the younger specimens, as shown in Photographs 1 and 2 for Great Burdock and Photographs 3 and 4 for Common Mullein.

Photograph 1: View of Great Burdock in Ontario during autumn. This specimen is about one year old and shows large leaves with no fruiting (seed) body.

Photograph 2: View of Great Burdock during second or third year of life with large leaves and vertical fruiting (seed) body.

Photograph 3: View of Common Mullein in Ontario during autumn. This specimen is about one year old and shows large leaves with no fruiting (seed) body.

Photograph 4: View of Common Mullein during second or third year of life with large leaves and vertical fruiting (seed) body.

4.3 Environmental Management Recommendations

This study has resolved existing environmental and biological features in proximity to the Site. Such resolution allows for the identification that natural habitats evident near the temporary bridge as well as the replacement bridge area. Since these habitats have been identified, they allowed for the evaluation of possible SAR presence. These habitats could provide candidate habitat for a number of SAR. It is also inferred that the protection of SAR will also convey protection of non-SAR. For example, environmental management measures to protect Eastern Sand Darter will also result in the protection of the other varied non-SAR fish that are resident in the creek, and/or migrate seasonally between the creek and Lake Erie. For these reasons, it is justified to recommend the application of Best Management Practices (BMPs) to enhance environmental management through effects avoidance as well as to mitigate unavoidable disturbance from the proposed activities to occur in the future. This process of effect avoidance is preferable to the implementation of mitigation measures after possible effects have already been created. Where possible, avoidance measures should be implemented before resorting to mitigation, and lastly, rehabilitation to minimize negative effects on natural features adjacent to the bridge area. The following BMPs are recommended for implementation for this proposed activity. If the BMPs are implemented, they will likely avoid or reduce the possible negative effects from the proposed activity. This approach is anticipated to benefit local vegetation, wildlife, and SAR. Hence the strategy here is that implementation of BMPs is intended to benefit SAR but will also provide protection to existing non-SAR vegetation and wildlife species. Hence, the approach represents a wholistic approach to environmental management with protections to SAR and non-SAR species as well as habitat features such as water quality.

SPECIES AT RISK

This study identified the likely presence of SAR fish, turtles and bats that may exist in the area. Key recommendations to avoid disturbance of candidate SAR habitats or SAR specimens as follows:

- Install sheet piles along shoreline during early spring, prior to fish spawning when water temperatures are below 5ºC. When the sheet piles are installed during early spring, it will avoid disturbance of fish that may spawn in the area;
- Early installation of sheet piles will also result in the avoidance of disturbance of SAR freshwater mussels (although none are reported) as well as SAR turtles that may exist in the area;
- To ensure no fish spawning near the work area, the sheet piles should remain in the creek until August 15, or later;
- To enhance the exclusion of the creek from the construction area, sediment erosion control fences should be installed around the entire work area, to prevent sediment transport to the creek;
- Use of sediment erosion control fences around work area will also exclude wildlife, including SAR turtles from using the gravel along the shoreline, near the footings of the old bridge;
- Sheet piles should be retained along the creek until at least August 15, to avoid disturbance of fish habitat along the shoreline that may be used by small fishes and other wildlife;

- Avoid disturbance of shoreline via installation of bridge abutments on shoreline of Catfish Creek;
- Placement of bridge abutments on shoreline will avoid disturbance of in-water channel features as well as avoid shoreline areas that could be used for future turtle nesting;
- No removal of woody stems with DBH $\geq$ 10 cm, and this option should be readily feasible given the very limited number of large trees in the study area. If no large trees are removed, it will avoid disturbance of candidate bat habitat; and
- Inspection of environmental management strategies through the active work period.

ACTIVITIES FOR USE BEFORE AND DURING INFRASTRUCTURE REPLACEMENT

If construction activities on-Site are completed after July 15, it will provide direct protection to any fish and turtles that may exist in the area. This approach will also avoid the spawning of fishes in Catfish Creek, as most species will spawn during the spring period in this warm water habitat (typically from March to June; DFO, 2017). Based on available literature on fish reproductive timing windows (DFO, 2017), it is probable that no permit for activities in water will be required, as the timing will be off-set. In addition, the majority of the proposed work will occur above the low water line.

This scenario of summer construction was also discussed with CCCA during March, 2019 (see Appendix A). The discussion with CCCA revealed that construction activities needed to carefully consider SAR as well as the large number of fishes and other wildlife that use the creek to complete life history activities. This view was confirmed with communications with MECP as well (see Appendix A). Generally, construction after July 15 will result in avoidance of interactions with most aquatic wildlife associated with the channel and shoreline of Catfish Creek.

Standard BMPs for construction activities should be used to mitigate other types of disturbance on the environment during the replacement of infrastructure at the bridge (Table 4). These BMPs will eliminate, reduce, and otherwise manage vegetation, soil, dust, vehicle exhaust, water runoff, and spills. The use of these mitigation measures is expected to reduce the extent and duration of negative effects of proposed activities. These BMPs and mitigation measures are framed relative to existing conditions and natural heritage features at the bridge relative to the timing of infrastructure replacement.

Sediment and Erosion Control

It is important to recognize the difference between erosion control and sediment control measures when preparing an effective erosion and sediment control plan. Specifically, erosion control is the process to reduce potential for erosion in the work area(s). In contrast, sedimentation control is the process that involves the management of eroded soil to be transported and/or deposited beyond the limits of the work area(s), to a desirable destination as opposed to the water course.

Measures to address both erosion control and sedimentation control are required at the bridge. Therefore, the design of erosion and sedimentation control measures is expected to be flexible and evolve throughout the construction process. This approach will limit effects on the creek area. Various BMPs can be applied to manage environmental features, reviewed by Hamilton Conservation (Hamilton Conservation, 2006).

All BMPs should be regularly inspected to ensure functionality as construction proceeds. For example, inspections should occur after rain events to ensure they are functioning as designed. It is also important that construction staff pay attention to weather forecasts. To prepare for upcoming rain events, operators should walk around the construction site to ensure that BMPs are functional and all facets of the work area are secure. Identification of these BMPs represents an opportunity to avoid the negative effects of the proposed development on the land and water environments.

Staff at the construction area should also visually inspect all BMPs when the site will be inactive for several days, such as over weekends and holidays. This will help to prepare for rain events that may occur when workers are away. These planned preparation procedures will help minimize the risk of on or off-site property damage.

4.4 Review of BMPs available for Future Use

As a preamble to the next phase of this study, the following BMPs are recommended for possible implementation on- Site. These recommendations follow standard guidance (e.g., HCA, 2006). If the BMPs are implemented, they will likely reduce the possible negative effects from the proposed development. Standard BMPs for construction activities should be used to mitigate other types of disturbance on the environment prior to and during the installation of the replacement structure. Standard BMPs involve use of activities to eliminate, reduce, and otherwise manage vegetation, soil, dust, vehicle exhaust, water runoff, and spills. The use of these mitigation measures is expected to reduce the extent and duration of negative effects of proposed activities. These BMPs and mitigation measures are framed on a site-specific basis to reflect existing conditions and natural heritage features near the bridge replacement relative to the timing of the bridge replacement installation. In addition, other BMPs include the use of appropriate timing windows for removal of vegetation and disturbance of soils. These timing windows are defined by the MNRF. Staff at the construction site should also visually inspect all BMPs when it will be inactive for several days, such as over weekends and holidays. Such inspections will help to prepare for rain events that may occur when workers are away. These planned preparations will reduce environmental disturbance.

In the future, exact use of the BMPs will need to occur in conjunction with different phases of the proposed development. It is expected that the use of these BMPs will result in the avoidance or reduction of disturbance on-Site. However, it is essential for proper timing of the use of BMPs, to ensure they reflect typical seasonal constraints, such as high runoff events during autumn rains etc. For the Site, the final set of BMPs for use will be established when the final plan for the bridge is established, based on the completion of follow up studies to fully define environmental constraints involving SAR that may or may not exist on-Site or in the area.

The findings from this study are framed within the Statement of Limitations in Appendix C.

5.0 LITERATURE CITED

1. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. COSEWIC assessment and status report on the Eastern Sand Darter *Ammocrypta pellucida*, Ontario populations and Quebec populations, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp. Available at: https://www.registrelep-sararegistry.gc.ca/

2. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2013. COSEWIC assessment and status report on the Little Brown Myotis *Myotis lucifugus*, Northern Myotis *Myotis septentrionalis* and Tri-colored Bat *Perimyotis subflavus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxiv + 93 pp. Available at: https://www.registrelep-sararegistry.gc.ca/

3. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2014. COSEWIC assessment and status report on the Milksnake *Lampropeltis triangulum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. Available at: https://www.registrelep-sararegistry.gc.ca/

4. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2018. COSEWIC assessment and status report on the Midland Painted Turtle *Chrysemys picta marginata* and the Eastern Painted Turtle *Chrysemys picta picta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xvi + 107 pp. (Species at Risk Public Registry).

5. Government of Ontario (Ontario). 2007. Endangered Species Act, 2007 – Ontario Regulation 230/08 (last amended O. Reg. 25/13).

6. Gross, K.L., and P.A. Werner. 1978. The Biology Of Canadian Weeds: 28. *Verbascum thapsus* L. and *V. blattaria* L. Canadian Journal of Plant Science, 58:401-413.

7. Hamilton Conservation Authority (Hamilton Conservation). 2006. Erosion and Sediment Control Guidelines for Urban Construction. Available at: https://conservationhamilton.ca/images/documents/pdf/ESCGuideline.pdf

8. Natural Heritage Information Centre (NHIC). 2019. Natural Heritage Information Centre Database. Ontario Ministry of Natural Resources and Forestry. http://nhic.mnr.gov.on.ca.

9. Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, Ontario.

10. Zimdahl, R.L., 2018. Fundamentals of weed science. Academic Press.

APPENDIX A

Communications with Catfish Creek Conservation Authority
and
Ministry of Environment, Conservation, and Parks

Catfish Creek Conservation Authority

From: Tony Difazio <planning@catfishcreek.ca>
Sent: March 21, 2019 2:06 PM
To: Dean Fitzgerald <Dean@elminc.ca>
Cc: agarnham@ksmart.ca; Brian Lima <blima@ELGIN.ca>
Subject: RE: Port Bruce bridge replacement/Environmental Assessment Notice

Good Day Gentlemen:

The Catfish Creek Conservation Authority (CCCA) would like to provide the following preliminary information with respect to the subject Environmental Assessment Notice and Study.

The Lower Main Branch of Catfish Creek provides seasonal spawning and rearing habitat for Lake Erie resident fishes such as freshwater drum, quillback, gizzard shad, rainbow trout, Chinook salmon and several sucker species. It also provides year round resident habitat for sport and bait fishes such as smallmouth bass, largemouth bass, stonecat, channel catfish, pumpkinseed, bluegill, rock bass and a variety of cyprinids.

Historical, National and provincially threatened populations of Eastern Sand Darter's are noted throughout the lower reaches of Catfish Creek to the confluence with Lake Erie, and black redhorse in the upper watershed. Although we have limited data in terms of fresh water mussels, several species have been recorded throughout the lower Catfish Creek Watershed.

We (CCCA) will be reviewing this proposal pursuant to the ***Conservation Authorities Act***, therefore, a permit from our office will be required. In terms of reviewing an application we would like to ensure the new stream crossing has regard for aquatic species at risk, fish habitat, and will allow for similar or improved floodwater/ice conveyance for the various flow return periods (including the Regional Storm/Hurricane Hazel) in the vicinity of the former bridge crossing location.

You may forward future information or inquiries on this matter to my attention.

Regards,

Tony Difazio
Resource Planning Coordinator
8079 Springwater Road, R.R.#5,
Aylmer ON. N5H 2R4
519-773-9037
planning@catfishcreek.ca

Ministry of Environment, Conservation, and Parks

From: Markham, Kathryn (MECP) <Kathryn.Markham@ontario.ca>
Sent: September 4, 2019 6:28 PM
To: Dean Fitzgerald <Dean@elminc.ca>
Subject: RE: Port Bruce bridge replacement

Hello Dean,

I apologize for the delay in response. The request for species at risk data for the Port Bruce bridge replacement project in the Township of Malahide, Elgin County was forwarded to the Ministry of Environment, Conservation and Parks (MECP) for review/action as part of the transition of the *Endangered Species Act, 2007* (ESA) and the species at risk (SAR) program transitioned from the Ministry of Natural Resources and Forestry (MNRF) to MECP.

The following species at risk have the possibility to occur in the general area of the project and should be considered in environmental studies for the project:

- Eastern Sand Darter (endangered, receives species and regulated habitat protection).
- Barn Swallow (threatened, receives species and general habitat protection)
- Northern Map Turtle (special concern)
- Snapping Turtle (special concern)

The requirement to register the project under Ontario Regulation 242/08 of the Endangered Species Act, 2007 will depend on if the project is likely to impact species at risk and/or protected habitat (i.e. species listed as extirpated, endangered or threatened and their habitat). If impacts to species at risk and/or habitat can be avoided, registration under the ESA is not required.

Regards,

Kathryn Markham
Management Biologist
Permissions and Compliance Section, Species at Risk Branch
Ministry of Environment, Conservation and Parks

From: Dean Fitzgerald <Dean@elminc.ca>
Sent: March 21, 2019 9:36 AM
To: Rowswell, Steven (MNRF) <Steven.Rowswell@ontario.ca>
Subject: Port Bruce bridge replacement

Steven Rowswell
Fish and Wildlife Technical Specialist
Aylmer District Ministry of Natural Resources and Forestry

Good Day Steven,

Good Day Tony,

Environmental Liability Management Inc. (ELM) was recently retained by K.Smart Associates Ltd (KSAL) to prepare an environmental study to support the pending replacement of the Port Bruce bridge over Catfish Creek.

In the past, ELM has completed studies to support other bridge and culvert replacements with KSAL. It seems prudent to reach out to Aylmer MNRF office at this time, as a way to identify the key environmental concerns for this project.

At ELM, we recently completed a desktop review of the natural heritage and biodiversity associated with Catfish Creek upstream and downstream of the bridge.

At this time, we would like to request advice from Aylmer MNRF office regarding Species At Risk concerns for this portion of Catfish Creek. We are interested to identify if it may be necessary to register the proposed activity following RASC due to possible presence of SAR in the area.

Look forward to reading your response. If you are not the individual we should be communicating with regarding this matter, could you kindly forward this message to that person.

Sincerely,
Dean Fitzgerald

Dean Fitzgerald, M.Sc., Ph.D.
Director of Environmental Services
Cambridge, Ontario
ELM Inc.
Mobile: (226) 606-1072
www.elminc.ca

Appendix B

Representative Photographs

Photo No. 1	
Date: May 6, 2019	
Description: View of the remaining southern abutment of the original Port Bruce Bridge.	

Photo No. 2	
Date: May 6, 2019	
Description: View of the western edge of the southern abutment. This photograph shows the drainage path from the roadside of Dexter Line to Catfish Creek.	

Photo No. 3 **Date:** May 6, 2019 **Description:** View of a patch of native and non-native herbaceous vegetation, in the drainage path from the roadside of Dexter Line to Catfish Creek.	

Photo No. 4 **Date:** May 6, 2019 **Description:** View of the land use western side of the southern abutment. Mature woody stems (DBH > 10cm) are visible along the edge of the property. Mature woody specimens on this side of the abutment include predominately Black Walnut (*Juglans nigra*) and Bur Oak (*Quercus macrocarp*a).	

Photo No. 5 **Date:** May 6, 2019 **Description:** Mature Black Walnut tree growing in proximity to the drainage path located on the western side of the southern abutment of the original Port Bruce Bridge.	

Photo No. 6 **Date:** May 6, 2019 **Description:** A closer view of drainage path on the western side of the southern abutment. Vegetation tolerant of moist soil was documented along this drainage from the roadside of Dexter Line to Catfish Creek.	

Photo No. 7	
Date: May 6, 2019	
Description: View of a large Bur Oak tree which exists near the western bank of the southern abutment of the original Port Bruce Bridge.	

Photo No. 8	
Date: May 6, 2019	
Description: View of a Common Alder tree (*Alnus glutinosa*) observed in proximity to the existing southern abutment on the west side.	

Photo No. 9	
Date: May 6, 2019	
Description: View across Catfish Creek of the northern abutment of the original Port Bruce Bridge. Land use surrounding the abutment appears to be dominated by urban uses with a few planted mature woody stems (i.e., conifers).	

Photo No. 10	
Date: May 6, 2019	
Description: View downstream from the southern bank of Catfish Creek. The temporary bridge is visible in the background of this photograph (blue arrow).	

Photo No. 11	
Date: May 6, 2019	
Description: View of the southern bank of Catfish Creek in proximity to the existing abutment. This area represent candidate habitat for SAR turtle nests. So, this area should be isolated from the creek prior to turtle nesting season (e.g., fence area with sediment-erosion control before May 15 in any year).	

Photo No. 12	
Date: May 6, 2019	
Description: General view of the eastern side of the southern bank. A mature Sugar Maple (*Acer saccharum*) tree is visible in the midground of the photograph. This tree represents candidate habitat for SAR bats and ideally should be retained, if feasible.	

Photo No. 13 **Date:** May 6, 2019 **Description:** View of the remaining southern abutment from the southeastern bank. A mature Sugar Maple tree is visible in close proximity to the abutment.	

Photo No. 14 **Date:** May 6, 2019 **Description:** A closer view of the mature Sugar Maple (*Acer saccharum*) tree growing in proximity to the remaining southern abutment of the original Port Bruce Bridge. This tree represents candidate habitat for SAR bats and should be retained, if feasible.	

Photo No. 15 **Date:** May 6, 2019 **Description:** View a parking area on the south bank of Catfish Creek. This area lies just east of the southern abutment. This parking area shows clear evidence of erosion to the creek that requires correction during the proposed project.	

Photo No. 16 **Date:** May 6, 2019 **Description:** A closer view of a defined path (red arrows) of erosion draining through the parking area towards Catfish Creek.	

Photo No. 17 **Date:** May 6, 2019 **Description:** View of the southern bank on the eastern side of the existing abutment. This area represents candidate turtle habitat and should also be isolated from the creek before turtle nesting season in any given year (i.e., install fence before May 15).	

Photo No. 18 **Date:** May 6, 2019 **Description:** View Great Mullein (*Verbascum Thapsus*, marked with yellow arrow), an invasive species to Ontario. Great Mullein was observed frequently in proximity to the southern abutment. Weed control should be applied to the entire work area in the future.	

Photo No. 19 **Date:** May 6, 2019 **Description:** View of the temporary bridge installed approximately 200 metres downstream of the original Port Bruce Bridge.	

Photo No. 20 **Date:** May 6, 2019 **Description:** General view of the temporary bridge from the southern bank, looking north.	

Photo No. 21 **Date:** May 6, 2019 **Description:** View of the western side of the southern abutment of the temporary bridge. This slope appears to be stable with no apparent erosion, likely due to the presence of rockfill and grassy vegetation.	

Photo No. 22 **Date:** May 6, 2019 **Description:** View of the western side of the northern abutment of the temporary bridge.	

Photo No. 23	
Date: May 6, 2019	
Description: View of a mature Red Spruce (*Picea rubens*) tree in proximity to the southern abutment of the temporary bridge. Red Spruce has been designated as a Provincially Rare species. This tree is located well away from the bridge area, so it will not be disturbed.	

Photo No. 24	
Date: May 6, 2019	
Description: A view of second Red Spruce tree in proximity to the temporary bridge. The small cones (~5 cm) of the Red Spruce were evident on ground below the tree.	

Photo No. 25 **Date:** May 6, 2019 **Description:** General view of the eastern side of the southern abutment of the temporary bridge. This slope appears to be stable with no apparent erosion, likely due to the presence of rockfill and grassy vegetation.	

Photo No. 26 **Date:** May 6, 2019 **Description:** View of an Eastern Cottontail Rabbit (*Sylvilagus floridanus*) observed near the bank of Catfish Creek in proximity to the southern abutment of the temporary bridge.	

Photo No. 27	
Date: May 6, 2019	
Description: View of the rockfill on the eastern side of the southern abutment. Rockfill on the banks of the creek contributes to stable slopes, thereby combating erosion.	

Photo No. 28	
Date: May 6, 2019	
Description: General view of the northern bank on the eastern side of the northern abutment of the temporary bridge.	

Photo No. 29 **Date:** May 6, 2019 **Description:** View underneath the temporary bridge. No Barn Swallow nests were observed, likely due to the intense rattling of the bridge during car use.	

Photo No. 30 **Date:** May 6, 2019 **Description:** View of the eastern side of the northern abutment. Sediment fencing has been installed. This slope appears to be stable with no apparent erosion, likely due to the presence of rockfill and grass.	

Photo No. 31	
Date: May 6, 2019	
Description: View of a mature Norway Maple (*Acer platanoides*) growing on the eastern side of the northern abutment.	

Photo No. 32	
Date: May 6, 2019	
Description: View of the western side of the northern abutment of the temporary bridge. Sediment fencing has been installed, however this slope appears to be stable with no apparent erosion, likely due to the presence of rockfill and grass.	

Photo No. 33 **Date:** May 6, 2019 **Description:** View of the southern abutment from the western side of the northern abutment.	

Photo No. 34 **Date:** May 6, 2019 **Description:** View of the rockfill on the western side of the northern abutment. Rockfill on the banks of the creek contributes to stable slopes, thereby combating erosion.	

APPENDIX C
Statement of Limitations

For this study, the information, conclusions and recommendations given herein are specifically for K. Smart Associates Limited (Client) only and for the scope of work described herein for Port Bruce Bridge located on Imperial Rd, Aylmer, County of Elgin, Ontario N5H 2R2. The scope of work involved environmental screening for constraints based on a desktop review and a focal field inspection. Hence, the findings from study may not be sufficient for other uses. In this regard, ELM Inc. does not accept responsibility for this or other uses by third parties.

The data, conclusions and recommendations included within this report, and the quality thereof, are based on the scope authorized by the Client. Note however, that no scope of work, no matter how exhaustive, can identify all environmental constraints, environmental contaminants or all conditions above and below ground that may exist. For example, environmental observations may differ across survey dates. Hence, conditions may differ from those encountered in the investigation. Similarly, flood zone features may vary dramatically from year to year even when the site in question is not mapped as flood plain by government agencies. This report therefore cannot warrant that all conditions on or off the site are presented by those identified at specific locations on the focal inspection date. Any recommendations and conclusions provided that are based on conditions or assumptions reported herein will inherently include any uncertainty associated with those conditions or assumptions. In fact, many aspects involving professional judgment such as habitat available for Species At Risk, potential for Species At Risk to migrate to the site in question, and follow-up study recommendations inherently contain a degree of uncertainty that cannot be eliminated. Since uncertainty cannot be eliminated, uncertainty should be managed by periodic review and refinement as additional information becomes available.

Note also that standards, guidelines and practice related to environmental investigations may change with time. Those which are applied at the time of this investigation may be obsolete or unacceptable at a later date. The scope of work and findings reported may not be sufficient to determine all of the factors that may affect construction or other on-site activities. Contractors bidding on future aspects of this undertaking should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the conditions may affect their work. Similarly, ELM Inc. cannot warranty the accuracy of information supplied by the Client regarding the legal boundaries of the Site.

10. Hydrology Report

HYDROLOGY REPORT

PORT BRUCE BRIDGE REPLACEMENT

IMPERIAL ROAD (COUNTY ROAD 73)
AT CATFISH CREEK

COUNTY OF ELGIN

AUGUST 2019

K. SMART ASSOCIATES LIMITED
85 McIntyre Drive
Kitchener ON N2R 1H6

INDEX

PORT BRUCE BRIDGE REPLACEMENT
COUNTY OF ELGIN
HYDROLOGY REPORT

1.0 INTRODUCTION

The Port Bruce Bridge spans Catfish Creek on Imperial Road in the community of Port Bruce. On February 23, 2018, the bridge collapsed as a loaded dump truck and trailer was driving across. Subsequent to the collapse, the structure has been mostly removed; the entire south abutment (walls and footings), the north abutment footing, both pier footings, and both pier piles remain from the original structure. A temporary bridge was installed downstream of the original structure at Bank Street and Dexter Line and will be removed once a replacement bridge is constructed.

The purpose of this study is to ensure that the new bridge will have adequate hydraulic capacity, the upstream elevation of the Regional Storm will not be significantly changed, and the potential for ice jams to form at the bridge is mitigated.

2.0 LOCATION

Port Bruce Bridge is located on Imperial Road over Catfish Creek, between Rush Creek Line and Dexter Line, in the Community of Port Bruce in the County of Elgin. A Key Plan is provided in Appendix A.

3.0 BACKGROUND INFORMATION AND REFERENCES

3.1 Background Information

The following background information was compiled to prepare this report:

- Contours at 5m intervals from Ontario Integrated Hydrology Data (OIHD)
- Soil maps for Elgin, Oxford, Middlesex, and Norfolk Counties
- Record of flow from gauging station 02GC018 (Catfish Creek near Sparta) for the period of 1965 to 2017
- Historical Lake Erie water level data from the United States Army Corps of Engineers Detroit District for the period of 1918 to 2018
- Township of Malahide Official Plan Schedule ‘C’ – Land Use and Constraint Mapping for the community of Port Bruce
- Ministry of Natural Resources 1982 Flood Line Mapping for Port Bruce
- Topographic engineering survey completed by K. Smart Associates Limited in Spring of 2019
- Topographic engineering survey completed by Callon Dietz Inc. in Spring of 2018.
- Legal survey completed by Kim Husted Surveying Limited in Spring of 2018.

3.2 References

The following references were consulted:

- MTO Drainage Management Manual
- Canadian Highway Bridge Design Code 2014
- MTO Highway Drainage Design Standards published January 2008
- MTO Publication "Guide for Preparing Hydrology Reports for Water Crossings"

4.0 EXISTING CONDITIONS

4.1 Roadway Classification

Imperial Road is classified as a Rural Arterial Undivided with a design speed of 50 km/hr, otherwise known as RAU 50.

4.2 Watershed Characteristics

Area of Watershed = 394.9 km^2
Length of River = 53.6 km
Average Slope of Watershed = 0.0012 m/m or 0.12%
CN (AMC II) = 76.7
CN (AMC III) = 89.5
Time to Peak = 19.8 hours

4.3 Original Bridge

The original bridge was a three span concrete structure with a total span of 69.34m and an overall width of 12.9m. The original bridge was constructed in approximately 1964.

The approximate existing stream bed elevation is 172.50m .

The approximate soffit elevation of the original bridge was 178.30m.

There are three roadways (Imperial Road, Dexter Line, and Rush Creek Line) surrounding the bridge that essentially forms a berm to constrain flow in Catfish Creek upstream of the crossing. The low point elevation of this berm is 178.10 which is the low point of Rush Creek Line.

4.4 Waterway Adequacy

The original bridge opening area is adequate to pass the 10, 25, and 100 year design storms as well as the Regional Storm.

4.5 Major Flood

There are no signs of major flooding at the site as a result of the original bridge. However, the Township of Malahide Official Plan Schedule C – Land Use and Constraint mapping shows significant flooding can occur downstream of this crossing.

4.6 Ice

Local residents and the Catfish Creek Conservation Authority have indicated that ice jams commonly form upstream and downstream of the original structure. This phenomenon is confirmed by the evidence of ice scarring on trees within the surrounding area of the bridge. However, there are no reports of ice jams forming as a result of the original structure.

4.7 Relief Flows

The existing upstream topography (Dexter Line and Rush Creek Line) do not allow for any relief flow upstream of the original bridge.

4.8 Existing Roadside and Structure Drainage

Runoff from the roadway is directed to and collected in roadside ditches. These ditches then drain directly into Catfish Creek.

Runoff from the original bridge deck was directed to deck drains. These deck drains outletted directly into Catfish Creek.

4.9 Upstream Structures

a) Approximately 4.4 km upstream, there is a 32.0m single span truss bridge on Rush Creek Line.
Total Opening area = 157m^2

b) Approximately 12.4 km upstream, there is a 64.0m twin span truss bridge on Sparta Line.
Total opening area = 283m^2

4.10 Downstream Structures

A temporary bridge was installed downstream or the original bridge at Bank Street and Dexter Line. After a new bridge is constructed, this temporary bridge will be permanently removed. There are no other downstream structures.

5.0 ESTIMATED FLOWS

5.1 Flow Estimate Methods

The following methods were used to estimate the flows at this structure:

- Modified Index Flood Method
- Single Station Frequency Analysis
- Personal Computer Storm Water Management Model (PCSWMM) Software

5.2 Summary of Estimated Flows

Design Storm	Modified Index Flood Method (m^3/s)	Single Station Frequency Analysis (m^3/s)	PCSWMM Software (m^3/s)
10 Year	168.7	216.7	--
25 Year	213.5	272.4	--
50 Year	247.7	314.5	--
100 Year	281.8	356.6	--
Regional	--	--	551.2

5.3 Design Flows

Reference is made to "Highway Drainage Design Standards" to determine the return period of the normal design flood for this structure. Based on Imperial Road being classified as an arterial road and the proposed span exceeding 6.0m, a 50 year return period shall be used. 115% of the 100 year return period shall be used for the check flood for scour.

As Catfish Creek is a regulated watercourse, the Regional Storm shall also be considered.

As the flow rates generated using the Single Station Frequency Analysis produce the largest flow rates for the 10, 25, 50, and 100 year design storms, these flow rates will be used for these design storms. The flow rate generated using PCSWMM will be used for the Regional Storm.

Therefore the design flows shall be:

Q_{10} = 216.7 m^3/s
Q_{25} = 272.4 m^3/s
Q_{50} = 314.5 m^3/s
Q_{100} = 356.6 m^3/s
Q_{REG} = 551.2 m^3/s

6.0 DESIGN CRITERIA

The ideal replacement structure would be such that the following design criteria are met:

a) The opening of the proposed structure shall be adequate to convey the estimated design flow for a 50 year design storm without causing any flooding.

b) Scour adjacent to spread or strip footings and pile caps is considered and mitigated.

c) The structure geometry be chosen in such a way as to minimize the likelihood of ice jamming underneath the new structure.

d) There should not be a significant increase in the level of the Regional flood plain. An increase of more than 100mm would be considered a significant increase.

e) High water at the 50 year design storm shall have an average vertical clearance of 1000mm below the soffit of the proposed structure.

f) Roadway approaches may provide relief flow for storms greater than a 50 year design storm event (assuming adequate profile geometry of the adjacent roadway approaches).

g) The freeboard between the 50 year design storm high water level and the low point of the proposed roadway shall not be less than 1000mm.

h) A navigable clearance envelope of at least 20.0m wide by 3.5m tall.

i) A minimum longitudinal road grade of 0.5% is provided across the structure for positive roadway drainage.

7.0 PROPOSED STRUCTURE

The proposed structure shall be as follows:

3 span continuous slab-on-girder bridge (steel plate girders)
Construction type to be integral abutment style
Foundation to be driven steel piles
Span = 76.0m (17.55, 40.90, 17.55m centre to centre of bearings)
Skew = 0˚
Stream bed elevation = 172.50m (same as existing)
Low soffit elevation = 178.30m
Elevation of low point of roadway = 178.10m
Effective total opening area = 208.4m^2
High water elevation at 50 year design storm = 176.34m
Minimum clearance to soffit at 50 year design storm = 1960mm
Freeboard at 50 year design storm = 1760mm

8.0 ROADWAY IMPROVEMENTS

8.1 Horizontal Alignment

A slight improvement to the horizontal curve north of the bridge on Imperial Road is proposed, otherwise the existing alignment will be maintained.

The existing horizontal alignments of the intersecting roadways (Rush Creek Line and Dexter Line) will be maintained.

8.2 Vertical Alignment

The vertical alignment of Imperial Road will be raised to accommodate a deeper superstructure (i.e. steel girders and a concrete deck). A sag vertical curve, designed to meet a 60 km/hr design speed will be provided and will tie into the existing roadway on either side just past the bridge. The proposed approach grades (3.0% on the south and 1.8% on the north) will provide sufficient longitudinal grade to maintain positive drainage of the bridge deck.

Rush Creek Line and Dexter Line will be reconstructed to transition to Imperial Road.

8.3 Cross-Section Elements

The cross-section of Imperial Road will be widened slightly to provide 2 traffic lanes, on road cycling lanes, curb and gutter, and sidewalks. 2% cross-fall will be provided for positive roadway drainage, 2.0 Horizontal to 1.0 Vertical (2H:1V) embankments will be provided to tie into the existing ground. Roadway drainage will be provided by roadside ditches on both sides of Imperial Road. Roadside ditches will drain towards Catfish Creek.

The cross-section elements of Rush Creek Line and Dexter Line will remain similar to the existing. Only minimal work is planned on these intersecting roadways to transition to Imperial Road.

9.0 SUMMARY OF HYDRAULIC ANALYSIS

Hydraulic analysis using hand calculations has been completed for both the existing and proposed conditions. The Open Channel Method using Manning's Formula was used. As this bridge site is in close proximity to Lake Erie, one can reasonably assume that the water level elevation at the bridge is directly related to the water level elevation of Lake Erie. As a result, only the opening area above the Lake Erie water level elevation can be used to convey storm water collected throughout the watershed. For hydraulic analysis of this bridge, the average water level elevation of Lake Erie was calculated as 174.30m, based on historical averages obtained by the United States Army Corps of Engineers. A prorated Manning's Roughness Coefficient, "n", was incorporated in the analysis to account for the above assumption.

The table below shows a comparison for the existing and proposed conditions.

Location	Storm Event	Flow m^3/s	High Water Elevation (m)	
			Existing	Proposed
Bridge	10 Year	216.7	175.95	175.92
	25 Year	272.4	176.25	176.18
	50 Year	314.5	176.45	176.34
	100 Year	356.6	176.60	176.49
	Regional	551.2	177.25	177.15

For further details, see Appendix A.

The above table indicates there is a slight decrease in the water level elevations at the flow rates considered. Overall, there is not a significant change between the original bridge and proposed bridge conditions.

10.0 ICE

Reference is made to both the MTO Drainage Manual as well as MTO Publication "Guide for Preparing Hydrology Reports for Water Crossings" which states that the design of a crossing should be checked for the potential impact of ice and debris on the flow through the structure. These references further state that ice jams are usually formed during ice break-up and are caused by:

a) Constriction of flow

b) Obstruction of flow

c) Channel bend (radius < 4 times the channel width)

d) Solid-ice sheet downstream acting as an obstruction due to upstream flows experiencing earlier ice break-up (e.g. Rivers flowing north to James Bay or Hudson Bay).

With respect to the proposed structure:

- A 3-span structure is proposed rather than a 2-span structure; a two-span structure would have resulted in a pier being placed at the centre of the watercourse.
- The piers will be located near the edge of water so as to neither constrict the flow, nor create obstructions.
- Although there are channel bends both upstream and downstream of this structure, the structure itself is located in a straight section of channel.
- The subject site is located in southern Ontario and Catfish Creek flows south into Lake Erie.

Residents of Port Bruce and representatives from the Catfish Creek Conservation Authority report that ice jams do form in Catfish Creek both upstream and downstream of the Port Bruce Bridge, but not directly underneath the original bridge. The location of these ice jams typically occur within natural areas of Catfish Creek (change in direction of watercourse, and narrowing areas of of the watercourse).

Since there are no plans to modify the topography of Catfish Creek and the proposed new structure is essentially identical to the original bridge, there should be no change in the level of risk of ice jamming between the existing conditions and the proposed conditions.

11.0 EROSION PROTECTION

To protect against erosion, rock protection of adequate size and geometry (e.g. angular vs round) will be placed around the pier pile caps, and at the abutment embankments to above the 50 year design storm water level. Rock protection will be placed on a geotextile underlay.

12.0 SCOUR PROTECTION

To protect against possible undermining of the structure by scour, the underside of the abutments and pier footings will be located at least 1.6m below grade and the grade will be protected with rock protection. Furthermore, the proposed structure will be supported on a pile foundation. This pile foundation is not susceptible to damage as a result of scour.

13.0 BRIDGE DECK AND ROADWAY DRAINAGE

Bridge deck drainage will be accomplished by the following:

a) Overtop the bridge, runoff will be directed to the curb line via 2% deck cross-fall. No deck drains will be provided.

b) Runoff will flow along the curb line via longitudinal grade to the ends of the bridge.

c) Twin inlet catchbasins will be provided at each bridge corner to intercept the bridge deck run-off. These catchbasins will then outlet, via pipe, through the roadway embankments to the roadside ditches. Rip rap spillways will be provided as needed to prevent erosion of the embankments and ditches.

Roadway drainage will be accomplished using a combination of curb and gutter, gutter outlets, catchbasins, culverts, and roadside ditches.

14.0 EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION

A detailed erosion and sediment control drawing will be prepared to control erosion and sedimentation during the construction. This same drawing will also show the proposed dewatering scheme.

15.0 CONSTRUCTION

It is recommended that construction of the proposed structure occur in single stage construction. As the original bridge has already been removed, traffic is already detoured around the site via the temporary bridge and the existing road network.

Most of the original structure has already been removed; the entire south abutment (walls and footings), north abutment footing, both pier footings, and both pier piles still remain. These remaining concrete components will be removed, likely using a hydraulic excavator equipped with a hydraulic breaker. The proposed design will likely require the removal of some of the existing piles, as they will likely conflict with the deep foundations required to support the new bridge.

Construction of the proposed structure will require in-water work. To minimize effects to the natural environment, all in-water work will be completed within the allowable in-water work timing windows. Sheet pile cofferdams supplemented with traditional sump pumps will be constructed to isolate the watercourse from the working area and to permit work to proceed in the dry.

Construction of the new bridge will likely consist of the following:

- Installation of pier and abutment piles
- Construction of pier pile caps/footings
- Construction of pier shafts (walls)
- Construction of abutment walls and wingwalls to bearing seat elevation
- Installation of steel girders
- Construction of deck complete with sidewalk and remaining portions of abutment wingwalls
- Installation of the railing system.

The roadway would be constructed last so that it matches the bridge. Backfill adjacent to the new bridge would be placed in stages and only after the concrete deck has been placed.

16.0 CONCLUSIONS

The hydraulic analysis has indicated that there would not be a significant change in the hydrology for the proposed conditions. In fact, the analysis indicates that there is some improvement to the water levels for the flows considered in this report.

The proposed structure satisfies the stated design criteria. There is no increase to flooding at the 50 year design storm as evidenced by the decrease in water level elevation between the existing and proposed conditions. Scour has been addressed by providing rock protection to armour the native streambed and by supporting the proposed structure on a piled foundation. As demonstrated in the summary table above, there is actually a 100mm decrease in the water level at the Regional Storm under the proposed conditions. The clearance to the soffit at the 50 year design storm is 1960mm which is well above the required 1000mm. Freeboard at the 50 year design storm is 1760mm which again is well above the required 1000mm. A navigation clearance envelope of 20m wide by 3.5m tall is provided. Finally, a crest vertical curve with approach grades of 3.0% and 1.8% has been provided which exceeds the minimum recommended longitudinal grade of 0.5%.

Based on MTO guidelines concerning ice jamming, the proposed structure has been configured to neither constrict the flow, nor introduce obstructions (i.e. piers) into Catfish Creek. The proposed structure is essentially identical to the original structure so there should be no changes to the frequency or severity of ice jams upstream or downstream of this crossing.

Bridge deck drainage, erosion and sediment control during construction as well as construction details will be provided on the detailed engineering drawings. These drawings are not included with this report.

It is our conclusion that the proposed structure would adequately serve the hydrology requirements.

All of which is respectfully submitted.

Allan Garnham, P. Eng

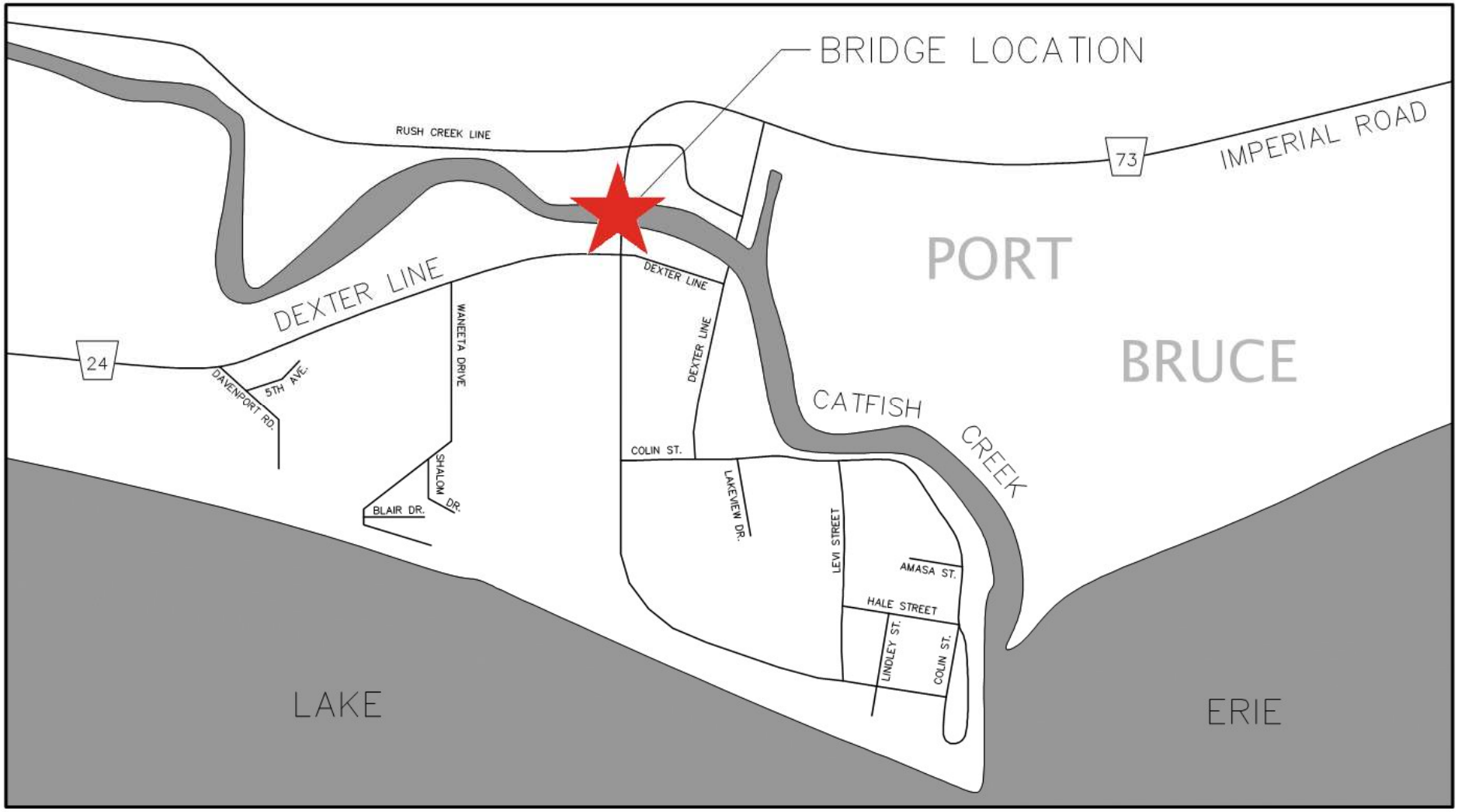
Darryl Schwartzentruber, C. Tech.

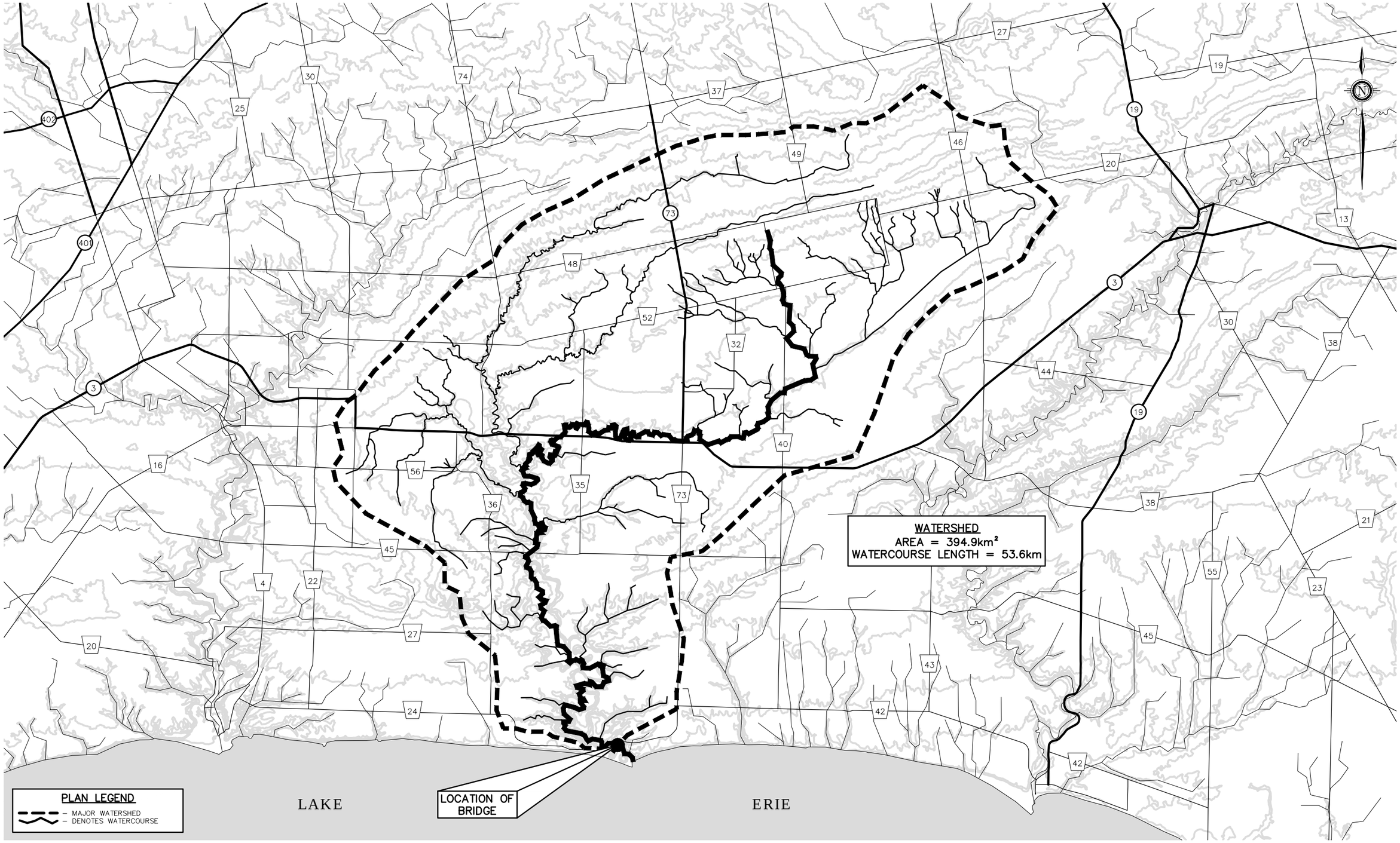
LICENSED PROFESSIONAL ENGINEER
A. L. GARNHAM
100123077
SEP 12 2019
PROVINCE OF ONTARIO

APPENDIX A

- Key Plan
- Watershed Plan Area
- Soils Map
- Hydraulic Computations
  - Design Flows
  - Existing Conditions
  - Proposed Conditions

Project Location





No.	REVISION	DATE

DESIGNED BY: --
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

SCALE
1: 75,000
750m 0 1500m
(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

WATERSHED PLAN

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER
18–283

DATE
AUGUST 2019

DRAWING NUMBER
WATERSHD

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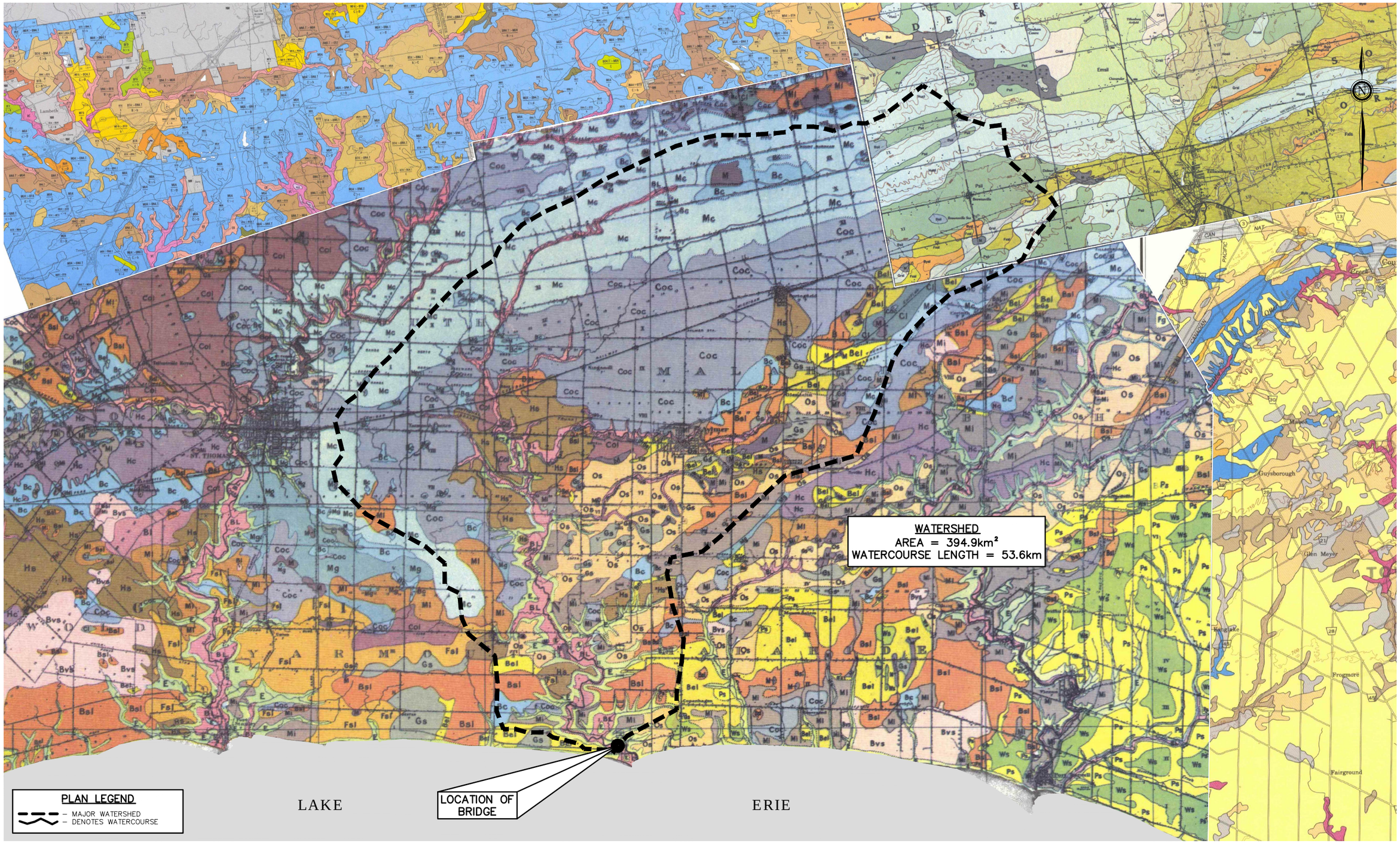


No.	REVISION	DATE

DESIGNED BY: --
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

SCALE
1:75,000
750m 0 1500m
(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

SOILS MAP

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE AUGUST 2019
DRAWING NUMBER SOILS

\\server\ksdata\Data\2018\18-283\Drafting\18-283 WS.dwg SOILS MAP 21-Aug-19 9:52:03 AM

Port Bruce Bridge Replacement Hydraulic Computations

KSAL File No. 18-283

Watershed Characteristics:

Watershed Area: **394.9** km²

Length of Creek: **53600** m

Slope of the Main Channel: By the 85/10 Method

Length at 10% = 53600 x 0.10 = 5360 m

Actual distance = **8144** m
Actual elevation= **180** m

Length at 85% = 53600 x 0.85 = 45560 m

Actual distance = **48216** m
Actual elevation= **230** m

$$\text{Slope} = \frac{\text{rise}}{\text{run}}$$

$$\text{Slope} = \frac{230 - 180}{48216 - 8144}$$

$$\text{Slope} = \frac{50}{40072}$$

Slope = 0.0012 m/m

Land Use:

From MTC Chart H2-7, Elgin County & Oxford County:

Elgin County		Oxford County	
% of Watershed:	90	% of Watershed:	10
Crop:	68	Crop:	69
Pasture:	22	Pasture:	24
Wood:	10	Wood:	7

Average Watershed Land Use:

Crop: **68** %
Pasture: **22** %
Wood: **10** %

Soil Classification:

From Soil Maps of Elgin County & Oxford County:

Soil Series	Map Symbol	Area	Hydraulic Soil Group
Berrien Loamy Sand	Bel	11.2 km^2	AB
Bottom Land	BL	17.0 km^2	C
Brady Sandy Loam	Bysl	2.1 km^2	AB
Brookston Clay	Bc	12.2 km^2	C
Brookston Sandy Loam	Bsl	19.1 km^2	B
Brookston Silt Loam	Bsil	1.7 km^2	C
Clyde Loam	Cl	3.6 km^2	BC
Conover Clay Loam	Coc	106.2 km^2	C
Conover Loam	Col	3.5 km^2	BC
Eroded	E	14.2 km^2	BC
Fox Sandy Loam	Fsl, Fxsl	3.7 km^2	AB
Granby Sand	Gs	6.8 km^2	B
Granby Sandy Loam	Grsl	2.3 km^2	B
Haldimand Silt Loam	Hs	23.7 km^2	BC
Huron Clay Loam	Hucl	12.8 km^2	CD
Huron Silt Loam	Husil	2.3 km^2	BC
Miami Clay Loam	Mc	77.1 km^2	D
Miami Gravelly Loam	Mg	1.0 km^2	AB
Miami Loam	Ml	6.2 km^2	BC
Mixed (Ottawa Sand & Miami Silty Clay Loam)	Mi	14.8 km^2	C
Muck	M	4.2 km^2	B
Oshtemo Loamy Sand	Os	33.1 km^2	A
Perth Silt Loam	Psil	16.1 km^2	AB
	Sum of Area =	394.9 km^2	
	Watershed Area =	394.9 *check*	

See MTO Drainage Management Manual Design Chart 1.08

Hydraulic Soil Group (HSG)	Area	% of Watershed
A	33.1 km^2	8.4%
AB	34.1 km^2	8.6%
B	32.4 km^2	8.2%
BC	53.5 km^2	13.5%
C	151.9 km^2	38.5%
CD	12.8 km^2	3.2%
D	77.1 km^2	19.5%
Sum of Area =	394.9 km^2	
Watershed Area =	394.9 *check*	

CN Calculation:

See MTO Drainage Management Manual Design Chart 1.09

		Crop		Pasture		Wood		
HSG	**Area (km²)**	**Area**	**CN**	**Area**	**CN**	**Area**	**CN**	**Sum of Areas x CNs**
A	33.1	22.53	66	7.34	58	3.21	50	2073.19
AB	34.1	23.22	70	7.57	62	3.31	54	2273.52
B	32.4	22.06	74	7.19	65	3.14	58	2282.58
BC	53.5	36.43	78	11.88	71	5.19	65	4022.40
C	151.9	103.44	82	33.72	76	14.73	71	12091.39
CD	12.8	8.72	84	2.84	79	1.24	74	1048.58
D	77.1	52.51	86	17.12	81	7.48	77	6477.71
							Total =	30269.4

$$CN_{avg} = \frac{\text{Total Sum of Areas x CN (km}^2\text{)}}{\text{WS Area (km}^2\text{)}}$$

$$CN_{avg} = \frac{30269.4}{394.9}$$

CN_{avg} = 76.7 (AMC II)

CN_{avg} = 89.5 (AMC III) (MTO Drainage Management Manual Design Chart 1.10)

Time to Peak:

Use three-parameter HYMO Equation

$$t_p = 0.0086 * A^{0.422} * S^{-0.46} * (L/W)^{0.133}$$

A = drainage area, hectares
A = 394.9 km^2 * 100
A = 39490 hectares

S = slope, m/m
S = 0.0012 m/m

L = Length of creek, m
L = 53600 m

W_{avg}= width of watershed, m

$$W_{avg} = \frac{W_1 + W_2 + W_3}{3}$$

W_1= 13943 m (at creek length = 50800m)
W_2= 14925 m (at creek length = 28150m)
W_3= 7592 m (at creek length = 13075m)

$$W_{avg} = \frac{13943 + 14925 + 7592}{3}$$

W_{avg}= 12153 m

t_p = time to peak, hours

$$t_p = 0.0086 * A^{0.422} * S^{-0.46} * (L/W)^{0.133}$$

$$t_p = 0.0086 * (39490)^{0.422} * (0.0012)^{-0.46} * (53600/12153)^{0.133}$$

t_p = 19.76 hours

Estimated Flows:

Modified Index Flood Method:

Watershed Type:	Southern	
Watershed Area:	394.9 km²	
Watershed Slope:	0.0012 m/m	
CN:	76.7	
Base Watershed Class:	9.0	(MTO Drainage Management Manual Design Chart 1.17)
	+	
Slope Adjustment:	**-0.3**	(MTO Drainage Management Manual Design Chart 1.18)
	=	
Net Watershed Class:	8.7	
Class Coefficient, C:	**2.41**	(MTO Drainage Management Manual Design Chart 1.15)

$Q_{25} = CA^{0.75}$

$Q_{25} = (2.41)(394.9)^{0.75}$

$\mathbf{Q_{25} = 213.5\ m^3/s}$

$Q_{10} = FCF_{10}Q_{25}$

$Q_{10} = (0.79)(213.5)^{0.75}$

$\mathbf{Q_{10} = 168.7\ m^3/s}$

$FCF_{10} = \mathbf{0.79}$

MTC Drainage Manual
Chapter H
Design Chart H5-9 (c)

$Q_{50} = FCF_{50}Q_{25}$

$Q_{50} = (1.16)(168.7)^{0.75}$

$\mathbf{Q_{50} = 247.7\ m^3/s}$

$FCF_{50} = \mathbf{1.16}$

MTC Drainage Manual
Chapter H
Design Chart H5-9 (c)

$Q_{100} = FCF_{100}Q_{25}$

$Q_{100} = (1.32)(213.5)^{0.75}$

$\mathbf{Q_{100} = 281.8\ m^3/s}$

$FCF_{100} = \mathbf{1.32}$

MTC Drainage Manual
Chapter H
Design Chart H5-9 (c)

Single Station Frequency Analysis:

Use gauging station 02GC018 - Catfish Creek Near Sparta:

From a regression analysis: $R^2 = 0.8765$

$y = 48.843 * \ln(x) + 61.647$

For Q_{10}, $y = (48.843)*\ln(10) + (61.647)$

$Q_{10} = 174.1$ m³/s

For Q_{25}, $y = (48.843)*\ln(25) + (61.647)$

$Q_{25} = 218.9$ m³/s

For Q_{50}, $y = (174.112)*\ln(50) + (0.000)$

$Q_{50} = 252.7$ m³/s

For Q_{100}, $y = (48.843)*\ln(100) + (61.647)$

$Q_{100} = 286.6$ m³/s

Now transport discharge back to Catfish Creek at Port Bruce Bridge

$A_1 = 394.9$ km²

$A_2 = 295$ km²

$A_1/A_2 = (394.90) / (295)$

$A_1/A_2 = 1.339$

$Q_{10} = Q_{10} (A_1/A_2)^{0.75}$

$Q_{10} = (174.1)(1.339)^{0.75}$

Q_{10} = 216.7 m³/s

$Q_{25} = Q_{25} (A_1/A_2)^{0.75}$

$Q_{25} = (218.9)(1.339)^{0.75}$

Q_{25} = 272.4 m³/s

$Q_{50} = Q_{25} (A_1/A_2)^{0.75}$

$Q_{50} = (252.7)(1.339)$

Q_{50} = 314.5 m³/s

$Q_{100} = Q_{100} (A_1/A_2)^{0.75}$

$Q_{100} = (286.6)(1.339)^{0.75}$

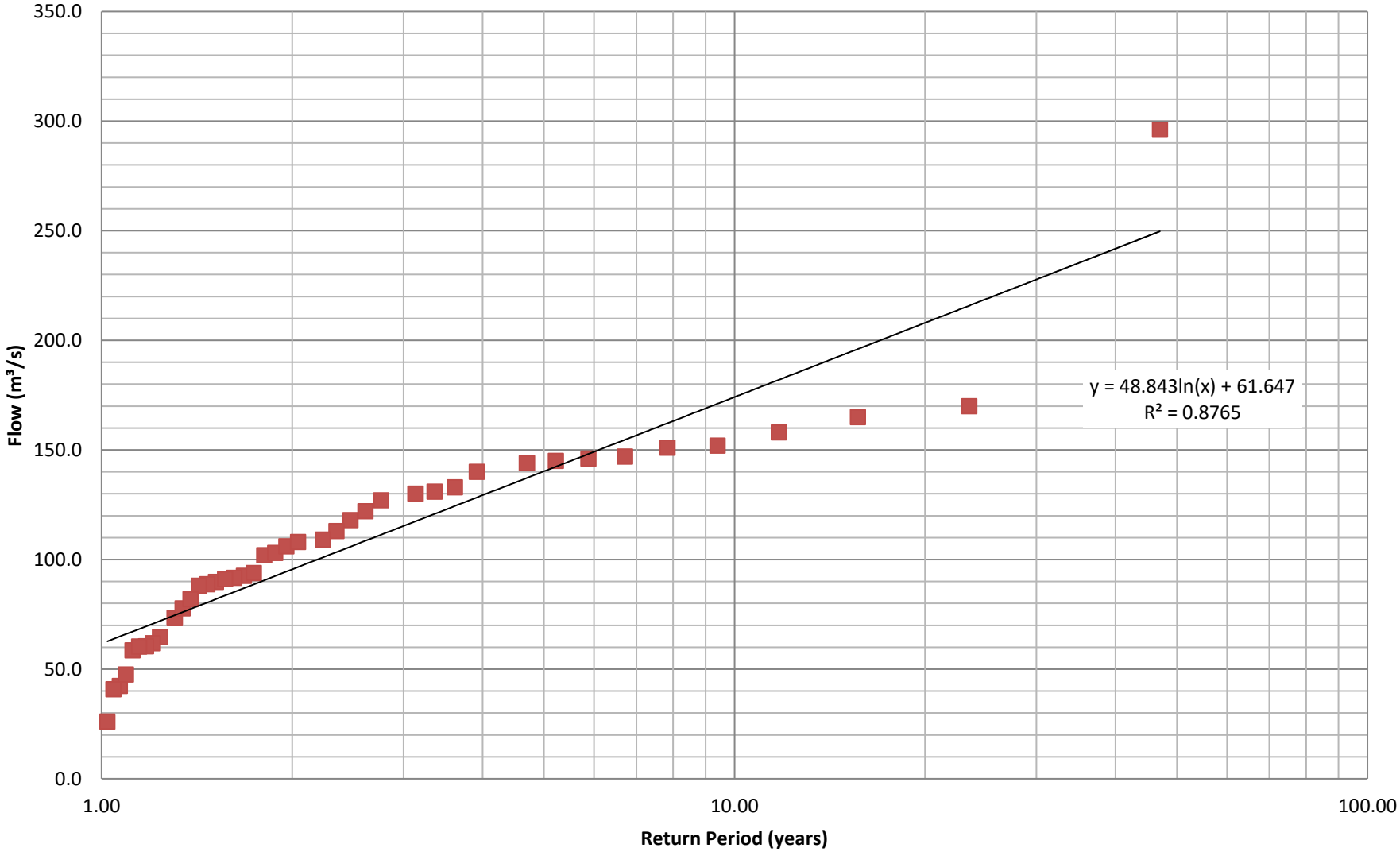
Q_{100} = 356.6 m³/s

Peak Data - Catfish Creek Near Sparta (02GC018) Watershed Area = 295 km²						
ID	PARAM	Year	TIMEZONE	HH:MM	MM--DD	MAX
02GC018	1	1965	EST	17:00	03--05	145.0
02GC018	1	1966	EST	22:30	12--07	58.6
02GC018	1	1967	EST	11:00	06--29	118.0
02GC018	1	1968	EST	12:00	02--02	144.0
02GC018	1	1969	EST	20:45	01--30	133.0
02GC018	1	1970	EST	17:46	04--02	92.6
02GC018	1	1971	EST	10:17	02--27	113.0
02GC018	1	1972	EST	9:50	03--22	89.8
02GC018	1	1973	EST	18:12	03--11	130.0
02GC018	1	1974	EST	10:21	01--27	91.7
02GC018	1	1975	EST	7:54	01--09	73.3
02GC018	1	1976	EST	12:50	03--05	140.0
02GC018	1	1977	EST	4:20	03--05	130.0
02GC018	1	1978	EST	16:38	03--21	146.0
02GC018	1	1979	EST	4:15	04--14	147.0
02GC018	1	1980	EST	14:11	03--21	127.0
02GC018	1	1982	EST	0:01	03--14	151.0
02GC018	1	1984	EST	6:42	02--14	296.0
02GC018	1	1985	EST	19:54	02--24	158.0
02GC018	1	1986	EST	3:32	03--11	131.0
02GC018	1	1987	EST	10:19	04--05	64.6
02GC018	1	1988	EST	0:47	03--26	42.4
02GC018	1	1989	EST	11:04	06--22	26.1
02GC018	1	1990	EST	8:10	12--30	102.0
02GC018	1	1991	EST	1:12	03--07	61.8
02GC018	1	1992	EST	0:58	11--13	152.0
02GC018	1	1993	EST	18:43	01--04	165.0
02GC018	1	1995	EST	19:28	11--11	103.0
02GC018	1	1996	EST	19:33	05--10	88.8
02GC018	1	1997	EST	3:48	02--22	122.0
02GC018	1	1998	EST	7:00	01--08	91.1
02GC018	1	1999	EST	2:00	01--24	60.4
02GC018	1	2000	EST	16:15	06--13	73.3
02GC018	1	2002	EST	23:00	02--20	60.3
02GC018	1	2004	EST	19:45	12--31	144.0
02GC018	1	2005	EST	0:00	01--01	88.1
02GC018	1	2006	EST	16:00	12--01	106.0
02GC018	1	2007	EST	6:55	01--06	77.7
02GC018	1	2010	EST	15:00	04--08	109.0
02GC018	1	2011	EST	18:00	11--29	170.0
02GC018	1	2012	EST	16:00	01--17	47.6
02GC018	1	2013	EST	11:40	01--13	109.0
02GC018	1	2014	EST	2:00	09--06	93.9
02GC018	1	2015	EST	19:00	03--17	40.8
02GC018	1	2016	EST	2:00	04--01	108.0
02GC018	1	2017	EST	9:00	05--05	81.9

Year	Flow	Rank	Probability	Return Period
1965	145.0	9	0.191	5.22
1966	58.6	42	0.894	1.12
1967	118.0	19	0.404	2.47
1968	144.0	10	0.213	4.70
1969	133.0	13	0.277	3.62
1970	92.6	28	0.596	1.68
1971	113.0	20	0.426	2.35
1972	89.8	31	0.660	1.52
1973	130.0	15	0.319	3.13
1974	91.7	29	0.617	1.62
1975	73.3	36	0.766	1.31
1976	140.0	12	0.255	3.92
1977	130.0	15	0.319	3.13
1978	146.0	8	0.170	5.88
1979	147.0	7	0.149	6.71
1980	127.0	17	0.362	2.76
1982	151.0	6	0.128	7.83
1984	296.0	1	0.021	47.00
1985	158.0	4	0.085	11.75
1986	131.0	14	0.298	3.36
1987	64.6	38	0.809	1.24
1988	42.4	44	0.936	1.07
1989	26.1	46	0.979	1.02
1990	102.0	26	0.553	1.81
1991	61.8	39	0.830	1.21
1992	152.0	5	0.106	9.40
1993	165.0	3	0.064	15.67
1995	103.0	25	0.532	1.88
1996	88.8	32	0.681	1.47
1997	122.0	18	0.383	2.61
1998	91.1	30	0.638	1.57
1999	60.4	40	0.851	1.18
2000	73.3	36	0.766	1.31
2002	60.3	41	0.872	1.15
2004	144.0	10	0.213	4.70
2005	88.1	33	0.702	1.42
2006	106.0	24	0.511	1.96
2007	77.7	35	0.745	1.34
2010	109.0	21	0.447	2.24
2011	170.0	2	0.043	23.50
2012	47.6	43	0.915	1.09
2013	109.0	21	0.447	2.24
2014	93.9	27	0.574	1.74
2015	40.8	45	0.957	1.04
2016	108.0	23	0.489	2.04
2017	81.9	34	0.723	1.38

count 46

Single Station Frequency Analysis to Estimate Design Flows
Record from Catfish Creek Near Sparta
Station No. 02GC018, Drainage Area = 295km²



EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)

WARNING 02: maximum depth increased for Node J10
WARNING 02: maximum depth increased for Node J13
WARNING 02: maximum depth increased for Node J2
WARNING 02: maximum depth increased for Node J3

****
Element Count
****
Number of rain gages 1
Number of subcatchments ... 8
Number of nodes 8
Number of links 7
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
48Hr_Hurricane_Hazel_(271-450)	48Hr_Hurricane_Hazel_(271-450)	INTENSITY	60 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
S1	4958.96	3525.80	3.00	2.2540	48Hr_Hurricane_Hazel_(271-450)	J2
S2	5663.82	4331.59	3.00	1.3120	48Hr_Hurricane_Hazel_(271-450)	J4
S3	3903.81	2765.85	3.00	1.7130	48Hr_Hurricane_Hazel_(271-450)	J2
S4	3037.91	5423.06	3.00	0.9220	48Hr_Hurricane_Hazel_(271-450)	J8
S5	7191.59	6432.97	3.00	1.5110	48Hr_Hurricane_Hazel_(271-450)	J13
S6	4428.33	6796.52	3.00	1.7180	48Hr_Hurricane_Hazel_(271-450)	J10
S7	2901.84	4699.14	3.00	1.6900	48Hr_Hurricane_Hazel_(271-450)	J12
S8	10994.54	8901.38	3.00	3.6900	48Hr_Hurricane_Hazel_(271-450)	J3

****
Node Summary

****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J10	JUNCTION	199.84	12.38	0.0	
J12	JUNCTION	194.59	15.41	0.0	
J13	JUNCTION	202.90	10.38	0.0	
J2	JUNCTION	217.92	10.38	0.0	
J3	JUNCTION	185.00	13.13	0.0	
J4	JUNCTION	229.12	5.88	0.0	
J8	JUNCTION	227.30	7.70	0.0	
J1	OUTFALL	175.00	13.13	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1_2	J12	J3	CONDUIT	8261.9	0.1161	0.0400
C1_3	J3	J1	CONDUIT	9396.0	0.1064	0.0400
C2	J10	J12	CONDUIT	1891.3	0.2773	0.0400
C3	J13	J10	CONDUIT	1794.6	0.1705	0.0400
C4	J2	J13	CONDUIT	5432.6	0.2767	0.0400
C5	J8	J13	CONDUIT	19726.9	0.1237	0.0400
C6	J4	J8	CONDUIT	2455.4	0.0742	0.0400

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1_2	T-C1_2	5.67	412.30	2.78	119.00	1	695.22
C1_3	T-C1_3	13.13	1446.26	4.93	185.00	1	3416.73
C2	T-C2	12.38	2634.62	7.78	320.00	1	13618.39
C3	T-C3	9.70	1231.32	3.27	211.00	1	2800.56
C4	T-C4	10.38	1752.88	3.52	299.00	1	5333.99
C5	T-C5	2.76	168.92	1.22	115.00	1	169.88
C6	T-C6	1.88	266.01	0.68	344.00	1	140.77

****
Transect Summary

****

Transect Generic

Area:

0.0032	0.0071	0.0117	0.0169	0.0229
0.0295	0.0368	0.0448	0.0535	0.0629
0.0729	0.0837	0.0951	0.1072	0.1200
0.1335	0.1477	0.1625	0.1781	0.1943
0.2112	0.2288	0.2471	0.2661	0.2857
0.3061	0.3271	0.3488	0.3712	0.3943
0.4181	0.4425	0.4677	0.4935	0.5200
0.5472	0.5751	0.6037	0.6329	0.6629
0.6935	0.7248	0.7568	0.7895	0.8229
0.8569	0.8917	0.9271	0.9632	1.0000

Hrad:

0.0349	0.0642	0.0905	0.1147	0.1377
0.1598	0.1813	0.2022	0.2228	0.2431
0.2631	0.2829	0.3026	0.3222	0.3416
0.3609	0.3802	0.3994	0.4185	0.4376
0.4567	0.4756	0.4946	0.5135	0.5324
0.5513	0.5701	0.5890	0.6078	0.6265
0.6453	0.6641	0.6828	0.7015	0.7202
0.7389	0.7576	0.7763	0.7950	0.8137
0.8323	0.8510	0.8696	0.8883	0.9069
0.9255	0.9442	0.9628	0.9814	1.0000

Width:

0.0954	0.1138	0.1323	0.1508	0.1692
0.1877	0.2062	0.2246	0.2431	0.2615
0.2800	0.2985	0.3169	0.3354	0.3538
0.3723	0.3908	0.4092	0.4277	0.4462
0.4646	0.4831	0.5015	0.5200	0.5385
0.5569	0.5754	0.5938	0.6123	0.6308
0.6492	0.6677	0.6862	0.7046	0.7231
0.7415	0.7600	0.7785	0.7969	0.8154
0.8338	0.8523	0.8708	0.8892	0.9077
0.9262	0.9446	0.9631	0.9815	1.0000

Transect T-C1_2

Area:

0.0002	0.0019	0.0039	0.0062	0.0107
0.0184	0.0264	0.0347	0.0438	0.0532
0.0631	0.0742	0.0859	0.0982	0.1129
0.1281	0.1444	0.1619	0.1800	0.1993
0.2192	0.2402	0.2630	0.2859	0.3089
0.3318	0.3549	0.3780	0.4015	0.4257
0.4505	0.4765	0.5027	0.5289	0.5552

0.5814	0.6078	0.6351	0.6641	0.6932
0.7225	0.7521	0.7822	0.8124	0.8434
0.8746	0.9058	0.9370	0.9683	1.0000

Hrad:

0.0197	0.0416	0.0763	0.0653	0.0597
0.0939	0.1303	0.1621	0.1877	0.2221
0.2341	0.2594	0.2901	0.3126	0.3422
0.3669	0.3954	0.4213	0.4457	0.4677
0.4899	0.5081	0.5246	0.5435	0.5635
0.5844	0.6058	0.6273	0.6463	0.6650
0.6841	0.6985	0.7180	0.7379	0.7581
0.7787	0.7994	0.8043	0.8218	0.8396
0.8575	0.8719	0.8897	0.9035	0.9198
0.9377	0.9557	0.9740	0.9918	1.0000

Width:

0.0100	0.0570	0.0620	0.1164	0.2213
0.2407	0.2485	0.2629	0.2859	0.2938
0.3307	0.3509	0.3628	0.4362	0.4537
0.4676	0.5316	0.5361	0.5678	0.6072
0.6115	0.6721	0.6990	0.7006	0.7022
0.7039	0.7055	0.7103	0.7331	0.7515
0.7638	0.7995	0.8008	0.8021	0.8034
0.8047	0.8060	0.8839	0.8883	0.8925
0.8968	0.9175	0.9210	0.9427	0.9510
0.9529	0.9548	0.9567	0.9604	1.0000

Transect T-C1_3

Area:

0.0011	0.0028	0.0077	0.0129	0.0183
0.0244	0.0326	0.0436	0.0549	0.0670
0.0811	0.0977	0.1146	0.1317	0.1488
0.1660	0.1832	0.2005	0.2179	0.2355
0.2534	0.2718	0.2909	0.3120	0.3345
0.3571	0.3798	0.4026	0.4255	0.4484
0.4714	0.4944	0.5175	0.5408	0.5648
0.5899	0.6164	0.6441	0.6723	0.7007
0.7292	0.7578	0.7865	0.8152	0.8440
0.8729	0.9035	0.9348	0.9669	1.0000

Hrad:

0.0426	0.0393	0.0798	0.1282	0.1604
0.2044	0.2253	0.2425	0.2655	0.2754
0.2980	0.3145	0.3341	0.3564	0.3803
0.4053	0.4310	0.4567	0.4825	0.5086
0.5295	0.5542	0.5743	0.5780	0.5970
0.6168	0.6372	0.6580	0.6792	0.7009
0.7228	0.7449	0.7654	0.7867	0.7992

0.8046	0.8179	0.8277	0.8430	0.8611
0.8795	0.8982	0.9170	0.9362	0.9554
0.9716	0.9708	0.9858	0.9950	1.0000

Width:

0.0409	0.1109	0.1512	0.1565	0.1774
0.1851	0.3147	0.3337	0.3395	0.3989
0.4925	0.4961	0.5084	0.5096	0.5107
0.5119	0.5131	0.5167	0.5206	0.5236
0.5464	0.5507	0.5711	0.6664	0.6712
0.6747	0.6774	0.6799	0.6817	0.6830
0.6843	0.6856	0.6924	0.6965	0.7252
0.7757	0.7988	0.8322	0.8446	0.8473
0.8498	0.8521	0.8544	0.8563	0.8582
0.8684	0.9236	0.9344	0.9611	1.0000

Transect T-C2

Area:

0.0008	0.0047	0.0116	0.0212	0.0341
0.0491	0.0644	0.0798	0.0952	0.1108
0.1266	0.1423	0.1581	0.1738	0.1903
0.2071	0.2263	0.2456	0.2650	0.2845
0.3039	0.3236	0.3435	0.3634	0.3833
0.4032	0.4234	0.4437	0.4654	0.4878
0.5108	0.5338	0.5568	0.5803	0.6040
0.6276	0.6514	0.6758	0.7001	0.7250
0.7512	0.7782	0.8053	0.8324	0.8595
0.8867	0.9141	0.9423	0.9709	1.0000

Hrad:

0.0126	0.0319	0.0470	0.0576	0.0761
0.1009	0.1320	0.1630	0.1937	0.2212
0.2521	0.2828	0.3134	0.3439	0.3724
0.3999	0.4215	0.4436	0.4662	0.4891
0.5123	0.5344	0.5572	0.5801	0.6030
0.6250	0.6474	0.6699	0.6831	0.7005
0.7190	0.7377	0.7566	0.7726	0.7909
0.8093	0.8245	0.8422	0.8600	0.8731
0.8827	0.8956	0.9108	0.9261	0.9417
0.9573	0.9672	0.9819	0.9924	1.0000

Width:

0.0696	0.1545	0.2599	0.3878	0.4708
0.5103	0.5110	0.5117	0.5124	0.5224
0.5230	0.5236	0.5242	0.5248	0.5601
0.5625	0.6443	0.6449	0.6455	0.6461
0.6467	0.6599	0.6605	0.6612	0.6619
0.6719	0.6733	0.6747	0.7420	0.7626
0.7636	0.7646	0.7702	0.7852	0.7860

0.7868	0.8096	0.8106	0.8117	0.8677
0.8842	0.9004	0.9010	0.9016	0.9022
0.9027	0.9350	0.9368	0.9609	1.0000

Transect T-C3

Area:

0.0001	0.0002	0.0005	0.0009	0.0027
0.0078	0.0145	0.0212	0.0280	0.0349
0.0437	0.0557	0.0677	0.0797	0.0918
0.1040	0.1170	0.1322	0.1497	0.1684
0.1876	0.2072	0.2269	0.2466	0.2665
0.2869	0.3107	0.3361	0.3620	0.3883
0.4148	0.4414	0.4684	0.4963	0.5262
0.5561	0.5859	0.6158	0.6458	0.6768
0.7083	0.7399	0.7715	0.8032	0.8351
0.8675	0.9005	0.9336	0.9668	1.0000

Hrad:

0.0256	0.0512	0.0768	0.1024	0.0346
0.0691	0.1256	0.1810	0.2354	0.2888
0.3234	0.3390	0.3635	0.3913	0.4211
0.4523	0.4815	0.5025	0.5149	0.5261
0.5407	0.5564	0.5760	0.5970	0.6181
0.6385	0.6348	0.6484	0.6535	0.6697
0.6871	0.7053	0.7187	0.7063	0.7246
0.7437	0.7634	0.7836	0.8042	0.8080
0.8280	0.8483	0.8690	0.8899	0.9039
0.9239	0.9373	0.9581	0.9790	1.0000

Width:

0.0033	0.0067	0.0100	0.0133	0.1356
0.1983	0.2011	0.2040	0.2069	0.2097
0.3589	0.3601	0.3613	0.3630	0.3651
0.3671	0.4456	0.4724	0.5603	0.5690
0.5831	0.5909	0.5937	0.5964	0.6051
0.6414	0.7615	0.7667	0.7927	0.7950
0.7973	0.8019	0.8173	0.8974	0.8980
0.8986	0.8991	0.8997	0.9003	0.9485
0.9495	0.9505	0.9515	0.9525	0.9720
0.9756	0.9963	0.9975	0.9988	1.0000

Transect T-C4

Area:

0.0018	0.0049	0.0084	0.0120	0.0156
0.0194	0.0236	0.0291	0.0354	0.0424
0.0518	0.0627	0.0738	0.0853	0.0980
0.1113	0.1275	0.1444	0.1620	0.1807
0.2010	0.2221	0.2432	0.2643	0.2860

0.3080	0.3301	0.3526	0.3768	0.4013
0.4260	0.4508	0.4758	0.5017	0.5284
0.5564	0.5847	0.6131	0.6420	0.6721
0.7027	0.7334	0.7643	0.7957	0.8274
0.8596	0.8944	0.9295	0.9647	1.0000

Hrad:

0.0413	0.0810	0.1369	0.1914	0.2446
0.2918	0.2945	0.2806	0.3172	0.3498
0.3811	0.4047	0.4331	0.4597	0.4836
0.5048	0.5160	0.5256	0.5393	0.5535
0.5491	0.5647	0.5826	0.6020	0.6172
0.6368	0.6578	0.6681	0.6804	0.7003
0.7199	0.7404	0.7614	0.7682	0.7881
0.7940	0.8135	0.8318	0.8389	0.8563
0.8720	0.8899	0.9083	0.9225	0.9404
0.9554	0.9480	0.9649	0.9827	1.0000

Width:

0.0717	0.0988	0.1004	0.1020	0.1036
0.1073	0.1300	0.1685	0.1811	0.2070
0.2945	0.3115	0.3149	0.3484	0.3626
0.4247	0.4675	0.4840	0.5034	0.5345
0.5923	0.5945	0.5965	0.5983	0.6176
0.6226	0.6253	0.6637	0.6930	0.6944
0.6993	0.7023	0.7080	0.7486	0.7762
0.7972	0.7987	0.8048	0.8502	0.8527
0.8646	0.8704	0.8753	0.8919	0.8978
0.9700	0.9877	0.9924	0.9952	1.0000

Transect T-C5

Area:

0.0019	0.0046	0.0078	0.0135	0.0207
0.0285	0.0370	0.0459	0.0550	0.0645
0.0742	0.0840	0.0939	0.1040	0.1141
0.1244	0.1348	0.1455	0.1563	0.1676
0.1814	0.1959	0.2123	0.2292	0.2477
0.2674	0.2878	0.3095	0.3329	0.3580
0.3853	0.4130	0.4412	0.4702	0.4999
0.5298	0.5602	0.5916	0.6232	0.6550
0.6872	0.7201	0.7534	0.7868	0.8203
0.8548	0.8902	0.9265	0.9631	1.0000

Hrad:

0.0395	0.0657	0.0935	0.0902	0.1235
0.1521	0.1910	0.2279	0.2620	0.3010
0.3404	0.3794	0.4191	0.4584	0.4973
0.5356	0.5681	0.6020	0.6395	0.6584
0.6848	0.7102	0.7320	0.7536	0.7677

0.7821	0.7942	0.8058	0.8113	0.8162
0.8193	0.8247	0.8315	0.8378	0.8460
0.8545	0.8620	0.8696	0.8804	0.8917
0.9026	0.9120	0.9249	0.9388	0.9533
0.9565	0.9648	0.9777	0.9909	1.0000

Width:

0.0573	0.0832	0.0997	0.1785	0.2001
0.2235	0.2311	0.2397	0.2501	0.2552
0.2592	0.2632	0.2662	0.2693	0.2723
0.2755	0.2814	0.2865	0.2896	0.3485
0.3745	0.4240	0.4467	0.4547	0.5209
0.5293	0.5696	0.5868	0.6531	0.7120
0.7351	0.7449	0.7585	0.7864	0.7938
0.8039	0.8220	0.8394	0.8459	0.8535
0.8649	0.8831	0.8884	0.8919	0.8954
0.9403	0.9656	0.9713	0.9775	1.0000

Transect T-C6

Area:

0.0002	0.0007	0.0016	0.0029	0.0046
0.0074	0.0119	0.0166	0.0239	0.0320
0.0405	0.0495	0.0589	0.0684	0.0783
0.0885	0.0988	0.1094	0.1207	0.1336
0.1475	0.1617	0.1761	0.1918	0.2082
0.2260	0.2463	0.2672	0.2885	0.3102
0.3330	0.3567	0.3812	0.4071	0.4347
0.4632	0.4925	0.5221	0.5536	0.5869
0.6221	0.6580	0.6947	0.7325	0.7723
0.8164	0.8616	0.9070	0.9532	1.0000

Hrad:

0.0274	0.0547	0.0821	0.1095	0.0973
0.0901	0.1427	0.1929	0.1686	0.2075
0.2597	0.2897	0.3404	0.3905	0.4202
0.4718	0.5209	0.5613	0.6081	0.6471
0.6830	0.7192	0.7537	0.7823	0.8109
0.8308	0.8411	0.8569	0.8730	0.8907
0.9020	0.9169	0.9293	0.9374	0.9448
0.9518	0.9639	0.9775	0.9761	0.9732
0.9797	0.9900	0.9934	0.9948	0.9896
0.9828	0.9883	0.9971	1.0001	1.0000

Width:

0.0073	0.0146	0.0220	0.0293	0.0536
0.0923	0.0940	0.1340	0.1597	0.1733
0.1752	0.1920	0.1945	0.1969	0.2094
0.2108	0.2132	0.2190	0.2340	0.2811
0.2895	0.2916	0.3143	0.3347	0.3388

```
            0.3791     0.4247     0.4313     0.4435     0.4506
            0.4847     0.4962     0.5182     0.5461     0.5749
            0.6006     0.6051     0.6094     0.6595     0.7197
            0.7349     0.7380     0.7645     0.8012     0.8636
            0.9199     0.9295     0.9323     0.9586     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
**********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... DYNWAVE
Starting Date ............ 03/08/2019 00:00:00
Ending Date .............. 03/10/2019 12:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......     10899.525       253.002
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      5151.154       119.570
```

```
Surface Runoff ...........      3301.871        76.644
Final Storage ............      2446.326        56.785
Continuity Error (%) .....         0.002


**************************        Volume         Volume
Flow Routing Continuity        hectare-m       10^6 ltr
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......      3298.563      32985.969
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........         0.000          0.000
External Outflow .........      2187.644      21876.673
Flooding Loss ............         0.000          0.000
Evaporation Loss .........         0.000          0.000
Exfiltration Loss ........         0.000          0.000
Initial Stored Volume ....         0.001          0.006
Final Stored Volume ......      1001.036      10010.462
Continuity Error (%) .....         3.331


*************************
Highest Continuity Errors
*************************
Node J13 (25.97%)
Node J8 (22.50%)
Node J3 (13.67%)
Node J12 (7.10%)
Node J10 (1.31%)


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
```

```
*************************
Minimum Time Step           :     4.50 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
S1	253.00	0.00	0.00	78.76	90.40	4482.97	121.18	0.357
S2	253.00	0.00	0.00	78.90	81.35	4607.62	119.87	0.322
S3	253.00	0.00	0.00	78.86	83.93	3276.54	86.14	0.332
S4	253.00	0.00	0.00	151.68	68.26	2073.56	74.76	0.270
S5	253.00	0.00	0.00	151.68	55.00	3955.17	127.97	0.217
S6	253.00	0.00	0.00	78.25	119.29	5282.43	166.47	0.471
S7	253.00	0.00	0.00	151.68	74.37	2158.15	82.53	0.294
S8	253.00	0.00	0.00	151.68	65.33	7182.46	252.29	0.258

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J10	JUNCTION	0.73	2.14	201.97	2 04:14	2.14
J12	JUNCTION	1.39	4.54	199.13	2 04:17	4.54
J13	JUNCTION	1.61	4.89	207.79	2 05:45	4.89
J2	JUNCTION	0.76	2.57	220.49	2 01:01	2.57
J3	JUNCTION	2.09	6.99	191.99	2 04:45	6.99
J4	JUNCTION	0.67	1.72	230.84	2 01:07	1.72
J8	JUNCTION	0.72	2.38	229.68	2 04:35	2.38
J1	OUTFALL	0.88	3.16	178.16	2 04:45	3.16

```
*******************
Node Inflow Summary
*******************
```

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min		Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J10	JUNCTION	166.474	392.636	2	04:06	5.28e+003	1.76e+004	1.324
J12	JUNCTION	82.532	434.651	2	03:22	2.16e+003	1.96e+004	7.643
J13	JUNCTION	127.975	403.659	2	01:00	3.95e+003	1.67e+004	35.075
J2	JUNCTION	207.323	207.323	2	00:00	7.75e+003	7.75e+003	1.628
J3	JUNCTION	252.290	592.539	2	02:04	7.18e+003	2.53e+004	15.836
J4	JUNCTION	119.875	119.875	2	00:00	4.6e+003	4.6e+003	2.008
J8	JUNCTION	74.762	181.610	2	01:00	2.07e+003	6.58e+003	29.029
J1	OUTFALL	0.000	551.156	2	04:45	0	2.19e+004	0.000

```
**********************
Node Surcharge Summary
**********************
```

No nodes were surcharged.

```
*********************
Node Flooding Summary
*********************
```

No nodes were flooded.

```
************************
Outfall Loading Summary
************************
```

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
J1	97.82	103.547	551.156	21876.573

System 97.82 103.547 551.156 21876.573

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1_2	CHANNEL	430.764	2	04:17	3.88	0.62	0.90
C1_3	CHANNEL	551.156	2	04:45	1.71	0.16	0.39
C2	CHANNEL	392.528	2	04:15	>50.00	0.03	0.27
C3	CHANNEL	308.965	2	05:27	1.88	0.11	0.36
C4	CHANNEL	198.162	2	01:01	1.21	0.04	0.34
C5	CHANNEL	122.552	2	04:35	0.83	0.72	0.93
C6	CHANNEL	111.731	2	01:07	0.52	0.79	0.96

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1_2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.98	0.00
C1_3	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
C2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.90	0.00
C3	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.11	0.00
C4	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.87	0.00
C5	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
C6	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.20	0.00

****
Conduit Surcharge Summary
****

	Hours Full	Hours Above Full	Hours Capacity

Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
C1_2	0.01	0.01	11.20	0.01	0.01
C5	0.01	0.01	13.23	0.01	0.01
C6	0.01	0.01	11.53	0.01	0.01

Analysis begun on: Mon Mar 11 11:34:32 2019
Analysis ended on: Mon Mar 11 11:34:34 2019
Total elapsed time: 00:00:02

Summary of Estimated Flows:

Design Storm (Years)	Modified Index (m^3/s)	Single Station Frequency Analysis (m^3/s)	PCSWMM (m^3/s)
10	168.7	216.7	--
25	213.5	272.4	--
50	247.7	314.5	
100	281.8	356.6	--
Regional	--	--	551.2

Therefore, the design flows for this structure will be:

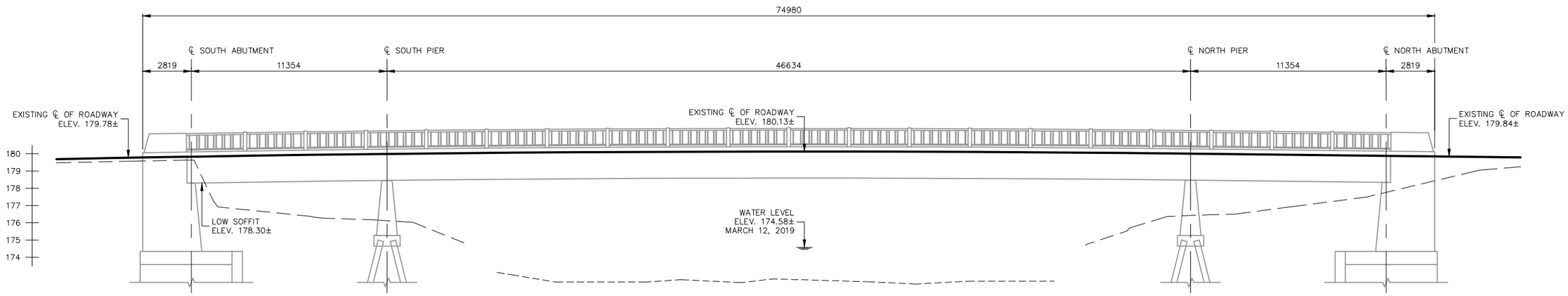
Q_{10} = **216.7** m^3/s

Q_{25} = **272.4** m^3/s

Q_{50} = **314.5** m^3/s

Q_{100} = **356.6** m^3/s

$Q_{REGIONAL}$ = **551.2** m^3/s



ORIGINAL 1962± STRUCTURE

No.	REVISION	DATE

DESIGNED BY: A.G.
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

SCALE
1:125
1.25m 0 2.5m
(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

ORIGINAL 1962± STRUCTURE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER
18-283
DATE
AUGUST 2019
DRAWING NUMBER
EXIST

C:\Users\darryls\Desktop\Hydrology Port Bruce Bridge.dwg EXISTING 12-Sep-19 9:52:28 AM

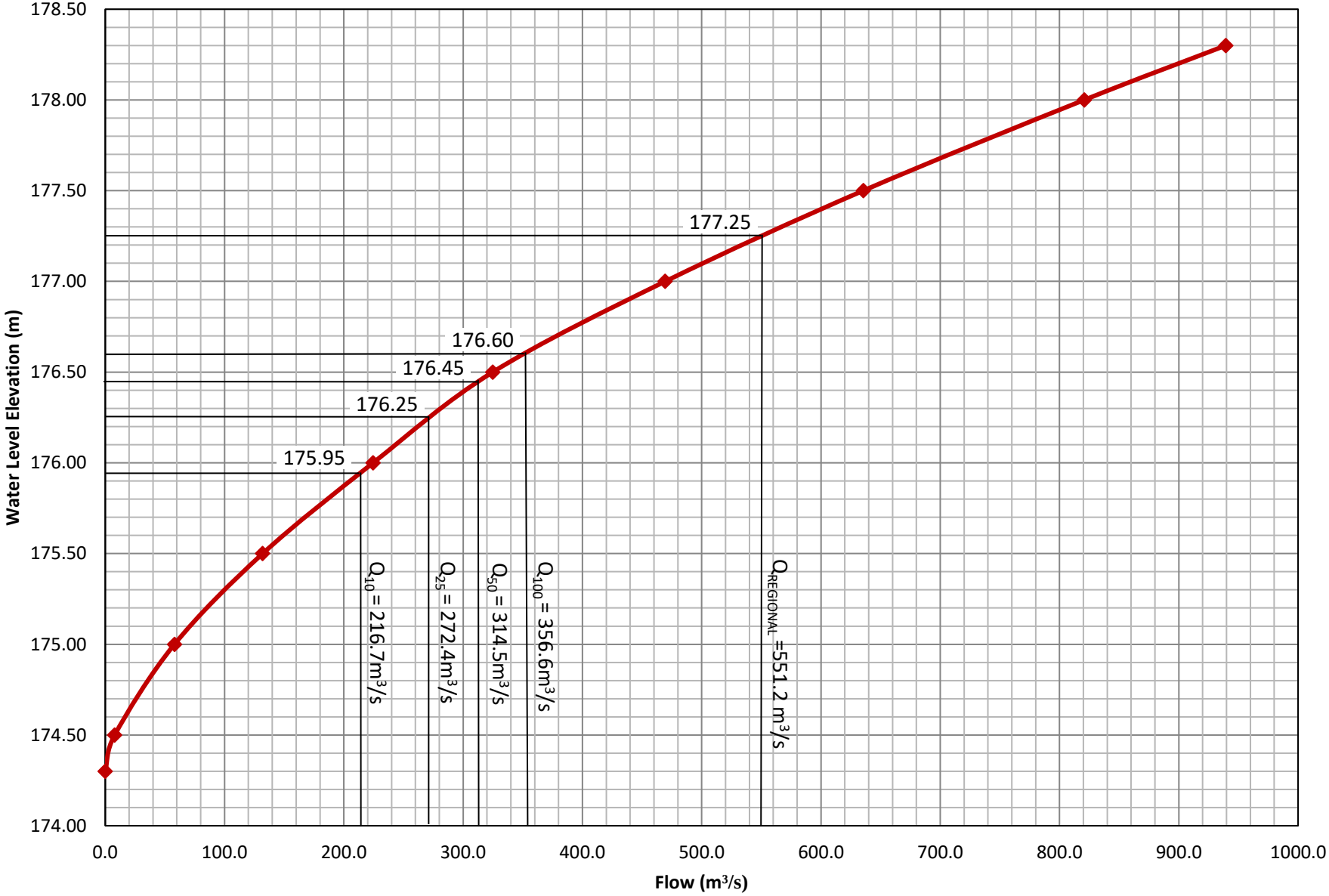
Existing Bridge Conditions SOUTH SPAN							
Water Elevation **(m)**	**Area (A)** **(m^2)**	**Perimeter (P)** **(m)**	**Hydraulic Radius (R) = A / P** **(m)**	**Slope (s)** **(m/m)**	**Roughness Coefficeint** **(n)**	**Velocity (v) = [($R^{2/3}$*$s^{1/2}$)/n]** **(m^2/s)**	**Flow (Q1) = A x V** **(m^3/s)**
178.30	17.76	13.06	1.360	0.0012	0.025	1.701	**30.2**
178.00	14.72	12.43	1.184	0.0012	0.025	1.551	**22.8**
177.50	9.75	11.37	0.857	0.0012	0.025	1.250	**12.2**
177.00	4.94	10.28	0.480	0.0012	0.025	0.849	**4.2**
176.50	1.13	5.52	0.204	0.0012	0.025	0.480	**0.5**
176.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.30	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**

Existing Bridge Conditions CENTRE SPAN							
Water Elevation (m)	**Area (A) (m^2)**	**Perimeter (P) (m)**	**Hydraulic Radius (R) = A / P (m)**	**Slope (s) (m/m)**	**Roughness Coefficeint (n)**	**Velocity (v) = $[(R^{2/3}*s^{1/2})/n]$ (m^2/s)**	**Flow (Q2) = A x V (m^3/s)**
178.30	169.54	50.56	3.353	0.0012	0.015	5.236	**887.7**
178.00	155.75	49.96	3.118	0.0012	0.015	5.030	**783.4**
177.50	132.80	48.95	2.713	0.0012	0.014	4.651	**617.7**
177.00	109.90	47.95	2.292	0.0012	0.014	4.221	**463.9**
176.50	87.05	46.94	1.854	0.0012	0.014	3.725	**324.3**
176.00	64.85	43.26	1.499	0.0012	0.013	3.463	**224.5**
175.50	44.27	40.58	1.091	0.0012	0.012	2.981	**132.0**
175.00	24.94	37.63	0.663	0.0012	0.011	2.326	**58.0**
174.50	6.93	35.14	0.197	0.0012	0.010	1.134	**7.9**
174.30	0.00	0.00	0.000	0.0012	0.010	0.000	**0.0**

Existing Bridge Conditions NORTH SPAN							
Water Elevation **(m)**	**Area (A)** **(m^2)**	**Perimeter (P)** **(m)**	**Hydraulic Radius (R) = A / P** **(m)**	**Slope (s)** **(m/m)**	**Roughness Coefficeint** **(n)**	**Velocity (v) = [($R^{2/3}$*$s^{1/2}$)/n]** **(m^2/s)**	**Flow (Q3) = A x V** **(m^3/s)**
178.30	14.51	13.13	1.105	0.0012	0.025	1.481	**21.5**
178.00	11.28	12.53	0.900	0.0012	0.025	1.292	**14.6**
177.50	6.01	10.88	0.552	0.0012	0.025	0.932	**5.6**
177.00	2.05	6.48	0.317	0.0012	0.025	0.644	**1.3**
176.50	0.05	2.13	0.023	0.0012	0.025	0.112	**0.0**
176.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.30	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**

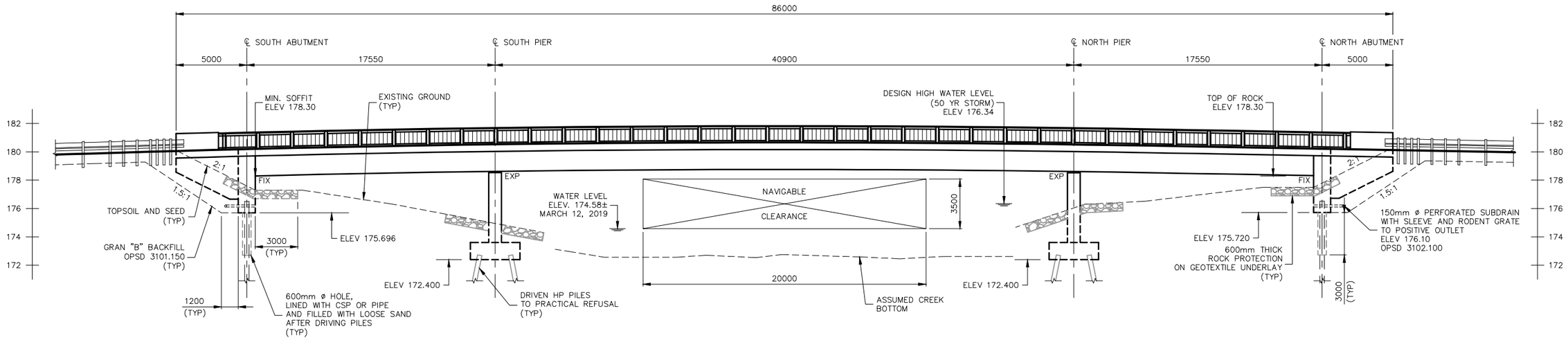
Existing Bridge Conditions SUMMARY OF FLOWS				
Water Level Elevation (m)	**South Span Q1 (m^3/s)**	**Centre Span Q2 (m^3/s)**	**North Span Q3 (m^3/s)**	**Total Flow (Q1 + Q2 +Q3) (m^3/s)**
178.30	30.2	887.7	21.5	**939.4**
178.00	22.8	783.4	14.6	**820.7**
177.50	12.2	617.7	5.6	**635.5**
177.00	4.2	463.9	1.3	**469.4**
176.50	0.5	324.3	0.0	**324.8**
176.00	0.0	224.5	0.0	**224.5**

Existing Conditions - Water Level Elevations vs. Flow



Summary of Existing Conditions

Design Storm	Flow m^3/s	High Water Elevation (m)
Regional	551.2	177.25
100 Year	356.6	176.60
50 Year	314.5	176.45
25 Year	272.4	176.25
10 Year	216.7	175.95



ELEVATION
SCALE 1:150

No.	REVISION	DATE

DESIGNED BY: A.G.
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

SCALE
1:125
1.25m 0 2.5m
(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PROPOSED STRUCTURE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER
18-283
DATE
AUGUST 2019
DRAWING NUMBER
PROPOSED

C:\Users\darryls\Desktop\Hydrology Port Bruce Bridge.dwg PROPOSED 21-Aug-19 11:34:18 AM

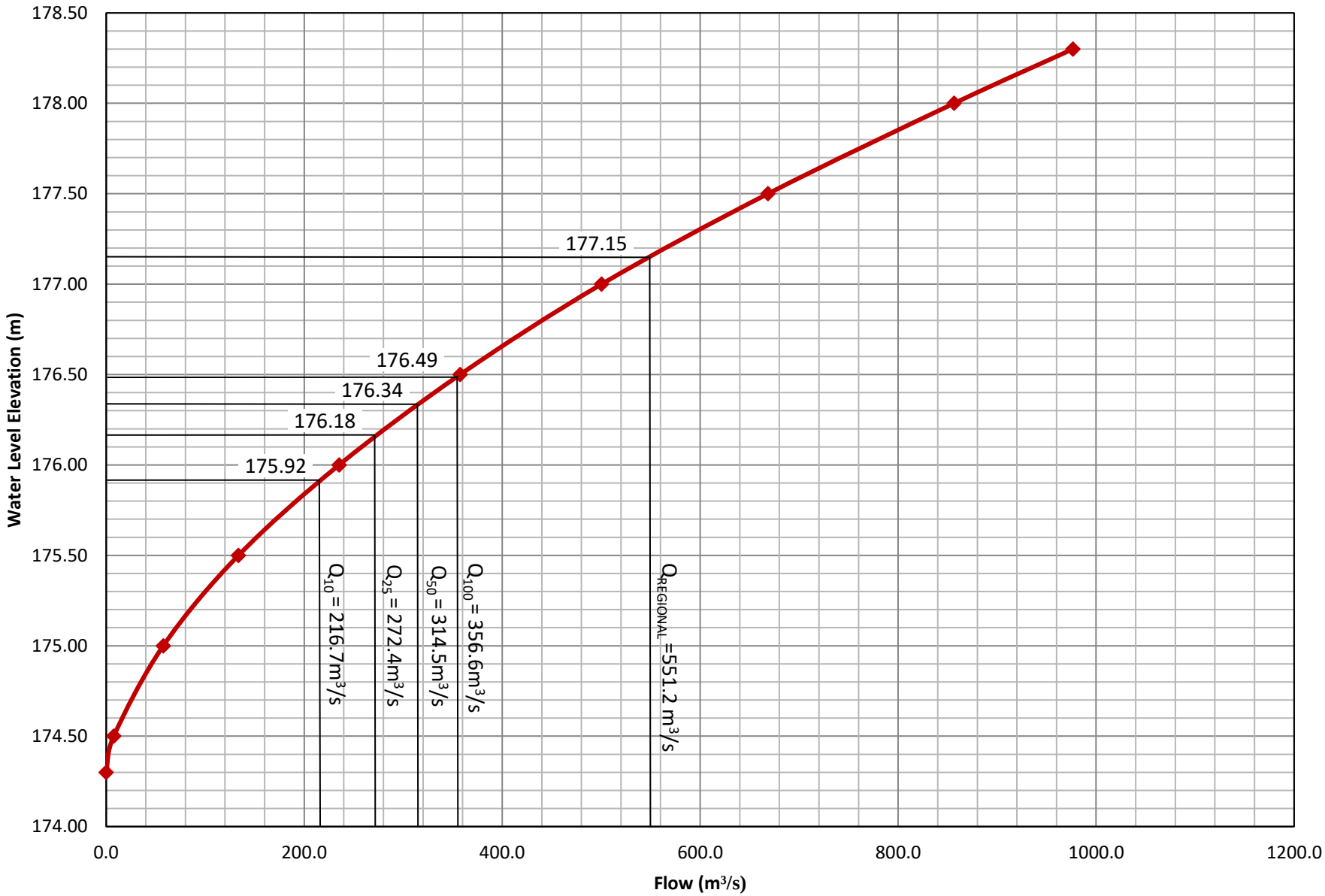
Proposed Bridge Conditions SOUTH SPAN							
Water Elevation (m)	**Area (A) (m^2)**	**Perimeter (P) (m)**	**Hydraulic Radius (R) = A / P (m)**	**Slope (s) (m/m)**	**Roughness Coefficeint (n)**	**Velocity (v) = $[(R^{2/3}*s^{1/2})/n]$ (m^2/s)**	**Flow (Q1) = A x V (m^3/s)**
178.30	30.36	20.57	1.476	0.0012	0.025	1.796	**54.5**
178.00	25.41	19.97	1.272	0.0012	0.025	1.627	**41.3**
177.50	17.16	18.97	0.905	0.0012	0.025	1.296	**22.2**
177.00	8.91	17.97	0.496	0.0012	0.025	0.868	**7.7**
176.50	2.45	9.70	0.253	0.0012	0.025	0.554	**1.4**
176.00	0.14	1.23	0.113	0.0012	0.025	0.323	**0.0**
175.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.30	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**

Proposed Bridge Conditions CENTRE SPAN							
Water Elevation (m)	**Area (A) (m^2)**	**Perimeter (P) (m)**	**Hydraulic Radius (R) = A / P (m)**	**Slope (s) (m/m)**	**Roughness Coefficeint (n)**	**Velocity (v) = $[(R^{2/3}*s^{1/2})/n]$ (m^2/s)**	**Flow (Q2) = A x V (m^3/s)**
178.30	155.94	46.03	3.388	0.0012	0.014	5.654	**881.7**
178.00	143.94	45.43	3.168	0.0012	0.014	5.466	**786.7**
177.50	123.94	44.43	2.789	0.0012	0.013	5.116	**634.1**
177.00	103.94	43.43	2.393	0.0012	0.013	4.713	**489.9**
176.50	83.94	42.43	1.978	0.0012	0.013	4.241	**356.0**
176.00	63.94	41.43	1.543	0.0012	0.013	3.678	**235.2**
175.50	43.99	40.04	1.099	0.0012	0.012	3.037	**133.6**
175.00	24.74	37.49	0.660	0.0012	0.011	2.330	**57.6**
174.50	6.80	34.61	0.196	0.0012	0.010	1.115	**7.6**
174.30	0.00	0.00	0.000	0.0012	0.010	0.000	**0.0**

Proposed Bridge Conditions NORTH SPAN							
Water Elevation **(m)**	**Area (A)** **(m^2)**	**Perimeter (P)** **(m)**	**Hydraulic Radius (R) = A / P** **(m)**	**Slope (s)** **(m/m)**	**Roughness Coefficeint** **(n)**	**Velocity (v) = [($R^{2/3}$*$s^{1/2}$)/n]** **(m^2/s)**	**Flow (Q3) = A x V** **(m^3/s)**
178.30	24.97	19.90	1.255	0.0012	0.025	1.612	**40.2**
178.00	20.02	19.30	1.037	0.0012	0.025	1.420	**28.4**
177.50	11.77	18.30	0.643	0.0012	0.025	1.032	**12.1**
177.00	4.22	12.72	0.332	0.0012	0.025	0.665	**2.8**
176.50	0.49	3.87	0.126	0.0012	0.025	0.348	**0.2**
176.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
175.00	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.50	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**
174.30	0.00	0.00	0.000	0.0012	0.025	0.000	**0.0**

Proposed Conditions SUMMARY OF FLOWS				
Water Level Elevation (m)	**South Span Q1 (m^3/s)**	**Centre Span Q2 (m^3/s)**	**North Span Q3 (m^3/s)**	**Total Flow (Q1 + Q2 +Q3) (m^3/s)**
178.30	54.5	881.7	40.2	**976.5**
178.00	41.3	786.7	28.4	**856.5**
177.50	22.2	634.1	12.1	**668.5**
177.00	7.7	489.9	2.8	**500.4**
176.50	1.4	356.0	0.2	**357.5**
176.00	0.0	235.2	0.0	**235.2**

Proposed Conditions - Water Level Elevations vs. Flow



Summary of Proposed Conditions

Design Storm	Flow m^3/s	High Water Elevation (m)
Regional	551.2	177.15
100 Year	356.6	176.49
50 Year	314.5	176.34
25 Year	272.4	176.18
10 Year	216.7	175.92

11. Geotechnical Report

CHUNG & VANDER DOELEN
ENGINEERING LTD.

GEOTECHNICAL INVESTIGATION
PROPOSED BRIDGE REPLACEMENT
Imperial Road
Port Bruce, Ontario

SUBMITTED TO:
K. Smart Associates Ltd.
85 McIntyre Drive
Kitchener, Ontario
N2R 1H6

ATTENTION:
Mr. Allan Garnham, P.Eng.

FILE NO / G19736 /August 21, 2019

CHUNG & VANDER DOELEN
ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1
519-742-8979

August 21, 2019
File No.: G19736

K. Smart Associates Ltd.
85 McIntyre Drive
Kitchener, Ontario
N2R 1H6

Attention: Mr. Allan Garnham, P.Eng.

RE: Geotechnical Investigation
Proposed Bridge Replacement
Imperial Road, Port Bruce, Ontario

We take pleasure in enclosing one (1) copy of our Geotechnical Investigation Report carried out at the above-referenced Site. Soil samples will be retained for a period of three (3) months and will thereafter be disposed of unless we are otherwise instructed.

If you have any questions or clarifications are required, please contact the undersigned at your convenience.

We thank you for giving us this opportunity to be of service to you.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

Eric Y. Chung, M. Eng., P.Eng.
Principal Engineer

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LIST OF ENCLOSURES

1.0 INTRODUCTION

CHUNG & VANDER DOELEN ENGINEERING LTD. (CVD) has been retained by K. Smart Associates Limited to carry out a subsurface investigation for the proposed reconstruction of the bridge on Imperial Road over Catfish Creek in Port Bruce, Ontario.

It is understood that the previous bridge has partially collapsed in early 2018, and the remainder has been demolished later that year, except for the south abutment.

A review of bridge drawings from 1962 indicates that the demolished bridge was a three-span structure, about 75 m long and 13 m wide. Two piers were located on either side of the river channel and founded on concrete-filled tube piles. The abutments located about 11 m from the piers were founded on spread footings.

It is our understanding that the replacement bridge will be constructed as a three-span semi-integral abutment bridge with a layout similar to the previous bridge. No detail design drawings of the proposed bridge were available at the time of report preparation.

The purpose of the investigation was to determine the subsurface conditions at the site and, based on the findings, make geotechnical recommendations for the design and construction of the foundation elements of the proposed replacement bridge, and possible widening of the approach embankments.

2.0 FIELD WORK

In order to investigate the subsurface conditions at the site, two (2) boreholes were advanced to depths between 30.94 and 46.18 m below ground surface between March 26 and 28, 2019. The borehole locations are indicated on the Borehole Location Plan, Drawing No. 1.

The field work was carried out under the supervision of a member of our engineering team, who logged the boreholes in the field, effected the subsurface sampling, and monitored the groundwater conditions.

The boreholes were advanced using a track-mounted drilling rig, supplied and operated by a specialized contractor. The drill rig was equipped with 108 mm I.D. continuous hollow stem augers, mud rotary tooling and standard soil sampling equipment. Standard penetration tests (SPTs) in accordance with ASTM Specification D1586, were carried out at frequent intervals of depth, and the results are shown on the Borehole Logs as Penetration Resistance or “N”-values. The undrained shear strength of the cohesive soil deposit was determined on the slightly disturbed SPT samples using a field pocket penetrometer. The compactness condition or consistency of the soil strata has been inferred from these test results.

The location and ground surface elevation of the boreholes were surveyed by CVD for the purpose of this report. The ground surface elevations were referenced to two temporary benchmarks (TBM) which are shown on Drawing No. 1 and described below:

TBM 1: Cut cross in concrete curb at the southeast corner of the intersection of Imperial Road and Dexter Line, as shown on Drawing No. 1
Elevation: 178.62 m (geodetic)

TBM 2: Cut cross in concrete curb at the southwest corner of the intersection of Imperial Road and Rush Creek Line, as shown on Drawing No. 1
Elevation: 178.73 m (geodetic)

3.0 LABORATORY TESTING

Soil samples obtained from the in-situ tests were examined in the field and subsequently brought to our laboratory for visual and tactile examination to confirm field classification. Moisture content determination of all retrieved samples occurred.

In addition, nine (9) grain size distribution analyses and three (3) sets of Atterberg Limits were performed on the major soil deposits to confirm field identification and to provide information on the soil properties.

4.0 EXISTING SITE CONDITIONS

The previous bridge was located on Imperial Road over Catfish Creek in Port Bruce, Ontario. The bridge was a three-span structure, about 75 m long and 13 m wide. Two piers were located on either side of the river channel.

The river channel is about 35 m wide at the bridge location. The water level in the creek was recorded at 174.58 m on March 2019. The river banks are at elevation between 176.0± and 176.5± m and the ground surface slopes about 3 m upwards on either of the river banks.

On the north side, the approach embankment is all that remains from the previous bridge, whereas on the south side the concrete abutment still stands.

5.0 SUBSURFACE CONDITIONS

The detailed subsurface conditions encountered in the two (2) boreholes advanced as part of this investigation are shown on the Borehole Log Sheets, Enclosures 1 and 2, inclusive. The following sections provide descriptions of the major soil deposits encountered in the boreholes.

Stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling conducted during advancement of the borehole drilling procedures and, therefore, represent transitions between soil types rather than exact planes of geologic change. The subsurface conditions may vary between and beyond the borehole locations.

In general, the surficial topsoil and fill were underlain by a deposit of very loose to loose sandy silt which on the north side was followed by very loose organic silt and loose to compact sand to silt. These fine granular deposits were in turn underlain by a major deposit of stiff to hard silty clay till followed by a hard sandy clayey silt till.

5.1 Topsoil

Topsoil was encountered at ground surface in Borehole 1, with a measured thickness of 450 mm.

5.2 Fill

A layer of fill was encountered at ground surface in Borehole 2 to and extended to a depth of approximately 0.76 m.

5.3 Sandy Silt

A deposit of sandy silt was encountered below the topsoil and fill materials in Boreholes 1 and 2. The sandy silt extended to respective depths of 4.42 and 2.90 m below ground surface. In Borehole 1, the sandy silt contained rootlets, peat seams, and sand seams in the upper 3 m below ground surface. Results of one (1) grain size distribution analysis from Borehole 1 are shown graphically on Enclosure 3.

The SPT “N”-values measured within the sandy silt ranged from 1 to 8 blows per 300 mm of penetration, indicating a very loose to loose compactness condition. The measured water content of the samples ranged between 21 and 29%, thus indicating a wet to saturated moisture condition.

5.4 Organic Silt

A deposit of organic silt was encountered below the sandy silt in Borehole 2 and extended to a depth of 4.42 m. The organic silt contained some sand, trace clay, and shell and wood fragments. Results of one (1) grain size distribution analysis from Borehole 2 are shown graphically on Enclosure 8.

The SPT “N”-value measured within the organic silt was 3 blows per 300 mm of penetration, indicating a very loose compactness condition. The measured water content of the samples ranged between 22 and 23%, thus indicating a saturated moisture condition.

5.5 Sand

A deposit of sand containing some silt was encountered below the organic silt in Borehole 2, and extended to a depth of 6.40 m.

The SPT “N”-values measured within the sand ranged from 6 to 15 blows per 300 mm of penetration,

indicating a loose to compact compactness condition. The measured water content of the samples ranged between 18 and 24%, thus indicating a saturated moisture condition.

5.6 Silt

A deposit of silt was encountered below the sand in Borehole 2, and extended to a depth of 11.58 m. The silt deposit contained trace sand, trace clay and occasional clay seams and sand seams. Results of one (1) grain size distribution analysis from Borehole 2 are shown graphically on Enclosure 9.

The SPT "N"-values measured within this silt deposit ranged from 12 to 28 blows per 300 mm of penetration, indicating a compact compactness condition. The measured water content of the samples ranged between 18 and 23%, thus indicating a saturated moisture condition.

5.7 Silty Clay Till

A deposit of silty clay till was encountered below the sandy silt and silt deposits in Boreholes 1 and 2. Borehole 2 was terminated within the silty clay till deposit at a depth of 30.94 m (elevation 137.63 m). In Borehole 1, the deposit was fully penetrated at a depth of 38.33 m (elevation145.91 m).

The silty clay till contained trace to some sand and trace gravel. Although not encountered within the boreholes, till deposit are known to contain occasional cobbles and boulders. Results of five (5) grain size distribution analyses from Boreholes 1 and 2 are shown graphically on Enclosures 4, 5, 6, 10 and 11.

The results of two (2) Atterberg Limit tests yielded Liquid Limits between 34 and 36%, Plastic Limits between 17 and 18% and Plasticity Indices between 16 and 19%. The test results indicate an inorganic silty clay with medium plasticity (CI).

The SPT "N"-values measured within this deposit ranged from 7 to 56 blows per 300 mm of penetration. The undrained shear strength obtained on the retrieved samples ranged from 48 kPa to over 250 kPa. Based on the above test results, the silty clay till is considered to have a firm to hard consistency. The measured water content of the samples collected from this deposit ranged between 17 and 24%, thus indicating a moist moisture condition.

5.8 Sandy Clayey Silt Till

A deposit of sandy clayey silt till containing trace gravel was encountered below the silty clay till in Borehole 1, which was terminated within the deposit at a depth of 46.18 m (elevation 129.78 m). Results of one (1) grain size distribution analysis from Borehole 1 are shown graphically on Enclosure 7.

The results of one (1) Atterberg Limit test yielded a Liquid Limit of 31%, Plastic Limit of 16% and a Plasticity Index of 15%. The test results indicate an inorganic clayey silt with low to medium plasticity (CL-CI).

The SPT "N"-values measured within this deposit ranged from 60 and 67 blows per 300 mm of penetration. The undrained shear strength obtained on the retrieved samples ranged between 190 kPa and over 250 kPa. Based on the above test results, the sandy clayey silt till is considered to have a hard consistency. The measured water content of the samples collected from this deposit ranged between 11 and 18%, thus indicating a moist moisture condition.

5.9 Groundwater

Groundwater conditions were monitored during and following completion of borehole sampling. A saturated condition was encountered at a depth of about 2.3 m in both boreholes. The water level of the river was recorded at elevation 174.58 m in March 2019. The water levels observed during and following the completion of drilling was consistent with the water level in the river.

It is noted that the observed groundwater table will fluctuate seasonally and in response to major weather events.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

It is understood that the previous bridge has partially collapsed in early 2018, and the remainder has been demolished later that year, except for the south abutment.

A review of bridge drawings from 1962 indicates that the demolished bridge was a three-span structure, about 75 m long and 13 m wide. Two piers were located on either side of the river channel and founded on concrete-filled tube piles. The abutments located about 11 m from the piers were founded on spread footings.

It is our understanding that the replacement bridge will be constructed as a three-span semi-integral abutment bridge with a layout similar to the previous bridge. No detail design drawings of the proposed bridge were available at the time of report preparation.

In general, the surficial topsoil and fill were underlain by a deposit of very loose to loose sandy silt which on the north side was followed by very loose organic silt and loose to compact sand to silt. These fine granular deposits were in turn underlain by a major deposit of stiff to hard silty clay till followed by a hard sandy clayey silt till.

A saturated condition was encountered at a depth of about 2.3 m in both boreholes. The water level of the river was recorded at elevation 174.58 m in March 2019. The water levels observed during and following the completion of drilling was consistent with the water level in the river.

6.2 Pile Foundation

The semi-integral design of the bridge demands the abutments to be supported on H-Piles. The demolished piers have been supported on concrete-filled battered tube piles which are assumed still remain in the ground. With the new piers possibly located near the location of the previous piers, it is likely that the buried battered tube piles may pose an obstacle to pile driving.

The recommendations given below are for H-piles as it is understood that this foundation option is preferred. Helical piers and drilled caissons may also be a feasible foundation option. If an alternative bridge design is chosen in the future, CVD will provide further recommendations for other deep foundation options.

6.2.1 Axial Pile Capacity

Typically, H-piles are designed as end-bearing on either rock or very dense soils. However, at this particular site, no soils adequate for supporting end-bearing piles were found to a depth of 46.18 m. Hence, it has been necessary to design the H-piles as friction piles. The design was based on empirically derived formulas as well as information obtained from pile load tests in similar soils.

The following table summarizes the embedment lengths and factored geotechnical resistance for two pile types:

Pile Embedment Length (m)	Factored Geotechnical Resistance for Different Pile Sizes (kN)	
	310x79	360x108
20	400	480
30	600	720
40	800	960

The above given factored axial geotechnical resistance values are at ULS. The settlement for these values would be less than 10 mm. The pile group effects will need to be evaluated in order to ensure that the pile group will not undergo excessive settlement. The piles should be spaced a minimum distance of 3 pile diameters apart.

It is recommended that a static pile load test be carried out in accordance with ASTM D1143. The test pile should be allowed a minimum 30 day set-up prior to testing in order to allow for pore water pressure dissipation required for the pile to reach the full load capacity.

The geotechnical resistance factor can be increased from 0.4 to 0.6 (possible 50% increase in design resistance) if a load test is carried out.

The minimum pile spacing should be calculated in accordance with the CHBDC.

6.2.2 Lateral Resistance for Piles

To provide the required flexibility in the piles, the top 3 m of each pile below the abutment stem should be surrounded by a 600 mm diameter CSP as specified by the integral abutment design procedure in MTO Report SO-96-01 “integral Abutment Bridges”. The space between the pile and the pre-drilled oversize hole should be backfilled with sand after the pile is driven. The lateral resistance may be assumed to have a value of ks = 1,200 kPa/m.

The lateral resistance of the piles and the depth to the point of contraflexure may be analyzed on the basis of an assumed value of ks. A coefficient of horizontal subgrade reaction of 2,000 kPa/m for the upper very loose sandy silt and 15,000 kPa/m for stiff to hard silty clay till.

The value for k_s must be reduced based on the closeness of the piles and the direction of the applied lateral loading. The reduction factors are listed in the following table.

Reduction Factors for Pile Spacing in Pile Groups

Pile Spacing Perpendicular to Direction of Loading		Pile Spacing in Direction of Loading	
centerline to centerline distance between Piles	reduction factor (multiply k_s by factor)	centerline to centerline distance between Piles	reduction factor (multiply k_s by factor)
4 **D** and more	1	8 **D** and more	1
3.5 **D**	0.69	6 **D**	0.7
2.5 **D**	0.63	4 **D**	0.4
2.0 **D**	0.5	3 **D** and less	0.25

Note: **D** is the pile diameter

6.2.3 Pile Driving

The silty clay till and the underlying sandy clayey silt till has hard zones throughout its stratum and hard driving may be encountered in these zones. Also, it is possible that cobbles and boulders may be present in the till soil, and as such appropriate measures should be taken by the piling contractor. The piles should be provided with driving shoes in accordance with OPSD 3301.00.

In accordance with MTO standard practice, the piles should be driven to pre-determined elevations (embedment lengths). If the driven pile encounters refusal above the recommended elevations, the geotechnical engineer should be notified immediately.

The pile driving should be carried out using a hammer capable of delivering energy of at least 40 kJ but not exceeding 60 kJ.

During the driving process, piles, which have already been driven, should be monitored to determine if they are heaving due to the effects of driving adjacent piles. If this phenomenon occurs, the affected piles should be re-driven.

The base of the pile caps should be provided with a minimum 1.2 m of earth cover for frost protection purposes.

6.3 Seismic Considerations

The seismic assessment has been prepared based on the currently proposed bridge and foundation design and existing ground conditions with accordance to the Canadian Highway Bridge Design Code, version CSA S6-14 (CHBDC).

Based on the underlying soils encountered at the boreholes, the site can be classified as a Site Class C in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC.

In accordance with Section 4.4.3.1 of the CHBDC, the reference (Site Class C) peak seismic hazard values specific to the bridge location have been obtained from the Geological Survey of Canada (GSC) website and are attached in Appendix B. These reference values must be modified to site specific values in accordance with Section 4.4.3.3 of the CHBDC. The PGA_{ref} for the use with Tables 4.2 to 4.9 shall be taken as 0.8 of PGA (for Class Site C) if Sa(0.2)/PGA is less than 2.0 hence, the PGA_{ref} value is 0.063.

The following site-specific seismic hazard values given below can be used to design (based on a 2% exceedance in 50 years – 2,475 year return period):

- PGA (g) = 0.079
- PGV (m/s) = 0.061
- Sa(0.2) (g) = 0.128
- Sa(0.5) (g) = 0.078
- Sa(1.0) (g) = 0.044
- Sa(2.0) (g) = 0.022
- Sa(5.0) (g) = 0.005
- Sa(10.0) (g) = 0.002

The liquefaction susceptibility of granular soils was evaluated in accordance with Section C4.6.6 of the CHBDC Commentary. The analysis involves comparing the cyclic shear stress applied to the soil by the design earthquake to the cyclic shear stress, represented by the cyclic stress ratio (CSR) and cyclic resistance ratio (CRR), respectively. The results of the liquefaction assessment indicate the granular soils at the bridge abutments would not be liquefiable when subject to the design earthquake loading.

6.4 Lateral Earth Pressure

The lateral earth pressures acting on the bridge abutments will depend on the type and method of placement of the backfill materials and on the subsequent lateral movement of the structure. The lateral earth pressures to be used in the design should be computed in accordance with Section 6.12 of CAN/CSA-S6-14.

The granular backfill should conform to OPSS Form 1010 for either Granular “A” or “B” Type II. To maintain free-draining characteristics in granular fill materials, the maximum percentage passing the No. 200 sieve (75 mm) should be limited to 8%. The excavated material is not considered suitable as granular backfill. Free-draining granular material specified above should be imported.

The backfill should be placed in accordance with OPSS 501. Any slopes should be benched as per OPSD 208.010 prior to backfill placement. A perforated sub-drain must be installed behind the walls with a positive outlet to maintain the granular fill in a drained condition. Alternatively, weep holes can be used to effect drainage.

The lateral earth pressure, P_h, may be computed using the equivalent fluid pressures presented in Clause 6.12.2.3 of CAN/CSA-S6-14.

Alternatively, the following equation based on unfactored earth pressure distributions can be used:

$$P_h = K\ (\gamma\, h + q)$$

Where:

K = earth pressure coefficient, use value from table below
γ = unit weight of soil = 21.2 kN/m^3 for Granular "B" Type II
= 22.8 kN/m^3 for Granular "A"
h =depth below top of wall, m
q = surcharge pressure, of 0.8 m of fill as per Clause 6.12.5, CAN/CSA-S6-14

Wall Type	**Earth Pressure Coefficient (K)**	
	Granular "A" (ϕ = 35°)	**Granular "B" Type II (ϕ = 34°)**
Non-Yielding Wall (K_o)	0.43	0.44
Yielding Wall (K_a)	0.27	0.28

The submerged unit weight of the backfill should be used for any submerged portion of the granular backfill when calculating the lateral earth pressure.

The above parameters are based on a horizontal back slope (not exceeding 5°) behind the retaining walls.

A compaction surcharge equal to 12 kPa should be included in the lateral earth pressures for the structural design of the abutment and retaining walls in accordance with Clause 6.12.3 of CAN/CSA-S6-14.

Vibratory equipment for use behind retaining walls should be restricted in size as per current MTO practices.

In accordance with Section 4.6.5 of the CHBDC, seismic loading must be considered in the design of soil retaining structures. The seismic active pressure coefficients presented below can be used for design for retaining walls where the ground above the walls is horizontal (flat).

Wall Type	Seismic Active Pressure Coefficient (K_{AE})	
	Granular "A" (ϕ = 35°)	Granular "B" Type II (ϕ = 34°)
Non-Yielding Wall	0.30	0.31
Yielding Wall	0.27	0.28

6.5 Construction and Groundwater Control

Excavation for this project will involve the removal of the existing bridge structure, excavation for the pile driving at the abutments and demolition of a portion of the existing building attached to the bridge.

The excavation is expected to be 2 to 5 m deep below the existing road surface and may be some 1 to 2 m below the Catfish Creek water level. Excavations to depths of 5 m should not present any special difficulties using heavy excavation equipment.

All excavations must be carried out in compliance with the requirements of the current Occupational Health and Safety Act (OHSA). For this purpose, the upper fill materials, very loose sandy silt and organic silt are classified as Type 4 soils. Within the Type 4 soils, the excavation should be cut to no steeper than 3H:1V throughout.

Due to the proximity to the river, temporary steel sheeting (sheet piling) will most likely be used to enclose the abutment area to support the soil and water pressure and to provide positive cut off against water ingress from the river/groundwater. If positive cut off cannot be achieved with the steel sheeting enclosure, dewatering with well-points could be required.

Proper groundwater control must be maintained throughout the construction of the foundation and abutment walls and during backfilling. Where saturated granular deposits are exposed, the cut slopes may have to be temporarily flattened during excavation until the groundwater bleeds out.

A granular working platform will be required to support the construction equipment to drive the H-piles and steel sheeting. Prior to placing fill materials, the areas where steel sheet piles will be driven should be prepared by removing any boulders or obstructions which may be present. The fill should be coarse pit-run sand and gravel materials, placed in thin layers and compacted to 98% SPMDD for the support of the construction equipment.

Even with the installation of the steel sheeting enclosure, the sand/silt subgrade soils are saturated and could be unstable to support the formwork for the pile cap. A relatively thick layer of clear stone should be placed on the subgrade to provide such support and to act as a drainage layer to facilitate removal of surface water and groundwater by a sump pump. Further, it is recommended that the joints between each steel sheet be monitored for leakage which should be maintained to a manageable level with the use of sump pumping.

Vibration induced settlement and cracking could result from driving the steel sheeting, H-piles, compaction equipment and simply construction traffic. Dewatering the upper very loose sandy silt layer may produce settlement. It is therefore recommended that a pre-construction condition survey of the structures on the neighbouring properties be carried out to document the existing condition of these structures.

It is noted that the concrete filled tube piles (especially the battered ones) supporting the former bridge may hinder the advancement of the steel sheet piles and the driving of the steel H-piles. Consideration should be given to extracting the existing steel tube piles prior to driving steel sheeting and H-piles.

6.6 Shored Excavation

As excavation is expected to be in the order of 2 to 5 m deep, a shoring system will be required for temporary excavation support during construction where sufficient space is not available for open cut excavation and to support the adjacent structures. Possible shoring supports include steel sheeting, soldier pile and timber lagging system or caisson wall.

The shoring system is generally designed and built by a specialized shoring contractor. The shoring system should be designed in accordance with the guidelines provided in the Canadian Foundation Engineering Manual (CFEM) 4th Edition.

The shoring system will have to withstand the lateral earth pressure, the adjacent roadways, buried services and the traffic loads as well as the adjacent building structures. Frost pressures on the shoring system should be considered if the concrete-filled is exposed to winter freezing condition. The shoring system should be monitored to ensure deflection and lateral movements are acceptable, and modifications made to the shoring system if deflection and lateral movements become a problem.

The following soil parameters may be used in the design of shoring. K_o (at rest condition) should be used where the shoring will need to support any existing building/structure.

Soil	Unit Weight (kN/m^3)	Friction Angle (ϕ^0)	Undrained Shear Strength (C_u, kPa)	K_o	Ka	Kp
Fill Materials	19	28	n/a	0.53	0.36	2.77
Very Loose to Loose Sandy Silt to Sand	18	26	n/a	0.56	0.39	2.26
Stiff Silty Clay	18	20	150	0.62	0.49	2.04

The shoring system can be supported by soil anchor tie-backs and/or raker footings. Soil anchors will provide an unobstructed open space for construction whereas raker supports will obstruct the forming and construction of pile cap and abutment wall.

6.7 Embankment Widening

If the approach embankments are to be widened, the surficial topsoil, very loose to loose sandy silt and organic silt and any deleterious materials should be stripped or excavated prior to placing fill materials. The fill to be used for embankment construction should be imported granular materials. Embankments constructed using these materials and/or approved imported suitable soils can be safely constructed with side slopes of not steeper than 2.5 H:1V. The slope surface is protected with rip-raps.

Backfill adjacent to the abutments should be carried out in conformance with OPSD 3501.00, and the fill should be placed in accordance with OPSS 501. The fill placement should begin at the toe of the embankment, in levelled lifts and each lift compacted to at least 95% SPMDD. The new embankment fill should be benched into the existing embankment as per OPSD 208.010.

After stripping, the exposed subgrade should be inspected and approved by the geotechnical engineer. The approved subgrade should then be proof-rolled using a heavy compactor, as directed by the engineer. If water is encountered during stripping and preparation of the subgrade to receive the embankment fills, gravity drainage and pumping from open filtered sumps should suffice.

Measures should be incorporated into the design and staging to ensure that the slope surfaces are protected from surface erosion. Proper erosion control measures should be implemented both during construction of the embankment fills and permanently. Erosion control during construction should be carried out by installing silt fences. Properly designed erosion control blankets could also be placed on any new embankments after completion of fill placement. A vegetative cover should be established as soon as practicale upon completion of fill placement to minimize the chances of surface erosion.

Revetments such as a rip-rap blanket should be provided at the toe of the slope to prevent erosion/scour by surface water. The design of the rip-rap blanket should be carried out cognizant of the stream hydraulics.

7.0 CLOSURE

The Limitations of Report, as quoted in Appendix A, is an integral part of this report.

We trust that the information presented in this report is complete within our terms of reference. If there are any further questions concerning this report, please do not hesitate to contact our office.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

Chris Sternik, P.Eng.
Geotechnical Engineer

Eric Y. Chung, M. Eng., P.Eng.
Principal Engineer

APPENDIX A

LIMITATIONS OF REPORT

APPENDIX "A"

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. CHUNG & VANDER DOELEN ENGINEERING LIMITED accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report. The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

APPENDIX B

2015 National Building Code Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 42.662N 81.015W **User File Reference:** Port Bruce 2019-06-14 18:40 UT

Requested by: Chris Sternik, CVD

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.108	0.062	0.037	0.010
Sa (0.1)	0.142	0.084	0.052	0.015
Sa (0.2)	0.128	0.078	0.050	0.016
Sa (0.3)	0.103	0.063	0.041	0.014
Sa (0.5)	0.078	0.049	0.032	0.011
Sa (1.0)	0.044	0.028	0.018	0.005
Sa (2.0)	0.022	0.014	0.008	0.002
Sa (5.0)	0.005	0.003	0.002	0.000
Sa (10.0)	0.002	0.001	0.001	0.000
PGA (g)	0.079	0.046	0.029	0.008
PGV (m/s)	0.061	0.036	0.023	0.006

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada Ressources naturelles Canada

Canada

ENCLOSURES

FILE No: G19736

BOREHOLE No. 1

Client: **K. Smart Associates Ltd.**

Project: **Imperial Road Bridge Replacement**

Location: **Port Bruce, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA/MR**
Size: **108 mm I.D./75 mm O.D.**
Date: **Mar 26 - 19** TO **Mar 27 - 19**

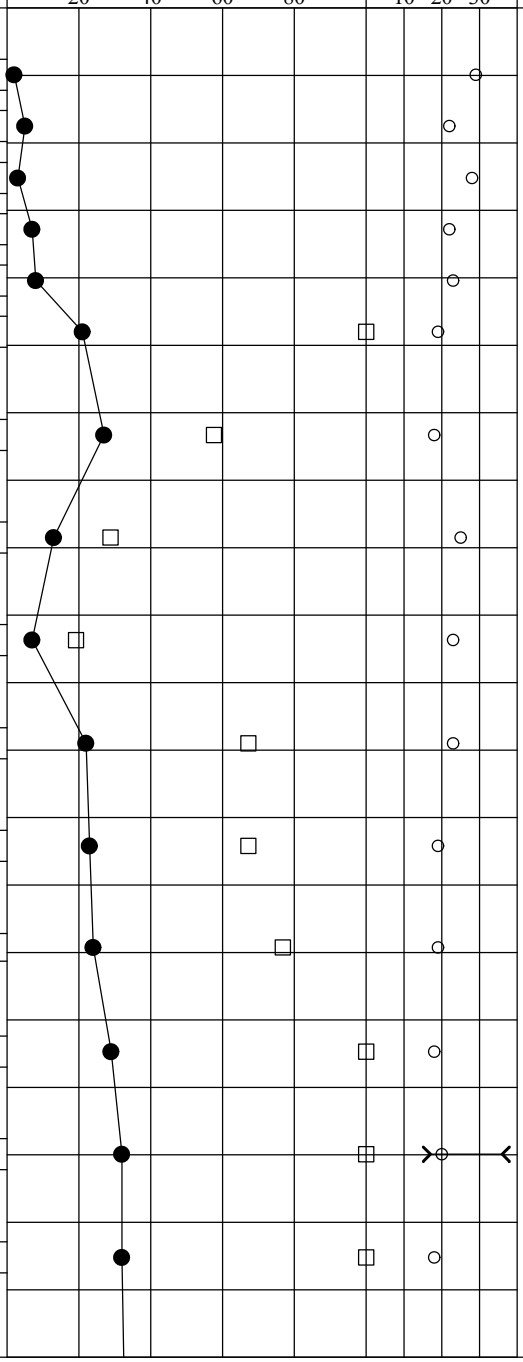
SOIL LITHOLOGY

Ground Elevation: **175.96 m**

ELEV./ DEPTH (m)	DESCRIPTION
175.51 / 0.45	450 mm TOPSOIL
	very loose to loose dark brown to grey SANDY SILT contains rootlets, peat seams and, sand seams in the upper 3 m wet to saturated
171.54 / 4.42	firm to hard brown to grey SILTY CLAY TILL trace to some sand trace gravel moist

SAMPLE

SAMPLE ID	TYPE	N-VALUE
1	SS	2
2	SS	5
3	SS	3
4	SS	7
5	SS	8
6	SS	21
7	SS	27
8	SS	13
9	SS	7
10	SS	22
11	SS	23
12	SS	24
13	SS	29
14	SS	32
15	SS	32



WELL DATA

REMARKS

- Borehole grouted upon completion of drilling
- saturated condition observed in Sample No. 3

PROJECT MANAGER: **CS**

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FILE No: G19736

BOREHOLE No. 1

Client: **K. Smart Associates Ltd.**

Project: **Imperial Road Bridge Replacement**

Location: **Port Bruce, Ontario**

EQUIPMENT DATA

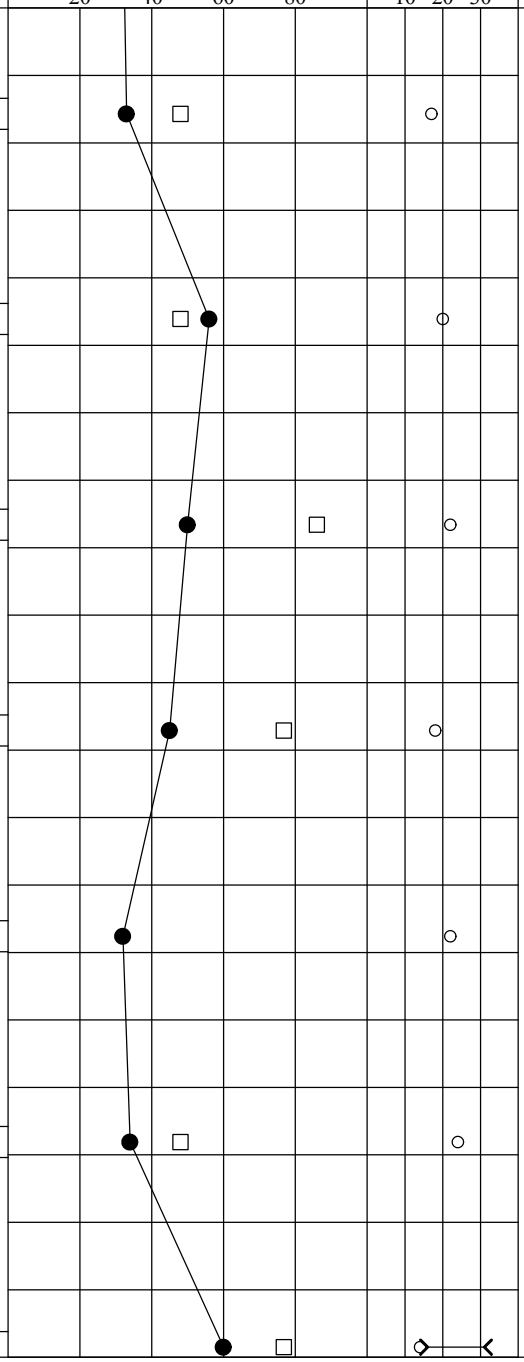
Machine: **Diedrich D50T**
Method: **HSA/MR**
Size: **108 mm I.D./75 mm O.D.**
Date: **Mar 26 - 19** TO **Mar 27 - 19**

SOIL LITHOLOGY

ELEV./ DEPTH (m)	DESCRIPTION (continued)
	------- firm to hard brown to grey SILTY CLAY TILL trace to some sand trace gravel moist
137.63 / 38.33	hard, grey SANDY CLAYEY SILT TILL trace gravel moist

SAMPLE

SAMPLE ID	TYPE	N-VALUE
16	SS	33
17	SS	56
18	SS	50
19	SS	45
20	SS	32
21	SS	34
22	SS	60



WELL DATA

DEPTH (m) 20.5 – 39.5

REMARKS

PROJECT MANAGER: **CS**

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FILE No: G19736

BOREHOLE No. 1

Client: **K. Smart Associates Ltd.**

Project: **Imperial Road Bridge Replacement**

Location: **Port Bruce, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA/MR**
Size: **108 mm I.D./75 mm O.D.**
Date: **Mar 26 - 19** TO **Mar 27 - 19**

SOIL LITHOLOGY (continued)

SHEAR STRENGTH (kPa): FIELD VANE: Peak ⊗ Rem. ×; LAB TEST: Unc. ■ P.P. □; 50 100 150 200

PENETRATION RESISTANCE: STANDARD ● DYN. CONE ○; 20 40 60 80

WATER CONTENT (%): W_P W W_L; 10 20 30

ELEV./ DEPTH (m)	DESCRIPTION	SAMPLE ID	TYPE	N-VALUE
	------ hard, grey SANDY CLAYEY SILT TILL trace gravel moist	23	SS	61
		24	SS	67
129.78 / 46.18	End of Borehole			

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FILE No: G19736

BOREHOLE No. 2

Client: **K. Smart Associates Ltd.**

Project: **Imperial Road Bridge Replacement**

Location: **Port Bruce, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA/MR**
Size: **108 mm I.D./75 mm O.D.**
Date: **Mar 28 - 19** TO **Mar 28 - 19**

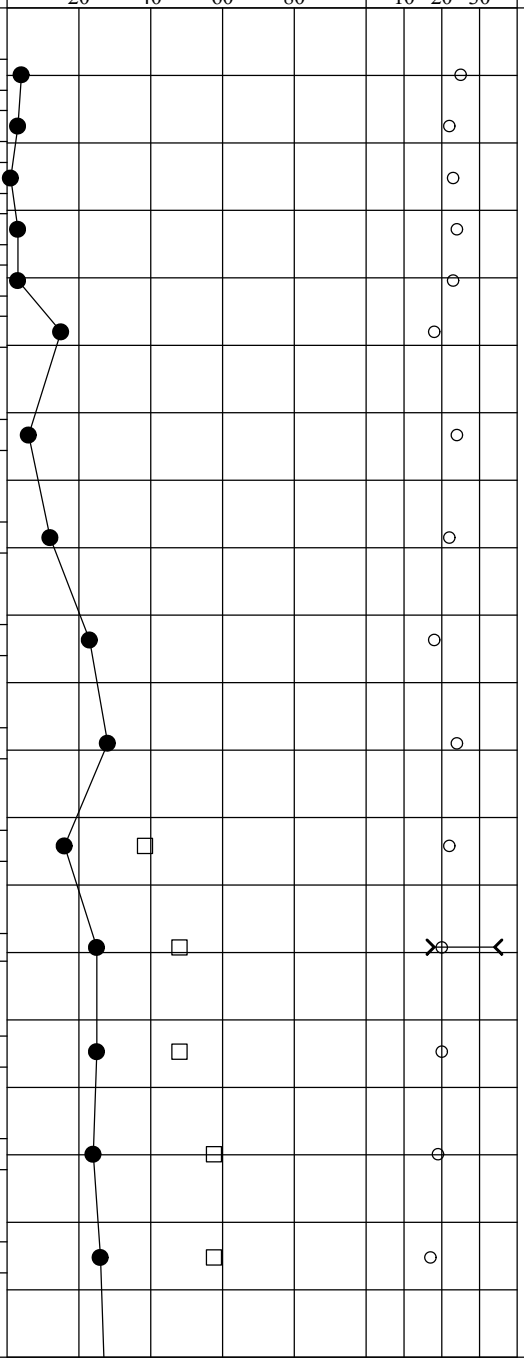
SOIL LITHOLOGY

Ground Elevation: **176.85 m**

ELEV./ DEPTH (m)	DESCRIPTION
176.09 / 0.76	loose, brown, FILL, sand and gravel, some silt, concrete fragments, moist
	very loose to loose, grey SANDY SILT saturated
173.95 / 2.90	very loose, grey ORGANIC SILT, some sand, trace clay, contains shells and wood fragments, saturated
172.43 / 4.42	losse to compact brown SAND some silt saturated
170.45 / 6.40	compact grey SILT trace sand, trace clay occ. clay seams, sand seams saturated
165.27 / 11.58	stiff to hard brown to grey SILTY CLAY TILL trace to some sand trace gravel moist

SAMPLE

SAMPLE ID	TYPE	N-VALUE
1	SS	4
2	SS	3
3	SS	1
4	SS	3
5	SS	3
6	SS	15
7	SS	6
8	SS	12
9	SS	23
10	SS	28
11	SS	16
12	SS	25
13	SS	25
14	SS	24
15	SS	26



WELL DATA

REMARKS

- Borehole grouted upon completion of drilling
- saturated condition observed in Sample No. 3

PROJECT MANAGER: **CS**

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FILE No: G19736

BOREHOLE No. 2

Client: **K. Smart Associates Ltd.**

Project: **Imperial Road Bridge Replacement**

Location: **Port Bruce, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA/MR**
Size: **108 mm I.D./75 mm O.D.**
Date: **Mar 28 - 19** TO **Mar 28 - 19**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa) FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200 PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	WATER CONTENT (%) W_P W W_L 10 20 30	WELL DATA		
ELEV./ DEPTH (m)	DESCRIPTION *(continued)*	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE				DEPTH (m)	REMARKS
	------ stiff to hard brown to grey SILTY CLAY TILL trace to some sand trace gravel moist	20.5								20.5	
		21.0								21.0	
		21.5		16	SS	28				21.5	
		22.0								22.0	
		22.5								22.5	
		23.0								23.0	
		23.5								23.5	
		24.0								24.0	
		24.5		17	SS	38				24.5	
		25.0								25.0	
		25.5								25.5	
		26.0								26.0	
		26.5								26.5	
		27.0								27.0	
		27.5		18	SS	37				27.5	
		28.0								28.0	
		28.5								28.5	
		29.0								29.0	
		29.5								29.5	
		30.0								30.0	
		30.5		19	SS	29				30.5	
145.91 30.94	End of Borehole	31.0								31.0	
		31.5								31.5	
		32.0								32.0	
		32.5								32.5	
		33.0								33.0	
		33.5								33.5	
		34.0								34.0	
		34.5								34.5	
		35.0								35.0	
		35.5								35.5	
		36.0								36.0	
		36.5								36.5	
		37.0								37.0	
		37.5								37.5	
		38.0								38.0	
		38.5								38.5	
		39.0								39.0	
		39.5								39.5	

PROJECT MANAGER: **CS**

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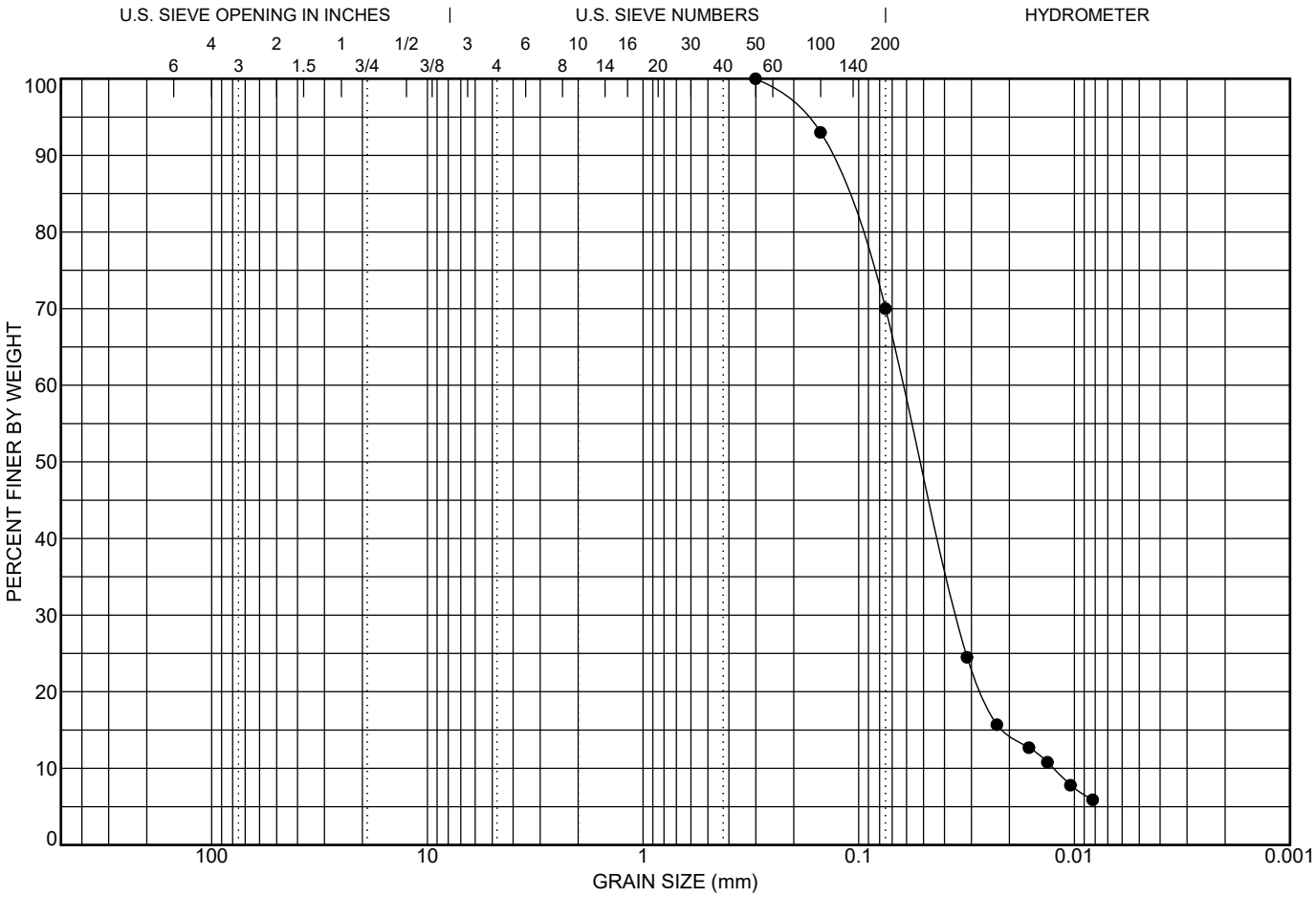

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			1.58	4.97	0.3	0.062	0.035	0.012	0.0	30.0	70.0	

Date: Mar. 27 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 1 - SA 5, 3.81 m to 4.27 m depth
Sample No.: 1-5
Date Sampled: Mar. 27 - 2019
Sampled By: CS
Lab No.: 0248
Date Tested: Apr. 04 - 2019
Type of Material: Sandy Silt

Sieve Size (mm)	Percent Passing	No Specifications

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Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

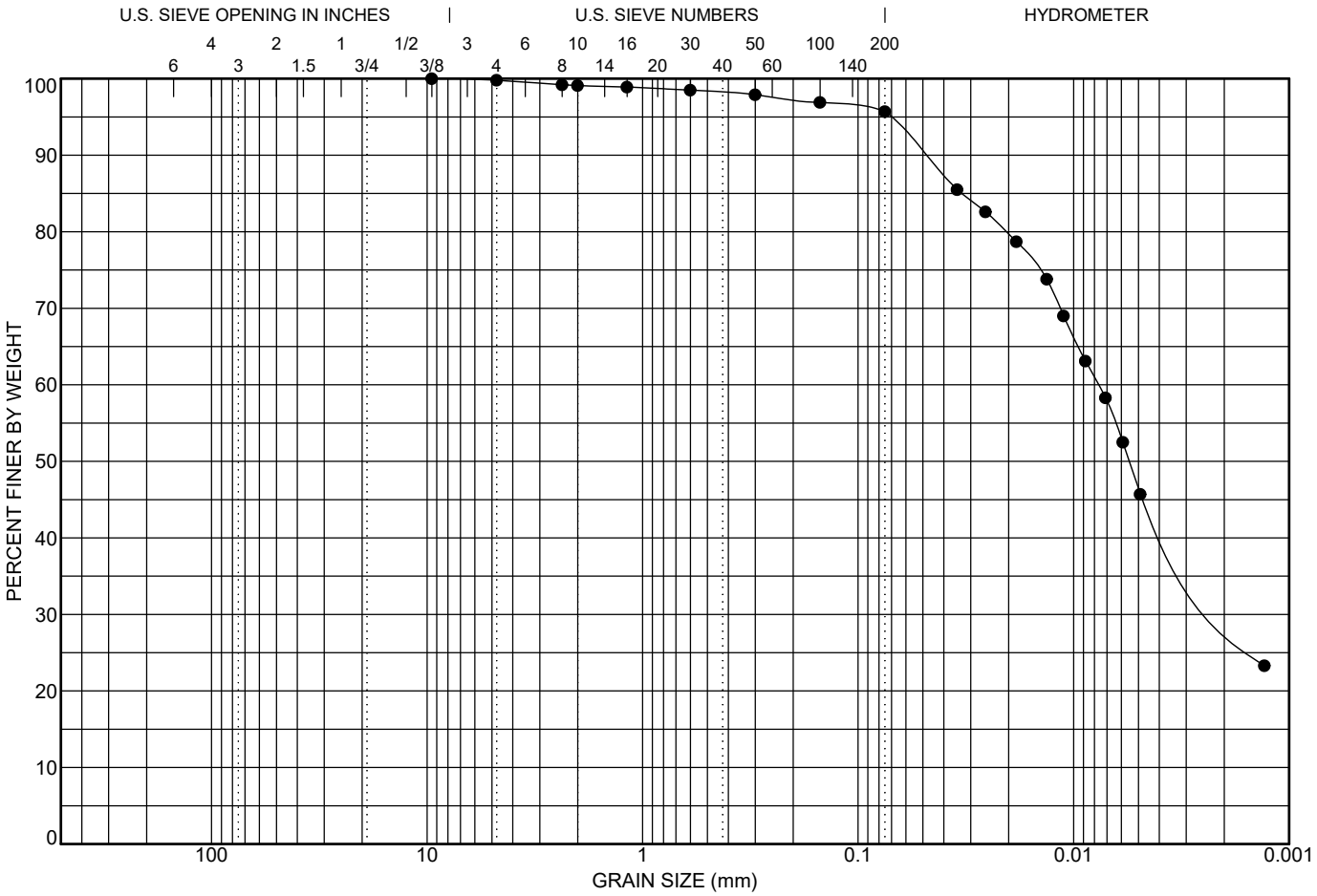
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 3

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					9.5	0.008	0.002		0.2	4.1	95.7	

Date: Mar. 27 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 1 - SA 9, 9.14 m to 9.60 m depth
Sample No.: 1-9
Date Sampled: Mar. 27 - 2019
Sampled By: CS
Lab No.: 0249
Date Tested: Apr. 04 - 2019
Type of Material: Silty Clay Till, trace sand

Sieve Size (mm)	Percent Passing	No Specifications

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Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

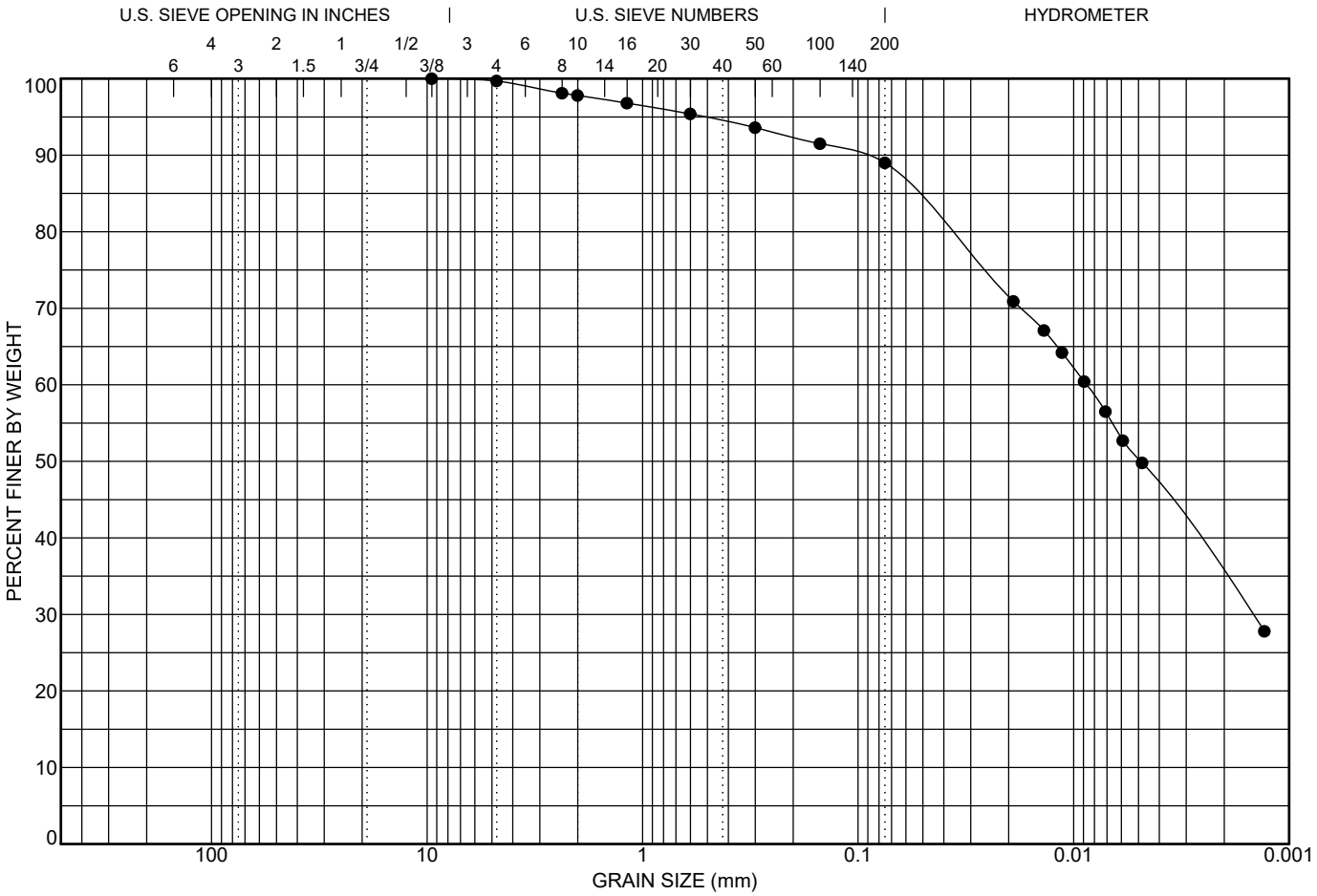
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 4

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
36	17				9.5	0.009	0.001		0.3	10.7	89.0	

Date: Mar. 27 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 1 - SA 14, 16.76 m to 17.22 m depth
Sample No.: 1-14
Date Sampled: Mar. 27 - 2019
Sampled By: CS
Lab No.: 0250
Date Tested: Apr. 04 - 2019
Type of Material: Silty Clay Till, some sand

Sieve Size (mm)	Percent Passing	No Specifications

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GRAIN SIZE DISTRIBUTION

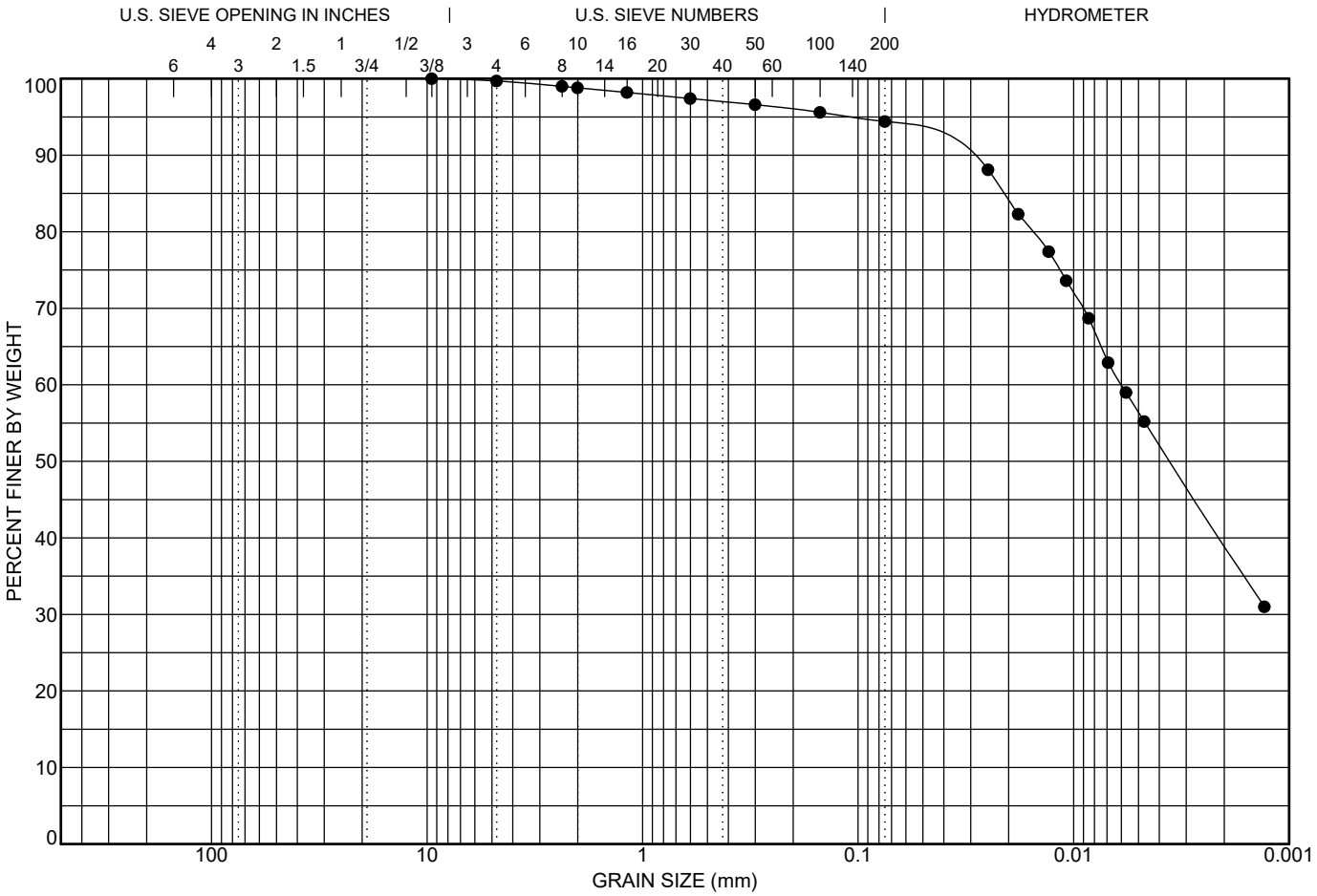
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 5

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					9.5	0.006			0.3	5.3	94.4	

Date: Mar. 27 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 1 - SA 18, 27.43 m to 27.89 m depth
Sample No.: 1-18
Date Sampled: Mar. 27 - 2019
Sampled By: CS
Lab No.: 0252
Date Tested: Apr. 04 - 2019
Type of Material: Silty Clay Till, trace sand

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
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311 Victoria Street North
Kitchener, Ontario N2H 5E1
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Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

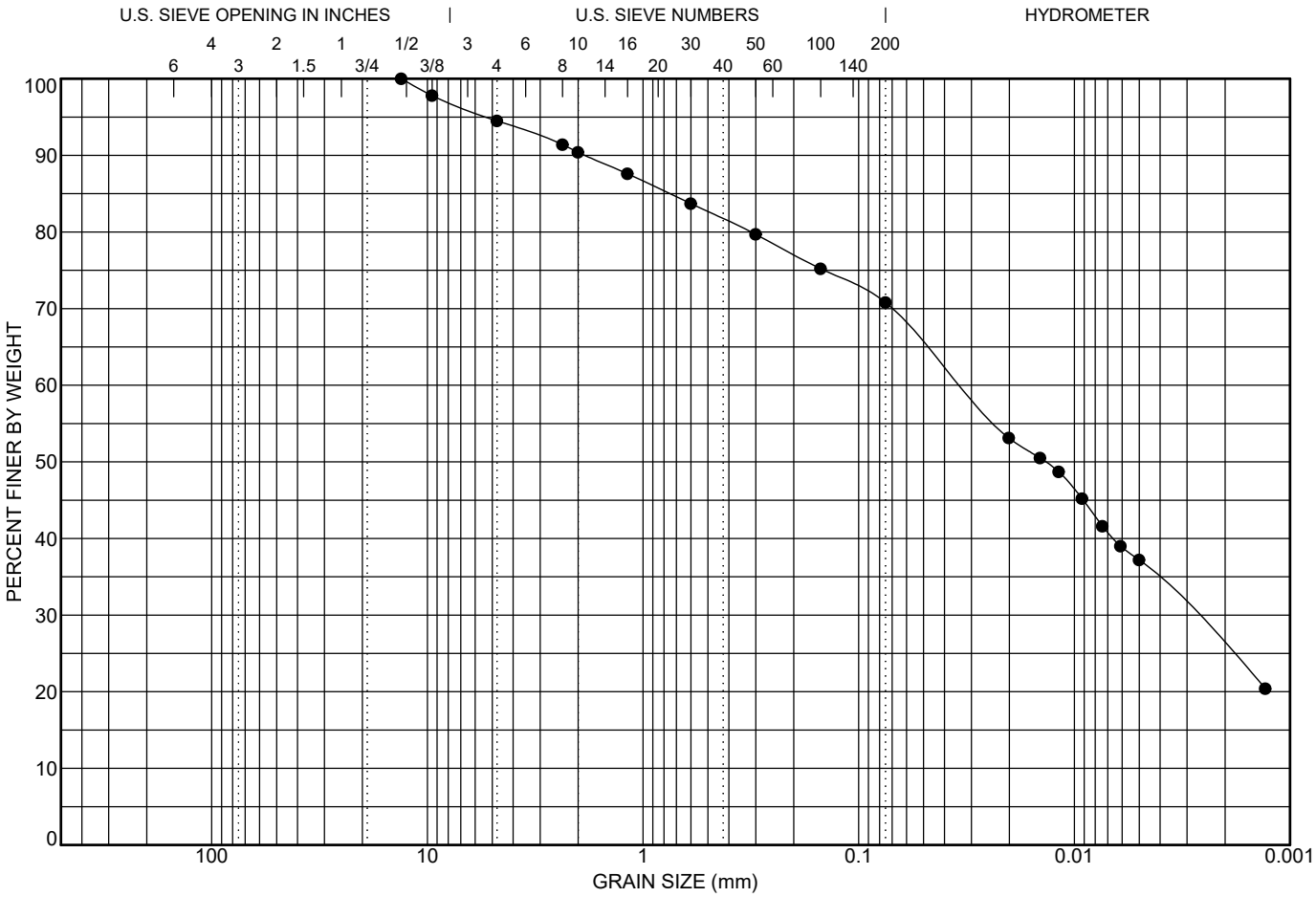
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 6

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
31	16				13.2	0.034	0.003		5.5	23.7	70.8	

Date: Mar. 27 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 1 - SA 22, 39.62 m to 40.08 m depth
Sample No.: 1-22
Date Sampled: Mar. 27 - 2019
Sampled By: CS
Lab No.: 0253
Date Tested: Apr. 04 - 2019
Type of Material: Sandy Clayey Silt Till, trace gravel

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
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GRAIN SIZE DISTRIBUTION

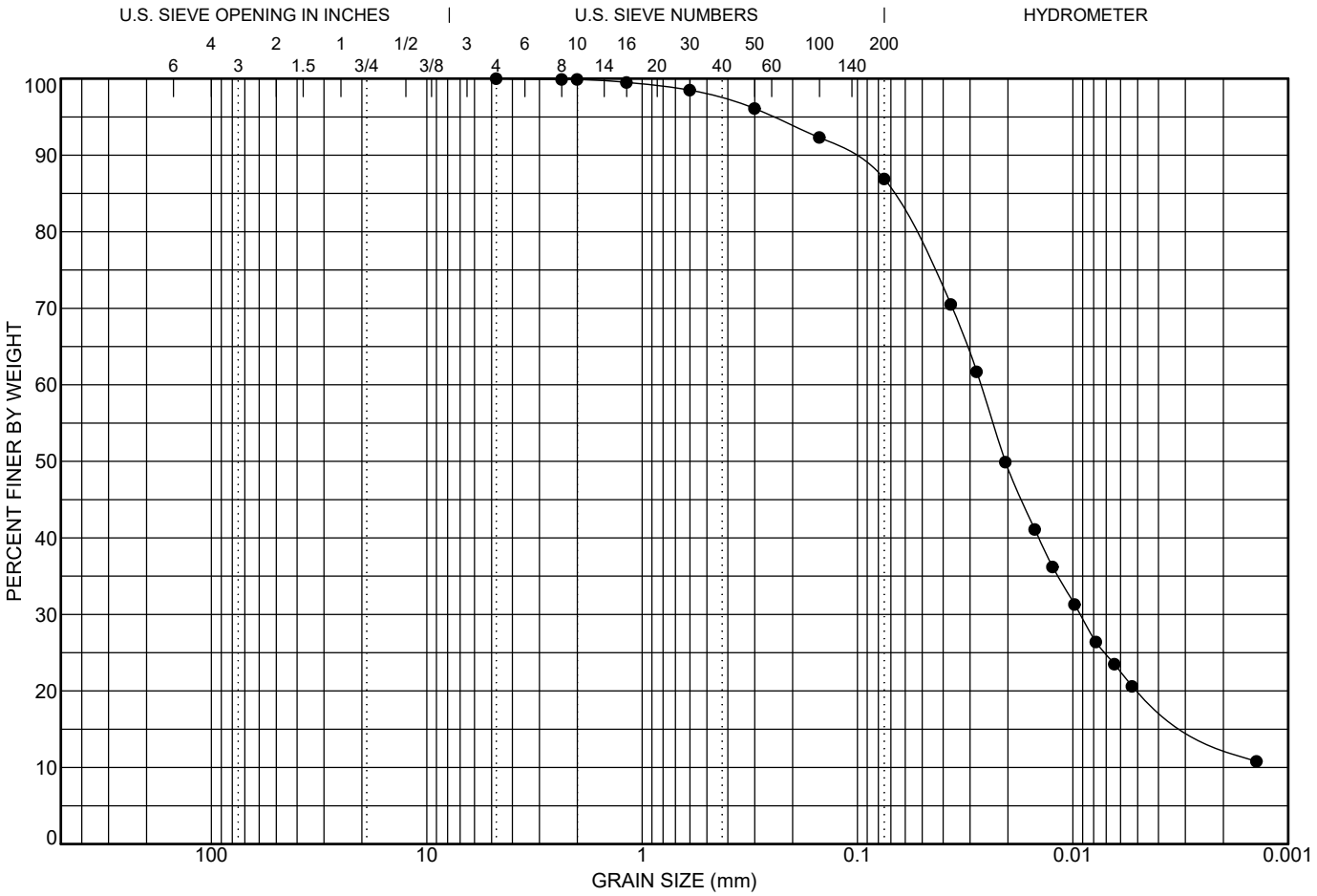
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 7

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					4.75	0.027	0.009		0.0	13.1	86.9	

Date: Mar. 28 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 2 - SA 5, 3.81 to 4.27 m depth
Sample No.: 2-5
Date Sampled: Mar. 28 - 2019
Sampled By: CS
Lab No.: 0255
Date Tested: Apr. 04 - 2019
Type of Material: Silt, some sand, trace clay, occ. clay seams

Sieve Size (mm)	Percent Passing	No Specifications

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Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

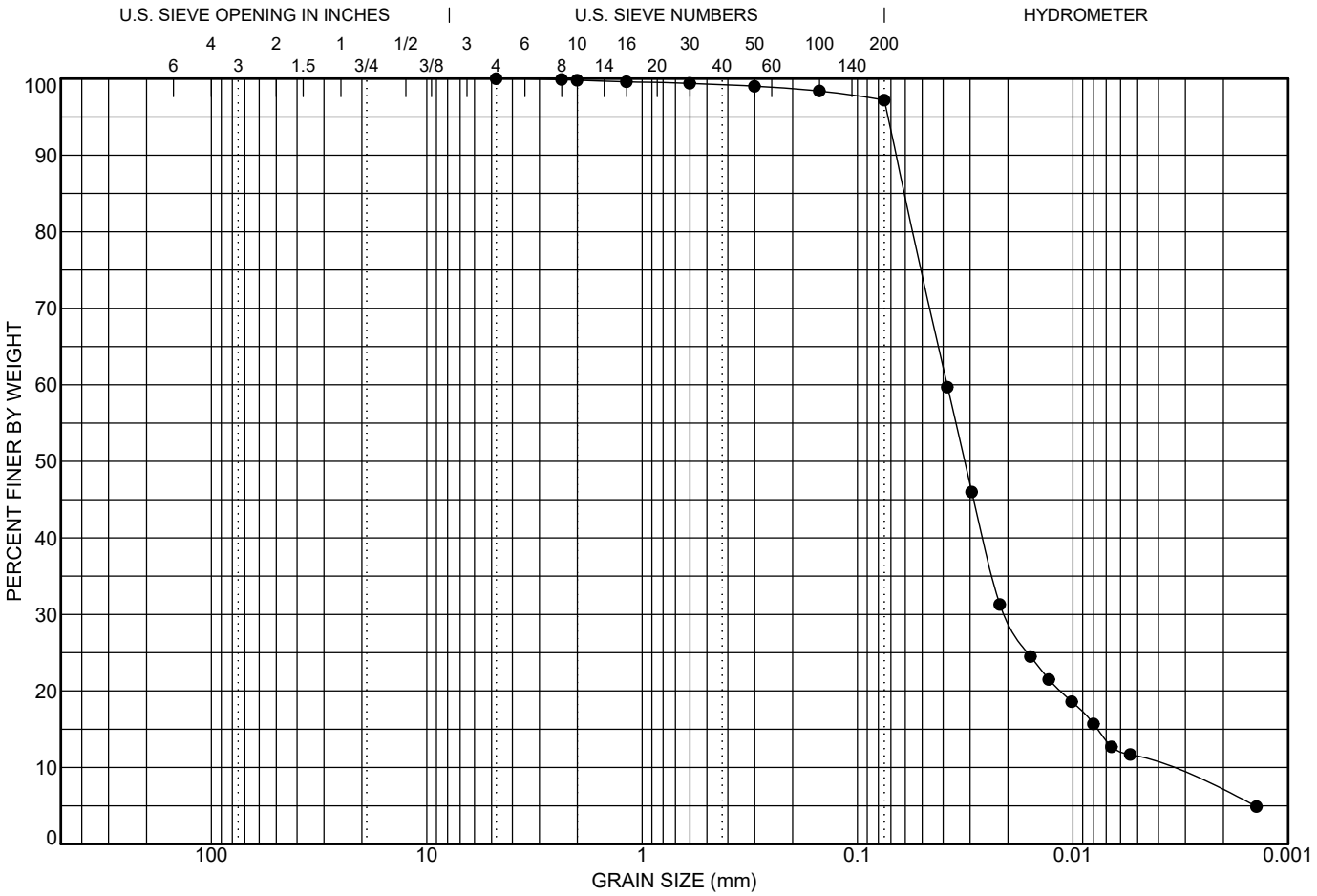
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 8

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			2.83	9.97	4.75	0.038	0.02	0.004	0.0	2.8	97.2	

Date: Mar. 28 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 2 - SA 10, 10.67 m to 11.13 m depth
Sample No.: 2-10
Date Sampled: Mar. 28 - 2019
Sampled By: CS
Lab No.: 0256
Date Tested: Apr. 04 - 2019
Type of Material: Silt, trace sand, trace clay

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

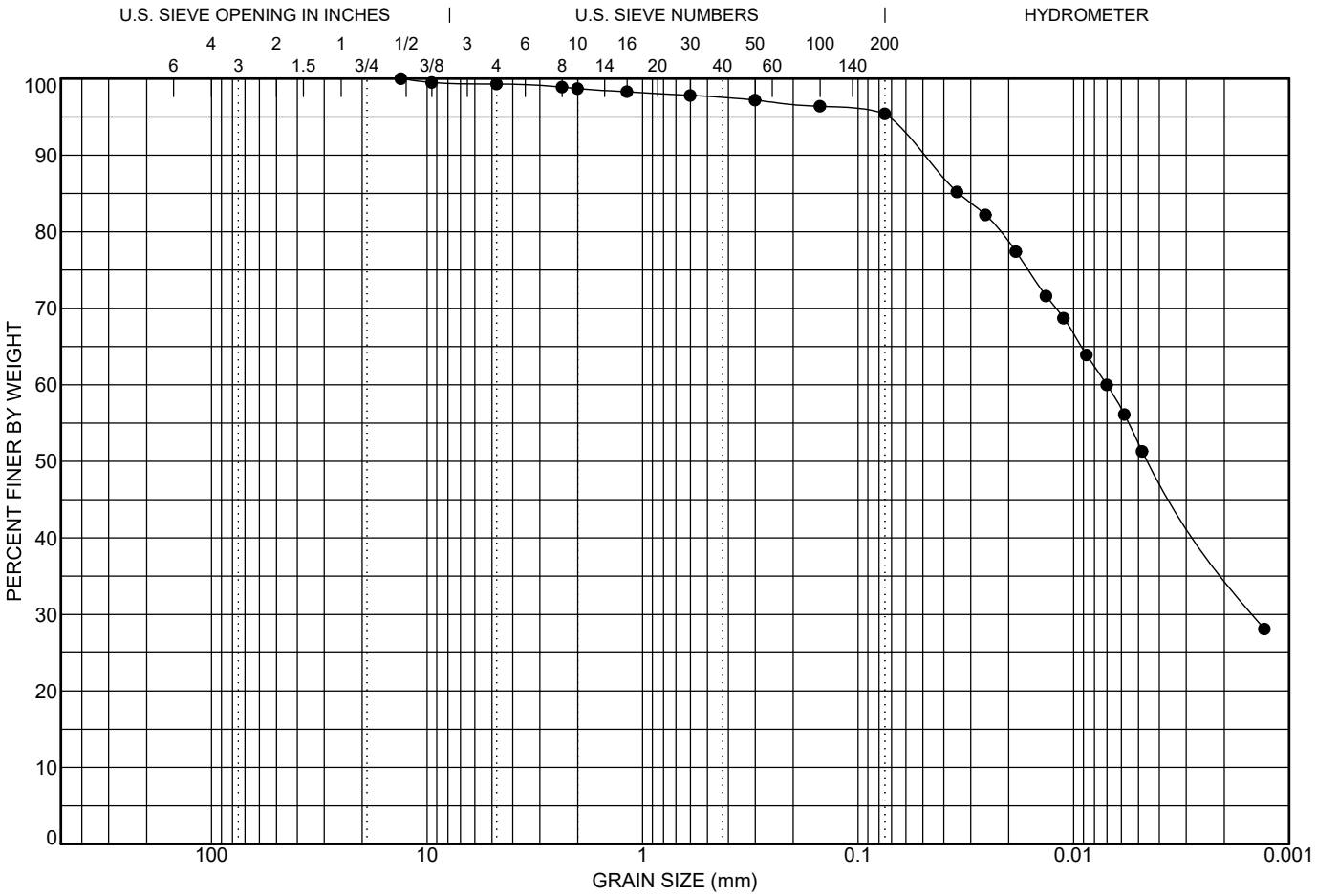
Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 9

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
34	18				13.2	0.007	0.001		0.7	3.9	95.4	

Date: Mar. 28 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 2 - SA 12, 13.72 m to 14.13 m depth
Sample No.: 2-12
Date Sampled: Mar. 28 - 2019
Sampled By: CS
Lab No.: 0257
Date Tested: Apr. 04 - 2019
Type of Material: Silty Clay Till, trace sand

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

Project: Imperial Road Bridge Replacement

Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 10

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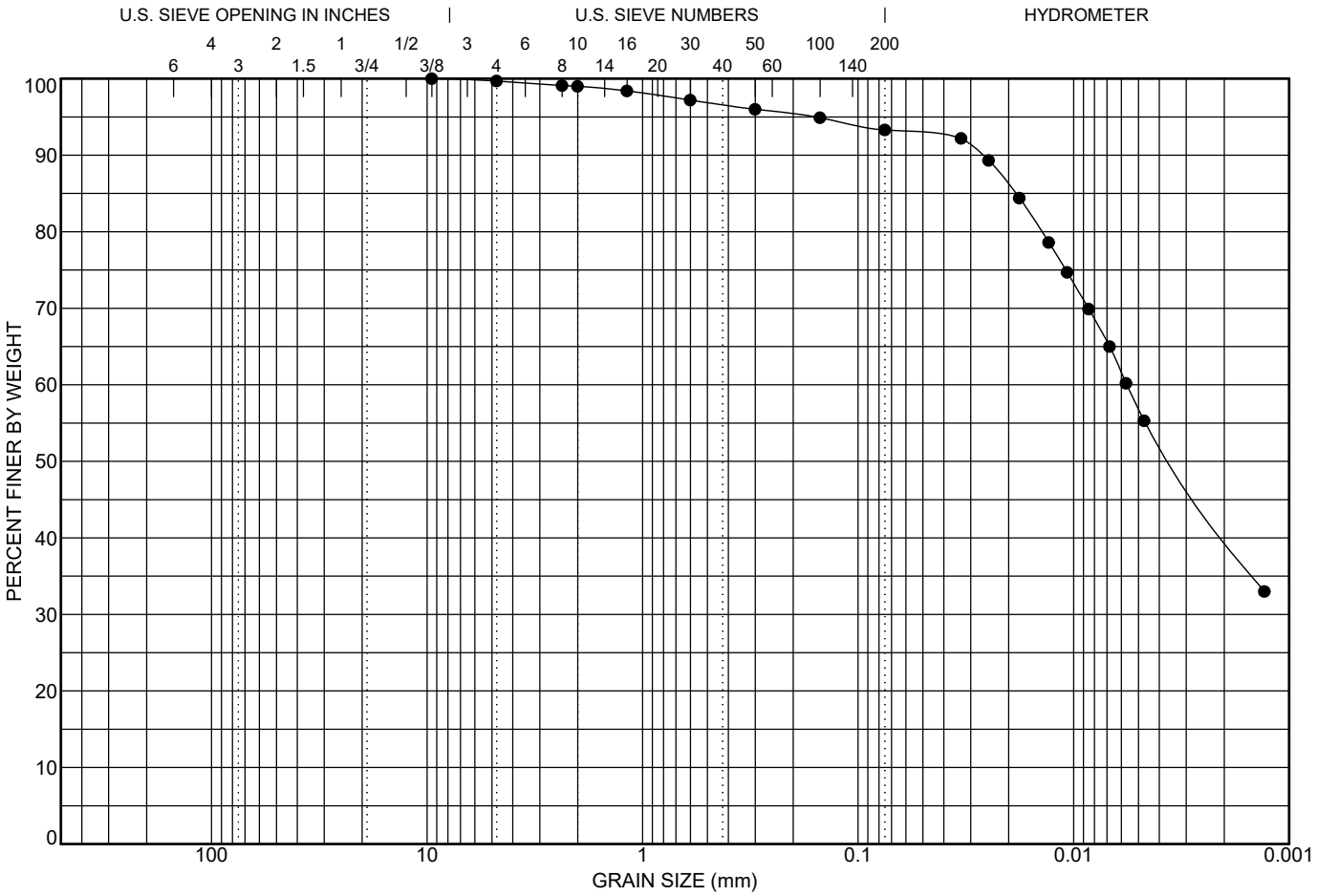


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					9.5	0.006			0.3	6.4	93.3	

Date: Mar. 28 - 2019
Client: K. Smart Associates Ltd.
Contractor:
Source:
Sampled From: BH 2 - SA 17, 24.38 m to 24.84 m depth
Sample No.: 2-17
Date Sampled: Mar. 28 - 2019
Sampled By: CS
Lab No.: 0259
Date Tested: Apr. 04 - 2019
Type of Material: Silty Clay Till, trace sand

Sieve Size (mm)	Percent Passing	No Specifications

CHUNG & VANDER DOELEN
ENGINEERING LTD.
311 Victoria Street North
Kitchener, Ontario N2H 5E1
Telephone: 519-742-8979
Fax: 519-742-7739
e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

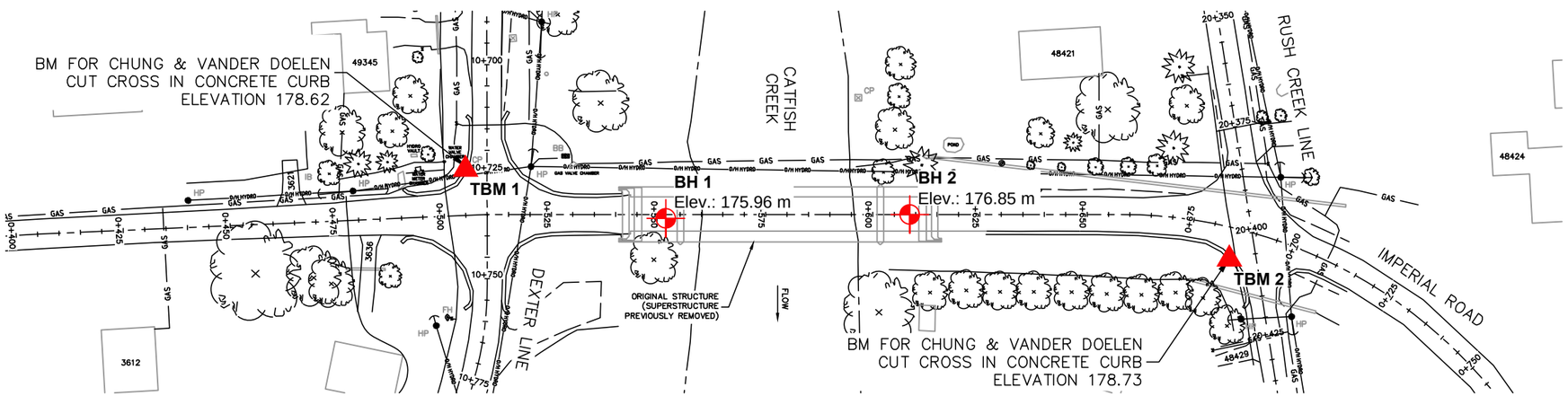
Project: Imperial Road Bridge Replacement

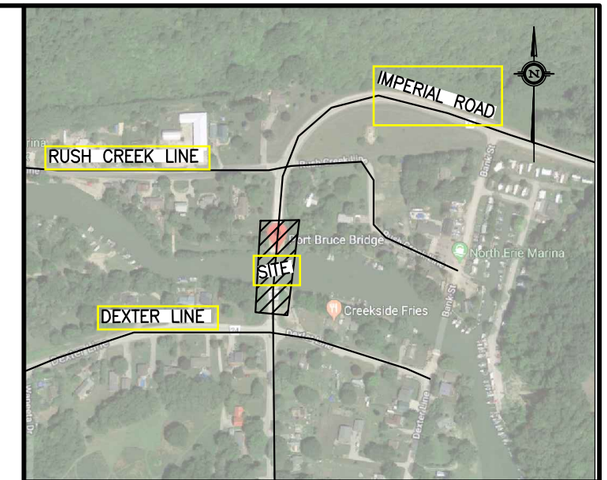
Location: Port Bruce, Ontario

File No.: G19736

Enclosure No.: 11

DM - NO SPECIFICATIONS G19736 PORT BRUCE.GPJ LAW LNDN.GDT 19-8-16





KEY PLAN **SOURCE:** Google Earth

LEGEND

- **TBM Location**
- **Borehole Location**

BOREHOLE LOCATION PLAN

Proposed Bridge Replacement

Imperial Road
Port Bruce, Ontario

CHUNG & VANDER DOELEN ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1 / 519-742-8979

Drawn By: AB	Date: August, 2019	File No.: G19736
Checked By: CS	Scale: 1:1250	Drawing No.: 1

12. Site Photos

North Approach (looking south)

South Approach (looking north)

North Approach (looking north)

South Approach (looking south)

Far South Approach (looking north)

Looking West (upstream)

Existing South Abutment

Single Lane Modular Bridge 150m Downstream

13. Potential Environmental Impacts and Mitigating Measures Associated with Implementation of the Preferred Alternative

13.1 Construction Process – In-Water Aspect

13.2 Construction Process – Terrestrial Aspect

13.1 Construction Process – In-Water Aspect

13.1.1 Removal and Demolition of Existing Substructure and Foundations

There are existing elements from the original bridge that will need to be removed to allow for the construction of the proposed alternative. Elements of the original bridge that remain are the entire south abutment (walls and footings), the north abutment footings, both pier footings, and both pier pile foundations. The steps involved in accomplishing this task are as follows:

- Installation of silt fence at the perimeter of the construction zone to prevent turtles and other small animals from entering the construction zone and to prevent the migration of silt from the construction zone.
- Installation of cofferdams around the piers to isolate these areas from the river;
- Dewatering of the area inside the cofferdams to allow any work to proceed in dry conditions;
- Demolition and removal of pier footings;
- Extraction of existing pier piles which will interfere with new piles;
- Demolition and removal of the south concrete abutment walls and footings;
- Demolition and removal of the north abutment footings;

Cofferdams will be strategically installed to allow for both demolition and removal of the existing pier footings and foundations, as well as to allow for the construction of new pier footings and abutments. Thus, removal and re-installation of steel sheeting for both purposes should be avoided. Prior to installation of cofferdams, a floating silt curtain will be installed in the water to contain any disturbance and prevent its spread throughout the remainder of the watercourse. Once the cofferdams are complete, the area inside will be dewatered to allow for work to proceed in dry conditions; conventional submersible pumps can be used. Prior to complete dewatering, all trapped aquatic life will be gathered (with nets) and relocated alive to the adjacent river as required by a qualified technician under a 'License to Collect Fish' obtained from the Ministry of Natural Resources and Forestry.

What remains of the concrete abutments and foundations will be demolished using a hydraulic excavator. As this general work will be contained within the cofferdams, all debris will be contained inside as well. After demolition, the debris will be removed via hydraulic excavator and re-used as roadway fill if deemed acceptable. Reinforcing steel (if any) will be recycled.

The cofferdams will remain intact until the foundation and abutments of the new structure are constructed and backfilled.

13.1.2 Construction of Piers and Abutments

All work associated with the construction of the new bridge piers and abutments will be completed entirely within the cofferdams that were previously installed to allow for existing structure removals.

Excavation of the river bed and embankments will be required to provide sufficient frost cover and to provide room for rock protection. Rock protection is required to prevent erosion/scouring of the stream bed in front of the abutments and surrounding the piers. This work will be contained within the cofferdams.

The foundation of the new bridge will be driven steel piles and will be designed for loads of the bridge as well as vehicular loads. Vehicular loads will be current loads as per the Canadian Highway Bridge Design Code. Again, all this work is contained within the cofferdams.

Cast-in-place concrete will be used to construct the pier footings and pier shaft, as well as abutments walls. Formwork comprised of wood and/or steel will be erected to contain the wet concrete. Steel reinforcing bars will be tied within the formwork to reinforce the concrete. After the concrete has cured, all formwork will be removed and disposed of outside the limits of the project. This work is isolated from the water by the cofferdams.

Backfilling of the piers and abutment will then take place. Backfill materials will be Granular "B" obtained from a licensed pit and trucked to the site. Backfill will be compacted to eliminate air pockets and to eliminate the potential for excessive settlements after the construction is complete. Rock protection will be placed in front of the abutments as dictated by the design. This work is again all contained within the cofferdams.

Once backfilling is complete, dewatering apparatus will be removed, allowing in the area within the cofferdams to be flooded. After flooding, the cofferdams will be completely removed. Once complete, the floating silt curtain will be removed shortly thereafter.

13.1.3 Construction of Superstructure

Once the bridge substructure is complete, construction of the bridge superstructure will begin. The superstructure will consist of:

- Steel girder installation
- Cast-in-place concrete deck construction
- Installation of a steel railing

The steel girders will be placed with a mobile crane from the roadway approaches. Prior to lifting the girders into place, a labourer will brush the girders with a broom to remove any foreign material (e.g. mud, tree branches, etc.) that may have collected on the girder during fabrication or transportation. This procedure will eliminate any foreign material from entering the river.

Once the steel girders are erected and temporarily secured in place, wood falsework will be installed between the girders to support a cast-in-place concrete deck. The girders themselves, the falsework, and the installation of a wood side form will prevent debris and wet concrete from entering the water below. Any small gaps between girders, falsework, and formwork will be sealed. Along the edges of the bridge, and between the girders, a temporary platform will be installed to facilitate construction. At the edges of the bridge deck, a railing will be installed to protect workers from the adjacent fall hazard. This railing can be utilized to protect workers from the adjacent fall hazard, as well as to contain debris from entering the river below.

Once the concrete deck has been cast and cured, the steel railing will be installed. The steel railing will be delivered to the bridge site via truck from a manufacturing facility.

Upon completion of the steel railing, the deck falsework and formwork will be removed. This operation will occur by a combination of the following methods: from the bridge deck itself by means of a bridge master or similar aerial lift, from the temporary platform previously constructed, or from a vessel floating in the river below. To prevent dust and debris from entering the river, a floating barge covered with tarps will be employed.

13.1.4 Water Quality and Quantity

There are no anticipated impacts to water quality or quantity in the river. The various aforementioned mitigation measures that will be implemented during various stages of construction are deemed sufficient to address the potential for aquatic impacts including sedimentation, fuel spillage and other deleterious substances. Proper spill response planning combined with appropriate fuel and chemical best management practices will ensure that precautions are exercised to prevent any spills from entering the river.

13.1.5 Fuel and Chemical Storage

Proper prevention and spill response procedures are to be put in place to deal with the potential for spills to occur during refueling and maintenance of equipment. Refueling, fuel storage, chemical storage, and maintenance of equipment is not to occur in or within 30 metres of any to watercourse. In addition, the Contractor will:

- Conduct proper spill response training for all personnel associated with chemical and fuel handling and storage;
- Be responsible for ensuring that all material required for the containment and cleanup of a spill is present, on site, in close proximity to fueling and maintenance areas; and
- Immediately report any fuel or chemical spills to the Ontario Spills Action Centre (1-800-268-6060).

13.1.6 Discharge of Excavation Water

All water which is pumped from the cofferdams during the construction will be piped to a dewatering trap. The dewatering trap will prevent the migration of sediment throughout the construction site and from entering the watercourse. The dewatering trap will be designed by the Contractor and will be located well away from the river and the edge of the excavations.

13.1.7 Aquatic Species-at-Risk

Various aquatic species-at-risk (SAR), identified elsewhere in this Report, have been identified as potentially being present near the bridge replacement site.

To mitigate against impacts to the various aquatic species-at-risk, the following is proposed:

- No in-water work will occur within the restricted window of March 15 to July 15;
- Installation of silt curtains, cofferdams, and silt fence to isolate the construction area by March 15th, prior to fish spawning and turtle nesting season (no overwinter habitat for turtles exist in the area of the site);
- Erosion and sediment control measures be installed prior to construction and maintained throughout the construction;
- A qualified biologist or environmental technician be retained to perform fish/mussel salvage and transfer operations during the installation and removal of cofferdams;
- Removal of cofferdams after August 15th.

13.2 Construction Process – Terrestrial Aspect

13.2.1 Roadway Approach Construction

In order to match the new bridge, the existing roadway approaches will need to be reconstructed. This reconstruction will require the removal of ground vegetation on the sideslopes of the roadway.

The grade change is necessary to achieve a safe, effective approach to the bridge. Not addressing the vertical alignment of the roadway and structure is not an option because the County is required to adhere to current design criterion for roadways set in place by Regulatory Agencies.

Minimizing the removal of vegetation is a project goal and will be achieved by;

- Minimizing the extent of the work during the design phase of the project
- Identifying the extent of clearing required prior to the commencement of work and demarking the area
- Restoring disturbed areas as the work progresses
- Avoiding equipment & material use or storage within naturalized and recently restored areas.

The implementation of these measures will minimize the amount of vegetation clearing/disturbance and maximize the amount of existing vegetation to be retained.

As the roadway construction will create the potential for materials to migrate towards the river, sufficient erosion and sediment control measures (e.g. silt fence, flow check dams, erosion control blankets, rock protection, re-seeding of exposed areas, etc.) will be incorporated into the work. These erosion and sediment control measures will be installed at strategic locations (e.g. existing ditches, construction limits, watercourse and roadway embankments, etc.) in order to ensure proper erosion and sediment control.

13.2.2 Adjacent Landowners

The land surrounding the bridge is generally urbanized. Immediately northwest of the bridge, there is a residency with a manicured grass lawn. Immediately to the northeast, there is a large open ditch that is lined with a mix of trees and other vegetation. Beyond the tree line and vegetation, there is a residency with a manicured grass lawn. Immediately to the southeast, there is a granular area that often vehicles use as a temporary parking area. Beyond the granular parking area, there is a permanent residency with auxiliary buildings that are typically used as cottages. Immediately southwest of the bridge, there is a vacant lot with a manicured grass lawn.

Construction of the bridge itself will be contained between Dexter Line and Rush Creek Line. Since there are no private entrances on this portion of the roadway, there will be no interference to local residents for the majority of the construction. Once the bridge has been constructed, the roadway approaches will be re-constructed and transitioned to the existing roadway network. During this time, interruptions to normal traffic may occur, however access to private accesses located within the construction zone will be maintained. There will be some grade changes required as private accesses due to road design requirements associated with raising the approach elevations.

13.2.3 Disruption of Traffic

As a result of the collapse of the original structure, traffic within the local area was greatly impacted as there was no way to cross Catfish Creek. In order to maintain emergency services, the County installed a temporary bridge downstream of the Imperial Road crossing. This temporary crossing will be maintained throughout the construction of the new bridge at the Imperial Road site, and therefore disruption to traffic will be minor in nature. The majority of construction consists of the bridge itself, which will occur between Rush Creek Line and Dexter Line. Once the new bridge is constructed, the roadway approaches will be re-constructed and transitioned to the existing roadway network. Construction will be scheduled to ensure traffic can travel from the north side of Catfish Creek to the south side of Catfish Creek and to the west towards Port Stanley, similar to how traffic is maintained at the current state.

13.2.4 Noise Impacts

Noise is anticipated to arise from removal of the existing structure, dewatering pumps, generators used to supply power to the site, installation of steel piles to support the new bridge structure, and general construction equipment and vehicles (e.g. hydraulic excavators, material handlers, concrete pump trucks, and trucks used to haul material and supplies to the site). The noise is expected to extend throughout the length of the project. Construction is anticipated to occur during daylight hours (unless there are extenuating circumstances), and therefore will comply with the Township of Malahide Noise By-law (noise from construction activities allowed between 7:00am and 8:00pm). Steps will be taken during the construction to minimize the level of noise, such as requesting that stationary noise generating equipment (e.g. generators) be enclosed and that construction equipment (e.g. hydraulic excavators, trucks, etc.) be fitted with mufflers and maintained in good working order.

Impacts to wildlife are anticipated to be minimal for the same reasons given in the previous paragraph. Another reason for impacts to wildlife to be minimal as the construction of the new bridge is only expected to take one (1) season to complete.

13.2.5 Dust Impacts

Normal construction activities have the potential to generate dust which has the potential to impact nearby vegetation, aquatic habitats and residents. Dust can arise from a range of activities, including vehicular traffic, excavations and removal of the existing structure foundations. Appropriate dust control measures will be implemented to control dust (e.g. use of dust-suppressing materials, enclosures, etc.). As a result of the implementation of dust control measures, significant dust impacts are not anticipated.

13.2.6 Terrestrial Rehabilitation

All scarred and bare soils including roadway sideslopes and backslopes will be rehabilitated by placing topsoil, native seed mix, and the placement of erosion control blanket (if necessary). Areas identified for habitat enhancement will be completed by the strategic implementation of new plantings.

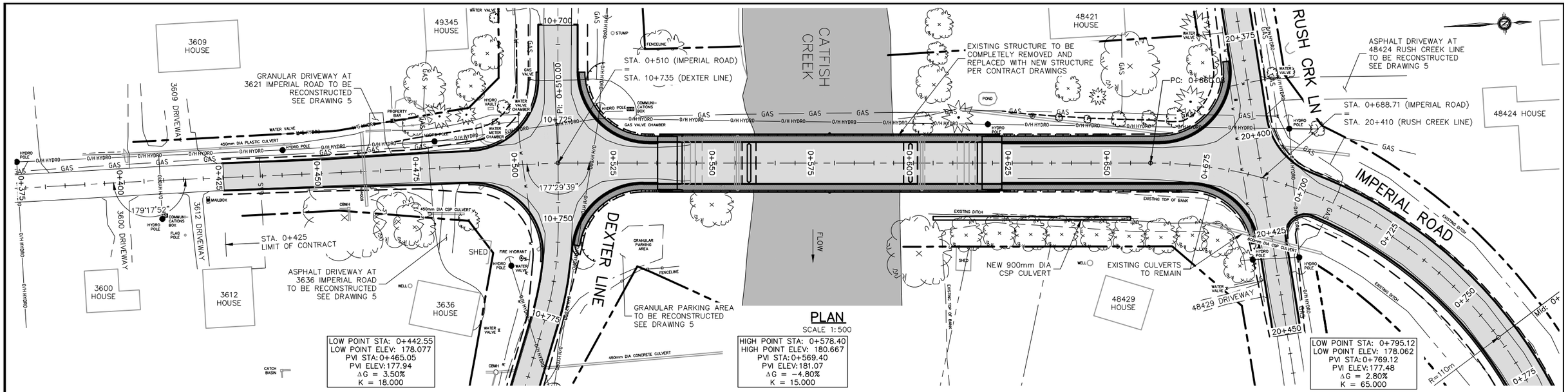
13.2.7 Terrestrial Species-at-Risk

Various terrestrial species-at-risk (SAR), identified elsewhere in this Report, have been identified as potentially being present near the bridge replacement site.

To mitigate against impacts to the these species-at-risk, the following is proposed:

- Isolate the construction working area by placing erosion control fence at the limits of construction;
- Limit removals of large diameter trees where possible;
- Where large diameter trees need to be removed, complete removals after the bat hibernation period and prior to the migratory bird nesting period
- Re-seed and re-vegetate all disturbed areas as soon as feasible.

14. Drawings of the Proposed Structure



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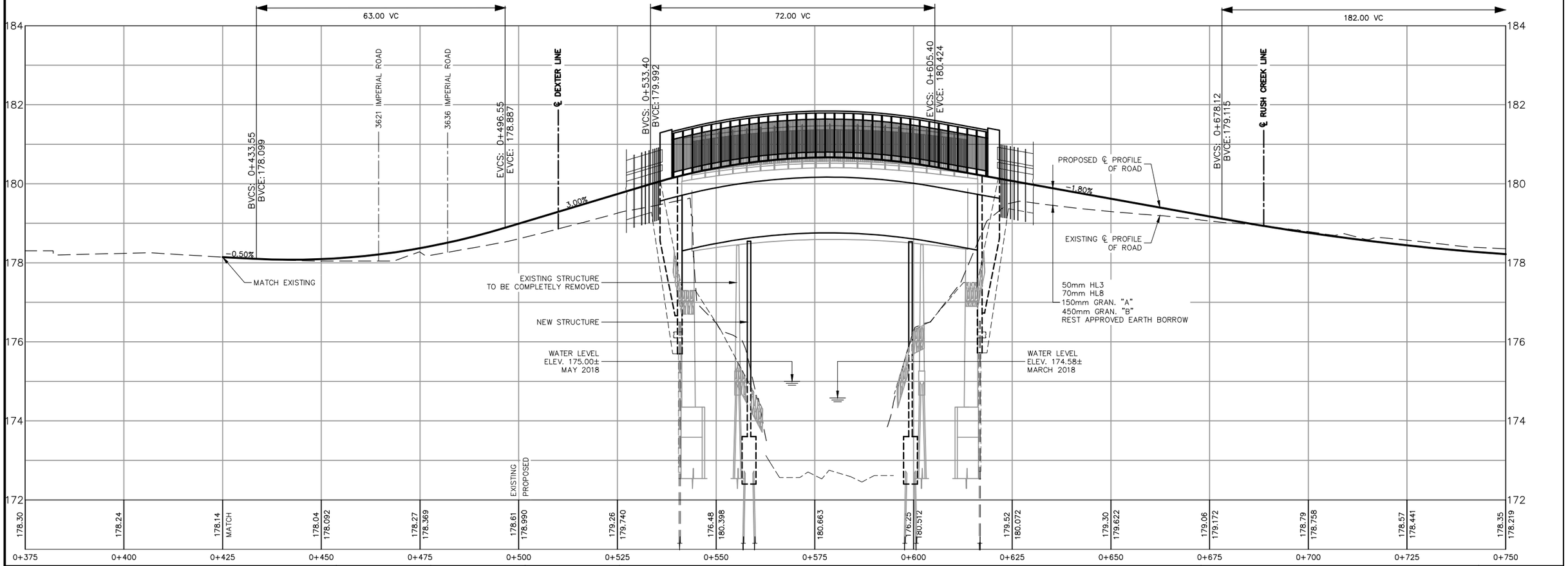

No.	REVISION	DATE
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CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

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VERT. 1:50
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(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - IMPERIAL ROAD

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 1

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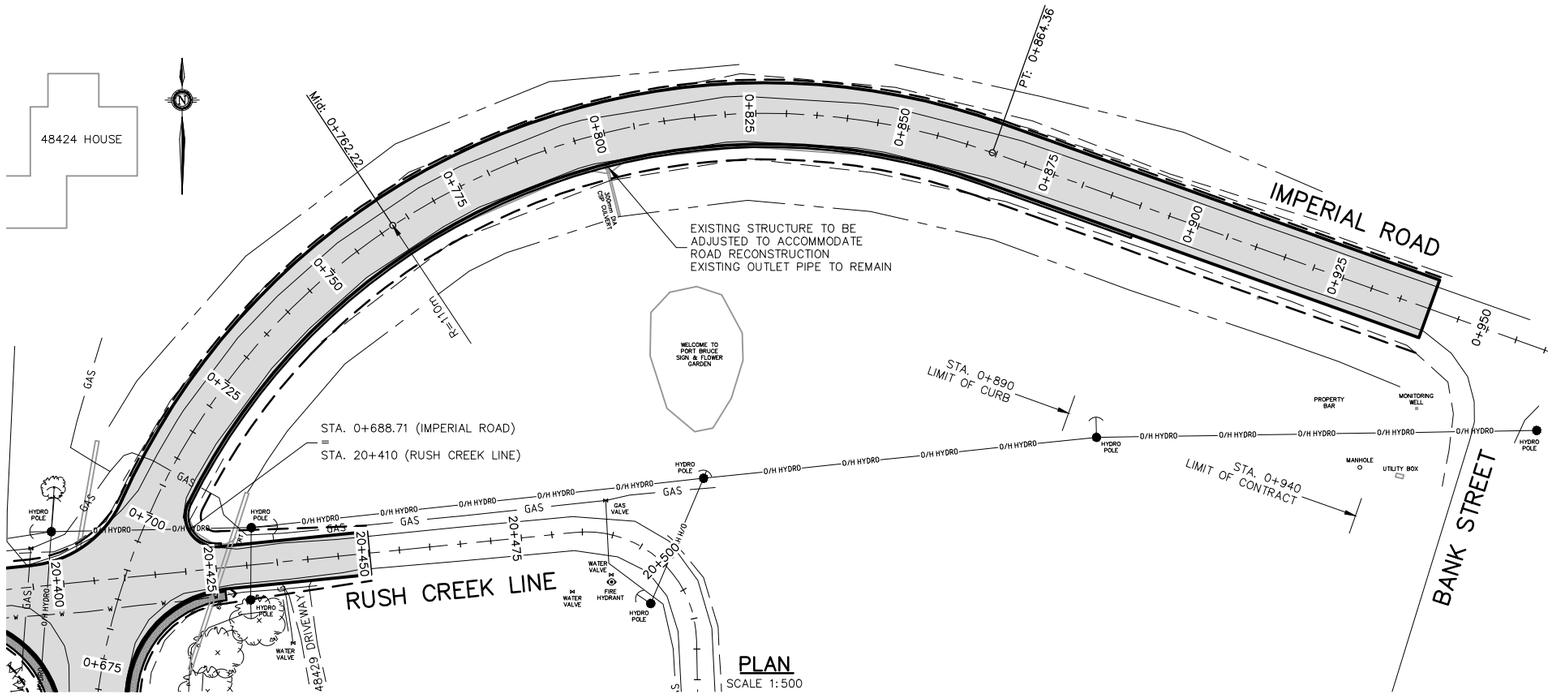
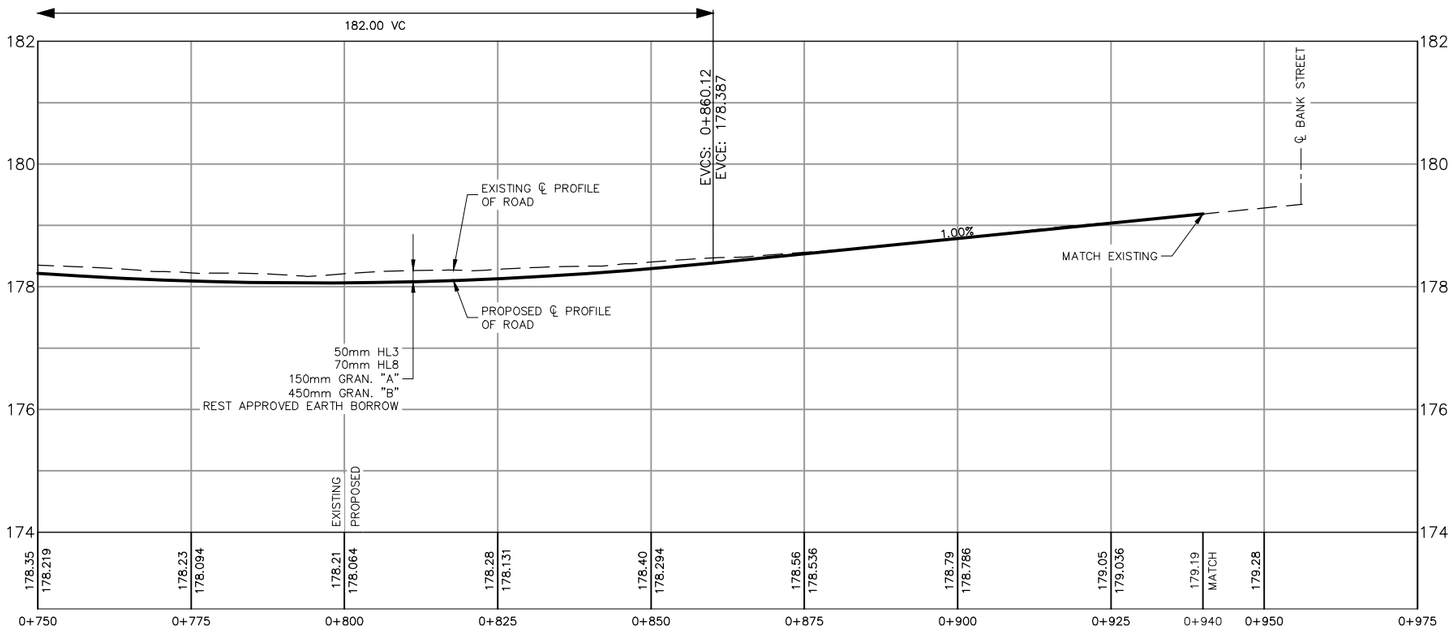


PLAN
SCALE 1:500

LOW POINT STA: 0+795.12
LOW POINT ELEV: 178.062
PVI STA: 0+769.12
PVI ELEV: 177.48
ΔG = 2.80%
K = 65.000



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DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - IMPERIAL ROAD CONTINUED

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 2

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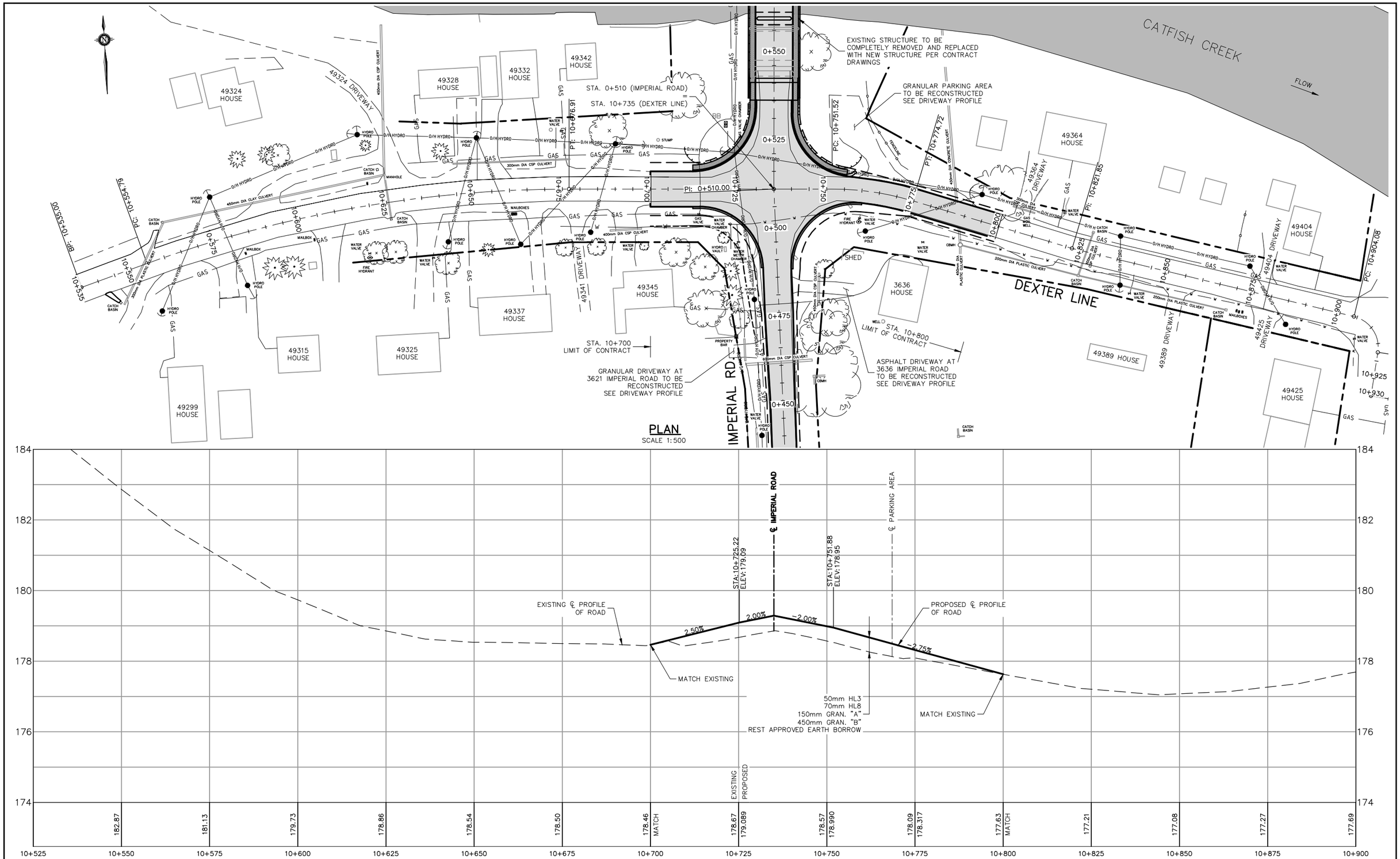

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1.	ISSUED FOR PIC	JULY 16/19

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CHECKED BY: A.G.
FIELD BOOK:

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - DEXTER LINE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 3

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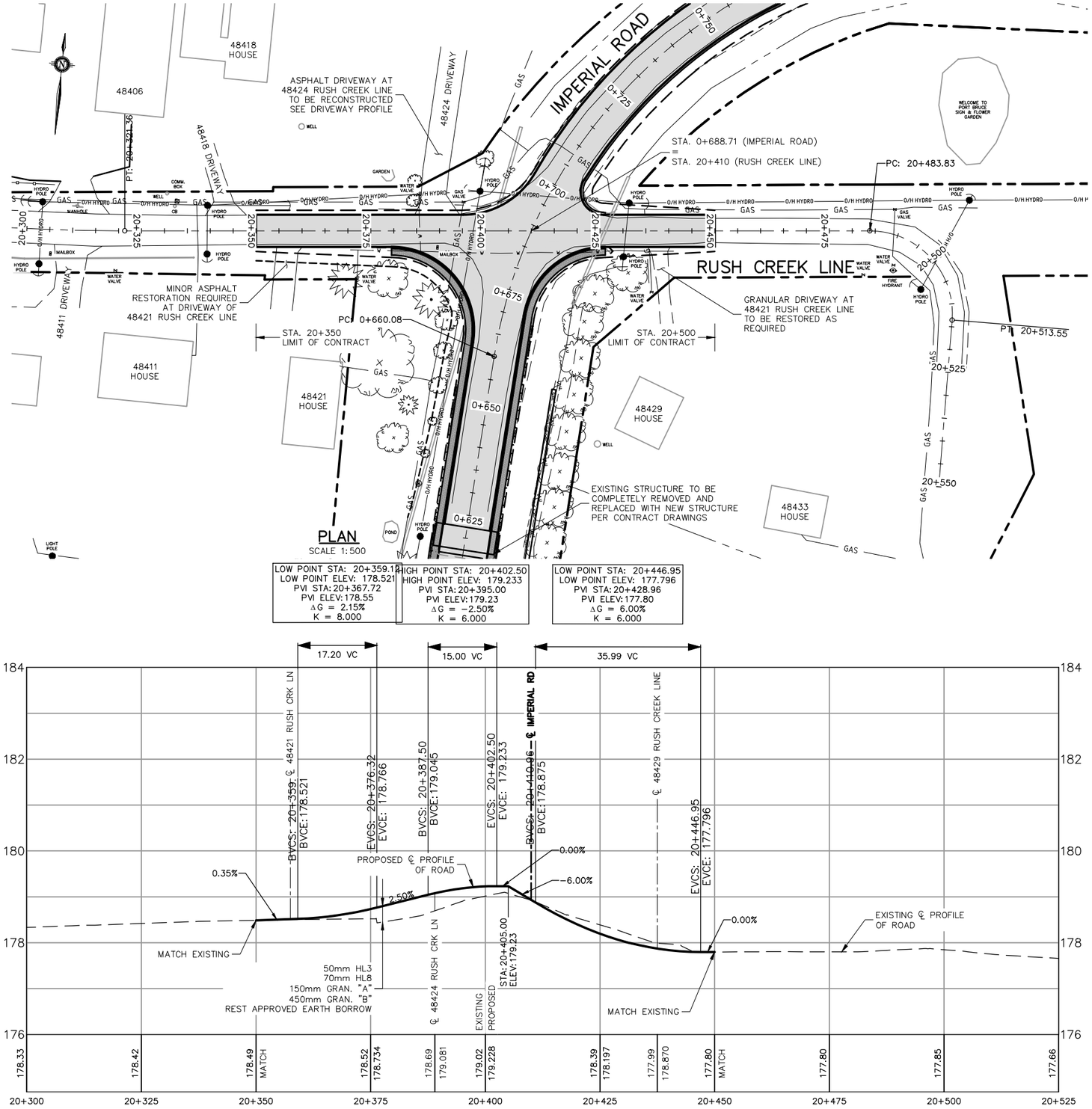

PLAN

SCALE 1:500

LOW POINT STA: 20+359.19 LOW POINT ELEV: 178.521 PVI STA: 20+367.72 PVI ELEV: 178.55 ΔG = 2.15% K = 8.000	HIGH POINT STA: 20+402.50 HIGH POINT ELEV: 179.233 PVI STA: 20+395.00 PVI ELEV: 179.23 ΔG = −2.50% K = 6.000	LOW POINT STA: 20+446.95 LOW POINT ELEV: 177.796 PVI STA: 20+428.96 PVI ELEV: 177.80 ΔG = 6.00% K = 6.000

No.	REVISION	DATE
1.	ISSUED FOR PIC	JULY 16/19

DESIGNED BY: A.G.
CHECKED BY: --
DRAWN BY: D.S.
CHECKED BY: A.G.
FIELD BOOK:

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(ON 24 x 36 PAPER)

PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

PLAN & PROFILE - RUSH CREEK LINE

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 4

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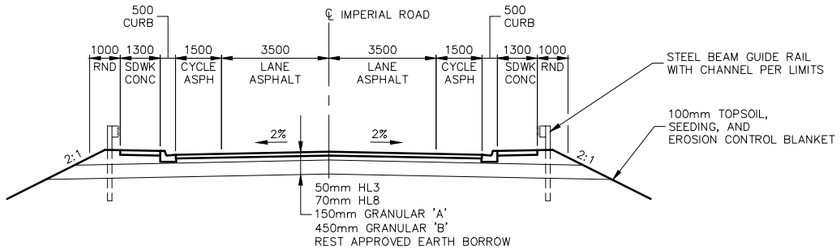
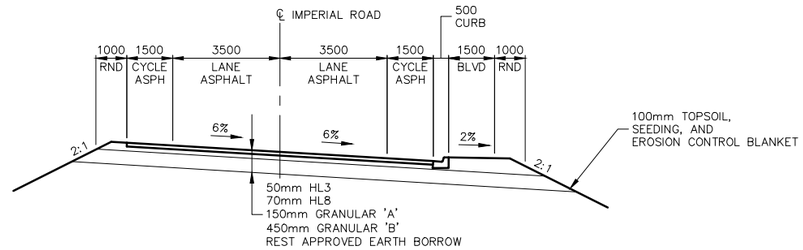


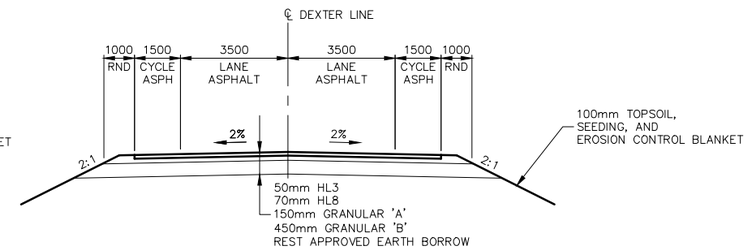
IMPERIAL ROAD
END OF BRIDGE BARRIER TO INTERSECTIONS

SCALE 1:100



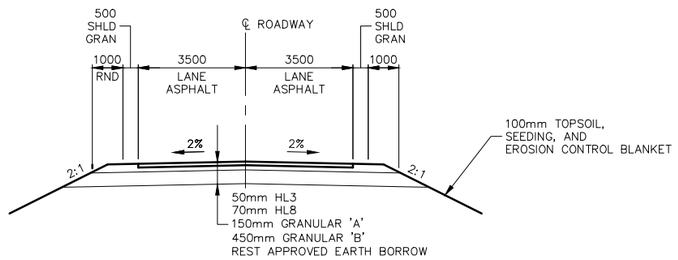
IMPERIAL ROAD
RUSH CREEK LINE TO BANK STREET
(SUPERELEVATED)

SCALE 1:100



DEXTER LINE
WEST CONSTRUCTION LIMIT TO IMPERIAL ROAD

SCALE 1:100



RUSH CREEK LINE (FULL LENGTH)
IMPERIAL ROAD (SOUTH CONST. LIMIT TO DEXTER LINE)
DEXTER LINE (IMPERIAL ROAD TO EAST CONST. LIMIT)

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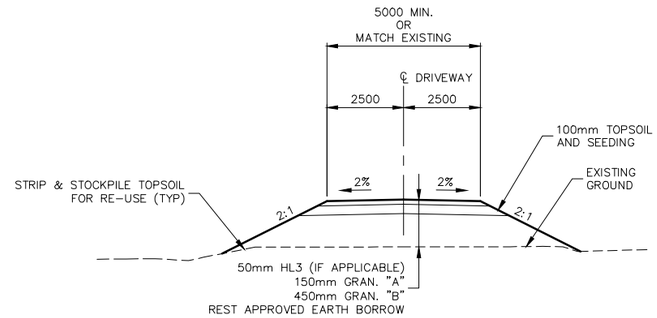

TYPICAL DRIVEWAY SECTION

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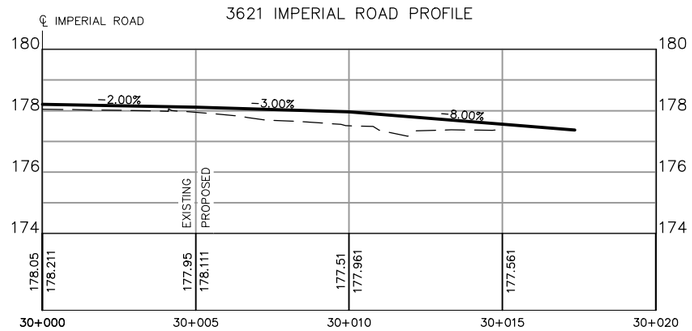

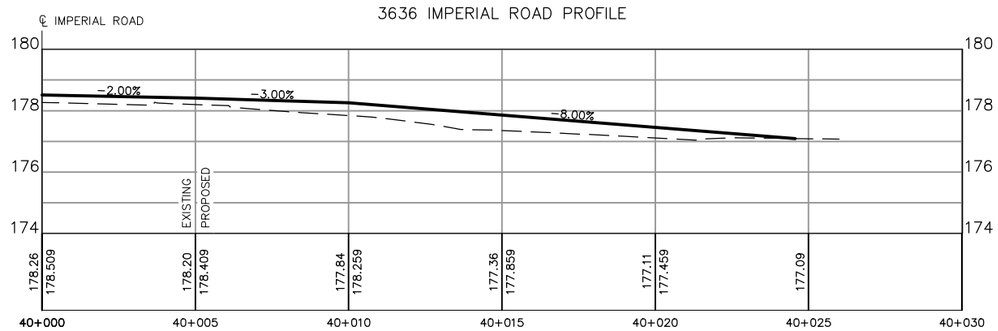

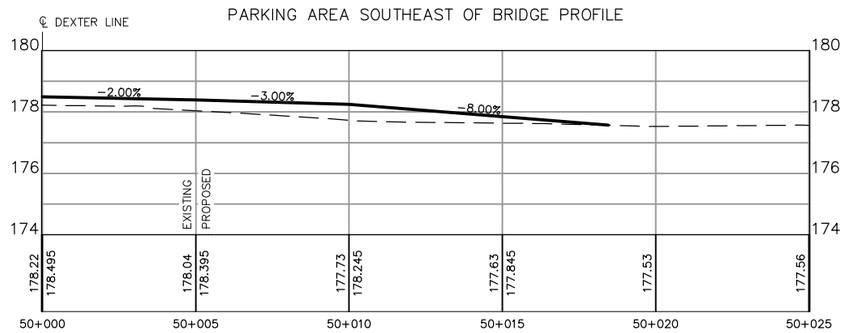

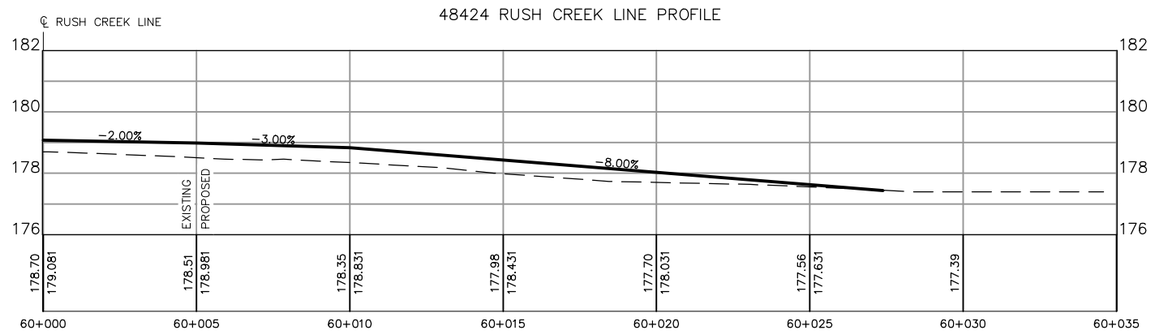

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

ROADWAY CROSS SECTIONS & DRIVEWAY PROFILES

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 5

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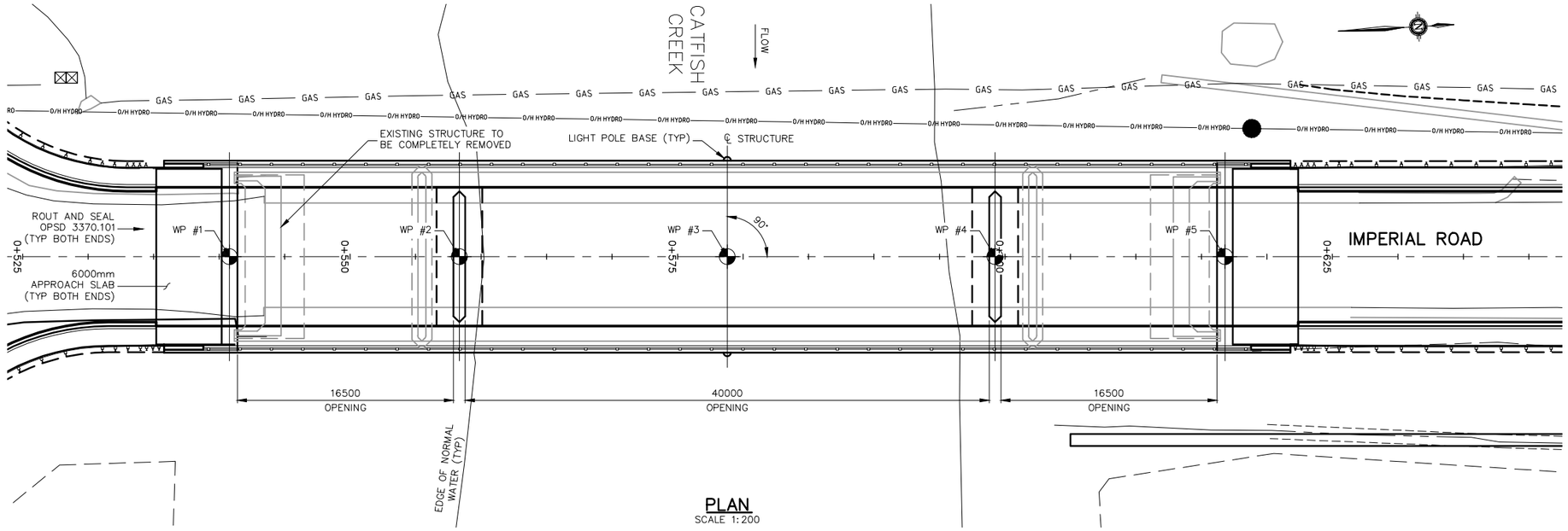

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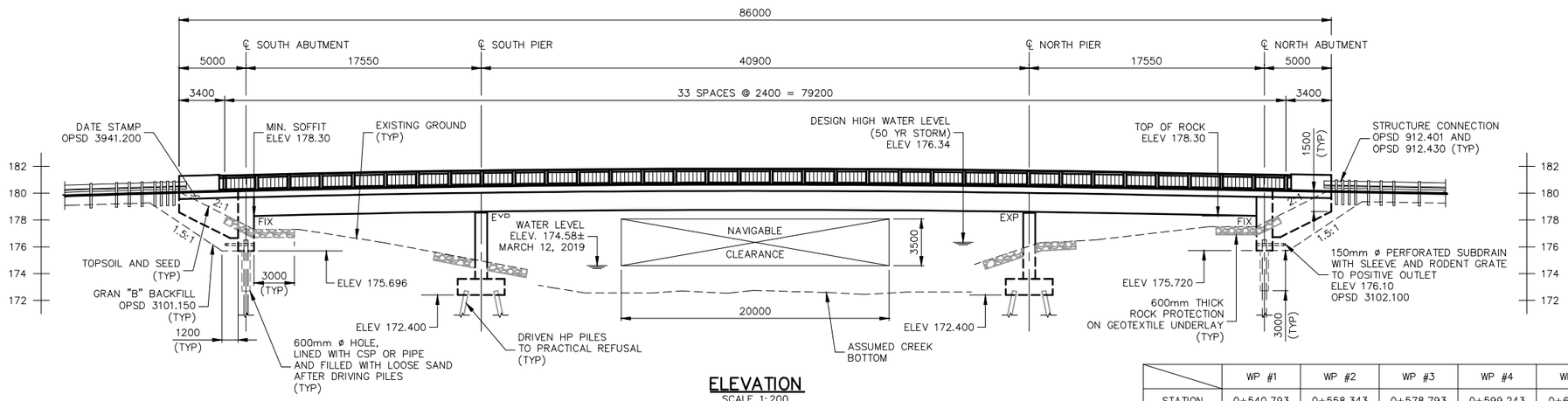

ELEVATION
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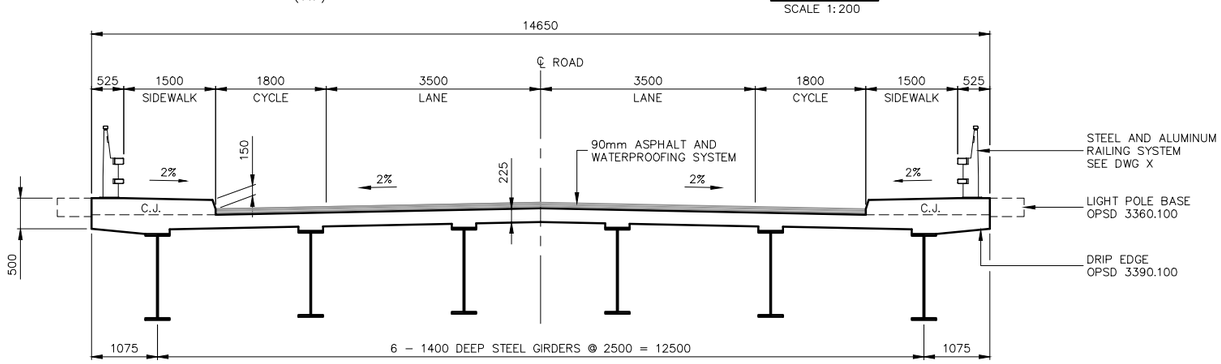
	WP #1	WP #2	WP #3	WP #4	WP #5
STATION	0+540.793	0+558.343	0+578.793	0+599.243	0+616.793
ELEVATION	180.196	180.533	180.667	180.523	180.219

NOTE: WORKING WORKING POINT ELEVATIONS GIVEN TO TOP OF ASPHALT



DECK CROSS SECTION
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GENERAL NOTES

1. STRUCTURE DESIGNED FOR CL-625 (ONT) LOADING PLUS 90mm ASPHALT AND WATERPROOFING SYSTEM IN ACCORDANCE WITH THE CANADIAN HIGHWAY BRIDGE DESIGN CODE 2014.
2. WORK ON THE STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE CONTRACT ADMINISTRATOR
3. STRUCTURE TO BE BUILT IN ACCORDANCE WITH THE MOST CURRENT OPS SPECIFICATIONS AND DRAWINGS AS WELL AS THE CONTRACT ADMINISTRATORS SPECIFICATIONS.
4. THE COMPLETE SOIL INVESTIGATION REPORT BY CHUNG & VANDER DOELEN ENGINEERING LTD. FORM PART OF THE CONTRACT DOCUMENTS. THE ENGINEER DOES NOT GUARANTEE THE ACCURACY OF THIS REPORT. THE CONTRACTOR SHALL REVIEW THE REPORT AND DETERMINE HIS OWN METHOD TO CONTROL GROUND WATER DURING THE CONSTRUCTION.
5. THE CONTRACTOR SHALL CHECK AND VERIFY ALL DIMENSIONS ON THE JOB AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK
6. CLASS OF CONCRETE:

   CAST-IN-PLACE CONCRETE 35 MPA C-1 MIX

   ALL CONCRETE SHALL INCLUDE AN APPROVED AIR ENTRAINING ADMIXTURE
7. CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25mm
BOTTOM OF ABUTMENTS	100 ± 25mm
BOTTOM OF DECK	40 ± 10mm
REMAINDER (UNLESS NOTED OTHERWISE)	70 ± 20mm

8. REINFORCING STEEL SHALL BE GRADE 400. BARS MARKED WITH A POSTFIX "S" DENOTE STAINLESS STEEL BARS. UNLESS OTHERWISE SHOWN, TENSION LENGTH LAPS NOT INDICATED ON THE CONTRACT DRAWINGS SHALL BE CLASS "B". BAR HOOKS SHALL BE MINIMUM LENGTH AND STIRRUPS SHALL HAVE MINIMUM HOOKS, UNLESS INDICATED OTHERWISE.
9. STAINLESS STEEL BARS SHALL BE TYPE 316 LN OR DUPLEX 2205 WITH A MINIMUM YIELD STRENGTH OF 500 MPA.
10. MINIMUM LAP OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH THE CHBDC (2014)
11. ALL CONCRETE SHALL BE PLACED IN THE DRY.
12. NO CONCRETE SHALL BE PLACED BEFORE MATERIALS, FORMWORK AND REINFORCING STEEL HAVE BEEN CHECKED BY THE CONTRACT ADMINISTRATOR
13. ALL EXPOSED EDGES TO BE CHAMFERED 19mm UNLESS OTHERWISE NOTED. ALL ACUTE ANGLES SHALL BE FILLETED AS NOTED.
14. CONSTRUCTION JOINTS NOT SHOWN ON THE PLANS MUST BE APPROVED BY THE CONTRACT ADMINISTRATOR.
15. BEARING SEATS SHALL BE FINISHED DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ±3mm.
16. THE BRIDGE DECK SHALL BE FINISHED USING AN APPROVED FINISHING MACHINE IN ACCORDANCE WITH OPS.MUNI 904.
17. ANY EXCAVATED OR IMPORTED MATERIAL SHALL BE STOCKPILED WELL AWAY FROM THE EDGE OF THE EXCAVATION AND AT APPROVED LOCATIONS.
18. NO BACKFILL SHALL BE PLACED UNLESS APPROVED BEFOREHAND BY THE CONTRACT ADMINISTRATOR. NATIVE MATERIAL SHALL NOT BE REMOVED FROM THE CONSTRUCTION SITE WITHOUT WRITTEN APPROVAL FROM THE CONTRACT ADMINISTRATOR.
19. ROCK PROTECTION SHALL BE 300mm NOMINAL SIZE WITH 50% LARGER THAN 300mm AND 50% SMALLER THAN 300mm. ROCK PROTECTION SHALL BE PLACED ON GEOTEXTILE UNDERLAY.

APPLICABLE STANDARD DRAWINGS

OPSD – 3101.150	WALLS, ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD – 3102.100	WALLS, ABUTMENT, BACKFILL DRAIN
OPSD – 3360.100	DECK, LIGHT POLE BASES, STRUCTURES WITH BARRIER WALLS
OPSD – 3419.100	BARRIERS AND RAILINGS STEEL GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD – 3941.200	FIGURES IN CONCRETE SITE NUMBER AND DATE LAYOUT
OPSD – 3370.100	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD – 3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS

SEQUENCE OF CONSTRUCTION

1. THE ABUTMENTS, WINGWALLS, AND PIERS SHALL BE CONSTRUCTED FIRST TO BEARING SEAT ELEVATIONS.
2. THE GIRDERS SHALL BE PLACED ON A SUPPORT THAT ALLOWS ROTATION AND DEFLECTION OF THE GIRDERS DUE TO SELF WEIGHT AND DEAD WEIGHT OF THE DECK.
3. THE DECK AND THE PORTION OF THE ABUTMENTS AND WINGWALLS ABOVE THE BEARING SEAT ELEVATIONS SHALL BE CAST INTEGRALLY WITH THE GIRDERS.
4. THE DECK AND THE PORTION OF THE ABUTMENTS AND WINGWALLS ABOVE THE BEARING SEAT ELEVATIONS SHALL BE POURED IN SEQUENCE SO THAT THE STRUCTURE BECOMES INTEGRAL WITH NO RESIDUAL STRESSES. THE ENDS OF THE DECK SHALL BE PLACED LAST UNLESS CONCRETE CAN BE SUFFICIENTLY RETARDED TO ALLOW THE PLACEMENT FROM ONE END TO THE OTHER IN A SINGLE POUR, SUBJECT TO THE APPROVAL OF THE CONTRACT ADMINISTRATOR
5. THE STABILITY AND INTEGRITY OF THE STRUCTURE SHALL BE MAINTAINED AT ALL STAGES OF CONSTRUCTION INCLUDING BREAKS IN THE CONSTRUCTION TIMELINE.
6. BACKFILL SHALL NOT BE PLACED BEHIND THE ABUTMENTS UNTIL THE DECK HAS REACHED 75% OF ITS SPECIFIED STRENGTH AND PERMISSION FROM THE CONTRACT ADMINISTRATOR IS GRANTED.
7. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN HEIGHTS OF BACKFILL BE GREATER THAN 500mm.

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PORT BRUCE BRIDGE REPLACEMENT
TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

GENERAL ARRANGEMENT

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 6

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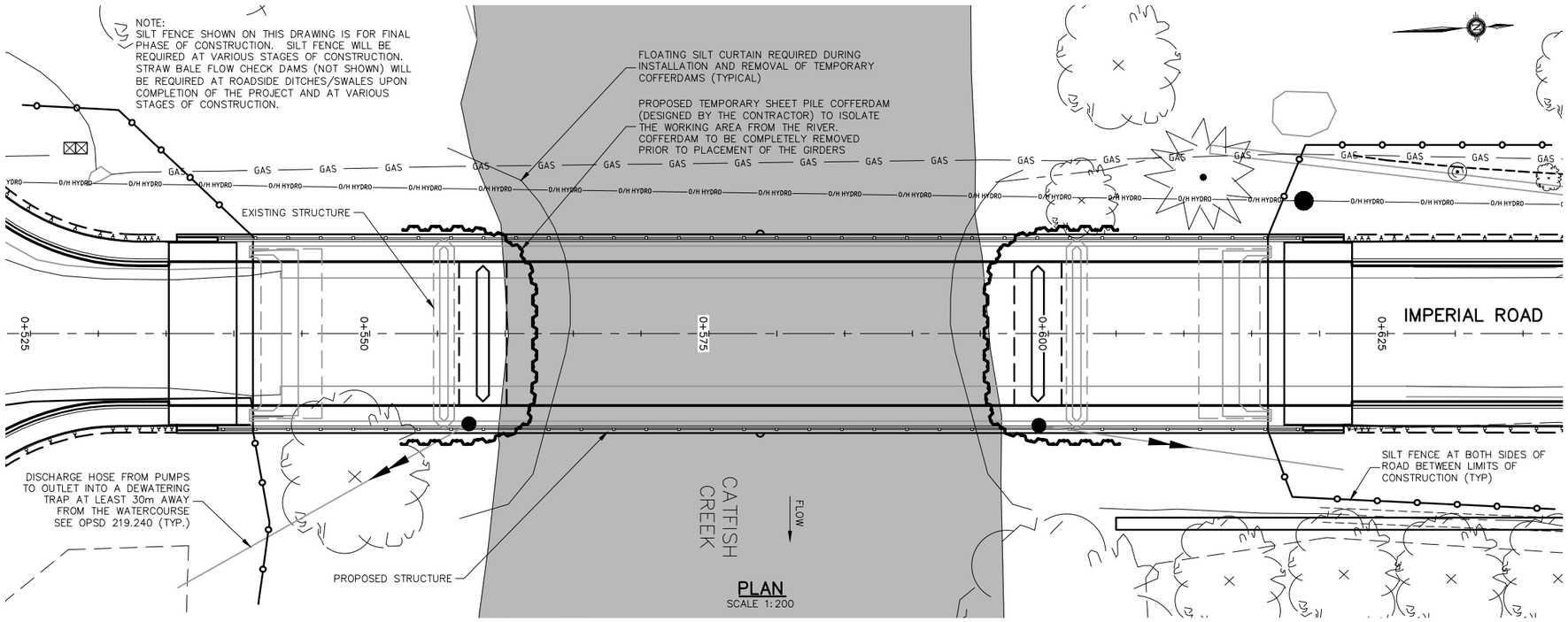

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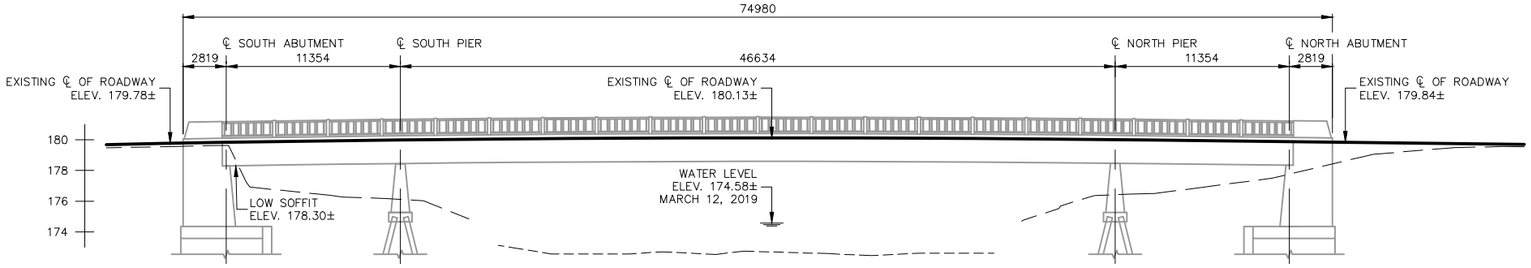

NOTE:
THE ORIGINAL STRUCTURE COLLAPSED IN FEBRUARY 2018 AND HAS SINCE BEEN REMOVED; ONLY THE SOUTH ABUTMENT AND PIER PILES REMAIN

ORIGINAL 1962± STRUCTURE
SCALE 1:200

NAVIGATION

1. SIGNS TO BE PLACED 50m UPSTREAM AND DOWNSTREAM WARNING BOATERS OF THE CONSTRUCTION WORK AHEAD.
2. SILT CURTAINS OR DEWATERING BERMS, INSTALLED DURING NAVIGATION SEASON, ARE TO BE MARKED WITH YELLOW BUOYS AND/OR YELLOW LIGHTS.
3. NO PERSON SHALL PERMIT ANY TOOLS, EQUIPMENT, VEHICLES, TEMPORARY STRUCTURES OR PARTS THEREOF USED OR MAINTAINED FOR THE PURPOSE OF BUILDING OR PLACING A WORK IN A NAVIGABLE WATER TO REMAIN IN SUCH WATER AFTER THE COMPLETION OF THE PROJECT.
4. WHERE A WORK OR PORTION OF A WORK THAT IS BEING CONSTRUCTED OR MAINTAINED IN A NAVIGABLE WATER CAUSES DEBRIS OR OTHER MATERIAL TO ACCUMULATE ON THE BED OR ON THE SURFACE OF THE WATER, THE OWNER OF THAT WORK OR PORTION OF THAT WORK SHALL CAUSE THE DEBRIS OR OTHER MATERIAL TO BE REMOVED TO THE SATISFACTION OF THE MINISTER OF TRANSPORT, INFRASTRUCTURE AND COMMUNITIES.

DEWATERING SEQUENCE

1. INSTALL SILT FENCE, STRAW BALE FLOW CHECK DAMS AND ANY OTHER EROSION CONTROL MEASURES WHICH MAY BE REQUIRED.
2. PLACE FLOATING SILT CURTAINS UPSTREAM AND DOWNSTREAM OF WORKING AREA.
3. INSTALL SHEET PILE COFFERDAMS OR OTHER CONTAINMENT SYSTEM(S) AS REQUIRED.
4. DEWATER AND DE-FISH THE WORKING AREA SIMULTANEOUSLY.
5. COMPLETE DEMOLITION AND REMOVAL OF THE EXISTING BRIDGE SUBSTRUCTURE.
6. EXCAVATE AS REQUIRED IN ORDER TO CONSTRUCT NEW FOUNDATIONS, ABUTMENTS, AND PIERS.
7. PLACE BACKFILL AS REQUIRED ON BOTH SIDES OF ABUTMENTS AND PIERS TO FACILITATE REMOVAL OF COFFERDAMS. PLACE ROCK PROTECTION.
8. REMOVE COFFERDAMS.
9. REMOVE FLOATING SILT CURTAINS.
10. COMPLETE REMAINING CONSTRUCTION OF THE BRIDGE.
11. COMPLETE ROADWORK.
12. INSTALL PERMANENT SILT FENCE AND STRAW BALE CHECK DAMS.

EROSION CONTROL – BRIDGE RECONSTRUCTION

1. ALL WORK SHALL BE DONE IN THE DRY.
2. NO IN-WATER WORK SHALL TAKE PLACE BETWEEN _____ AND _____.
3. DEWATERING OF THE SITE SHALL BE ACHIEVED BY THE INSTALLATION OF COFFERDAMS TO ISOLATE THE WORKING AREA, AND THE PLACEMENT OF CONVENTIONAL SUMP PUMPS WHERE REQUIRED. THE CONTRACTOR'S SPECIFIC METHOD SHALL BE APPROVED BEFOREHAND BY THE CONTRACT ADMINISTRATOR. ALTERNATIVE METHODS OF DEWATERING SUCH AS SHEET PILE COFFERDAMS AROUND THE ABUTMENTS MAY BE POSSIBLE PENDING THE WRITTEN APPROVAL OF THE CONTRACT ADMINISTRATOR.
4. THE CONTRACTOR SHALL APPLY AND OBTAIN A PERMIT TO TAKE WATER (PTTW) SHOULD PUMPING EXCEEED 50,000 LITRES PER DAY.
5. DISCHARGE FROM PUMPING OPERATIONS SHALL FIRST OUTLET INTO A SILTING POND OR SEDIMENT TRAP BEFORE THE WATER IS ALLOWED TO RE-ENTER THE RIVER OR ANOTHER WATERCOURSE.
6. COFFERDAMS SHALL BE DESIGNED BY THE CONTRACTOR AND SUBMITTED TO THE CONTRACT ADMINISTRATOR FOR APPROVAL.
7. ALL DISTURBED AREAS INCLUDING BANKS ABOVE WATER LEVEL SHALL BE REGRADED, TOPSOILED AND SEEDED TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR AS SOON AS POSSIBLE.
8. ALL EROSION CONTROL MEASURES (SILT FENCE, ROCK DAMS, SILTATION POND/DEWATERING TRAP, ETC.) SHALL BE CHECKED DAILY DURING ON-SITE WORK AND BE MAINTAINED IN GOOD STATE SO THAT THEY ARE FUNCTIONING PROPERLY. SILT FENCE AND STRAW BALE CHECK DAMS TO BE LEFT IN PLACE FOR 12 MONTHS OR UNTIL SUCH TIME AS THE SITE STABILIZES (THESE ARE LOCATED ABOVE HIGH WATER LEVEL).
9. NO MACHINERY SHALL CROSS THE RIVER AT ANY TIME. ANY MACHINERY THAT IS REQUIRED ON THE OTHER SIDE OF THE RIVER WHILE THE BRIDGE IS DISMANTLED OR UNDER CONSTRUCTION SHALL BE HAULED BY FLOAT OR DRIVEN AROUND ON THE ROADS. MACHINERY, VEHICLES, EQUIPMENT PUMPS, ETC., WILL NOT BE REFUELED WITHIN 30 METRES OF THE WATERCOURSE. MACHINERY SHALL NOT BE CLEANED WITHIN 30 METRES OF THE RIVER.
10. ALL WASTE MATERIAL FROM CONSTRUCTION SHALL BE STORED AWAY AND ABOVE THE HIGH WATERMARK AND AT NO TIME SHALL SUCH MATERIAL ENTER IN THE WATER.
11. FOR TYPICAL CHECK DAMS REFER TO OPSD 219.210
12. FOR SILT FENCE REFER TO OPSD 219.110.
13. SEED MIX TO BE STANDARD ROADSIDE MIX PER OPSS.MUNI 804.

ADDITIONAL ENVIRONMENTAL MEASURES TO BE ADHERED TO:

1. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE IMPLEMENTED PRIOR TO WORK, AND MAINTAINED DURING THE WORK PHASE, TO PREVENT THE ENTRY OF SEDIMENT INTO THE WATER OR THE MOVEMENT OF RE-SUSPENDED SEDIMENT.
2. A FLOATING TURBIDITY CURTAIN OR SILT FENCE SHOULD BE PLACED IMMEDIATELY AROUND THE WORK SITE PRIOR TO THE INSTALLATION OF COFFERDAMS.
3. ALL DISTURBED WORK AREAS SHOULD BE STABILIZED AND RE-VEGETATED AS REQUIRED UPON THE COMPLETION OF WORK AND RESTORED TO A PRE-DISTURBED STATE OR BETTER.
4. SEDIMENT AND EROSION CONTROL MEASURES SHOULD BE LEFT IN PLACE UNTIL ALL DISTURBED AREAS HAVE BEEN STABILIZED.
5. EXISTING STREAM FLOWS SHOULD BE MAINTAINED DOWNSTREAM OF THE DE-WATERED WORK AREA WITHOUT INTERRUPTION, DURING ALL STAGES OF WORK. THERE SHOULD BE NO INCREASE IN WATER LEVELS UPSTREAM OF THE DE-WATERED WORK AREA.
6. FISH SHOULD BE REMOVED FROM THE WORK AREA PRIOR TO DE-WATERING AND RELEASED ALIVE IMMEDIATELY DOWNSTREAM.
7. SILT OR DEBRIS THAT HAS ACCUMULATED AROUND THE TEMPORARY COFFERDAMS SHOULD BE REMOVED PRIOR TO THEIR WITHDRAWAL.
8. NATURAL STRUCTURES SUCH AS LOGJAMS AND IN-STREAM WOODY COVER SHOULD NOT BE REMOVED UNLESS THEY REPRESENT A BARRIER TO FLOWS OR FISH MOVEMENT.
9. OPERATE HEAVY MACHINERY ON LAND AND IN A MANNER THAT MINIMIZES DISTURBANCE TO THE BANKS OR BED OF THE RIVER.
10. ENSURE THAT MACHINERY ARRIVES ON SITE IN A CLEAN, WASHED CONDITION AND IS MAINTAINED FREE OF FLUID LEAKS.
11. WASH, REFUEL AND SERVICE MACHINERY AND STORE FUEL AND OTHER MATERIALS FOR THE MACHINERY AWAY FROM THE WATER TO PREVENT ANY DELETERIOUS SUBSTANCE FROM ENTERING THE WATER OR SPREADING ONTO THE ICE SURFACE.
12. KEEP AN EMERGENCY SPILL KIT ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.
13. STABILIZE ANY WASTE MATERIALS REMOVED FROM THE WORK SITE TO PREVENT THEM FROM ENTERING THE WATERBODY. THIS COULD INCLUDE COVERING STOCKPILES WITH BIODEGRADABLE MATS OR TARPS, OR PLANTING STOCKPILES WITH GRASS OR SHRUBS.
14. ALL UNSTABLE BANKS OF THE WATERCOURSE SHOULD BE STABILIZED AND SIDE RUN-OFF DITCHES SHOULD BE CONSTRUCTED TO DIVERT ROAD RUN-OFF THROUGH THE GREENBELT BEFORE ENTERING THE STREAM.
15. VEGETATE AND STABILIZE ANY DISTURBED AREAS BY SEEDING AND PLANTING TREES, SHRUBS, OR GRASSES.
16. STREAM CROSSINGS SHOULD ALLOW FOR UNIMPEDED UPSTREAM AND DOWNSTREAM MOVEMENT OF FISH.
17. CONCRETE LEACHATE IS ALKALINE AND HIGHLY TOXIC TO FISH AND AQUATIC LIFE AND MEASURES MUST BE TAKEN TO PREVENT ANY INCIDENCE OF CONCRETE OR CONCRETE LEACHATE FROM ENTERING THE WATERCOURSE. ALL CAST-IN-PLACE CONCRETE, GROUT, MORTARS, ETC. SHOULD BE TOTALLY ISOLATED FROM PRECIPITATION AND THE WATERS OF THE CANAL FOR A MINIMUM 48 HOUR PERIOD OR UNTIL SIGNIFICANTLY CURED TO ALLOW THE pH TO REACH NEUTRAL LEVELS. CONTAINMENT FACILITIES SHOULD BE PROVIDED AT THE SITE FOR THE WASH-DOWN FROM CONCRETE DELIVERY TRUCKS, CONCRETE PUMPING EQUIPMENT, AND OTHER TOOLS AND EQUIPMENT AS REQUIRED.

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PORT BRUCE BRIDGE REPLACEMENT
TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

EROSION AND SEDIMENT CONTROL / DEWATERING PLAN

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
DRAWING NUMBER 7

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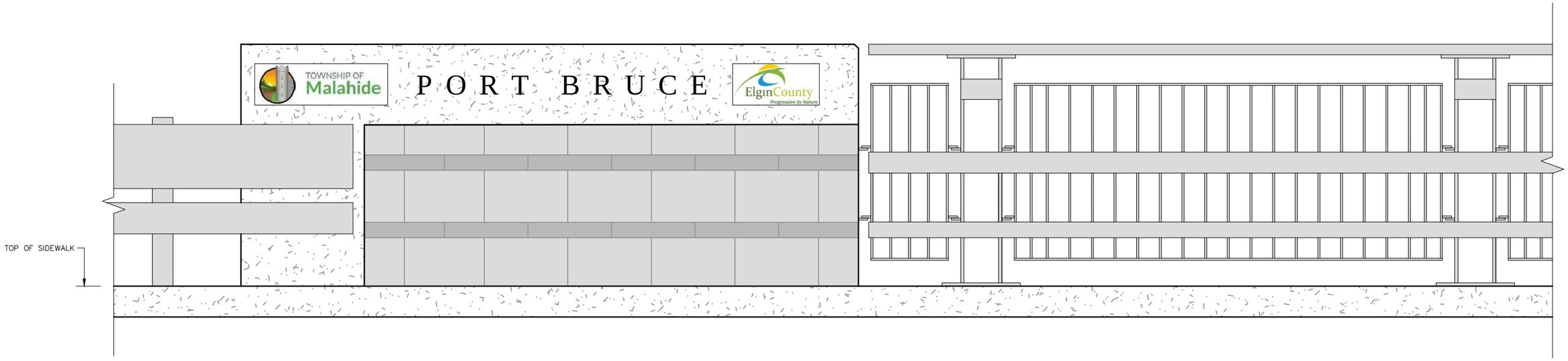

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PORT BRUCE BRIDGE REPLACEMENT

TOWNSHIP OF MALAHIDE — COUNTY OF ELGIN

BRIDGE RAILING & CONCRETE END POST

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS
KITCHENER — SUDBURY

JOB NUMBER 18-283
DATE JULY 2019
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