Project File Report

Municipal Class Environmental Assessment for
Joshua's Creek Flood Mitigation Study

Town of Oakville

Executive Summary

GHD Limited (GHD) was retained by the Town of Oakville (Town) to conduct a Schedule 'B' Municipal Class Environmental Assessment (MCEA) as part of the Joshua's Creek Flood Mitigation Opportunities Study. The MCEA examined the need for improvements and opportunities to address flood control issues along the studied portion of Joshua's Creek from Upper Middle Road to Lake Ontario.

Problem and Opportunity Statement

The Town conducted multiple hydraulic modeling studies to identify riverine flood risk sites along Joshua's Creek from Upper Middle Road to Lake Ontario. The Town used the studies' findings to assess areas of flood risk within the Joshua's Creek watershed and have undertaken this study to establish feasible flood mitigation options and control measures that will most effectively address the identified flood risk sites within the Study Area.

Existing Conditions

An inventory of the existing environment was completed through a desktop review and field investigations for the Study Area and is summarized below.

Hydrology and Hydraulics

A hydrologic model of the Joshua's Creek catchment area was developed and used to estimate peak flow rates along the creek, associated with the 2 to 100-year return period storm events, the climate change adjusted 100-year storm event, and the Regional (Regulatory) storm event. The climate change adjusted 100-year storm event represents rainfall parameters based on worst case scenario greenhouse gas concentrations over a time period of 2080-2100. The Regional (Regulatory) storm event refers to rainfall conditions experienced during the 1954 Hurricane Hazel storm event. Then a combination of 1-dimensional (1D) steady state and 2D unsteady state hydraulic models were developed and used to route the flow rates through the geometry of the creek to calculate corresponding channel velocities and water surface elevations. The water surface elevations were mapped over the terrain to establish the flood inundation boundaries under existing conditions. Results indicate that the majority of flood risk occurs under the highest peak flow conditions possible during the Regional storm event. Under 2 to 100-year return period storm events and under climate change conditions flood risk is significantly reduced. No residential buildings are inundated during flood events up to and including the 100-year climate change storm.

Under the Regional flood event the following flood risk was identified:

- Flood inundation of the commercial and residential areas downstream of the Metrolinx tracks, in the right overbank area of the creek in the Regional flood event
- Inter-watershed flows (spill) to the Wedgewood Creek system near the Royal Windsor Drive and Metrolinx corridor

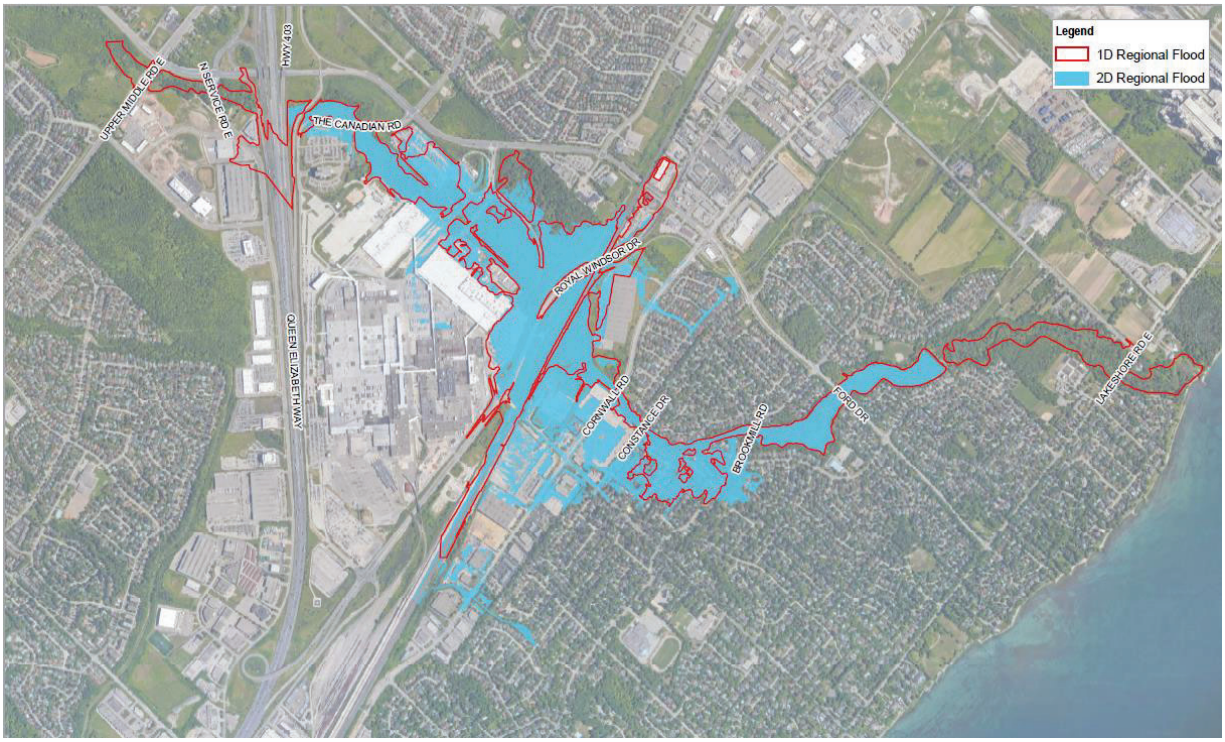

Figure 1 Regional Flood Inundation Map

Natural Environment

Joshua's Creek is a natural watercourse with moderately clear water, silty-sand sediment and large cobble stones. The majority of Joshua's Creek is located in the central and southern regions (south of Royal Windsor Drive) of the town, which are urbanized with commercial, industrial, and residential developments. There are several road and railway crossings of the creek, and portions of the channel are lined with gabion walls. In the naturalized areas of the creek corridor and surrounding areas, field investigations identified a total of 73 vascular plant species and confirmed the presence of a diverse community of predominantly cool-coldwater fish with tolerances ranging from intermediate to intolerant consisting of forage/baitfish with one salmonid sportfish species identified (rainbow trout). Furthermore, terrestrial investigations identified 22 Species at Risk with the potential to occur in the Study Area, in addition to a mix of both disturbance-tolerant species and other species (both vegetative and wildlife) associated with higher quality habitats.

Social and Economic Environment

Under the Town of Oakville's Official plan[1], the Study Area comprises of land designated as Employment Area, Parkway Belt and Residential Area.

[1] Livable Oakville, Town of Oakville Official Plan, 2009, https://www.oakville.ca/assets/2011%20planning/2018-08-28_Livable_Oakville_Office_Consolidation_schedules-E-to-K.pdf, Last updated 2018.

Cultural Environment

A review of the Oakville Heritage Database[2] resulted in the identification of three heritage properties located within the Study Area. After completing the Criteria for Evaluating Archaeological Potential checklist, in addition to consulting the Ministry of Heritage, Sport, Tourism and Culture Industries, it was determined that an archaeological assessment would be needed in response to any project activities resulting in ground disturbance within previously undisturbed areas (pre-1960). The majority of the Study Area is largely disturbed due do previous watercourse alterations, as well as the residential, industrial, and commercial developments.

Alternative Solutions

The following eight alternative solutions were established to address flood risks identified:

- **Alternative 1 - Do Nothing:** The Do Nothing alternative involves maintenance of existing conditions of the creek system, with no implementation of, or improvements to flood mitigation infrastructure. It is to be included within the Municipal Class EA to provide a benchmark for the other alternatives.
- **Alternative 2 – Increase the Hydraulic Capacity of the Metrolinx Crossing:** This alternative involves the installation of a second bridge on private property, adjacent to the existing structure to increase the effective flow area of the crossing. It also includes the construction of a floodwall along the right creek bank between Constance Drive and Brookmill Road, adjacent to an existing municipal trail.
- **Alternative 3 – Construct Flood Control Infrastructure:** This alternative involves the construction of a flood control berm on private property to direct floodwater away from the commercial and residential areas, and toward the creek. It also includes the construction of a floodwall along the right creek bank between Constance Drive and Brookmill Road.
- **Alternative 4 - Install a Relief Culvert under Royal Windsor Drive:** This alternative involves the installation of a relief culvert under Royal Windsor Drive to prevent overtopping of the road during a flood event.
- **Alternative 5 - Construct an Offline Storage Facility:** This alternative involves the diversion of creek flows to an offline flood storage facility to attenuate peak flow rates and discharge any remaining water back into Joshua's Creek.
- **Alternative 6 - Implement LID Measures:** This alternative involves the installation of low impact development (LID) measures to promote infiltration, evaporation, harvesting, filtration, and detention of stormwater by mimicking natural hydrologic processes in urbanized areas throughout the Joshua's Creek watershed.
- **Alternative 7 - Construct a Flow Diversion Channel:** This alternative involves the diversion of creek flows into an adjacent drainage system, or downstream location within the same system, to by-pass the identified flood risk sites.

[2] Oakville Heritage Planning - https://www.oakville.ca/business/heritage-planning.html

- **Alternative 8 - Implement Non-Structural Flood Mitigation Measures:** This alternative involves the development and implementation of an emergency preparedness plan that includes measures to help reduce the extent and severity of flooding at flood risk sites.

Evaluation of Alternatives and the Preferred Alternative

A comparative evaluation of the eight alternative solutions was completed using a quantitative ranking system that looks at the technical feasibility and effectiveness of each alternative in meeting the project objectives and assesses impacts with respect to the natural environment, social/cultural environment, and economic considerations. The preferred flood mitigation alternatives recommended for implementation in the Joshua's Creek watershed are a combination of Alternative 8 in the short-term, with future consideration for implementation of Alternative 2. Alternative 8 calls for the implementation of non-structural flood mitigation measures, specifically an emergency preparedness plan, while Alternative 2 calls for the replacement of the Metrolinx bridge crossing with a higher capacity hydraulic structure, and the construction of a floodwall along the right creek bank between Constance Drive and Brookmill Road. Alternative 2 is contingent on acceptance from Metrolinx.

Alternative 2 is presented in the figure below and is the most effective alternative in terms of mitigating riverine flood risk during the Regional storm event; however, several drawbacks reduced its score in the evaluation process including ownership and high capital cost. The bridge is owned by Metrolinx; therefore, any upgrades, improvements, or replacements to the structure would be outside of the Town's jurisdiction to implement. In the long-term, when the bridge is scheduled for replacement, the Town could consider partnering with Metrolinx to ensure adequate capacity. At this time, various cost sharing and/or government funding opportunities could be explored to plan and execute the work, which could make Alternative 2 a more viable option.

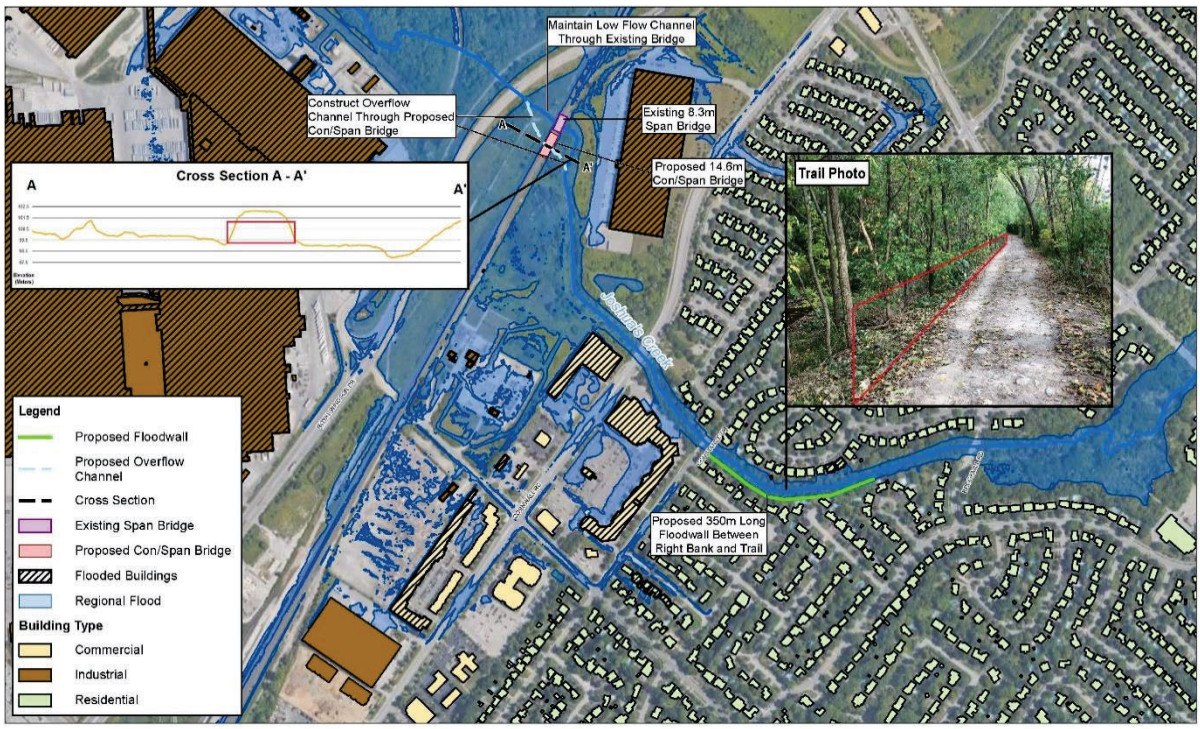

Figure 2 Alternative 2 Schematic

The results presented in the tables below demonstrate the effectiveness of Alternative 2 in terms of flood risk reduction. The tables show that 76 of the 88 total properties, and 12 of the 17 total buildings will experience reduced flood risk below the flood risk criteria by implementing Alternative 2. The results also show that 114 of the 170 residential properties, and 124 of the 134 residential buildings will be removed from the Regional flood boundary.

Table 1.1 Reduction of At-Risk Properties/Buildings After Implementation of Alternative 2

Land Use Type	Number of At-Risk Properties	Number of At-Risk Buildings
	Existing / After Alternative 2 Implemented	
Residential	79/5	12/0
Industrial/ Commercial	9/7	5/5

Table 1.2 Reduction of Properties/Buildings in the Regional Floodplain Boundary After Implementation of Alternative 2

Land Use Type	Number of Properties within the Regional Flood Boundary	Number of Buildings within the Regional Flood Boundary
	Existing / After Alternative 2 Implemented	
Residential	170/56	134/10
Industrial/ Commercial	21/17	29/24

Next Steps/Project Implementation

The Town is in the process of completing or nearing completion of several riverine flood mitigation studies within the next 6 to 12 months. Each of these studies will provide recommendations that will also have budgetary demands on the capital flood mitigation program. These studies include Munn's Creek, Fourteen Mile /McCraney Creek, Lower Morrison and Wedgewood Creek and Joshua's Creek. Once all studies are completed, a prioritization of flood mitigation works will be carried out and implemented with consideration of level of risk, return on investment and funding availability. The timing for the implementation of the Joshua Creek flood mitigation solutions will depend on the prioritization given to the Joshua's Creek watershed and the available funding.

Consultation

Public consultation is an integral component of the MCEA process. Although only two mandatory points of contact are required for Schedule B activities, four were included as part of the project to increase the opportunities for review agencies, Indigenous communities, and the public to be involved. Consultation activities completed as part of the Joshua's Creek Flood Mitigation Opportunities Study include the following:

- Notice of Study Commencement
- Review of the alternative flood mitigation solutions as part of Phase 2 of the MCEA through a Public Information Centre
- Confirmation of the preferred solution through a second Public Information Centre

- Review of the Draft Project File Report by Conservation Halton and filing of the Final Project File Report for review

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1. Introduction

1.1 Background and Purpose

The Town of Oakville (Town) has retained GHD Limited (GHD) to complete the Joshua's Creek Flood Mitigation Opportunities Study, including a Municipal Class Environmental Assessment (MCEA) and Preliminary Design to address flood control issues along the studied portion of Joshua's Creek from Upper Middle Road to Lake Ontario.

The project was undertaken as a Schedule 'B' MCEA in accordance with Phases 1 and 2 of the Municipal Engineers Association (MEA) MCEA process; (October 2000, as amended in 2007, 2011, and 2015). As a result, the problem has been documented and various alternative solutions, including the installation of a higher capacity hydraulic structure, the construction of flood control infrastructure, and the implementation of non-structural flood mitigation measures have been identified and comparatively evaluated following an investigation of the potentially affected environment.

This Project File Report has been prepared in accordance with the MCEA process to document the study completed for Joshua's Creek. This report includes the problem statement, alternative solutions being considered, description of the environment, evaluation of alternatives, selection of the preferred alternatives, and comments received in response to public consultation.

1.2 Governance

This study was initiated and is led by the Town of Oakville to assess flood risk in the Joshua's Creek watershed and establish viable and responsible flood mitigation measures that could be implemented as part of the municipal capital works program as needed, with consideration of level of risk, return on investment, and funding availability. The Town retained GHD to perform the hydrologic and hydraulic modelling of Joshua's Creek within the Study Area and carry out the MCEA process. Conservation Halton (CH) provided a technical and advisory review at key milestones in the study. The study is not intended to produce an update of the regulatory floodplain mapping for Joshua's Creek, which is under the jurisdiction of CH pursuant to the *Conservation Authorities Act*. However, the results from this study will be used by CH to update its Approximate Regulation Limit (ARL) mapping and may also be used to inform regulatory floodplain mapping updates by CH in the future.

1.3 Study Area

Joshua's Creek is located in the Town of Oakville within the jurisdiction of the Halton Region Conservation Authority (CH). It spans approximately 11 kilometres (km) from its headwaters near Lower Baseline Road between Trafalgar Road and Ninth Road to Lake Ontario, south of Lakeshore Road East, and just east of the Oakville-Mississauga municipal border. The Joshua's Creek watershed is long and narrow with a total contributing drainage area of approximately 21 km^2. Highway 403/Queen Elizabeth Way (QEW) intersects the watershed approximately 7 km downstream of the headwaters. The Study Area is defined by the Joshua's Creek watershed from Upper Middle Road to Lake Ontario. Figure 1.1 presents a site location map and Figure 1.2 shows a

detailed view of the Study Area. The land use upstream of Highway 403 is mostly agricultural with some residential pockets. The land use downstream of Highway 403 is mostly residential, commercial, and industrial including the Ford Motor Company (Ford) industrial plant on the southwest side of the creek.

Figure 1.1 Site Location Map

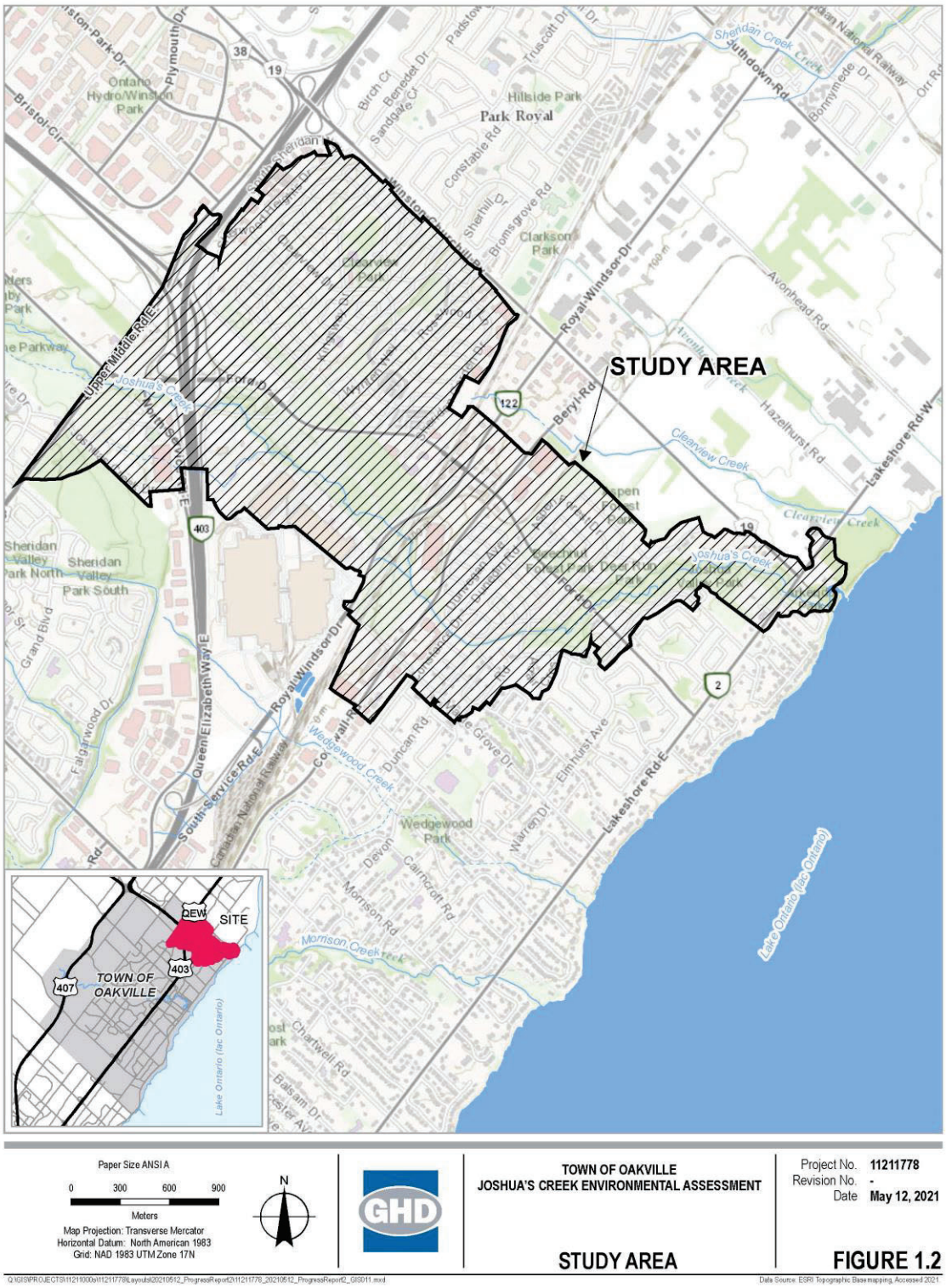


Figure 1.2 Study Area

1.4 Definitions and Conventions

As this study involves a hydraulic analysis of the creek, the report adopts the naming convention that assumes the observer stands in the middle of the creek and looks in the direction of flow. For example, references are made to left and right banks, which relate to what a person would see standing in the middle of the creek and looking downstream.

2. Overview of the Municipal Class Environmental Assessment Planning Process

As per the requirements of the *Ontario Environmental Assessment Act* (*OEAA*), this project followed the MCEA planning process prescribed by the Municipal Engineers Association document (October 2000, as amended in 2007, 2011, and 2015). The MCEA process allows the Town to satisfy the requirements of the *OEAA* for municipal infrastructure without the need for an Individual EA or request for a specific exemption for the project. Municipal projects addressed by the MCEA may be implemented without further approval under the *OEAA*, provided the approved MCEA planning process is carried out.

2.1 MCEA Project Schedules

The MCEA classifies municipal infrastructure projects into the following four groupings depending upon the nature of the project and potential for adverse effects:

Schedule A/A+

This category includes projects that are limited in scale, have minimal environmental impacts and include a number of municipal maintenance and operational activities. These undertakings are approved and may proceed directly to Phase 5 for implementation without completing the other phases. As part of the 2007 amendments to the MCEA process, the Schedule A+ classification was introduced to supplement the requirements of Schedule A undertakings, which includes projects that are pre-approved; however, the public must be notified prior to project implementation (i.e., Phase 5).

Schedule B

These projects have the potential for some adverse environmental effects and, therefore, the municipality is required to undertake a screening process (i.e., Phase 1 and 2) involving mandatory contact with the pubic that are directly affected and relevant agencies to ensure that they are aware of the project and that their concerns are addressed. In addition, it is required that a document be prepared and submitted for review by the public and review agencies for these undertakings. If there are no outstanding concerns, the municipality may proceed to Phase 5 for implementation.

Schedule C

Projects included under this classification have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the MCEA document (i.e., Phase 1 to 4). An Environmental Study Report must be prepared and submitted for

review by the public and relevant agencies for these undertakings. If there are no outstanding concerns, the municipality may proceed to Phase 5 for implementation.

2.2 Schedule 'B' Classification

This project will be completed following the Schedule 'B' MCEA process requirements. The MCEA is a self-assessment process. As such, it is the proponent's responsibility to identify the correct project schedule and meet the associated MCEA requirements. Failure to do so places the proponent in contravention of the *OEAA*, which is an offense subject to penalties.

The alternative solutions described in Section 4 of this report are most closely aligned with Schedule "A" and "B" activity descriptions:

- Municipal Road Projects Schedule A ID No. 17: Culvert repair and replacement where the capacity of the culvert is not increased beyond the minimum municipal standard or the capacity required to adequately drain the area, whichever is greater, and where there is no change in drainage area.
- Wastewater Management Projects Schedule B ID No. 15: Construct berms along a watercourse for purposes of flood control in areas subject to damage by flooding.

In light of this classification, the following MCEA planning phases were undertaken:

Phase 1: Problem or Opportunity

This phase involves not only identifying the problem/opportunity, but also describing it in sufficient detail to lead to a clear problem/opportunity statement.

Phase 2: Alternative Solutions

This phase involves the following six steps:

1. Identify all reasonable alternative solutions to the problem/opportunity.
2. Prepare a general inventory of the existing environment in which the project is to occur.
3. Identify the magnitude of the net positive and negative effects of each alternative solution and identify mitigation measures.
4. Evaluate the alternative solutions and identify a preliminary preferred solution.
5. Consult with review agencies and the public to solicit comment and input.
6. Select or confirm the preferred solution.

Upon completion of Phase 2, documentation of the two phases must be prepared. Once this documentation is complete, it must be placed on the public record for a period of at least 30 calendar days to allow for agency and public comment.

During the commenting period, a request may be made to the Ministry of the Environment, Conservation and Parks for an order requiring a higher level of study (i.e., requiring an individual/comprehensive EA approval before being able to proceed), or that conditions be imposed (e.g., require further studies), only on the grounds that the requested order may prevent, mitigate, or

remedy adverse impacts on constitutionally protected Aboriginal and treaty rights. Requests on other grounds will not be considered.

Once the comment period has ended and if there are no outstanding Part II Order requests, the municipality may proceed to the final phase of the planning and design process subject to an additional 30 days for MECP to respond to the proponent if they so wish.

Phase 5: Complete Contract Drawings and Documents and Proceed to Construct, Operate, and Monitor the Project

Phase 5 involves completing contract drawings and tender documents, incorporating the recommended solution and mitigation measures identified during the previous phases of the process. Once contracts are awarded, construction and project implementation can take place. Any monitoring programs identified during the MCEA process shall be undertaken to ensure that the environmental provisions and commitments made during the process are fulfilled and effective.

Figure 2.1 provides an overview of the MCEA process followed for this project.

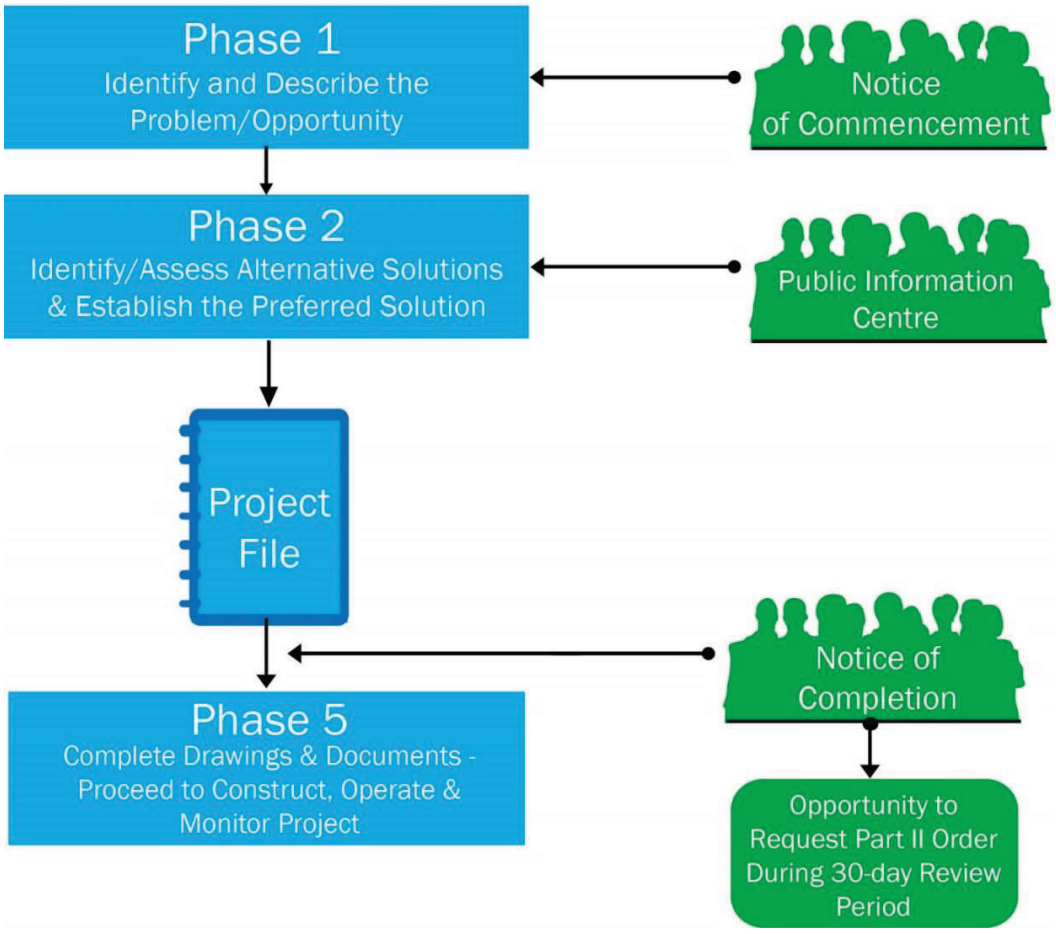


Figure 2.1 Schedule 'B' Municipal Class Environmental Assessment Process

2.3 Stakeholder Consultation

As required by the MCEA process for a Schedule 'B' project, consultation with review agencies, Indigenous communities, and the public is necessary. The purpose of the consultation process is to inform stakeholders of the project and provide them with an opportunity to comment on it.

Consultation for this project involves the Notice of Study Commencement, two PICs and the Notice of Study Completion. The purpose of the first PIC was to present the study objectives, problem/opportunity statement, description of the environment, alternatives being considered and to solicit feedback. The second PIC was held after the alternatives had been evaluated and the recommended alternatives had been selected.

3. Phase 1 – Identification and Description of the Problem/Opportunity

3.1 Identification of the Problem/Opportunity

The Town has conducted multiple studies to identify riverine flood risk along Joshua's Creek. The 2008 Flood Prioritization Study consisted of a comprehensive background review and documentation of all previously referenced riverine flood risk areas in the Town's jurisdiction. The study identified one priority flood risk site on Joshua's Creek at the Royal Windsor Drive and Metrolinx crossings and recommended to complete an additional detailed flood risk analysis.

GHD was retained by the Town to conduct the Joshua's Creek Flood Mitigation Opportunities Study, which was completed on January 28, 2020 (GHD 2020 study). The purpose of the study was to perform a hydrotechnical analysis of the creek system from Upper Middle Road to Lake Ontario to identify riverine flood risk sites and generate flood mitigation options. A flood risk site is considered an area where riverine flooding has the potential to adversely impact public safety, properties, and environmental and cultural heritage features.

A one-dimensional (1D) steady state hydraulic analysis of the Study Area was performed using the US Army Corps of Engineers HEC-RAS software. The HEC-RAS model results showed inundation of residential properties located in the right overbank area of Joshua's Creek between Constance Drive and Brookmill Road during the Regional (Hurricane Hazel) flood event, overtopping of Royal Windsor Drive during the 25-year flood event, and inundation of a parking lot on the Ford property during the 10-year flood event. The Ford parking lot is located within the existing floodplain and CH regulation limit. A map of the watercourse crossings within the Study Area is shown on Figure 3.1 for reference.

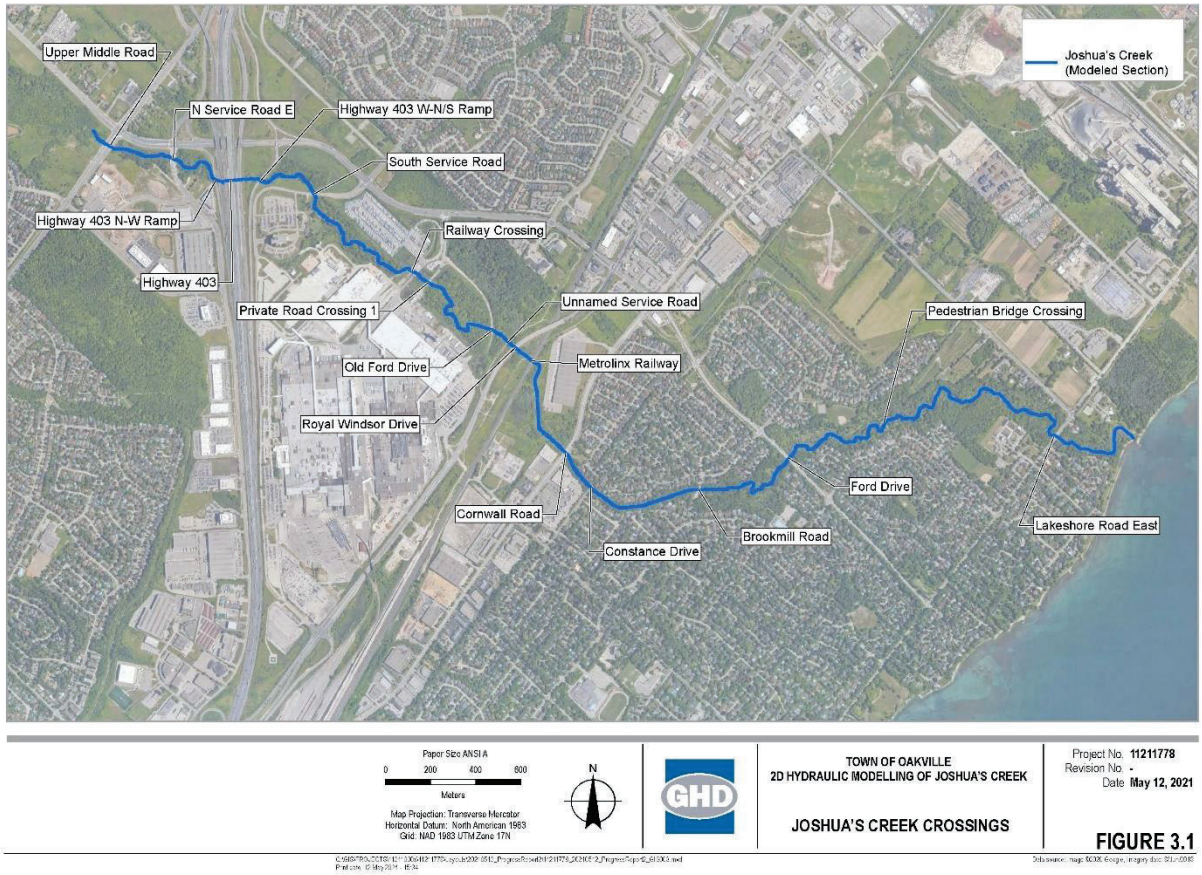


Figure 3.1 Joshua's Creek Crossings

The model results also showed the potential for inter-watershed flows (spills) from the creek system at two locations: (i) near the Royal Windsor Drive and Metrolinx crossings during the 50-year flood event; and (ii) upstream of the Highway 403 in the Regional flood event. However, the occurrence of inter-watershed flows, and the level and extent of flood inundation outside of the confined creek system could not be confirmed due to the limitations of the 1D steady state modelling approach. As a result, it was recommended to complete a two-dimensional (2D) unsteady hydraulic model of the creek system to provide a more accurate representation of the level and extent of flood inundation in the potential spill areas.

In October 2020, GHD developed a 2D unsteady hydraulic model of the creek system to address the limitations of the 1D analysis. Figures 3.2 to 3.4 show the flood inundation boundaries for the 100-year, 100-year climate change and the Regional flood events, respectively, based on the 1D and 2D model output. Additional figures showing the flood inundation boundaries for the 2-year to 50-year flood events, and the spill upstream of the Highway 403 crossing are presented in Appendix A.

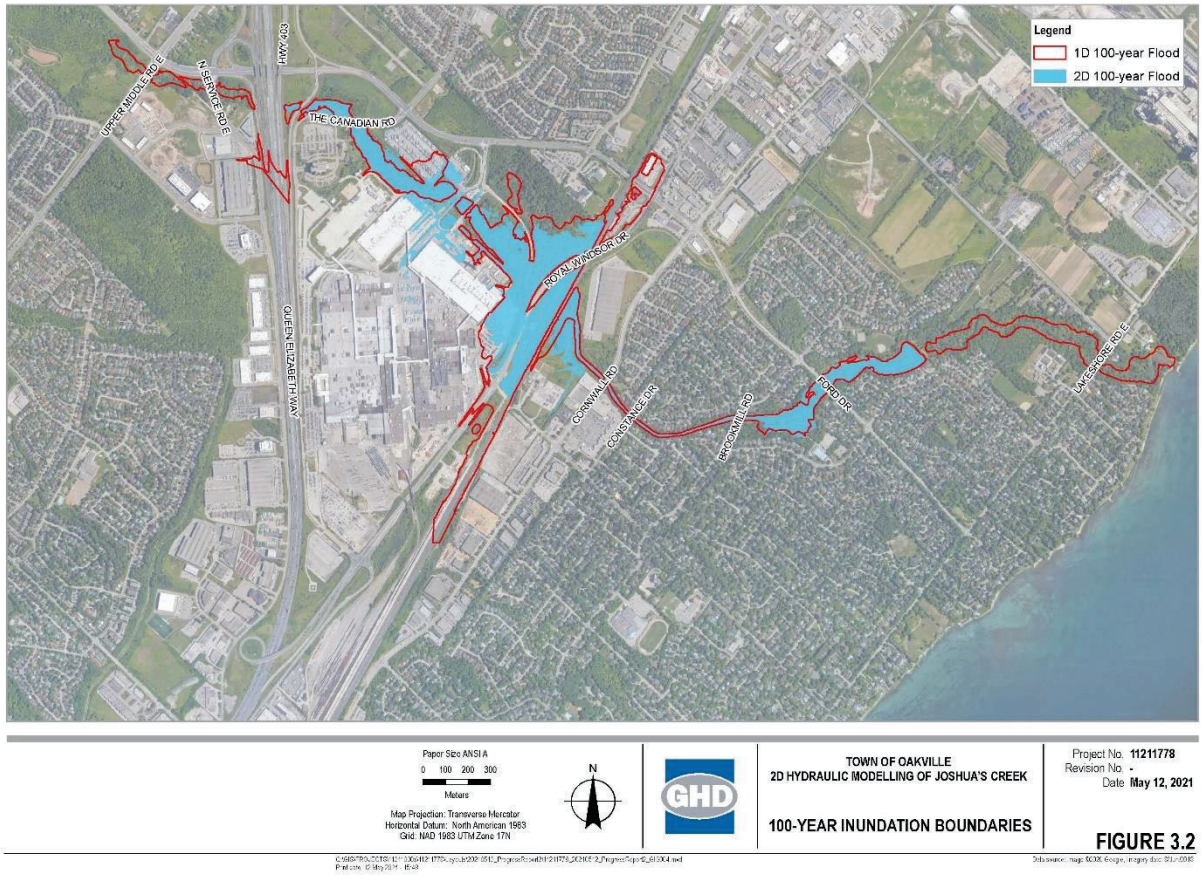


Figure 3.2 100-Year Inundation Boundaries

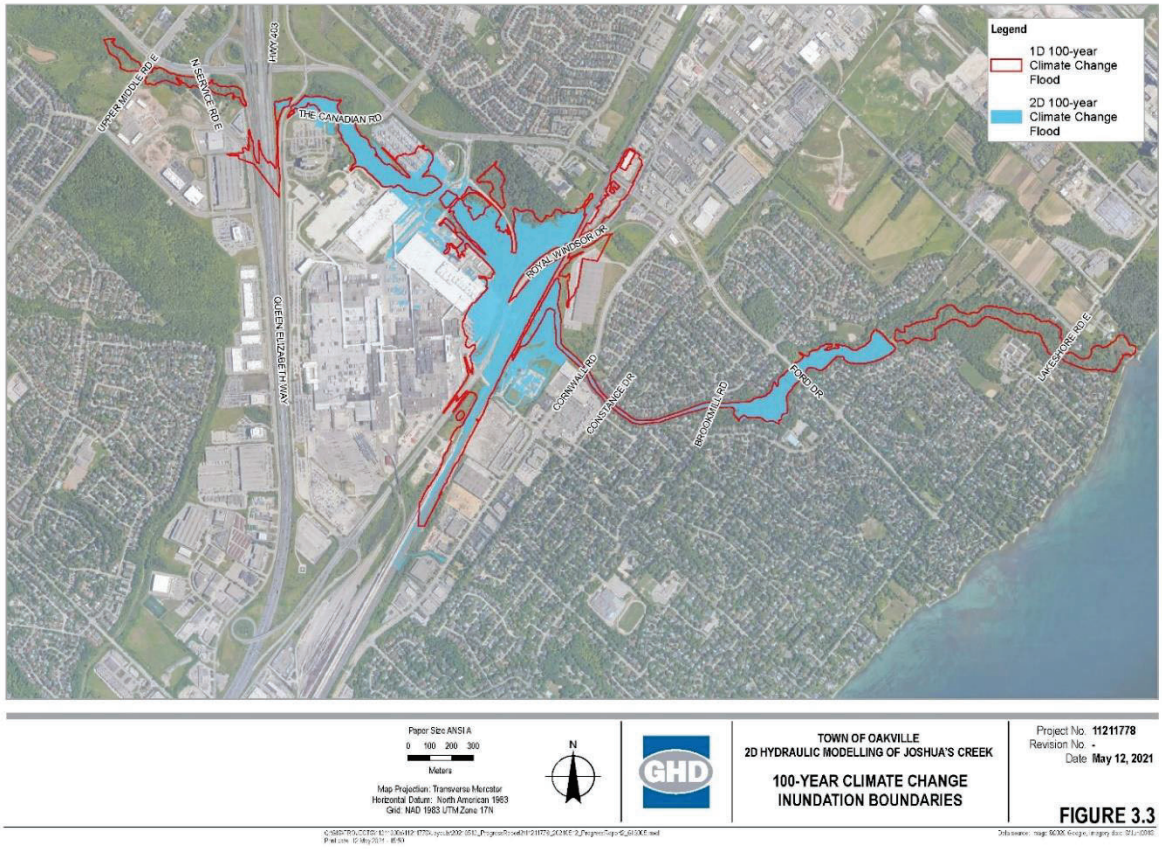


Figure 3.3 100-Year Climate Change Inundation Boundaries

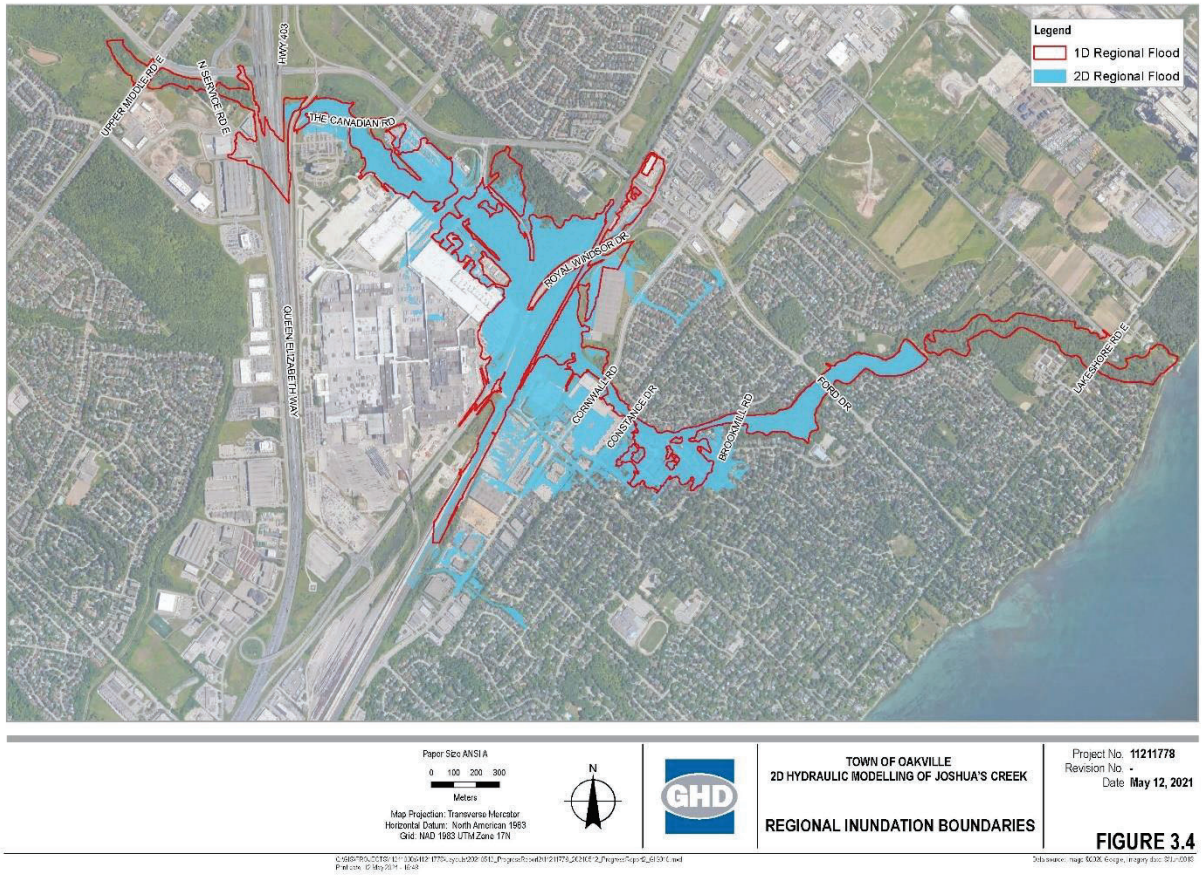


Figure 3.4 Regional Inundation Boundaries

The 2D model output demonstrates that the spill to the Wedgewood Creek system occurs during 100-year climate change and Regional flood events. The spill area has been included as a flood risk site because of the existing capacity issues in the Wedgewood Creek system. The 2D model also produced a larger Regional flood inundation boundary downstream of the Metrolinx crossing in the right overbank area of the creek. The model simulation reveals the Regional flood wave originates from overtopping of the Metrolinx tracks and overtopping of the right creek bank downstream of Constance Drive as shown on Figure 3.5.

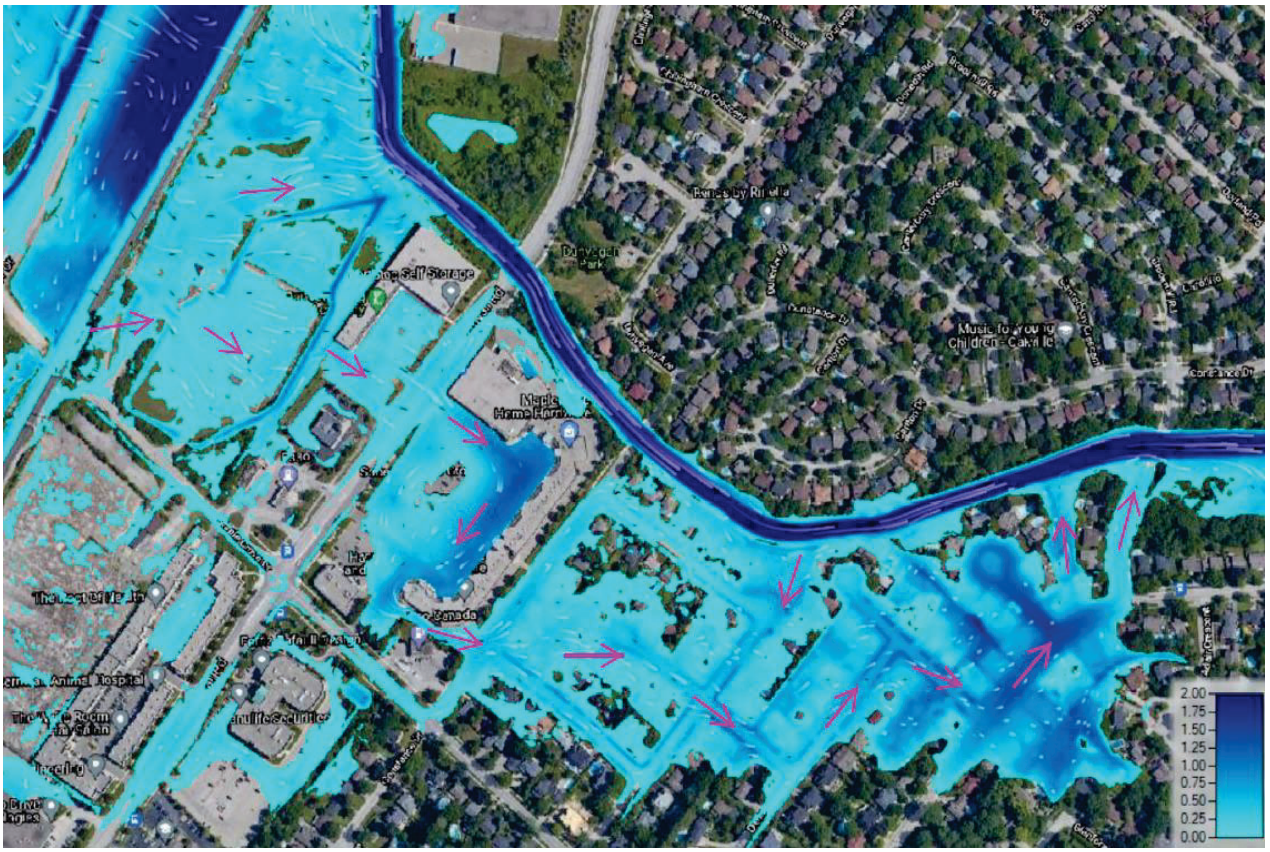


Figure 3.5 Regional Flow Path (Colour Scale Represents Flood Depth in "metres")

Figure 3.6 presents the Regional flood depths as a colour map. Flood depths less than 0.3 m are shown in grey and flood depths greater than 1.0 m are shown in red. The map demonstrates that the greatest impacts to developed areas include the commercial area on the southeast corner of Cornwall Road and Maple Grove Drive, and the residential area downstream of Constance Drive.

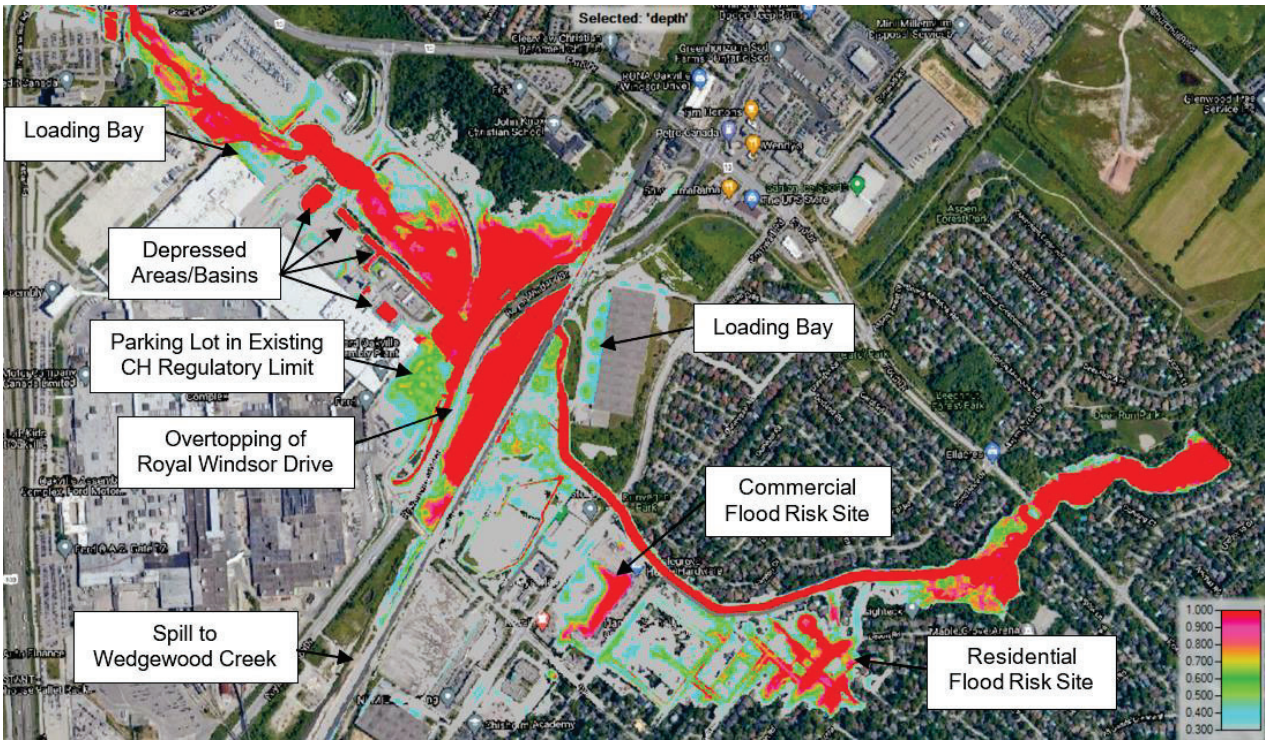


Figure 3.6 Flood Risk Sites (Colour Scale Represents Flood Depth in "metres")

A summary of flood risk sites is provided below:

1. Flood inundation of the commercial and residential areas downstream of the Metrolinx tracks, in the right overbank area of the creek during the Regional flood event
2. Inter-watershed flows (spill) to the Wedgewood Creek system near the Royal Windsor Drive and Metrolinx crossings in the 100-year climate change and Regional flood events
3. Overtopping of Royal Windsor Drive in the 25-year flood event
4. Inter-watershed flows from the creek system upstream of Highway 403 during the Regional flood event

3.2 Problem/Opportunity Statement

Riverine flood risk sites have been identified along Joshua's Creek from Upper Middle Road to Lake Ontario based on the outcomes of 1D steady state and 2D unsteady hydraulic models.

This project provides an opportunity to identify and evaluate feasible flood mitigation options, with the objective of determining the flood control measures that will most effectively address the identified flood risk sites within the Study Area, where flood risk sites are areas susceptible to flood inundation and potential contamination of riverine floodwater. The flood risk sites have been listed in order of priority for mitigation based on their impact to the community. Inter-watershed flows at Highway 403 was listed fourth because it is does not appear to cause critical impacts to private properties, in addition to the fact that the highway is under the jurisdiction of the Ministry of Transportation and any potential modifications to the freeway are outside of the Town's ability to implement. The flood mitigation alternatives must also consider reducing impacts to, or providing

opportunities to enhance, the natural environment, cultural heritage, and economic infrastructure in the Study Area.

4. Phase 2 – Identification and Evaluation of Alternative Solutions to the Problem

Next, alternative solutions were identified and described in response to the problem/opportunity statement in accordance with Phase 2 of the of the MCEA process. An alternative to “do nothing” is included and evaluated as a requirement of the MCEA process.

4.1 Identification and Description of the Alternative Solutions

A long list of eight (8) alternative solutions were identified to address the impacts at the flood risk sites.

The eight alternative solutions are illustrated on Figure 4.1 and include the following:

- Alternative 1: Do nothing
- Alternative 2: Increase the hydraulic capacity of the Metrolinx crossing (subject to negotiations and acceptance by Metrolinx)
- Alternative 3: Construct flood control infrastructure (subject to negotiations and acceptance by private landowners affected by construction)
- Alternative 4: Install a relief culvert under Royal Windsor Drive
- Alternative 5: Construct an off-line storage facility
- Alternative 6: Implement low impact development (LID) measures
- Alternative 7: Construct a flow diversion channel
- Alternative 8: Implement non-structural flood mitigation measures

Each of the preceding alternative solutions are further elaborated in the following sections.

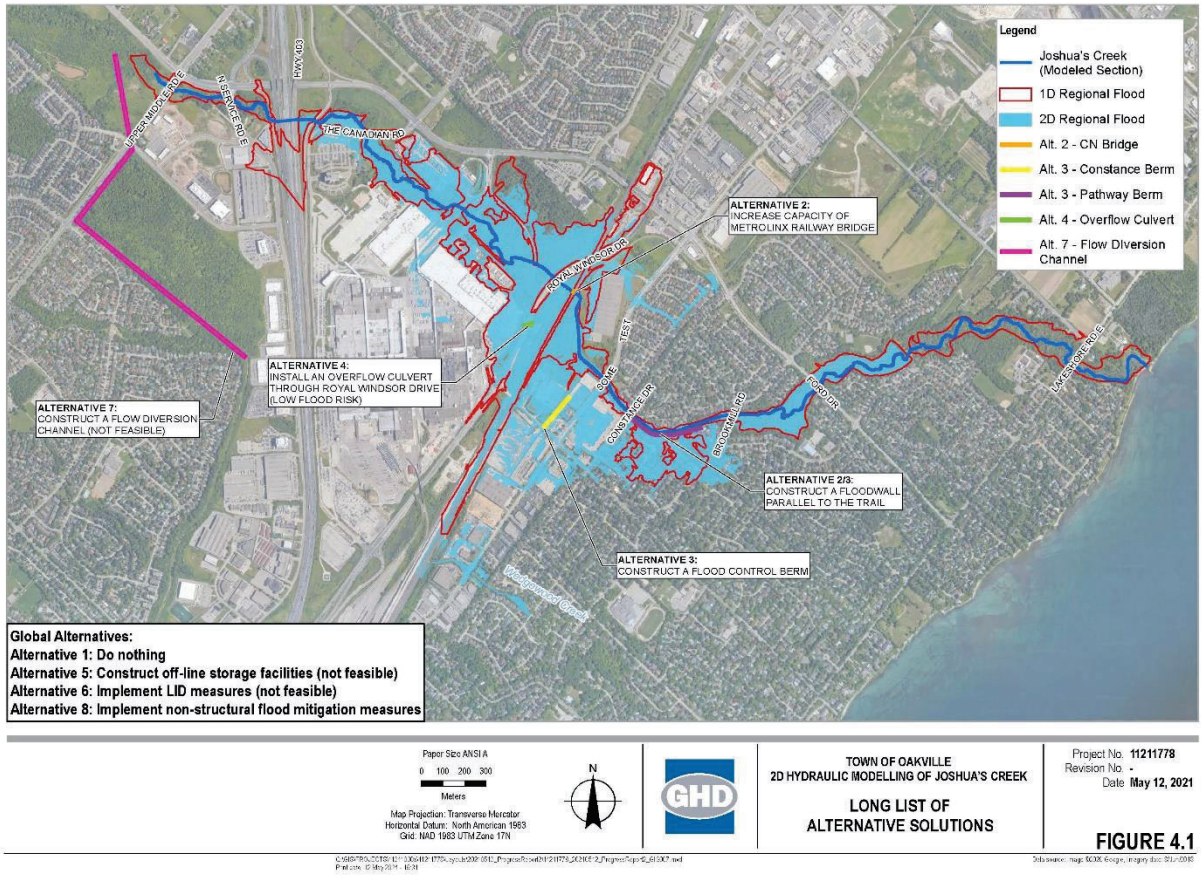


Figure 4.1 Long List of Alternative Solutions

4.1.1 Alternative 1 – Do Nothing

This alternative involves maintenance of existing conditions of the creek system, with no implementation of, or improvements to flood mitigation infrastructure. It also provides a benchmark for other alternatives to be compared to.

4.1.2 Alternative 2 – Increase the Hydraulic Capacity of the Metrolinx Crossing

The hydraulic capacity of the Metrolinx crossing would be increased by installing a second bridge adjacent to the existing structure to increase the effective flow area of the crossing from approximately 22 square meters (m^2) to approximately 52 m^2. Alternatively, if the existing bridge is scheduled for replacement in the future, it could be replaced with a single structure that provides the target effective flow area. Both options allow more water to pass underneath the tracks to lower upstream water levels.

Preliminary modelling shows that increasing the hydraulic capacity of the Metrolinx crossing on its own does not resolve inundation of the residential area between Constance Drive and Brookmill Road due to overtopping of the right bank at this location. As such, this alternative would include the construction of a floodwall adjacent to an existing trail on the right bank. Similarly, the floodwall

would not protect the residential area from inundation on its own. The combination of the Metrolinx crossing upgrades and floodwall construction would be required to mitigate flooding during the Regional storm event. The floodwall would be constructed entirely on public property and start at the trail entrance on Constance Drive and extend approximately 350 metres (m) in the downstream direction. The top of the floodwall would be approximately 0.5 to 0.75 m above the trail to contain the Regional flood. A conceptual drawing of the alternative is provided on Figure 4.2.

This alternative is contingent on acceptance by Metrolinx. It is included in the study because rail overtopping has been identified as a source of flood inundation at flood risk site 1. This alternative would effectively prevent overtopping of the tracks and inundation of the residential properties and reduce flood impacts to the commercial properties in a Regional flood event. It would also mitigate the spill to the Wedgewood Creek system during the 100-year climate change flood event; therefore, this alternative would reduce impacts at flood risk sites 1 and 2. The total cost for design and construction of this alternative is estimated to be $7.4 million.

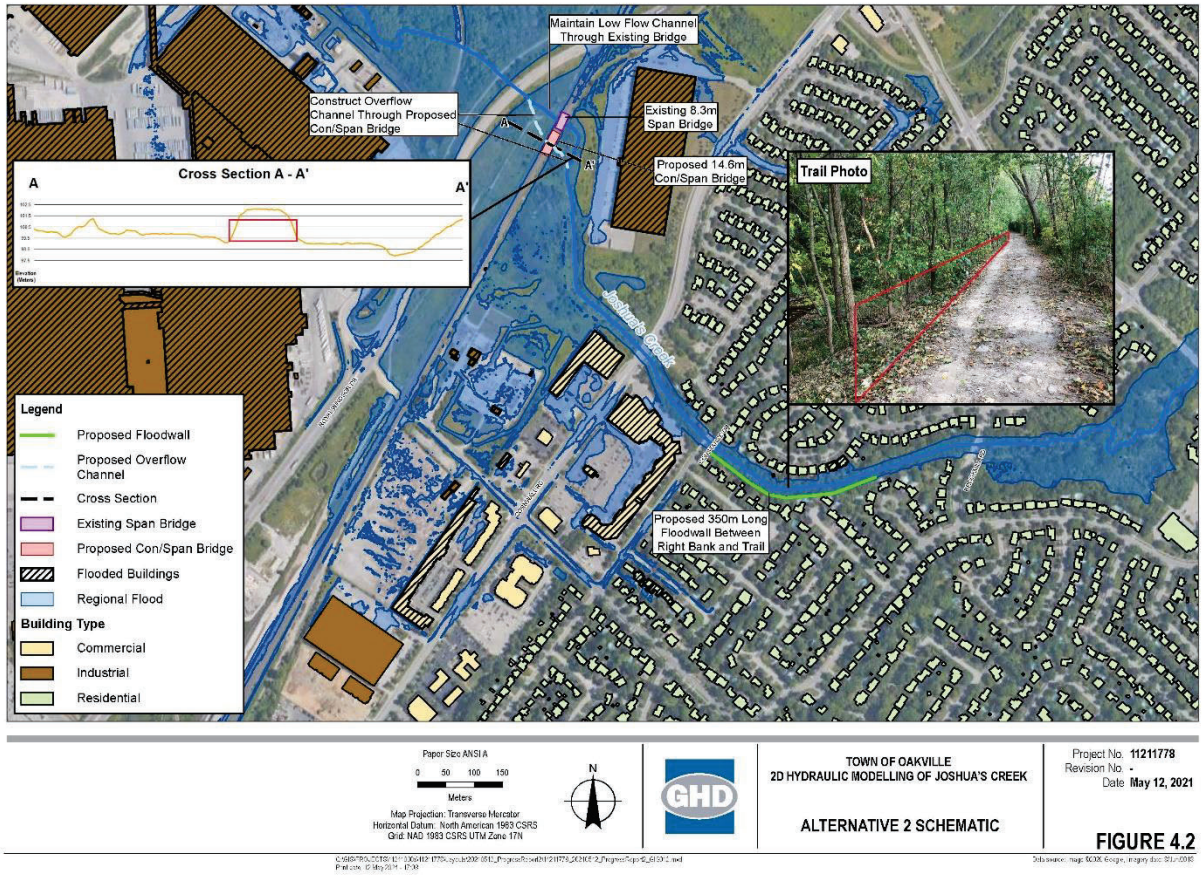


Figure 4.2 Alternative 2 Schematic

4.1.3 Alternative 3 – Construct Flood Control Infrastructure

A 150 m long floodwall would be constructed between the Hydro One property at 559 Maple Grove Drive and three private lots located at 541 Maple Grove Drive, 2035 Cornwall Road and 2055 Cornwall Road. The maximum height of the wall would be 1.0 m. This option would require the Town to secure sections of privately owned land to construct the wall. This option aims to allow overtopping of the tracks, capture the floodwater, and direct it back into Joshua's Creek to prevent inundation of the commercial and residential areas.

Two locations were initially considered for the installation of flood control infrastructure to redirect floodwater to the creek, including Cornwall Road and Constance Drive. These locations would have been preferred because they are on Town lands. However, the low points/inundated sections of these roads are lower than the creek banks at the respective crossings. The banks would need to be cut down or floodwater would need to be piped to the creek to drain the low areas, which would lower the capacity of the creek.

The installation of a floodwall at the selected location would effectively direct floodwater back to the creek without reducing the capacity of the system.

Preliminary hydraulic modelling shows that the floodwall by itself would not resolve inundation of the residential areas between Constance Drive and Brookmill Road due to overtopping of the right bank. As such, this alternative solution would include the construction of another floodwall between the right bank and the trail as presented in the Alternative 2 description. A conceptual drawing of Alternative 3 is presented on Figure 4.3.

This alternative would reduce the impacts at flood risk site 1; however, the spill to Wedgewood Creek would not be mitigated. The cost for design and construction of this alternative is estimated to be $1.3 million, not including land aquisition.

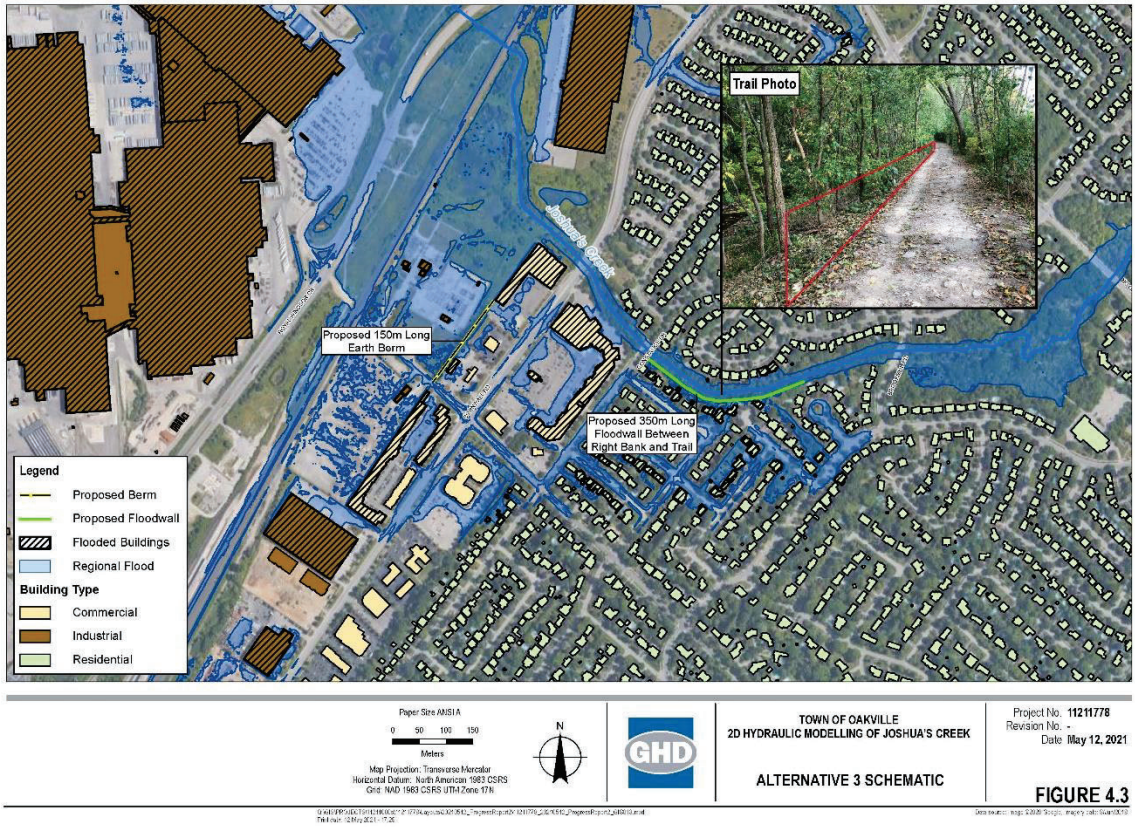


Figure 4.3 Alternative 3 Schematic

4.1.4 Alternative 4 – Install a Relief Culvert under Royal Windsor Drive

Alternative 4 includes the installation of a relief culvert under Royal Windsor Drive to prevent overtopping of the road during the 100-year event, in order to meet the Town's design guidelines (https://www.oakville.ca/assets/general%20-%20business/DevelopmentEngProceduresManual.pdf). There is an existing culvert (approximately 1.8 m span by 1 m rise reinforced concrete box culvert) located to the right of the creek crossing that appears to accommodate drainage from the Ford property. It is assumed that the existing culvert will flow at full capacity during a 100-year event, without accounting for Joshua's Creek floodwaters.

The Ontario Ministry of Transportation (MTO) Highway Drainage Design Standards (2008) provides relief flow criteria, which specifies a maximum flow depth and velocity over the road at a watercourse crossing in the Regulatory (Regional) flood event. The criteria states that the depth of flow over the road shall not exceed 0.3 m and the product of the depth and velocity of flow shall not exceed 0.8 m^2/s during the Regulatory flood. The 2D modelling results show that the maximum depth of floodwater on Royal Windsor Drive is mostly less than 0.3 m within the overtopped road reach and does not exceed 0.4 m at any point. The maximum product of depth and velocity of floodwater within the overtopped road reach does not exceed 0.8 m^2/s across any location during the Regional flood event as shown on Figure A.7 in Appendix A. The relief flow criteria are met during the 100-year

climate change flood event. In addition, there are several alternate routes available for vehicle passage in the event of an extreme flood in the Study Area, including Highway 403.

Based on this assessment, the risk associated with road overtopping at Royal Windsor Drive is considered to be low; therefore, this alternative will not be carried forward into the evaluation.

This alternative would effectively address the impacts at flood risk site 3, which is considered to be relatively low risk. It would not remove properties and buildings from flood inundation during the Regional storm.

4.1.5 Alternative 5 – Construct an Offline Storage Facility

Alternative 5 aims to mitigate flooding by reducing peak flow rates throughout the creek, as opposed to building higher capacity drainage infrastructure to pass the existing peak flow rates or constructing berms/floodwalls to protect developed areas from flood inundation.

Peak flow rates would be reduced by routing flows through an offline flood storage facility(s). A diversion structure would direct creek flows to the storage facility, which would attenuate the peak flow rates, and discharge back into Joshua's Creek.

To prevent overtopping of the Metrolinx tracks, the peak flow rate in the creek would have to be reduced to approximately 72 m^3/s to pass through the existing rail bridge without overtopping. The target peak flow rate was calculated using hydraulic computations in the Bentley Culvert Master software and a maximum allowable headwater elevation of 101.6 m (CGVD 2013), which represents the approximate overtopping elevation of the tracks. The target peak flow rate is also equal to the 100-year climate change peak flow rate calculated at the rail line, which does not cause overtopping of the tracks in the 2D hydraulic model.

It is estimated that a storage volume of approximately 1,500,000 m^3 would be required to attenuate the Regional peak flow rate of approximately 150 m^3/s to 72 m^3/s in the creek immediately upstream of the tracks. Assuming the storage facility would be designed with a maximum active storage depth of 1 m, the required footprint would be greater than 150 hectares (ha). As such, multiple distributed storage facilities would be required. Figure 4.4 shows the storage required for peak flow attenuation estimated using the hydrologic model in PCSWMM. The required storage volume is depicted by the blue shaded area.

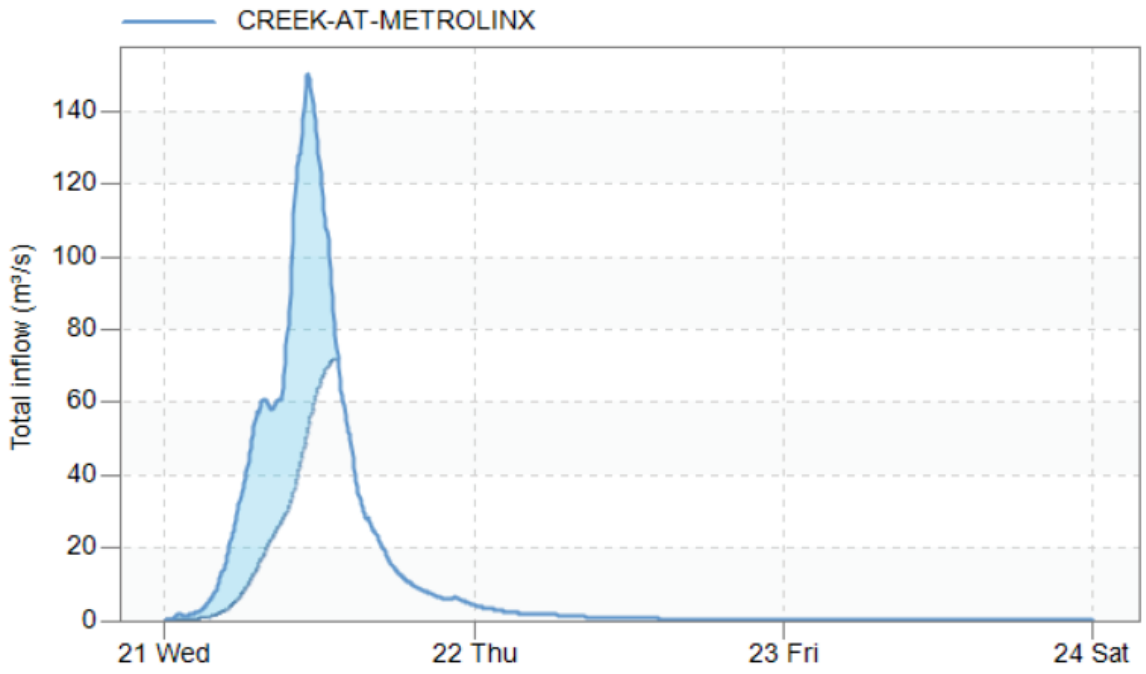


Figure 4.4 Storage Calculation Required to Attenuate Peak Flow Rate to 72 m^3/s at the Metrolinx Tracks

Based on these preliminary calculations, the required footprint of the flood control storage facility and/or number of multiple flood control storage facilities would be exceptionally large, resulting in very high land acquisition and construction costs, and significant impacts to the natural environment. In addition, this alternative would only provide the benefit of flood mitigation during flow events that occur less than once every 100-years on average. As a result, this option will be removed from the list of feasible alternatives considered in the remainder of the MCEA study.

This alternative has the potential to address the impacts at all flood risk sites; however, its implementation is not feasible.

4.1.6 Alternative 6 – Implement LID Measures

Alternative 6 involves the extensive installation of LIDs throughout the Joshua's Creek watershed. LIDs are designed to promote infiltration, evaporation, harvesting, filtration, and some detention of stormwater by mimicking the natural hydrologic processes in urbanized areas. In this application, LIDs would help provide some erosion protection, water quality treatment, groundwater recharge, and peak flow attenuation at small scales. However, LIDs are not intended to provide flood control for extreme events such as the Regional storm. Mitigation of extreme riverine flooding events is the focus of this study. For this reason, Alternative 6 will not be carried forward in the evaluation of feasible alternatives for flood mitigation.

This alternative is not capable of addressing impacts at any of the flood risk sites. However, LIDs are encouraged for new development or redevelopment projects as opportunities exist, as they do benefit the environment.

4.1.7 Alternative 7 – Construct a Flow Diversion Channel

Alternative 7 involves the diversion of creek flows to an adjacent drainage system, or downstream location within the same system, to by-pass the identified flood risk sites.

A review of background mapping shows the Morrison Wedgewood Diversion Channel is located approximately 1.2 km south of Joshua's Creek. The diversion channel runs from east to west, north of Highway 403, intercepts flow from Munn's Creek, West Morrison Creek, East Morrison Creek, West Wedgewood Creek, and East Wedgewood Creek, and ultimately discharges to Sixteen Mile Creek. The purpose of the diversion channel is to mitigate flooding in downstream residential neighbourhoods. Although the diversion channel is near to Joshua's Creek, challenging topography and existing capacity constraints make connection to channel impractical.

Wedgewood Creek and Clearview Creek are the neighbouring watercourses to Joshua's Creek. They are located southwest and northeast of the Joshua's Creek, respectively. Connection to the Wedgewood Creek system is not recommended due to existing higher risk flood concerns in this system. Connection to the Clearview Creek system is not feasible due to topographic constraints. Finally, construction of a bypass channel around the identified flood risk sites is not feasible due to spatial constraints as the areas are highly developed.

This alternative would address the impacts at all flood risk sites; however, its implementation is not feasible.

4.1.8 Alternative 8 – Implement Non-Structural Flood Mitigation Measures

Flood mitigation can be obtained by implementing non-structural measures. Flood control policies currently exist to mitigate flood risk by restricting development within floodplains. These policies are enforced by the local conservation authority (CH). Other non-structural mitigation measures include emergency preparedness plans, flood forecasting/warning, and land acquisition in high-risk areas. These measures should be considered for implementation in locations where it may not be feasible to construct structural flood mitigation measures (i.e., in highly developed areas such as the present Study Area).

An emergency preparedness plan would identify properties located in the floodplain and provide the residents with a set of actions/procedures they can follow to best protect themselves and their properties during an extreme flood event. The residents can use information that the Town, Region, Province, or their insurance companies may have available to develop individual emergency response plans and prepare to implement temporary or permanent flood proofing measures (i.e., sand bagging, sealing windows/doors that are not needed, waterproofing utilities). Flood warning/forecasting is the responsibility of the local conservation authority. CH would advise the Town of anticipated extreme flood conditions, and the Town would implement their emergency response/preparedness plans.

The development and implementation of an emergency preparedness plan will be carried forward in the evaluation of alternatives. This alternative will not resolve flooding issues, but has the potential to reduce the extent and severity of flooding at flood risk site 1.

4.1.9 Summary of Short-listed Alternative Solutions

Table 4.1 provides a summary of the alternative solutions that will be carried forward and evaluated to determine the preferred flood mitigation option along Joshua's Creek.

Table 4.1 Summary of Feasible Alternatives

Alternatives	Feasibility	Comments
Alternative 1 – Do nothing	✓	This alternative will be carried forward in the study.
Alternative 2 – Increase the hydraulic capacity of the Metrolinx rail bridge	✓	This alternative will be carried forward in the study.
Alternative 3 – Construct flood control infrastructure	✓	This alternative will be carried forward in the study.
Alternative 4 – Install a relief culvert under Royal Windsor Drive	X	This alternative does not reduce flooding of any employment, commercial, or residential lands. Road overtopping depth and velocity are not significant during the Regulatory/Regional flood event.
Alternative 5 – Construct an offline storage facility	X	Flood storage facility would not be feasible due to spatial and environmental constraints, and high land acquisition costs.
Alternative 6 – Implement LID measures	X	LIDs are not intended to provide flood control for extreme events such as the Regional flood.
Alternative 7 – Construct a flow diversion channel	X	Flow diversion is not feasible due to the significant development, challenging topography, and existing flood concerns in adjacent watercourses (i.e., Wedgewood Creek).
Alternative 8 – Implement non-structural flood mitigation measures	✓	This alternative will be carried forward in the study.

4.2 Description of the Study Area

With the problem defined and the alternative solutions identified, a description of the Study Area was established through a review of secondary information sources, field investigations, and detailed hydrologic and hydraulic analyses. A summary of the results and findings of these activities is provided in the following sections.

4.2.1 Hydrology

As part of the GHD 2020 study, GHD developed a semi-distributed event-based hydrologic model of Joshua's Creek using the PCSWMM software (Computational Hydraulics International, 2017). Runoff hydrographs were computed at subcatchment outlets and routed downstream through tributary/creek channels for the 2- to 100-year, 100-year climate change and the Regional storm events. The hydrologic model was built for future development conditions including increased

build-out and further development of existing properties. The percentage of impervious areas were increased to reflect the fullest extent of development possible under current zoning policies.

Subcatchments were delineated using the 2017 digital elevation model (DEM) provided by the Town and adjusted based on a review of drainage patterns and conveyance systems from various background reports and record drawings. During the study, the Town informed GHD that Wood was completing a Master Drainage Study for a residential area located within the Joshua's Creek watershed, downstream of Upper Middle Road. The Town requested that GHD incorporate Wood's hydrologic model within the Joshua's Creek hydrologic model in an effort to achieve consistent output between the studies. Figure 4.5 shows the resultant subcatchment delineation within the Joshua's Creek watershed boundary.

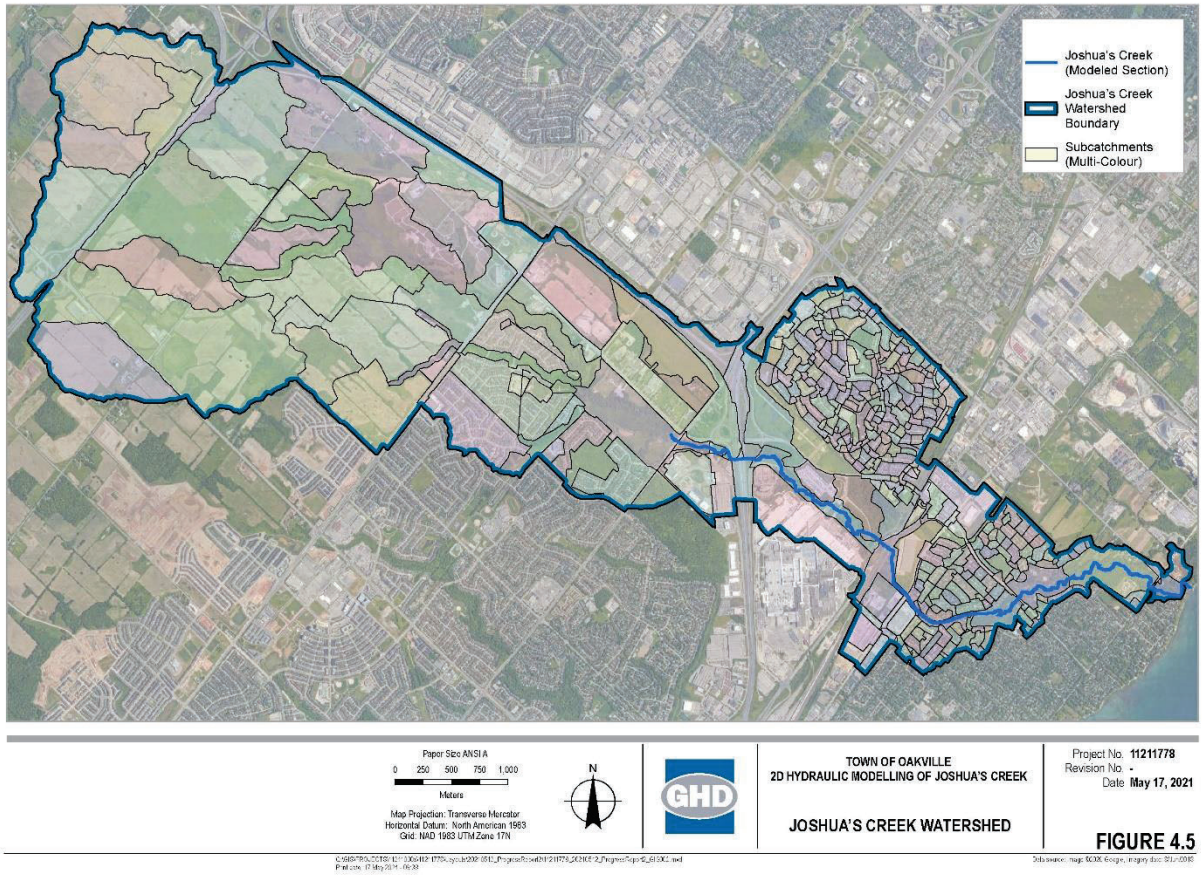


Figure 4.5 Joshua's Creek Watershed

Subcatchment parameters including area, flow length and subcatchment slope were assigned based on the 2017 DEM. Average imperviousness, Manning's 'n' values for overland flow and depression storages were assigned to the subcatchments based on land cover type determined from aerial imagery and background information. Infiltration was simulated using the Green-Ampt model based on the local soil data from the Soil Map of Halton County. Soils are mostly sandy loam south of Royal Windsor Drive and mostly clay loam north of Royal Windsor Drive.

The 2- to 100-year hyetographs were generated using the Town's 24-hour Chicago synthetic design storm distributions. The 100-year climate change adjusted distribution was generated using rainfall statistics based on the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) 8.5 scenario for the 2080 – 2100 time period. The climate change adjusted rainfall statistics were generated using the IDF-CC Tool (Version 2) developed in the Facility for Intelligent Decision Support at Western University. RCP scenarios represent a broad set of socioeconomic scenarios, while also incorporating carbon emission control, and utilize parameters such as climate, economic, land use, demographic, and energy-usage effects. The RCP scenarios 2.6, 4.5, 6.0, and 8.5 reflect various levels of climate change mitigation efforts, from successful mitigation of greenhouse gas emissions (i.e., RCP 2.6, resulting in an increase of 2.6 W/m^2 in radiative forcing to the global climate system), to the continuation of business-as-usual greenhouse gas emissions (i.e., RCP 8.5, an increase of 8.5 W/m^2).

The 12-hour duration Hurricane Hazel rainfall distribution was obtained from the Ministry of Natural Resources and Forestry (MNRF) Flood Hazard Limit Guidelines (MNRF, 2002), and used to model the Regional hydrograph. This distribution represents the last 12-hours of the 48-hour historical storm event; therefore, the infiltration parameters of the hydrologic model were adjusted to represent the saturated ground conditions at the beginning of the simulation.

Table 4.2 summarizes the peak flow rates calculated at key locations along Joshua's Creek for all design storm events. Review of the model output reveals a significant increase in peak flow rates between the 100-year climate change and Regional events. The Regional peak flow rates are almost three times greater than the 100-year peak flow rates, and slightly more than two times greater than the 100-year climate change peak flow rates.

Table 4.2 Summary of Peak Flow Rates at Various Locations along Joshua's Creek

Return Period	Peak Flow Rate at Various Locations (m^3/s)		
	Highway 403	Metrolinx Rail	Ford Drive
2-year	15.14	16.34	16.45
5-year	24.65	26.46	26.81
10-year	31.54	33.94	34.50
25-year	41.32	44.48	45.46
50-year	48.37	52.08	53.38
100-year	53.5	57.82	59.95
100-year Climate Change	67.75	72.37	74.47
Hurricane Hazel	135.5	150.4	159.7

More detailed information on hydrologic model development is provided in the GHD 2020 study.

4.2.2 Riverine Hydraulics

4.2.2.1 1D Steady State Hydraulic Model

GHD developed a 1D steady state HEC-RAS model of Joshua's Creek from upstream of Upper Middle Road to Lake Ontario as part of the GHD 2020 study. CH provided GHD with an existing 1D steady state hydraulic model of Joshua's Creek, which was used as a reference.

The model geometry was created using terrain data and aerial imagery provided by the Town at the commencement of the study in 2017. A terrain surface of the Study Area was created by merging a digital terrain model (DEM), topographic survey and building footprint shapefile into a single TIN layer.

The river reach centreline and bank stations were traced from the terrain and aerial imagery. Cross sections were cut through the terrain layer to characterize the channel and floodplain geometries. Ineffective flow areas were defined in the model cross sections and represent areas that contain water, but do not actively convey flow. Crossing and hydraulic structure information was input based on the field survey. Surface roughness was represented by Manning's 'n' values based on the land cover.

Steady flow data was input as the peak flow rates generated by the PCSWMM model described in Section 4.2.1.

The Town retained Calder Engineering to conduct a topographic survey of the hydraulic structures and model cross sections located upstream and downstream of the watercourse crossings. Geometric properties of the hydraulic structures are summarized in Table 4.3.

Table 4.3 Geometric Properties of the Hydraulic Structures in the 1D Model

Street Crossing	Structure Type	Span (m)	Rise (m)	No. Barrels
Upper Middle Road	Reinforced Concrete Box Culvert	13.7	3.0	1
Crossing at 1720 NSR	Bridge	24.7	3.2	1
QEW N-W Ramp	Bridge	16.1	4.2	1
QEW/Hwy 403	Reinforced Concrete Arch Culvert	9.1	4.6	1
QEW W-N/S Ramp	Bridge	12.5	5.0	1
South Service Road	Reinforced Concrete Box Culvert	5.4	3.6	3
Railway Crossing East of Hwy 403, South of Ford Drive	Reinforced Concrete Box Culvert	5.7	1.6	4
		12.6	1.5	1
		5.3	1.5	1
Private Road Crossing	Reinforced Concrete Box Culvert	6.1	1.5	4
		6.3	1.5	2
		6.5	1.5	2
Old Ford Drive	Reinforced Concrete Box Culvert	6.3	1.6	2
Unnamed Service Road	Reinforced Concrete Box Culvert	4.5	1.6	2
Royal Windsor Drive	Reinforced Concrete Arch Culvert	8.4	4.8	1

Street Crossing	Structure Type	Span (m)	Rise (m)	No. Barrels
Metrolinx Rail	Bridge	8.2	2.5	1
Cornwall Road	Bridge	16	3.6	1
Constance Drive	Bridge	15	3.5	1
Brookmill Road	Bridge	26	3.6	1
Ford Drive	Bridge	75	5.6	1
Pedestrian Walkway	Reinforced Concrete Box Culvert	3.5	2.4	2
	Circular Concrete Culvert	4.7	4.7	1
Lakeshore Road East	Bridge	19	4.0	1

More detailed information on the 1D hydraulic model development is provided in the GHD 2020 study.

4.2.2.2 2D Unsteady Hydraulic Model

It is known that 1D hydraulic models are not capable of accurately representing complex overland flow patterns that move in two dimensions outside of the linear channel system. In addition, steady state models conservatively assume the peak flow rates persist for an infinite amount of time and ignore the finite flood volume of the runoff hydrograph. To address these limitations, GHD developed a 2D unsteady hydraulic model of Joshua's Creek in the flood-prone area, identified at the Royal Windsor Drive and Metrolinx crossings. The 2D model was also developed using the HEC-RAS software.

The model geometry consists of a terrain layer overlaid by a computational mesh, which together, determine the direction of flow through the model domain. The terrain was generated from the Lidar-derived Ontario Digital Terrain Model (DTM) Land Information Ontario Dataset (https://geohub.lio.gov.on.ca/datasets/776819a7a0de42f3b75e40527cc36a0a, last accessed 7 September 2020). The computational mesh has a 4 metre (m) resolution in the channel, and a 10 m resolution elsewhere. Break lines were enforced along critical elevation boundaries of the mesh including crests, berms, buildings, and the floodplain boundary to ensure these elevations were accurately captured in the 2D geometry. Similar to the 1D model, surface roughness was represented by the Manning's 'n' values based on land cover. Critical hydraulic structures that restrict flow along the creek system were incorporated into the 2D geometry, including Old Ford Drive, Unnamed Service Road, Royal Windsor Drive and the Metrolinx tracks.

GHD performed a supplemental topographic survey of critical hydraulic structures located in the vicinity of the spill at Royal Windsor Drive and the Metrolinx crossings on September 28, 2020 (GHD September 2020 survey) in order to confirm the hydraulic openings. Table 4.4 provides a summary of the revised geometries. A photo log of the surveyed structures is provided with the 2D Modelling Memorandum in Appendix B of this report. Photos 1-7 show a significant amount of sediment accumulation in the Old Ford Drive and Unnamed Service Road culvert barrels. Sediment accumulation was represented in the model by blocking part of the barrel openings.

Table 4.4 Revised Geometric Properties of the Hydraulic Structures in the 2D Model Based on GHD 2020 Survey

Street Crossing	Structure Type	Span	Rise	No. Barrels
Old Ford Drive	Reinforced Concrete Box Culvert	6.2	1.8	2
Unnamed Service Road	Reinforced Concrete Box Culvert	4.5	1.8	2
Royal Windsor Drive	Reinforced Concrete Arch Culvert	8.3	3.8	1
Metrolinx Rail	Bridge	8.3	2.6	1

Design flow hydrographs from the PCSWMM model were used to represent the 2- to 100-year, 100-year climate change and Regional flow events.

4.2.2.3 Flood Inundation Boundaries

The resultant modelled flood inundation boundaries are described in this section. In areas where flood lines have been generated by both 1D and 2D models, and there are differences in the results, the 2D flood lines should govern.

Figures A.1 to A.4 in Appendix A show the 2- to 25-year flood inundation boundaries. A summary of the results is provided below:

- The flows are mostly confined within the channel/floodplain except for the undeveloped areas between Old Ford Drive and the Metrolinx crossings and the wetland immediately downstream of the Metrolinx tracks.
- The parking lot at the south end of the Ford property is inundated in the 10-year flood event. This parking lot is located within the CH regulatory limit.
- The Unnamed Service Road overtops during the 2-year event and Old Ford Drive overtops during the 10-year event. It is understood that Old Ford Drive was lowered to reduce upstream flood levels, and it is not currently in use.
- Royal Windsor Drive overtops west of the creek in the 25-year flood event.

Figure A.5 in Appendix A and Figure 3.2 show the 50- and 100-year flood inundation boundaries. The 1D model output identifies a spill to the Wedgewood Creek catchment (to the west) upstream of the Metrolinx crossing; however, the 2D model output shows there is no spill during the 50- and 100-year design flood events.

Figure 3.3 shows the 100-year climate change flood inundation boundary. The 1D and 2D model output indicate a spill to the Wedgewood Creek catchment upstream of the Metrolinx tracks. Preliminary modelling results show that Royal Windsor Drive is passable during the 100-year climate change flood event as the maximum depth of floodwater over the road is less than 0.3 m and the product of the maximum depth and maximum velocity of floodwater over the road is less than 0.8 m^2/s (MTO, 2008). The modelling results show that the maximum flood depth over the road is mostly less than 0.3 m and does not exceed 0.4 m and the product of the maximum depth and maximum velocity of floodwater is less than 0.8 m^2/s in the Regional flood event. As such, the lanes may not always be safely passable during the Regional flood event; however, there are alternate routes including Highway 403, for vehicle passage in the event of an emergency.

Figure 3.4 presents the Regional flood inundation boundary. The 2D model output shows a much larger flood extent downstream of the Metrolinx tracks on the southwest side of Joshua's Creek. The 1D model did not capture the flood extent in the right overbank area from Joshua's Creek to Maple Grove Drive. Both the 1D and 2D model results show overtopping of the right bank between Constance Drive and Brookmill Road, causing inundation of the residential neighbourhood.

The 2D unsteady model simulation shows the progression of flood inundation downstream of the Metrolinx tracks. The animation shows the Regional flood wave originates from overtopping of the tracks and overtopping of the right bank between Constance Drive and Brookmill Road. The maximum water level exceeds 1.5 m in the roadways and swales of the inundated residential area. The highest water levels are observed along Devon Road, Brook Place, Donnybrook Road, and in the swale between the houses on Brook Place and Donnybrook Road. Based on the results, the Metrolinx crossing appears to be the hydraulic restriction along the creek during the Regional flood event.

The 1D model output shows that water is confined to the channel system from Brookmill Road to Lake Ontario during all modelled flow events.

4.2.3 Natural Environment

Available secondary sources of information were collected and reviewed to determine existing natural environment conditions within the Study Area. The sources reviewed are outlined in Table 4.5.

Table 4.5 Secondary Source Information Reviewed

Source	Information reviewed
Ministry of Natural Resources and Forestry (MNRF)	• Natural Heritage Information Center (NHIC) mapping • Aquatic Resource Area (ARA) data
Ministry of Environment, Conservation and Parks (MECP)	• Species at Risk (SAR) information request
Fisheries and Oceans Canada (DFO)	• Species at Risk Fish and Mussel Maps
Ontario Breeding Bird Atlas	• Breeding Bird Data for Study Area
Town of Oakville Official Plan (September 2006)	• Schedules and Text
Halton Regional Official Plan (2009, 2019)	• Schedules and Text
Greenbelt Plan (2017)	• Text and mapping
Ontario Reptile and Amphibian Atlas	• Species records for Study Area
Ontario Butterfly Atlas	• Species records for Study Area
Bat Conservation International	• Checked range maps in species profiles for the four listed bat species that occur in Ontario
Species at Risk of Ontario List	• Checked range maps for SAR species not included in other atlases

4.2.3.1 Policy Framework

This section summarizes the applicable legislative acts that pertain to the inventory of the natural environment for this project including the *Fisheries Act*, *Species at Risk Act*, *Migratory Birds Convention Act*, *Conservation Authorities Act* and the *Endangered Species Act*.

Fisheries Act

The purpose of the *Fisheries Act* (1985) is to maintain healthy, sustainable and productive Canadian fisheries through the prevention of pollution, and the protection of fish and their habitat. On August 28, 2019 changes were made to the *Fisheries Act*. These changes include new protection provisions for fish and fish habitat in the form of standards, codes of practice, and guidelines for projects in and near water. They provide guidance on how to avoid and mitigate impacts to fish and fish habitat and comply with the *Fisheries Act* to avoid causing the death of a fish or harmful alteration, disruption or destruction of fish habitat from proposed work, undertaking or activity.

The fish and fish habitat protection provisions of the *Fisheries Act* are the authorities for the regulation of works, undertakings or activities that risk harming fish and/or fish habitat. Specifically, they include the two core prohibitions against persons carrying on works, undertakings or activities that result in the "death of fish by means other than fishing" (Subsection 34.4[1]), and the "harmful alteration, disruption or destruction of fish habitat" (Subsection 35[1]). Subsections 34.4(1)(b) and 35(2)(b) provides that Subsections 34.4(1) and 35(1) do not apply where the work, undertaking or activity has been authorized by the Minister and is carried out in accordance with the conditions established by the Minister in an authorization. Standards and codes of practice (under Section 34.2) are non-regulatory tools that specify procedures, minimum requirements, the potential harmful impacts to be managed, and the measures to implement to ensure the protection of fish and fish habitat. If the measures set out in the codes of practice or standards are implemented as described, proponents are not likely to contravene the prohibitions against the death of fish or the harmful alteration, disruption or destruction (HADD) of fish habitat.

Projects affecting waterbodies that support fish and fish habitat must comply with the provision of the *Fisheries Act*. The proponent is responsible for determining if the project is likely to cause impacts to fish and fish habitat and if these impacts can be avoided or mitigated. The proponent must gather information on the type and scale of impact on the fishery and determine if the impacts will result in the death of fish or a HADD of fish habitat. A request for review should be submitted to the Fisheries and Oceans Canada (DFO) if impacts cannot fully be avoided or mitigated. Following DFO review, if it is determined that the impacts cannot be avoided or mitigated and will result in death of fish or a HADD of fish habitat, an authorization under Subsection 35(2) of the *Fisheries Act* must be obtained from the DFO. Projects that have the potential to obstruct fish passage or affect flows needed by fish require an authorization.

Species at Risk Act

The *Species at Risk Act* (SARA, 2002) incorporates a number of prohibitions to protect individuals of listed threatened, endangered or extirpated species at risk – as designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). As per Section 34, Section 58 and Section 61, these prohibitions apply on all lands for aquatic species and migratory birds protected by the *Migratory Birds Convention Act* (MBCA 1994), and any other listed wildlife species when on federal lands or if recommended by the Minister of the Environment to the Governor in Council.

Migratory Birds Convention Act

The *Migratory Birds Convention Act* (MBCA, 1994) and Migratory Birds Regulations (MBR, 2014) protect most species of migratory birds and their nests and eggs. General prohibitions under the MBCA and MBR protect migratory birds, their nests and eggs and prohibit the deposit of harmful substances in waters and areas frequented by them.

The MBR includes an additional prohibition against incidental take, defined by Environment and Climate Change Canada (ECCC) as:

"The inadvertent harming, killing, disturbance or destruction of migratory birds, nests and eggs."

ECCC implements policies and guidelines to protect migratory birds, and guidance on the Environment Canada website is provided to help to minimize the risk of detrimental effects to migratory birds and to achieve compliance with the law. Compliance with the MBCA and MBR is best achieved through a due diligence approach based on a site-specific analysis in consideration of the avoidance guidelines on the ECCC website.

Conservation Authorities Act

In Ontario, Conservation Authorities (CAs) are governed by the *Conservation Authorities Act* (1990), which is administered by the Ministry of Natural Resources and Forestry (MNRF). Each CA has the responsibility to regulate activities in natural and hazardous areas (i.e., streams, floodplains, wetlands, areas in and near rivers, slopes and shorelines) through the Development, Interference with Wetlands and Alterations to Shorelines and Watercourse Regulation for their respective jurisdiction (e.g., Conservation Halton O. Reg. 162/06).

Development is generally prohibited in regulated areas, unless permission is obtained from the CA. An application for permission to develop often includes the requirement for an Environmental Impact Study (EIS) in support of the application to ensure that the regulated features will not be negatively impacted as part of the proposed works.

Endangered Species Act

The *Endangered Species Act* (ESA, 2007) came into effect June 30, 2008 and protects SAR and their habitats in Ontario. Species listed as endangered or threatened are afforded legal protection from harm and harassment under the ESA. The ESA also prohibits damage or destruction of habitat of endangered or threatened species. Habitat protection for a species can be general or subject to the specific provisions of a habitat regulation as set out in O. Reg. 242/08. General habitat protection is provided to all threatened and endangered species. Species-specific habitat regulations can be passed into law and further describe the extent and features of the protected habitat.

Should an ESA protected species be encountered, impacts to the species or its habitat can be avoided or mitigated through a number of avenues. These include avoidance (e.g., through design modifications or timing of works), adherence to an applicable Notice of Activity, or by obtaining an Overall Benefit Permit.

4.2.3.2 Agency Consultation

Agency data requests pertaining to natural heritage features and species were sent to MECP, the MNRF, and CH on April 21, 2020. Responses from the MNRF and CH were received on April 23, 2020, and April 29, 2020, respectively. There was no response from the MECP. A follow up request was sent on October 14, 2020.

A Terms of Reference for the field work was also developed in consultation with CH and used to guide the natural environment work.

Agency correspondence is included in Appendix C.

4.2.3.3 Species at Risk Screening

The SAR that could occur in the Study Area were assessed through database review, agency consultation and a comparison of the known habitat preference of those species identified in the area against the habitat available in the Study Area. Results are provided in Section 4.2.3.7.4.

4.2.3.4 Designated Areas

The Iroquois Shoreline Woods (ANSI, Life Science) is located west of the Study Area (Figure 4.6). Portions of the Halton Regional Natural Heritage System are present within the Study Area and are associated with Joshua's Creek and the contiguous riparian/vegetated communities surrounding it. According to Map 1G of the Halton Region Official Plan (2015, 2018), Joshua's Creek and associated valleylands and woodlands are identified as Key Features.

Livable Oakville (Town of Oakville Official Plan, 2009) identifies two areas of significant woodland habitat: one area immediately north of Royal Windsor Drive, and the other surrounding Joshua's Creek from Brookmill Road to its outlet to Lake Ontario. In accordance with Section 277(2) of the Halton Region Official Plan, a woodland of 2 hectares or larger when located within an Urban Area is categorized as a significant woodland. Livable Oakville also identifies these two significant woodlands as Environmentally Sensitive Areas. In accordance with Section 16.1.9(b)(ii) of Livable Oakville, Joshua's Creek is identified as a minor valley and tributary. One unevaluated wetland is present south of the Metrolinx rail line.

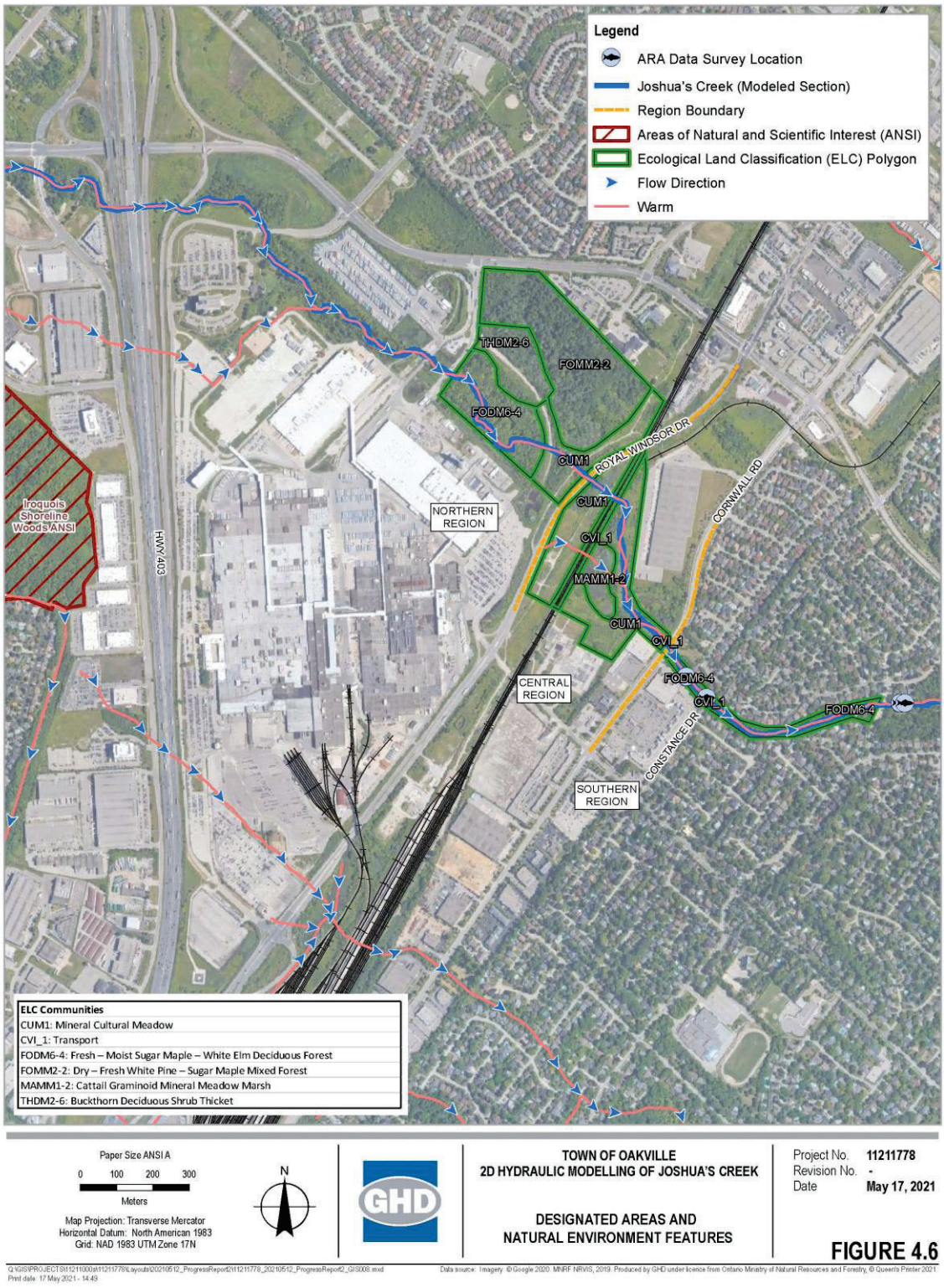


Figure 4.6 Designated Areas and Natural Environment Features

4.2.3.5 Field Work Methodology

Field work (outlined in Table 4.6) was conducted during the appropriate field seasons to confirm relevant habitat features and species' presence. The field studies focused on the area shown on Figure 4.6 where physical works were determined to be most likely based on a long list of alternatives. Specific field methods are described below.

Table 4.6 Field Investigations

Field Investigation Type	Field Investigation Dates
Bat Maternity Roost Assessment	May 22, 2020
ELC	September 16, 2020
Botanical Inventory	May 22 and September 16, 2020
Incidental Wildlife Observations	Collected during all Study Area visits

4.2.3.5.1 Bat Maternity Roost Assessment

GHD conducted a site visit on May 22, 2020, to assess potential bat maternity roosts as detailed in the *Survey Protocol for Species at Risk Bats within Treed Habitats* (MNRF 2017). This was conducted in early spring during leaf-off to allow for clear viewing into the tree canopy. Trees with cracks and crevices that could potentially house bats were recorded for species, breast height diameter, approximate height of potential roost, and snag classification.

4.2.3.5.2 Ecological Land Classification and Botanical Inventory

Vegetation communities were mapped and described following the Ecological Land Classification (ELC) System for Southern Ontario (Lee *et al*., 1998) and Southern Ontario Ecological Land Classification scheme (Draft; Lee *et al*. 2008). ELC was completed in the field on September 16, 2020, during which community polygons were mapped, characterized according to species and structural attributes, and a list of plant species were documented. A spring and late summer botanical inventory were also carried out.

4.2.3.5.3 Fish and Aquatic Habitat

The aquatic habitat characterization was carried out at a high level and focused on compiling existing background data for the creek including any fisheries information. Visual qualitative observations through the Study Area of general channel conditions were also made.

4.2.3.5.4 Incidental Wildlife

Any incidental wildlife observed during any site visit was recorded to species level where possible.

4.2.3.6 Fish and Aquatic Habitat Existing Conditions

As stated above, the aquatic characterization was completed at a high level for the EA phase. More detailed aquatic habitat characterization field work may be required at the design phase depending on the chosen solution to quantify specific potential impacts and mitigation measures.

Joshua's Creek has a warm thermal regime and flows from northwest to southeast through the Study Area. In the northern region (north of Royal Windsor Drive), Joshua's Creek is a natural watercourse, ranging from 1 - 2.5 m wetted width, with moderately clear water and a silty-sand sediment with large cobbles. Sections of the northern region are densely vegetated, while other sections running through sugar maple – white elm forest are relatively clear of in-stream vegetation. The majority of Joshua's Creek in the central and southern regions (south of Royal Windsor Drive) of the Study Area are lined with gabion walls. The central region ranges from 0.5-3 m wetted width, and contains clear water, with a silty substrate dominated with medium-large cobbles. This region supports extensive instream vegetation in the form of broad-leaved cattail (*Typha latifolia*) and European reed (*Phragmites australis* ssp. *australis*). The southern region (south of Cornwall Road) ranges from 2-3 m wetted width and its clear water flows between very distinct gabion walls. The substrate in this region is silt, dominated by cobbles of various sizes. There is minimal instream vegetation in this region, and the banks are densely vegetated in areas and sparsely vegetated in others.

Land Information Ontario (LIO, 2020) Aquatic Resource Area (ARA) data reports four aquatic surveys within the Study Area (Figure 4.6). One aquatic survey was conducted between Cornwall Road and Constance Drive, one immediately northwest of Constance Drive, and two approximately 30 m and 50 m east of Brookmill Road. Species observed include blacknose dace (*Rhinichthys atratulus*), bluntnose minnow (*Pimephales notatus*), common carp (*Cyprinus carpio*), common shiner (*Luxilus cornutus*), creek chub (*Semotilus atromaculatus*), fathead minnow (*Pimephales promelas*), hornyhead chub (*Nocomis biguttatus*), Johnny darter (*Etheostoma nigrum*), longnose dace (*Rhinichthys cataractae*), *Notropis* sp., rainbow trout (*Oncorhynchus mykiss*), rock bass (*Ambloplites rupestris*), and white sucker (*Catostomus commersonii*).

Based on these surveys, Joshua's Creek supports a diverse community of predominantly cool-coldwater fish with tolerances ranging from intermediate to intolerant consisting of forage/baitfish with one salmonid sportfish species identified (rainbow trout). Review of DFO Aquatic SAR mapping does not indicate the presence of aquatic SAR, nor any aquatic critical habitat within the Joshua's Creek Study Area.

A photo log is presented in Appendix D.

4.2.3.7 Terrestrial Ecology Existing Conditions

The terrestrial ecology of the Study Area was assessed through the review of digital resources and site investigations as described below. A photo log is presented in Appendix D.

4.2.3.7.1 Ecological Land Classification

The Study Area is a mixture of forest, cultural meadow and wetland, bounded by industrial complexes and residential areas. No vegetation communities within the Study Area are listed as rare within Ontario. Local rarity status for vegetation communities is not available through online

databases, however based on GHD's professional experience, the communities are not known to be locally rare. Descriptions of the vegetation communities are provided below. ELC communities are presented in Figure 4.6.

THDM2-6: Buckthorn Deciduous Shrub Thicket

This deciduous thicket was observed bordering the Unnamed Service Road on both sides at the northern-most end of the Study Area. The canopy was dominated by European buckthorn (*Rhamnus cathartica*), with abundant black walnut (*Juglans nigra*), and occasional sugar maple (*Acer saccharum*), basswood (*Tilia americana*), green ash (*Fraxinus pennsylvanica*), and white oak (*Quercus alba*). The sub-canopy featured occasional willow (*Salix* sp.), with an understory abundant in purple-flowering raspberry (*Rubus odoratus*) and riverbank grape (*Vitis riparia*). The ground layer had abundant goldenrods (*Solidago* sp.), European reed (*Phragmites australis* ssp. *australis*), and ground-ivy (*Glechoma hederacea*), with occasional common teasel (*Dipsacus fullonum*) and Canada thistle (*Cirsium arvense*).

CUM1: Mineral Cultural Meadow

This community was observed in the northern and central regions of the Study Area, mainly alongside roadways and in recently disturbed areas. In the northern region, this community runs either side of the Unnamed Service Road and borders Royal Windsor Drive. This location is dominated by goldenrods, European reed, yellow sweet-clover (*Melilotus officinalis*), fleabane (*Erigeron* sp.), wild carrot (*Daucus carota*), and spurge (*Euphorbia* sp.), with occasional white elm (*Ulmus americana*), staghorn sumac (*Rhus* typhina), purple jewelweed (*Impatiens glandulifera*), wild chicory (*Cichorium intybus*), common mullein (*Verbascum thapsus* ssp. *thapsus*), curled dock (*Rumex crispus*), purple loosestrife (*Lythrum salicaria*), common dandelion (*Taraxacum officinale*), and purple crown-vetch (*Securigera varia*). This location also features several piles of dumped rubble and a high abundance of household waste.

The upper central community is bordered to the northwest by Royal Windsor Drive and to the southeast by railway line. It featured the same vegetation as the northern community with a higher abundance of unidentified grass species being maintained alongside the roadway and underneath the power lines running parallel to the railway line. This location also featured multiple piles of dumped rubble, mulch, and sand.

The lower central community southeast of the railway line was dominated by goldenrods, European reed, fleabane, riverbank grape, and unidentified grasses. This location also featured patches dominated by buckthorn, with other shrubs and trees such as trembling aspen (*Populus tremuloides*), staghorn sumac, red-osier dogwood (*Cornus stolonifera*), white oak, black walnut, Manitoba maple (*Acer negundo*), Austrian pine (*Pinus nigra*), and willow. Common milkweed (*Asclepias syraca*) was also observed in this community. In parts where Joshua's Creek flowed through the community, it was dominated by European reed.

FODM6-4: Fresh – Moist Sugar Maple – White Elm Deciduous Forest

This forest was observed in the northern and southern regions of the Study Area. Joshua's Creek flowed through both locations. The northern location was dominated by a canopy of sugar maple, with occasional black walnut and trembling aspen. The sub-canopy featured abundant white elm, and occasional buckthorn, with a ground layer of occasional large false Solomon's seal

(*Maianthemum racemosum* ssp. *racemosum*), Jack-in-the-pulpit (*Arisaema triphyllum*), blue cohosh (*Caulophyllum thalictroides*), spotted geranium (*Geranium maculatum*), eastern spring beauty (*Claytonia virginica*), and white trillium (*Trillium grandiflorum*).

The southern location featured the same species as the northern location, with occasional white pine (*Pinus strobus*), Norway spruce (*Picea abies*), eastern cottonwood (*Populus deltoides* ssp. *deltoides*), trembling aspen, Manitoba maple, green ash, and willow. Given their location near residential communities, it is possible some of these species were planted.

FOMM2-2: Dry – Fresh White Pine – Sugar Maple Mixed Forest

This forest community was located in the northern region of the Study Area. It was dominated by a canopy of white pine and sugar maple, with a sub-canopy of occasional basswood and trembling aspen. The understory was dominated by riverbank grape, thicket creeper (*Parthenocissus vitacea*), and staghorn sumac, with a ground layer dominated by Jack-in-the-pulpit, common burdock (*Actium minus*), and white trillium.

MAMM1-2: Cattail Graminoid Mineral Meadow Marsh

This community is located in the central region of the Study Area, southeast of the railway line and bordered by Mineral Cultural Meadow (CUM1). It was a dry wetland generally dominated by broad-leaved cattail (*Typha latifolia*), with occasional patches dominated by European reed. Other species observed in this community included common teasel, riverbank grape, buckthorn, New England aster (*Symphyotrichum novae-angliae*), common milkweed, thicket creeper, spotted jewelweed (*Impatiens capensis*), and red-osier dogwood. There were small tributaries flowing through the community from northwest to southeast connecting to Joshua's Creek. The water was contained to these tributaries during the time of survey, but likely overflow filling the wetlands earlier in the year.

CVI_1: Transport

Several roads and one major railway line intersected the Study Area.

4.2.3.7.2 Flora

A total of 73 vascular plant species were observed during field investigations, eight of which could not be identified beyond genus due to insufficient characteristics for identification. A complete vascular plant list is provided in Appendix E.

Of the identified species, 58% are native 42% are non-native. Of the native species for which information is available, all have provincial S Ranks[3] of S4 and S5, indicating they are 'apparently secure' or 'secure' in the province, with the majority being S5. The majority (58%) of the species have a coefficient of conservatism[4] values between 0 and 6, indicating they are tolerant to moderately tolerant of disturbance. One species, wood anemone (*Anemone quinquefolia* var.

[3] Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario.

[4] Ranks of 0 to 10 based on plant's degree of fidelity to a range of synecological parameters: (0-3) Taxa found in a variety of plant communities; (4-6) Taxa typically associated with a specific plant community but tolerate moderate disturbance; (7-8) Taxa associated with a plant community in an advanced successional stage that has undergone minor disturbance; (9-10) Taxa with a high fidelity to a narrow range of synecological parameters (Oldham et al. 1995).

quinquefolia) has CC values of 7, indicating a lower tolerance to disturbance. This species was not unexpected given the vegetation types present in the Study Area, as it is commonly associated with woodlands.

No provincially rare (S-Rank of S1-S3) or provincially listed species were observed.

Blue Cohosh is listed as locally (Halton Region) rare, with eastern cottonwood, spotted geranium and eastern spring beauty listed as locally uncommon (Crins *et al.* 2006, Varga 2005).

4.2.3.7.3 Incidental Wildlife

The Study Area is expected to support a mix of both disturbance-tolerant species and others associated with higher quality habitats given the prevalence of natural features within and surrounding the Study Area. Incidental wildlife observed during all field surveys are listed in Appendix E. All species observed within the Study Area have provincial S Ranks[5] of S4 and S5, indicating they are 'apparently secure' or 'secure' in the province, with the majority being S5.

No provincially rare (S-Rank of S1-S3) or provincially listed species were observed.

4.2.3.7.4 Species At Risk

A total of 22 SAR with the potential to occur in the Study Area was developed from review of available background sources (Appendix E). Of these, nine species are considered to have high or moderate potential to occur in the Study Area. These species include: monarch (*Danaus plexippus*), barn swallow (*Hirundo rustica*), eastern wood-peewee (*Contopus virens*), wood thrush (*Hylocichla mustelina*), little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), tri-coloured bat (*Perimyotis subflavus*), snapping turtle (*Chelydra serpentina*), and butternut (*Juglans cinerea*). Habitat requirements and federal and provincial species statuses are provided in Appendix E, along with details on habitat presence.

4.2.3.7.4.1 Bat Maternity Roost Assessment

The presence of deciduous and mixed forest vegetation types qualifies these communities as potential bat habitat. Twenty-nine (29) trees offering potentially suitable maternity roost features were located during the May survey (Table 4.7). These trees represent the best potential maternity roost trees observed during the survey, primarily based on large size (>25 cm in diameter), height, and/or snag class. This information can be used to guide future acoustic surveys if impacts to SAR bat habitat are expected. Figure 4.7 displays trees with potentially suitable for maternity roost features.

[5] Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario.

Table 4.7 Potential Bat Maternity Roost Trees

Common Name	Scientific Name	DBH (cm)	Live or Dead	Tree Height	Snag Class	Tree Attributes Beneficial for Bat Maternity Roosts
Sugar Maple	*Acer saccharum*	69	Live	Co-dominant	1	Knot hole approx. 4" diameter, 20 m up, loose bark
Sugar Maple	*Acer saccharum*	63	Live	Co-dominant	2	Cavity 15 m up
Sugar Maple	*Acer saccharum*	77	Dead	Dominant	6	Cavity 12 m up
Sugar Maple	*Acer saccharum*	40	Live	Intermediate	2	Knot hole 8 m up
Sugar Maple	*Acer saccharum*	17	Live	Intermediate	2	Several knot holes ranging 8-12 m up
Sugar Maple	*Acer saccharum*	55	Live	Co-dominant	1	Knot holes 15 m up
Sugar Maple	*Acer saccharum*	89	Live	Co-dominant	2	Cavity 2 m up, several knot holes 15-20 m up
Sugar Maple	*Acer saccharum*	41	Live	Co-dominant	1	Knot hole 8 m up
Unknown	Unknown species	65*	Dead	Intermediate	6	Cavity 8 m up
White Oak	*Quercus alba*	124	Live	Dominant	2	Cavity 10 m up
Manitoba Maple	*Acer negundo*	77	Live	Co-dominant	2	Cavity, knot hole 10 m up
Manitoba Maple	*Acer negundo*	77	Live	Co-dominant	2	Cavity, knot hole 3 m up
Manitoba Maple	*Acer negundo*	70*	Live	Co-dominant	2	Cavity, knot hole 15 m up
Manitoba Maple	*Acer negundo*	75*	Live	Co-dominant	2	Cavity 15 m up
Manitoba Maple	*Acer negundo*	44	Live	Co-dominant	2	Cavity 8 m up
Manitoba Maple	*Acer negundo*	50	Live	Co-dominant	1	Cavity 3 m up
White Ash	*Fraxinus americana*	35	Dead	Co-dominant	5	Cavity 30 m up
White Ash	*Fraxinus americana*	30	Live	Co-dominant	2	Cavity 8 m up
Basswood	*Tilia americana*	45	Live	Dominant	1	Cavity 20 m up
Manitoba Maple	*Acer negundo*	43	Live	Co-dominant	2	Knot hole 6 m up
Trembling Aspen	*Populus tremuloides*	67	Live	Dominant	2	Cavity 6 m up
Black Walnut	*Juglans nigra*	50	Live	Dominant	1	Cavity 5 m up
Norway Maple	*Acer platanoides*	43	Live	Co-dominant	1	Cavity 10 m up
Green Ash	*Fraxinus pennsylvanica*	53	Dead	Co-dominant	3	Cavity 12 m up
Green Ash	*Fraxinus pennsylvanica*	78	Dead	Dominant	4	Cavity 6 m up
American Beech	*Fagus grandifolia*	73	Live	Intermediate	2	Knot hole 20 m up

Common Name	Scientific Name	DBH (cm)	Live or Dead	Tree Height	Snag Class	Tree Attributes Beneficial for Bat Maternity Roosts
Black Walnut	*Juglans nigra*	97	Live	Co-dominant	2	Cavity 15 m up
Unknown	Unknown species	141	Dead	Intermediate	6	Chimney-like cavity, knot hole 4 m up
White Oak	*Quercus alba*	89	Live	Co-dominant	2	Knot hole 10 m up

Note: DBH = Diameter at breast height
* size estimated due to limited access
Tree height:
- Dominant - above canopy
- Co-dominant - canopy height
- Intermediate - just below canopy
- Suppressed - well below canopy

Snag class:
1 - healthy, live tree
2 - declining live tree, part of canopy lost
3 - very recently dead, no canopy, bark intact, branches intact
4 - recently dead, bark peeling, only large branches intact
5 – older dead tree, 90 percent of bark lost, few branch stubs, broken top
6 – very old dead tree, advanced decay, no branches, parts of the stem have rotted away

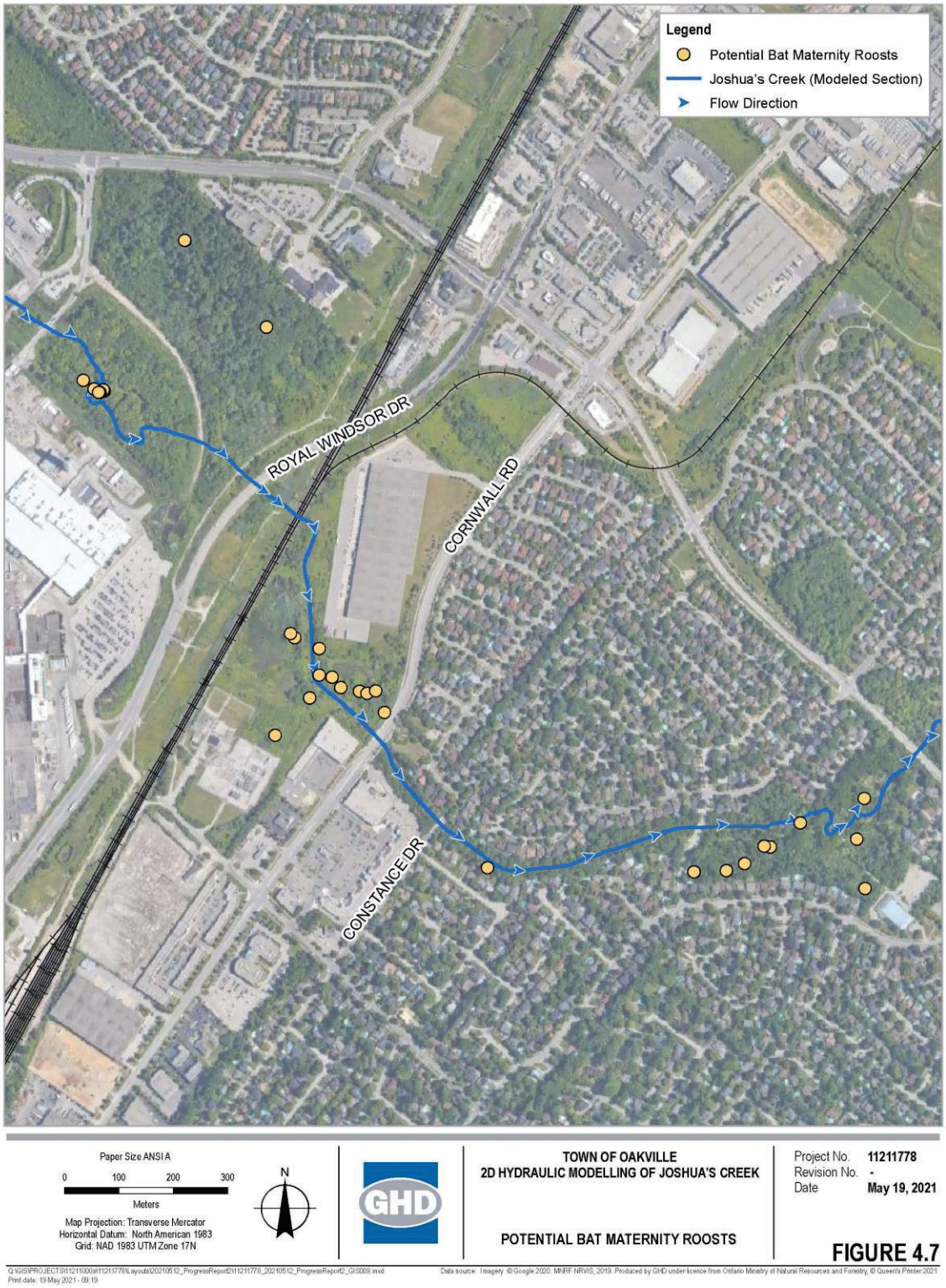


Figure 4.7 Potential Bat Maternity Roosts

4.2.4 Social and Economic Environment

4.2.4.1 Social

Under the Official Plan[6] the Study Area comprises of land designated as Employment Area, Parkway Belt and Residential Area (Figure 4.8). The designated Residential Areas have been developed and areas designated Parkway Belt have been maintained as natural pockets within the built-up areas. The Study Area has several recreational facilities including parks and walking trails (Figure 4.9) and is serviced by four transit routes including: 11 Linkbrook, 4 Speeders-Cornwall, 12 Winston Park and 120 East Industrial – Rush Hour Only (Figure 4.10).

[6] Livable Oakville, Town of Oakville Official Plan, 2009, https://www.oakville.ca/assets/2011%20planning/2018-08-28_Livable_Oakville_Office_Consolidation_schedules-E-to-K.pdf, Last updated 2018.

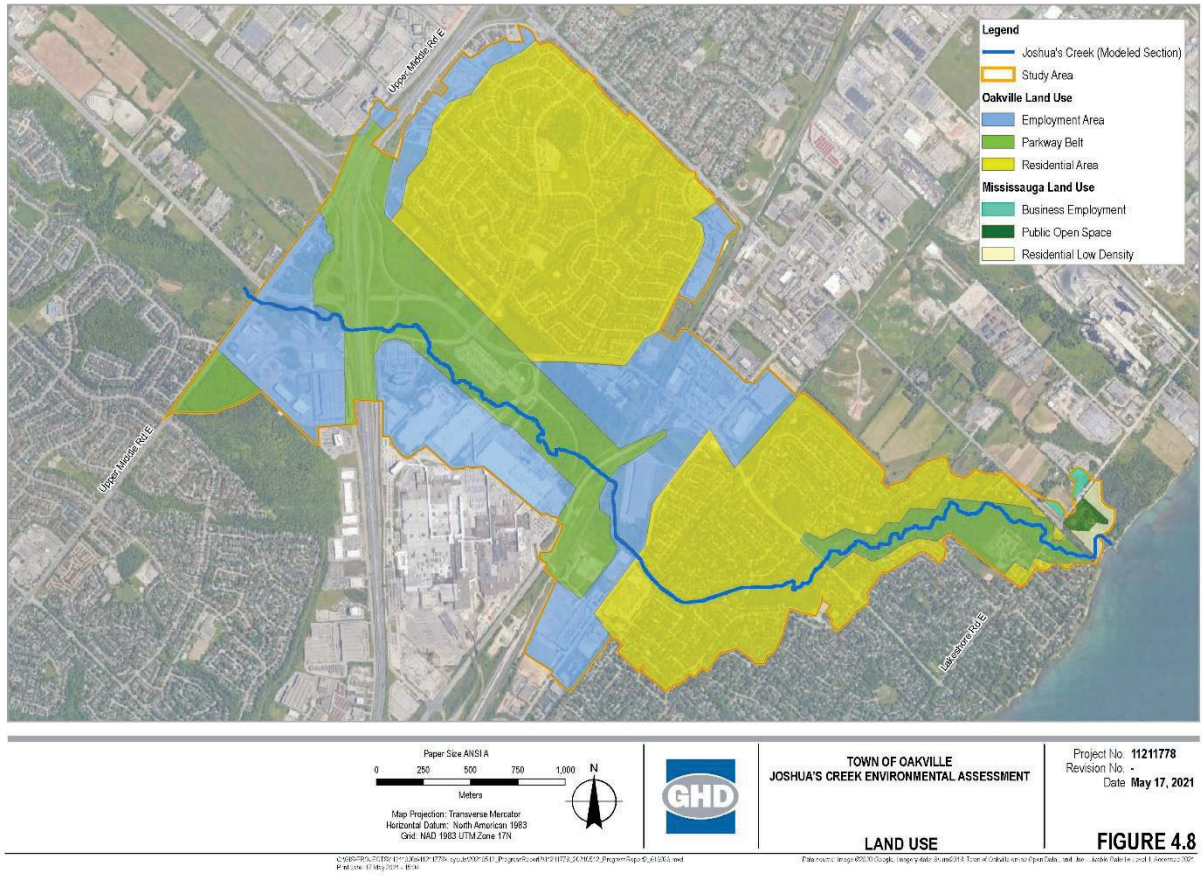


Figure 4.8 Land Use

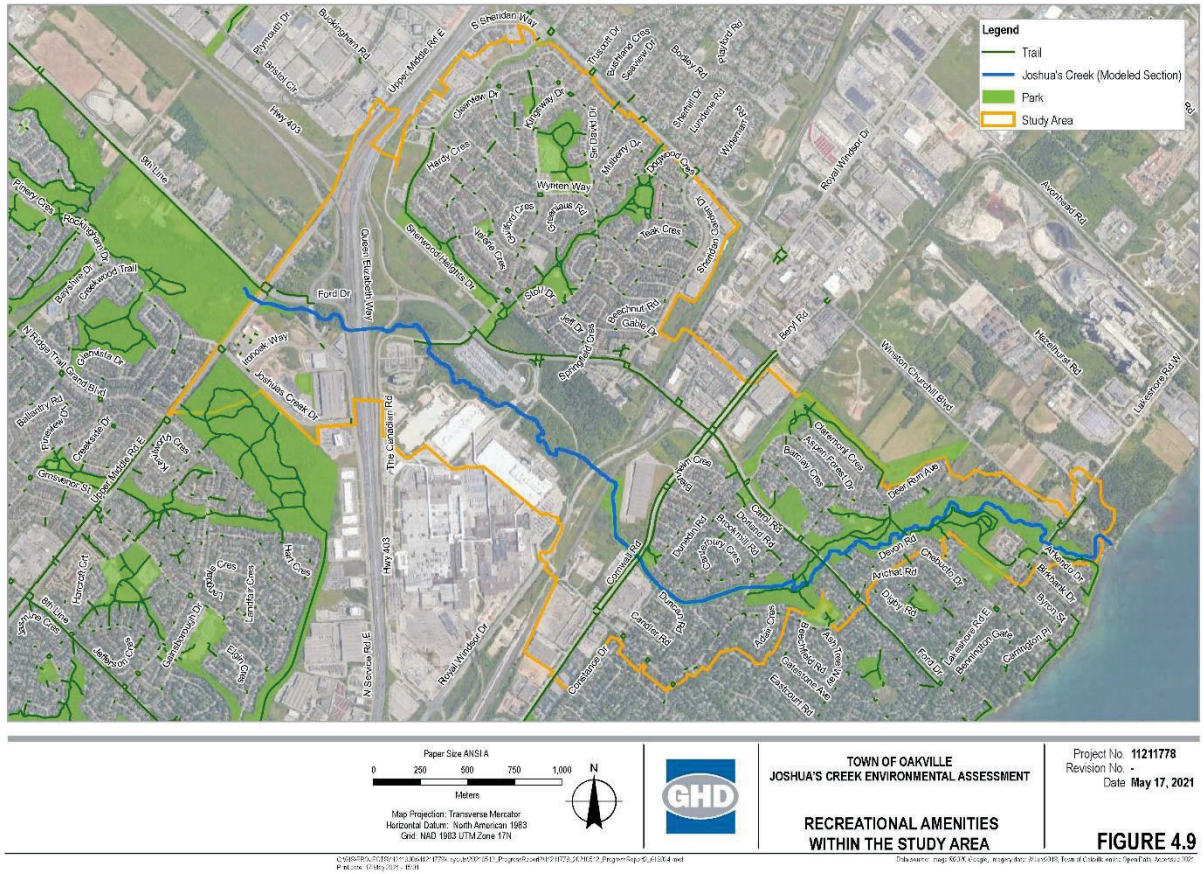


Figure 4.9 Recreational Amenities within the Study Area

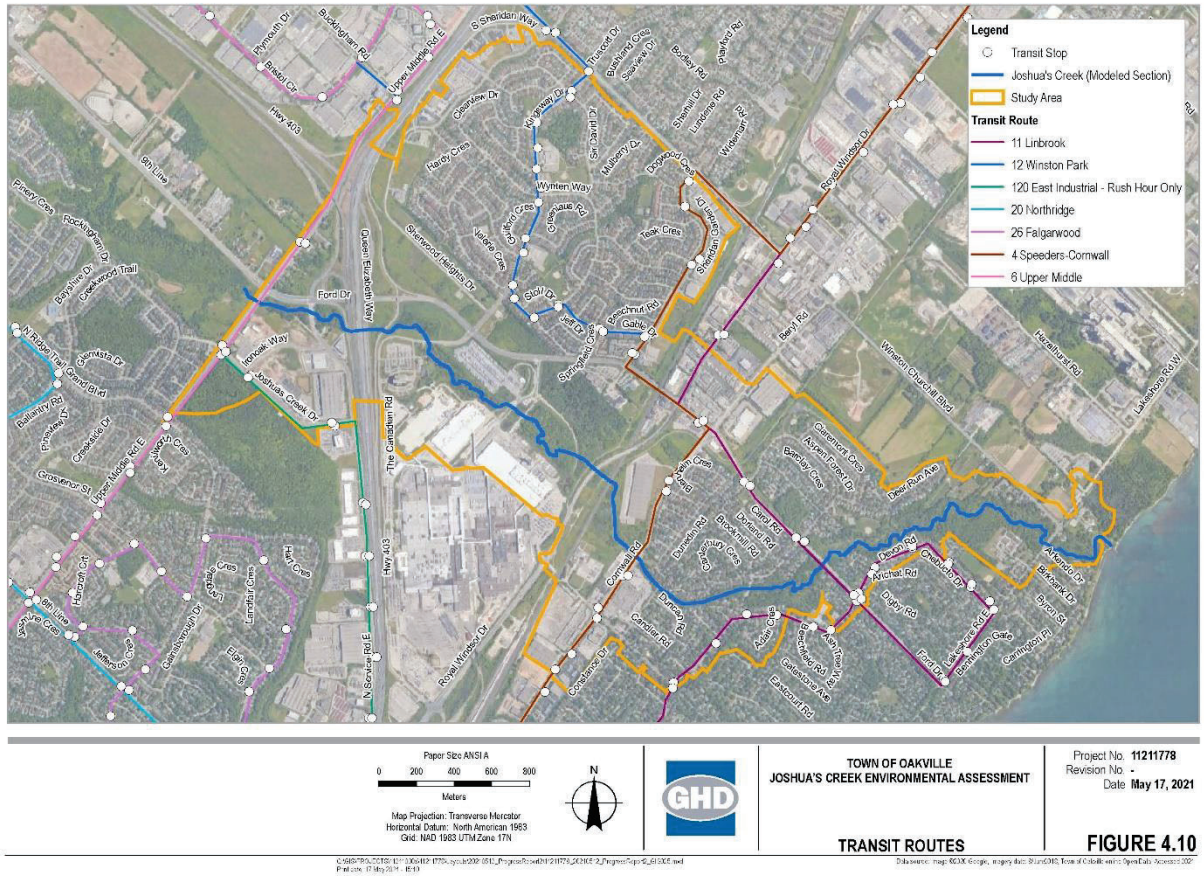


Figure 4.10 Transit Routes

4.2.4.2 Economic

As noted above some areas within the Study Area are designated Employment Area (Figure 4.8). These areas are already established with businesses, two of the larger companies that operate within this area include the Ford Motor Company located north of Royal Windsor Drive and Hydro-One property located south of Royal Windsor Drive. There is also a rail line track operated by Metrolinx that is located adjacent to the Royal Windsor Drive.

A review of the Town of Oakville's existing Development Engineering Permits and Site Plan Applications indicated that there are several future developments expected within the Study Area (Figure 4.11). A total of 26 new buildings and expansions to existing buildings are anticipated, a list of these developments is provided in Table 4.8.

Table 4.8 Proposed Developments

Development No.	Proposed development/expansion to existing infrastructure	Status of Approval
1	Extensions to the Hilton Garden Inn	Final Approval
2	6 Storey Hotel	In Progress
3	5 Storey Hotel	Final Approval
4	No description provided	Final Approval
5	5 buildings (all buildings are either 1 or 2 storeys)	Final Approval
6	Revisions to 2 CRU pads previously approved	Final Approval
7	2 storey office building	Final Approval
8	Single Storey retail building (Farm Boy)	Final Approval
9	3 Storey office building	In Progress
10	Multi-level commercial development	Final Approval
11	2 storey office building	Final Approval
12	1 storey warehouse	Final Approval
13	Maple Grove Corporate Centre - No description	Final Approval
14	Maple Grove Corporate Centre – sign variance	Final Approval
15	Maple Grove Village – sign variance	Final Approval
16	3 storey commercial building	Final Approval
17	3 single detached dwellings	Final Approval
18	1 single detached dwelling	Final Approval
19	Parking lot expansion and driveway access	Appealed
20	New commercial building	Final Approval
21	Royal Atlantic – no description	Final Approval
22	Joanne Fabrics Warehouse Addition	Final Approval
23	ACI Brands Project – no description	Final Approval
24	Kaneff – National Bank building	Final Approval
25	2 storey extension to the existing Clanmore Montessori School	Final Approval
26	Waste Water Treatment Plan	Final Approval

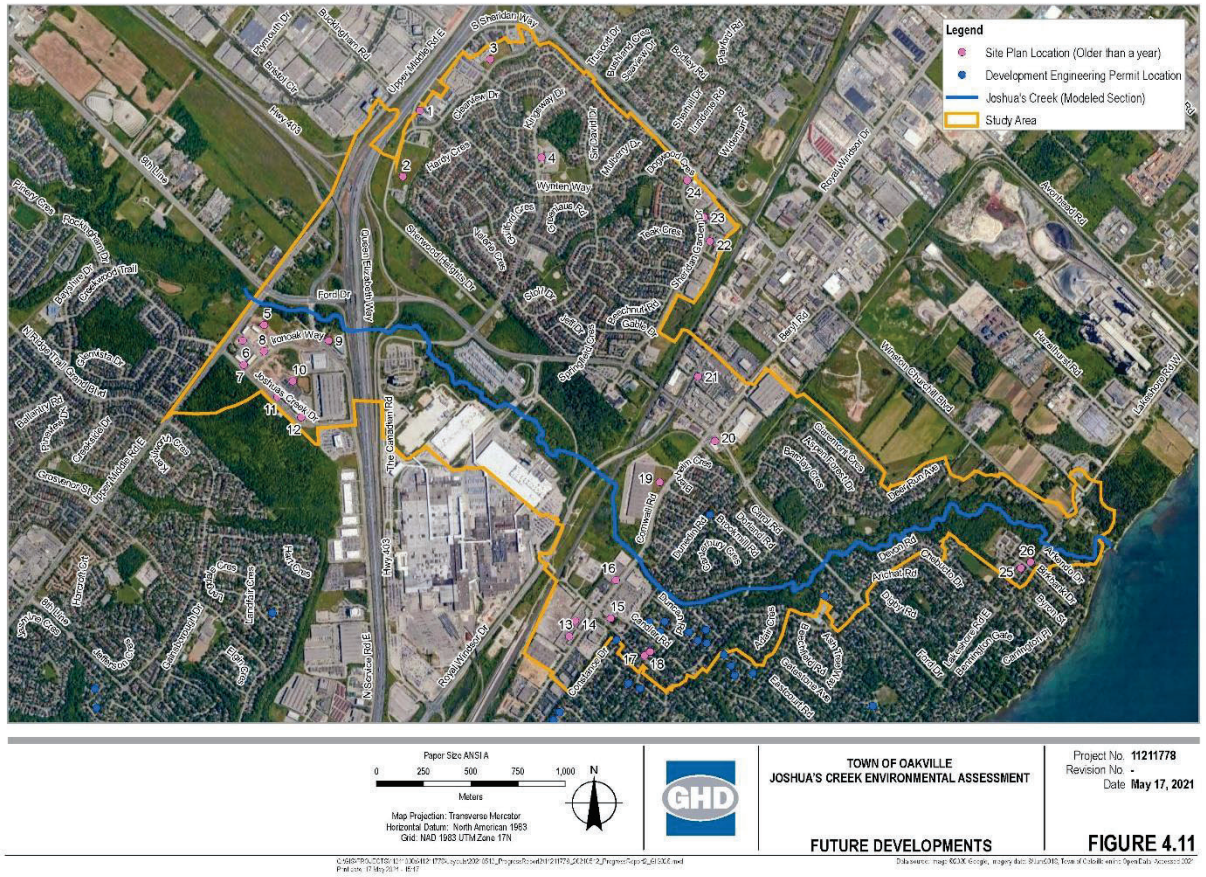


Figure 4.11 Future Developments

4.2.5 Cultural Environment

Through a review of the Oakville Heritage Database[7] it was identified that there are three heritage properties located with the Study Area (Figure 4.12) and several others located just outside of the Study Area. There is one Historic Village located within the Study Area, referred to as Spooky Hollow. The Oakville Heritage Register includes the following type of heritage properties:

- Individually designated properties which fall under Part IV of the Ontario Heritage Act (OHA)
- Properties designated within Heritage Conservation Districts which fall under Part V of the OHA
- Properties which are not designated by believed to be of cultural heritage value or interest (also known as 'listed' properties)

A list of heritage properties located within the Study Area and just outside of the Study Area presented in Table 4.9 and presented on Figure 4.12.

Table 4.9 Heritage Properties

Heritage Property Address	Heritage ID	Status	Description
Within the Study Area			
2463 Lakeshore Road E	69	IV	Isaac Cort Wilson bought the property where the building now stands in the 1880s and established a market garden farm on the 100 acre property providing such crops as raspberries, beets, peas etc. In 1902-03 he built the present building.
457 Maple Grove Dr	76	IV	Built during the mid to late 1850's by James Wesley Hill, who was born a slave in the southern United States and came to Canada in 1850 as a result of the "Fugitive Slave Law".
478 Maple Grove Dr	-	Listed	This property has potential cultural heritage value as an example of Edwardian architecture.
Outside of the Study Area			
2410 Lakeshore Road E	68	IV	"Rycroft". The building was built in 1917 for Ryland H. New and Isabel New. Ryland founded the National Sewer Pipe Company in 1929.
2366 Carrington Place	-	Listed	This property has potential cultural heritage value as an example of the International style of architecture.
61 Chancery Lane E	-	Listed	This property has potential cultural heritage value as an example of Oakville's historic estates.
73 Ryland Terr	-	Listed	This property has potential cultural heritage value in the remnants of the former historic estate (iron fence line).
77 Ryland Terr	-		
Lakeshore Road E	-	Listed	This property has potential cultural heritage value for its stone wall, a remnant of a former estate (stone wall only).

[7] Oakville Heritage Planning - https://www.oakville.ca/business/heritage-planning.html

Heritage Property Address	Heritage ID	Status	Description
46 Cameo St	-	Listed	Haslemere House - this property has potential cultural heritage value for its c.1908 Arts &Crafts style house, historically associated with the Cox family.
658 Winston Churchill Boulevard	-	Listed	This property has potential cultural heritage value for its historic farmstead, including the Queen Anne and Edwardian style farmhouse and outbuildings.
2960 Sheridan Way	-	Listed	This property has potential cultural heritage value as the remnant of a cultural heritage landscape.

4.2.6 Archaeological

The Criteria for Evaluating Archaeological Potential was completed as part of the desktop review and the Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI) was consulted through email at (archaeology@ontario.ca) to confirm if there are any known archaeological sites within the Study Area. In addition to this, the Criteria for Evaluating Archaeological Potential concluded that Archaeological Assessment should be completed for this Study Area if any ground disturbance is to occur within previously disturbed areas (pre-1960). The majority of the Study Area is largely disturbed due to previous watercourse alterations, as well as the residential, industrial, and commercial developments.

If one of the design alternatives is identified as the preferred alternative an archaeological assessment will be undertaken. However, if the preferred alternative is to "do nothing", the findings of the screening assessment do not need to be acted upon.

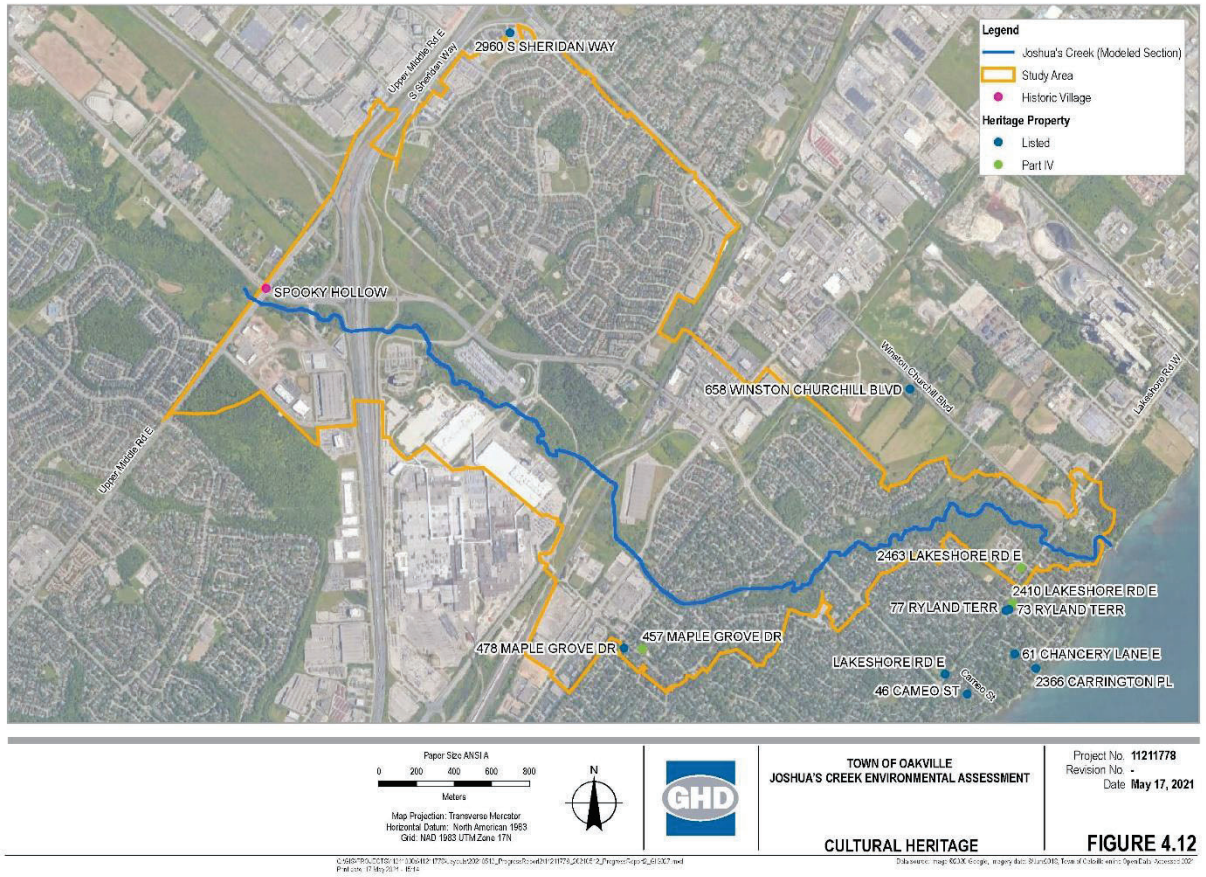


Figure 4.12 Cultural Heritage

4.3 Evaluation of Alternatives

The evaluation of alternatives was carried out following the MCEA process and took into consideration the effectiveness of each alternative in meeting the project objectives. The proposed alternatives were assessed with respect to the natural environment, social/cultural environment, costs, and technical factors.

4.3.1 Evaluation Criteria

Table 4.10 describes the criteria and basis of evaluation by which the proposed alternatives are evaluated using a quantitative ranking system that applies scores from 1 to 3 or 4. An assignment of 1 represents minimum quality or value, while an assignment of 3 or 4 represents the best outcome that can be reasonably attained for the alternative criteria. The scores for each of the criteria categories are determined as percentages of the maximum possible scores, then the category scores are averaged to determine the overall score for each alternative. The evaluation of short-listed alternatives with respect to the established criteria is presented in Table 4.11.

Table 4.10 Evaluation Criteria and Basis for Evaluation

Criteria	Scoring System		Basis of Evaluation
Technical			
Impacts to Floodplain	4	Significantly Reduced Flood Risk	The preferred alternative should effectively reduce the water quantity and quality impacts of flood inundation of the identified flood risk sites and should not increase flood potential along other sections of the creek.
	3	Reduced Flood Risk	
	2	Potential for Reduced Flood Risk	
	1	No Effect	
Constructability	4	No Construction	Requirements for specialized expertise or equipment, sensitivity to weather conditions, access restrictions, specialized materials, etc. are evaluated to assess overall constructability of each alternative.
	3	Routine Construction	
	2	Complex/Challenging Construction	
	1	Very Complex/Challenging Construction	
Approvability	4	No Approvals Required	The potential for the alternative to receive regulatory approval from applicable review agencies such as Conservation Halton, Fisheries and Oceans Canada, Ministry of Natural Resources and Forestry, Ministry of the Environment and Climate Change, and landowners impacted by the works.
	3	Routine Approvals Required	
	2	Challenging to Approve	
	1	Very Challenging to Approve	
Considerations for Climate Change Impacts	3	Works Adapted for Climate Change	The preferred alternative should be resilient to projected climate change impacts for the Study Area.
	2	Potential for Climate Change Adaptation	
	1	No Consideration for Climate Change Impacts	
Natural Environment			
Long-term Effects on Fish and Fish Habitat	3	Positive Effects	The ability of the alternative to provide species diversity and a stable, healthy fish and aquatic community in the long term.
	2	No Effects	
	1	Negative Effects	
	3	Positive Effects	

Criteria	Scoring System		Basis of Evaluation
Long-term Effects on Wildlife	2	No Effects	The ability of the alternative to provide species diversity and a stable, healthy terrestrial and wildlife community in the long term.
	1	Negative Effects	
Long-term Effects on Vegetation and Significant Woodlands	3	Positive Effects	The effect of the alternative on existing vegetation, including mature trees within the natural channel corridor, adjacent green spaces and significant woodlands.
	2	No Effects	
	1	Negative Effects	
Social Environment			
Short-term Impacts During Construction	3	No Effects	Evaluation of the potential temporary disruption to adjacent residents (i.e., traffic impacts, property access impacts), as well as nuisance factors such as noise and dust generation.
	2	Negative Effects	
	1	Significant Negative Effects	
Effects on Public Safety	3	Positive Effects	The alternative must provide a safe environment for members of the public of all ages.
	2	No Effects	
	1	Negative Effects	
Effects on Land Use	3	Positive Effects	Measure of the impact to adjacent private property (i.e., loss of property, access to property).
	2	No Effects	
	1	Negative Effects	
Effects on Potential Archaeological and Built Heritage Resources	3	Positive Effects	The alternative should mitigate impacts to areas of archaeological and cultural heritage interest and preserve existing historical/heritage features.
	2	No Effects	
	1	Negative Effects	
Economic/Financial			
Estimated Capital Costs	3	No Cost	The capital cost to implement the alternative is estimated based on conceptual level information.
	2	Moderate Cost	
	1	High Cost	

Table 4.11 Evaluation of Alternatives

Evaluation Criteria	Alternative 1 Do Nothing		Alternative 2 Metrolinx Bridge + Floodwall on Trail		Alternative 3 Flood Control Berm + Floodwall on Trail		Alternative 8 Non-structural Flood Control Measures	
Technical							15	Max. Possible Value
Impacts to Floodplain	1	163 buildings impacted by floodwater; 101 buildings impacted by 0.25 m of floodwater; 42 buildings impacted by 0.50 m of floodwater; 4 buildings impacted by at least 1 m of floodwater (Figure A.8 of Appendix A)	4	35 buildings impacted by floodwater; 14 buildings impacted by 0.25 m of floodwater; 6 buildings impacted by 0.50 m of floodwater; 1 building impacted by at least 1 m of floodwater (Figure A.9 of Appendix A)	3	86 buildings impacted by floodwater; 25 buildings impacted by 0.25 m of floodwater; 6 buildings impacted by 0.50 m of floodwater; 1 building impacted by at least 1 m of floodwater (Figure A.10 of Appendix A)	2	Decreased flood risk dependent on public participation
Constructability	4	No construction	2	Challenging staged construction, while maintaining rail traffic on adjacent lines	3	Routine construction	4	No construction

Evaluation Criteria	Alternative 1 Do Nothing		Alternative 2 Metrolinx Bridge + Floodwall on Trail		Alternative 3 Flood Control Berm + Floodwall on Trail		Alternative 8 Non-structural Flood Control Measures	
Approvability	4	No approvals	2	Long approval process. Approval may be required from DFO, CH and coordination required with local landowners	1	Very challenging coordination due to work on private property including potential impacts to flood risk on the Hydro One transformer stations. Increased flood risk to neighbouring properties would not likely be approved by CH.	3	Coordinated effort between the Town, CH, Region
Consideration for Climate Change Impacts	1	No consideration for climate change	3	Climate change resilience incorporated into the design process	3	Climate change resilience incorporated into the design process	2	Climate change resilience can be considered into the planning process
Score	**0.67**		**0.73**		**0.67**		**0.73**	
Natural Environment							9	Max. Possible Value
Long-term Effects to Fish Habitat	2	No effects	2	No effects	2	No effects	2	No effects
Long-term Effects to Wildlife	2	No effects	2	No effects	2	No effects	2	No effects
Long-term Effects to Vegetation and Significant Woodlands	2	No effects	2	No effects	2	No effects	2	No effects
Score	**0.67**		**0.67**		**0.67**		**0.67**	
Social Environment							15	Max. Possible Value
Short-term Effects During Construction	3	No construction	1	Disruption to rail commuters, trail users, residences adjacent to trail	2	Disruption to trail users, residences adjacent to trail	3	No construction
Effects on Public Safety	2	No effects	3	Decreased flood risk, floodwall can enhance safety for trail users	2	Decreased flood risk, floodwall can enhance safety for trail users; however, flood depths are increased on the Hydro One property.	2	Decreased flood risk dependent on public participation
Effects on Land Use	2	No effects	1	Metrolinx infrastructure and Hydro One property impacted by the bridge works	1	4 private property owners impacted by berm construction, including Hydro One property	2	No effects
Effects to Potential Archaeological and Built Heritage Resources	2	No potential to adversely affect potential archaeological resources	2	Potential to adversely affect archaeological resources. If this alternative is preferred a Stage 1 Archaeological Assessment will be required for impacted areas; however, the probability of impact is low.	2	No potential to adversely affect potential archaeological resources	2	No potential to adversely affect potential archaeological resources
Score	**0.60**		**0.47**		**0.47**		**0.60**	

Evaluation Criteria	Alternative 1 Do Nothing		Alternative 2 Metrolinx Bridge + Floodwall on Trail		Alternative 3 Flood Control Berm + Floodwall on Trail		Alternative 8 Non-structural Flood Control Measures	
Economic/Financial							3	Max. Possible Value
Estimated Capital Costs	3	No capital cost, but high cost of potential flood damages	2	High cost; however, potential funding and cost sharing opportunities could be available	2	High cost	3	No capital cost
Score	**1.00**		**0.67**		**0.67**		**1.00**	
TOTAL SCORE	**0.73**		**0.64**		**0.62**		**0.75**	

5. Selection of the Preliminary Preferred Alternative Solution

The selection of the preferred alternative solutions for the Joshua's Creek flood mitigation study are based on the development of feasible alternatives to address the identified issues, the comprehensive characterization of the Study Area, the evaluation of the feasible alternatives against a diverse range of evaluation criteria, and input received through public and stakeholder consultation.

The preferred flood mitigation alternatives recommended for implementation in the Joshua's Creek watershed are a combination of Alternative 8 in the short-term, with future consideration for construction of Alternative 2. Alternative 8 calls for the implementation of non-structural flood mitigation measures, specifically an emergency preparedness plan. Emergency preparedness plans are appropriate flood mitigation measures in highly developed areas, such as the Study Area, where structural flood control measures are not as practical and not as feasible to construct due to property issues and/or where infrastructure is owned by another authority, such as Metrolinx.

Alternative 2 includes the replacement of the Metrolinx crossing of Joshua's Creek with a higher capacity hydraulic structure and the construction of a floodwall on the right creek bank, downstream of Constance Drive. It is the most effective alternative in terms of mitigating risks related to water quantity (i.e., public safety and water damage to properties, infrastructure, and natural habitats) and water quality (i.e., as floodwater flows out of the creek corridor and over developed lands, it has the potential to pick up contaminants) of riverine flooding to employment, commercial, and residential properties during the Regional storm event; however, several drawbacks reduced its score in the evaluation process including ownership, high cost of $7.4 million, and constructability. The cost includes the total cost for construction of the bridge, without consideration for cost sharing. The bridge is owned by Metrolinx; therefore, any upgrades, improvements, or replacements to the structure would be outside of the Town's jurisdiction to implement. In the long-term, when the bridge is scheduled for replacement, it is recommended that the Town consider partnering with Metrolinx to ensure the bridge replacement has adequate capacity to pass the Regional flood event without causing uncontrolled overtopping and inundation of downstream lands. Conversely, various cost sharing and/or government funding opportunities could become available to plan and execute the work, which could make Alternative 2 a more viable option in the short-term.

The results presented in Table 5.1 to Table 5.3 demonstrate the effectiveness of Alternative 2 in terms of flood risk reduction. Table 5.1 presents the number of properties and buildings inundated by the Regional flood boundary and the number of properties and buildings determined to be "at-risk" in existing conditions. Flood risk is classified by the depth, velocity, and product of depth and velocity of the floodwater. An "at-risk" property or building exceeds one or more of the following flood risk criteria and a low-risk property or building meets each of the flood risk criteria based on the MNRF (2002) guidelines:

- Depth < 0.8 m
- Velocity < 1.7 m/s
- Depth x Velocity < 0.4 m^2/s

The depth threshold is based on the depth of water that would impose buoyant forces on a person and cause them to float. The velocity threshold is based on the force of flood flow exerted on a person standing in the floodplain that would cause them to become unstable. A person's ability to counteract the force of flood flow is reduced as they become more buoyant; therefore, the combination of depth and velocity (i.e., a product rule) should also be used to evaluate flood risk. A threshold of 0.4 m^2/s captures most combinations of depths and velocities classified as low risk; however, there are certain combinations of high depths and low velocities that meet the 0.4 m^2/s criteria but exceed the depth threshold, potentially causing a person to float. There are also combinations of low depths and high velocities that meet the product rule but exceed the velocity threshold, potentially causing instability. As such, it is important to apply all three criteria to assess flood risk.

Table 5.1 Existing Number of Inundated and At-Risk Buildings/Properties

Land Use Type	Existing Number of Inundated Buildings	Existing Number of At-Risk Buildings	Total Number of Inundated Properties	Existing Number of At-Risk Properties
Residential	134	12 out of 134	170	79 out of 170
Industrial/ Commercial	29	5 out of 29	21	9 out of 21

Table 5.2 compares the number of at-risk properties and buildings between existing conditions and after the implementation of Alternative 2. Table 5.3 compares the number of properties and buildings that are in the Regional flood inundation boundary between existing conditions and after the implementation of Alternative 2. Figure A.13 to Figure A.16 in Appendix A map the comparison of the flood risk metrics between existing conditions and the Alternative 2 scenario.

Table 5.2 Reduction of At-Risk Properties/Buildings After Implementation of Alternative 2

Land Use Type	Number of At-Risk Properties	Number of At-Risk Buildings
	Existing / After Alternative 2 Implemented	
Residential	79/5	12/0
Industrial/ Commercial	9/7	5/5

Table 5.3 Reduction of Properties/Buildings in the Floodplain Boundary After Implementation of Alternative 2

Land Use Type	Number of Properties within the Regional Flood Boundary	Number of Buildings within the Regional Flood Boundary
	Existing / After Alternative 2 Implemented	
Residential	170/56	134/10
Industrial/ Commercial	21/17	29/24

The results presented in Table 5.1 to Table 5.3 show that 76 of the 88 total properties, and 12 of the 17 total buildings will experience reduced flood risk below the flood risk criteria by implementing Alternative 2. The results also show that 114 of the 170 residential properties, and 124 of the 134 residential buildings will be removed from the Regional flood boundary. The cost of Alternative 2 will be approximately $60,000 per building removed from the Regional flood boundary.

The low probability of damaging flood impacts was considered in the evaluation process. The modelled flood inundation boundaries, up to and including the 100-year climate change flood event, do not impose significant concerns to public safety, properties, or cultural and environmental features. Figure 3.2 and Figure 3.3 show that there is no flooding of residential properties during the 100-year and 100-year climate change events, respectively. The modelled Regional flood presents the greatest impacts to the industrial, commercial, and residential properties located downstream of the Metrolinx tracks in the right overbank area of the creek. It is important to consider the magnitude of the Regional peak flow rate, which is almost three times greater than the 100-year peak flow rate and more than two times greater than the 100-year climate change peak flow rate. The 100-year climate change event by definition has a 1% probability of occurrence in a given year with consideration for climate change and future development conditions.

The study focuses on addressing riverine flood risk in the Joshua's Creek watershed, without consideration for flooding caused by external failure modes such as bank erosion and maintenance issues. Monitoring and maintenance of the creek system is recommended to ensure the banks and gabion basket walls are stable, and the creek corridor and hydraulic structures are free from debris that would cause flow obstructions.

In addition, the Town is in the process of completing or nearing completion of several riverine flood mitigation studies within the next 6 to 12 months. Each of these studies will provide recommendations that will also have budgetary demands on the capital flood mitigation program. These studies include Munn's Creek, Fourteen Mile /McCraney Creek, Lower Morrison and Wedgewood Creek and Joshua's Creek. Once all studies are completed, a prioritization of flood mitigation works will be carried out and implemented with consideration of level of risk, return on investment and funding availability.

6. Project Implementation

6.1 Next Steps

The Town of Oakville initiated and completed this MCEA for the Joshua's Creek Flood Mitigation Study to examine options to address the flood risk sites identified in the Study Area.

The preferred alternative is documented in Section 5. Further to the preferred alternative it is recommended that the Town proceed with the filing of the Project File Report for the extended 30-day public review period to solicit comments and feedback from interested parties. No approvals or permits will be required.

7. Overview of the Consultation Process Carried Out

Consultation with review agencies, Indigenous communities, and the public was carried out throughout the Joshua's Creek Flood Mitigation Study MCEA. Specifically, consultation was carried out early in and throughout the Project satisfying the following:

- The need for a minimum of two mandatory points of contact as specified in the MCEA for Schedule B activities (Section 7.1)
- The need to contact all main stakeholders identified in the MCEA: review agencies including municipalities, Indigenous communities, and the public (Section 7.2)
- The need to provide a variety of methods for involving the public as stated in the MCEA (Section 7.3)
- The need to integrate input received into the project and decision-making process as outlined in the MCEA (Section 7.4)

Each of the preceding requirements are further elaborated upon in the following subsections.

7.1 Points of Contact When Consultation Occurred

The consultation process is a key component of the Class EA process. The purpose of the consultation is to notify key stakeholders of the proposed project and to have the stakeholders provide input into the identified problem, alternative solutions, and preferred solution. Although only two mandatory points of contact are required for Schedule B activities, four were included as part of the project to increase the opportunities for review agencies, Indigenous communities, and the public to be involved. The four points of contact included the following:

- Notice of Commencement of Study
- Review of the alternative flood mitigation solutions as part of Phase 2 of the MCEA through a Public Information Centre
- Confirmation of the preferred solution (i.e., non-structural flood mitigation measures) through a second Public Information Centre
- Review of the Draft Project File Report by Conservation Halton

- Filing of the Final Project File Report for review

As a result, input was sought and obtained from the involved participants at the key decision-making points in the MCEA (i.e., Phase 2) and during the confirmation of the preferred solution.

7.2 Interested Participants and How Input was Obtained

At the project onset, potentially interested participants were grouped together into review agencies, Indigenous communities (First Nations and Métis organizations), and the public for consultation purposes.

Each participant group and how they were consulted is described in further detail in the following subsections.

7.2.1 Review Agencies

Review agencies included federal agencies and departments, provincial ministries and agencies, and local agencies, such as MECP, MNRF, Conservation Halton, and utilities. In total, 29 review agencies were consulted as part of the project (Table 7.1).

Review agency input on the project was obtained through email correspondence.

Table 7.1 Review Agencies

Review Agency
Federal Agencies
Fisheries and Oceans Canada
Provincial Agencies
Ministry of Indigenous Affairs
Ministry of Transportation
Infrastructure Ontario
Ministry of Agriculture, Food and Rural Affairs
Ministry of Environment, Conservation and Parks (MECP)
Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI)
Ministry of Natural Resources and Forestry (MNRF)
Municipality and Local Agencies
Conservation Halton (CH)
Oakvillegreen Conservation Association Inc. (OCA)
Oakville Chamber of Commerce
Trout Unlimited Canada
Joshua Creek Residents Association
Halton Region – Natural Heritage Advisory Committee
Halton Region – Forest Stewardship Advisory Committee

Review Agency
Halton region – Public Works Department
Halton Region – Legislative and Planning Services Department
Halton Region – Waste Management Planning & Collection Department
Halton Region – Water Department
Halton Region – Waste Management and Road Operations Department
Halton Regional Police Services
Infrastructure and Utilities
Hydro One Real Estate Management
Hydro One Distribution
Bell Canada
Telus
TransCanada Pipelines
Union Gas
Enbridge Gas Distribution Inc
Rogers Cable T.V. Ltd.

7.2.1 Indigenous Communities

The Indigenous communities who were invited to participate in the project are presented in Table 7.2 (those that may potentially be affected by the project).

E-mails were sent to the groups identified in Table 7.2 on August 6, 2020. Input from Indigenous communities on the project was encouraged through email and phone correspondence.

Table 7.2 Indigenous Communities

Indigenous Communities
Mississaugas of the Credit First Nation
Six Nations of Grand River Territory
Haudenosaunee Confederacy Council
Metis Nations of Ontario

7.2.2 The Public

Similar to review agencies and Indigenous communities, the public was also invited to participate in the study. Public participants that were directly notified included property owners adjacent to Joshua's Creek. The Notice of Study Commencement was mailed out to property owners adjacent to the creek and also advertised in the Local Newspaper (Oakville Beaver) on August 6, 2020.

Input from public participants on the project was obtained through email correspondence.

7.3 Consultation Activities Carried out

The consultation activities carried out during the project were tailored to each participant group with the intent to inform, efficiently obtain input, and address concerns/issues as much as possible. With this in mind, the following subsections summarize the consultation activities undertaken with each participant group beginning with review agencies and ending with the public.

7.3.1 Review Agencies

The consultation activities carried out during the project with review agencies largely involved email correspondence. Meetings and site visits are presented in Table 7.3.

Table 7.3 Agency Meetings

Review Agency	Purpose	Meeting Date/ Site Visit
Conservation Halton	To review the existing conditions of the study area and preliminary alternatives as well as the first PIC material	December 1, 2020
Conservation Halton	To review the evaluation of alternatives, selection of the preliminary preferred as well as the second PIC material	June 15, 2021

7.3.1 Indigenous Communities

Similar to review agencies, Indigenous communities were consulted on the project via e-mail correspondence. For instance, project related notices were issued by email to the Indigenous communities listed in Table 7.2.

7.3.2 The Public

A variety of consultation activities were carried out during the project with the public. These activities included the following:

- Notifications
- Virtual Public Information Centres
- Email correspondence

The preceding consultation activities are elaborated upon further in the following sections. Public meetings are presented in Table 7.4.

Table 7.4 Meetings with Public Members

Public Member	Purpose	Meeting Date/Site Visit
Impacted Private Business	To discuss various aspects of the study and the potential implications of flooding to their property	February 23, 2021 (virtual)

7.3.3 Notifications

A Notice of Study Commencement was sent to all relevant agencies and the public at the beginning of the project, outlining the project purpose, background, process, Study Area, and inviting comments. The notice was distributed via e-mail, published on the Town's website and advertised in the local newspaper (Oakville Beaver) on August 6, 2020.

7.3.4 Virtual Public Information Centres

Two virtual Public Information Centres (PICs) were held as part of the project for the public so that they could provide input at key decision-making points in Phase 2 of the MCEA Process.

7.3.4.1 Public Information Centre #1

The first virtual PIC was hosted on the Town's Website (https://www.oakville.ca/environment/flood-mitigation-joshuas-creek.html). The notice for the PIC was issued via mail and e-mail to agencies, adjacent property owners and utility companies identified in the Project Contact List on January 28, 2021 and was advertised in the local newspaper (Oakville Beaver). The Notice of PIC along with a detailed description of the study was issued to the identified Indigenous Communities on February 2, 2021. The purpose of the first PIC was to:

- Introduce the study including the Study Area, flooding issues and goals
- Provide an overview of the Class EA study process
- Present the draft Problem/Opportunity Statement
- Summarize existing environmental conditions within the Study Area
- Identify the potential flood mitigation alternatives
- Outline the proposed approach for evaluating the alternatives

The virtual PIC was available for four weeks.

A total of eight comments were received from the PIC, all of which were submitted via email. All of the submitted comments were formally responded to as summarized in Section 7.4.

7.3.4.2 Public Information Centre #2

The section virtual PIC was also hosted on the Town's website. The notice for the PIC was issued via mail and e-mail to agencies, adjacent property owners and utility companies identified in the Project Contact List on week of October 7, 2021 and was advertised in the local newspaper (Oakville Beaver). The Notice of PIC along with a detailed description of the study was issued to the identified Indigenous Communities on October 8, 2021. The purpose of the second PIC was:

- Solicit feedback on the preliminary alternative solution determined through the evaluation process

The section virtual PIC was available for four weeks.

A total of 20 comments were received from the PIC #2, all of which were submitted via email. All of the submitted comments were formally responded to as summarized in Section 7.4.

7.4 Consideration of Comments Received and Issues Raised

Comments were received from review agencies, Indigenous communities and the public. With this in mind, the comments received and issues raised and how they have been considered as part of the project are summarized in the tables below.

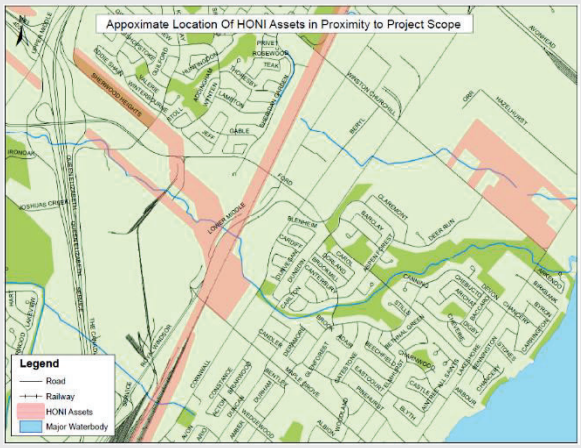
7.4.1 Comments Received on the Project and how they were Considered in the Project

At the project onset, potentially interested participants were grouped together into review agencies, Indigenous communities and adjacent property owners for consultation purposes.

Comments received by agencies and how they were considered for the project are provided in Table 7.5. No comments received by Indigenous Communities and comments received by the public and adjacent property owners are presented in Table 7.6.

Table 7.5 Comments received by Agencies

Summary of Comments from Agencies	Consideration of Comments Received
Notice of Study Commencement	
Agency: Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI) **Contact:** Dan Minkin, Heritage Planner **Comment:** It was suggested that while some cultural heritage resources may have been formally identified, others may be identified through screening and evaluation and through consultation with Indigenous Communities and Municipal Heritage Committees, historical societies and other local heritage organizations. MHSTCI also suggested that the project may impact archaeological resources and built heritage and cultural heritage landscapes and recommended that the project area be screened using the MHSTCI *Criteria for Evaluating Archaeological Potential* and *Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes.*	The project has been screened using the MHSTCI *Criteria for Evaluating Archaeological Potential* and *Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes.*
Agency: Ministry of the Environment, Conservation and Parks (MECP) **Contact:** Trevor Bell, Regional Environmental Assessment Coordinator **Comment:** Acknowledgment to the notice of commencement was provided by MECP. With this MECP also provided the following list of Indigenous Communities that should be consulted with as part of the Project: • Mississaugas of the Credit First Nation • Six Nations of the Grand River • Haudenosaunee Confederacy Chiefs Council	The listed Indigenous Communities were consulted during the project. Regarding the areas of interest, the study is not proposing any constructed works in the short-term and will therefore not impact areas of interest identified by MECP.

Summary of Comments from Agencies	Consideration of Comments Received
• Huron-Wendat Nation MECP also noted its areas of interest and concluded that the Town should identify which are applicable to the Project and ensure they are addressed.	
Agency: Hydro One **Contact:** Secondary Land Use (secondarylanduse@hydroone.com) **Comment:** Hydro One provided comment on the project to highlight that they have existing high voltage Transmission facilities located within the Study Area as indicated by the pink-coloured areas in the figure below.  Hydro One was unable to provide specific comments relating to potential impacts the project may have on their infrastructure without detailed information on the works being required. They requested to continue to be informed as the project progresses so that they can advise on alternative solutions that may present conflict with their assets. Additionally, Hydro One noted that if the project was to result in a Hydro One station expansion or transmission line replacement and/or relocation, an Environmental Assessment (EA) will be required as described under the Class Environmental Assessment for Minor Transmission Facilities (Hydro One, 2016). They advised that any changes to lot grading or drainage within, or in proximity to the Hydro One transmission corridor lands must be controlled and directed away from the transmission corridor, and that the proponent would be held responsible for all costs associated with modifications or relocations of Hydro One infrastructure that result from this project.	The study is not proposing any construction in the short-term that would impact Hydro One property or assets as the preferred alternative. Alternative 2 would reduce the depth of flooding on Hydro One property, upstream of the CN railway crossing.

Summary of Comments from Agencies	Consideration of Comments Received
Agency: Oakvillegreen Conservation Association **Contact:** Beatriz Gomez, Programs Director **Comment:** Oakvillegreen Conservation Association provided comment suggesting that the flood mitigation management measures to be developed as part of the project should incorporate green infrastructure approaches to stormwater management. These tools would include: • Rain gardens, • Bioswales, and • Rainwater harvesting The green infrastructure would be incorporated on private and public property to help increase stormwater infiltration. Oakvillegreen express the importance of increasing awareness and changing ideas about the design of urban landscapes and introducing climate-resilient infrastructure.	LID measures were considered and screened out as per the criteria in this report.
Public Information Centre #1	
Agency: Halton Region **Contact:** Christopher Pasquale **Comment:** It was noted that from a Water and Wastewater Infrastructure Planning and Policy perspective, the Region did not have any comments. However, consideration of existing water and wastewater infrastructure within the Study Area was not considered and should the Town require additional information on this, then the Region should be consulted further.	Comment noted.
Agency: Enbridge Pipeline Inc. **Contact:** Maria Bradley **Comment:** Enbridge noted that there are several high-pressure crude oil pipelines in the general Study Area. Should any ground disturbance or activities prescribed in the *Canada Energy Regulator (CER) Damage Prevention Regulation* be required within 30 m from each side of the identified pipelines, Enbridge is to be notified. In addition to this, all-proposed facilities crossing the pipeline right-of-way require approval from Enbridge in the form of a crossing agreement between Enbridge and the facility owner.	Enbridge will be notified should the Town proceed with Alternative 2.
Public Information Centre #2	
Agency: Enbridge Pipeline Inc. **Contact:** Maria Bradley	Enbridge will be notified should the Town proceed with Alternative 2.

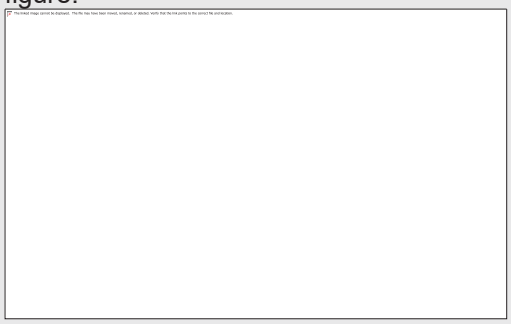
Summary of Comments from Agencies	Consideration of Comments Received
Comment: Enbridge noted the high-pressure crude oil pipelines in the area on the following figure.  Should any ground disturbance or activities prescribed in the *Canada Energy Regulator (CER) Damage Prevention Regulation* be required within 30 m from each side of the identified pipelines require Enbridge to be notified. In addition to this, all-proposed facilities crossing the pipeline right-of-way require approval from Enbridge in the form of a crossing agreement between Enbridge and the facility owner.	
Agency: Metrolinx **Contact:** Matthew Muratore **Comment:** The bridge in question was replaced in 2008 and therefore would not be scheduled for replacement in the near future. At the time of replacement, further analysis of downstream flood risk will be reviewed through the design process.	Noted.

Table 7.6 Comments Received from the Public

Category	Summary of comments received	How they were considered in the project
Notice of Study Commencement		
Interest in the findings of the study	Interested in understanding the implication of flood events	The results of the study will be made available to the public.
Concerns about existing flood mitigation measures	Concern about the state of the flood mitigation structures around the creek	The study aims to identify where measures can be implemented.
	Concerns about vegetation blocking the creek	The Town routinely checks creeks to ensure vegetation is not the cause of flooding.
	Concerns about erosion along the creek from previous storm events	Erosion impacts along the Creek would be assessed under a separate scope to this Flood Mitigation Study.

Category	Summary of comments received	How they were considered in the project
Other	Complaints about poor maintenance of parks adjacent to Joshua's Creek	Noted; however, this is outside of the scope of the flood mitigation study.
Public Information Centre #1		
Amphibians and reptiles	Natural environment description presented in PIC #1 material did not include frogs and turtles, which are directly dependent on the undisturbed condition of the creek habitat for their survival. Observed a snapping turtle and nest southeast of the Brookmill Road creek crossing.	The Environmental Assessment Study considers both aquatic and terrestrial habitat. More detailed aquatic habitat characterization and field work may be required at the design phase depending on the chosen solution in order to quantify specific potential impacts and mitigation measures.
Impacts of upstream developments	The study does not address the impact of upstream development on water quality and flow patterns in the creek.	Upstream developments provide water quantity and water quality controls as per Provincial and Town requirements. Specific improvements to water quality is beyond the scope of this study. The Town's Stormwater Master Plan details alternatives to improve water quality within the Town. Water quality will be considered as part of the overall environmental impacts as part of evaluating the alternatives.
Impact of snowmelt on flood inundation	The study does not mention flood risk due to snowmelt combined with intense rainfall.	While the floodplain modelling exercise does not specifically input snowmelt parameters, the Town took into consideration ground saturation to mimic more intense runoff that would be observed in the early spring. The Regional storm event represents the worst-case extreme rainfall scenario in terms of total rainfall volumes. Full ground saturation is assumed at the start of the event to maximize runoff volumes from the land and peak flows in the creeks, which are then used to fully characterize flood risk areas.
Mitigation Measures	Potential impacts and mitigation measures north of Upper Middle Road (outside of the Study Area).	The Town is currently developing a flood risk prioritization strategy. As part of the strategy five follow up flood studies are being carried out throughout the Town, including Joshua's Creek.

Category	Summary of comments received	How they were considered in the project
		The Study Area for this project is focused on capturing existing areas of flood risk (identified through the previous Town-wide flood study). Areas of flood risk were primarily recognized south of the QEW and are the result of the era of development where buildings and communities were built near or within natural hazards. Development north of Upper Middle Road occurred much later when policies and regulations were in place to ensure development occurred outside the Regional Storm floodplain (a.k.a. the Hurricane Hazel Storm event). This is evident when you compare the size of the creek blocks and buffer areas for Joshua's Creek north of Upper Middle Road versus the areas south of the QEW. The study does look at the entire Joshua's Creek watershed in our hydrologic modelling exercise to fully characterize flood risk. The study team also looked at mitigation options to the north of the Study Area to relieve flooding in the south.
	If pinch points were mitigated at creek crossing structures, then the need for mitigation downstream may be minimized. If stormwater retention ponds were implemented at the Ford of Canada site and 2175 Cornwall Road, this may minimize or eliminate the need to mitigate creek crossing structures.	Mitigation measures associated with crossings have been considered as part of the list of alternatives. Flood storage was considered within the Study Area and was screened from further consideration due to the impracticality of storing such a large volume of water that would be needed to reduce expected peak flows and provide any noticeable benefit to flood risk for the Regional storm conditions.
	Mitigation upstream would eliminate any downstream groundwater and water table contamination	Flood risk mitigation measure imposed is unlikely to eliminate point source contamination from upstream as pathways for entry into creeks and storm sewer systems would remain.
	Effectiveness of LIDs for 100-year and 100-year Climate Change	LIDs offer opportunities for mitigation at the more frequent

Category	Summary of comments received	How they were considered in the project
	Mitigation	storm events and have not been proven to provide relief for the more extreme rainfall events.
Additional clarification on information provided	Concerns that residents don't understand the alternatives and when they would be required or recommended over another alternative.	More information on the alternatives and when they would be required or recommended is provided in PIC #2 and the Project File Report.
	Clarification requested on the intention of Alternative No. 8	More information on the alternatives, including Alternative 8, is provided in the Project File Report.
	Confusion regarding the difference between the 100-year Climate Change Scenario and the 100-year Scenario	The 100-year storm event is based on historical rainfall data, whereas the 100-year climate change event is based on historical rainfall data and a multiplier to account for the anticipated impacts of climate change. 100-year and 100-year with climate change storm events are differentiated by their intensity, duration and frequency (IDF) curves that generate differences in peak flow rates when modelled. Peak flows are then input into a hydraulic model to generate flood elevations (i.e., water surface elevations). Higher peak flows typically produce higher water surface elevations. A summary of the peak flow rates generated for Joshua's Creek, for comparison, is as follows: Joshua's Creek peak flow rates at: **Highway 403:** 100 year - 53.5 cubic metres per section (m^3/s) 100 year adjusted for CC - 67.75 m^3/s **Metrolinx Railway** 100 year - 57.82 m^3/s 100 year adjusted for CC – 73.37 m^3/s **Ford Drive** 100 year - 59.95 m^3/s 100 year adjusted for CC – 74.47 m^3/s

Category	Summary of comments received	How they were considered in the project
	Concerns that the mapping does not reflect the requirement that structure (building) door sills need to be located 12" (300 mm) above the high-water flood line due to potential storm surge (i.e., wave action).	When infrastructure is designed within the vicinity of computed Regional flood levels, a "freeboard" or safety factor is often used, and this often varies between municipality and conservation authority. Designing a door sill 0.3 m above a Regional flood elevation is one example. In this study, the Town is working in conjunction with Conservation Halton and our consultant to determine the flood levels for extreme events (i.e., the 100-year, Regional, etc.). Safety factors, if required, would be applied later at the design stage. A detailed topographic survey would be required to compare the computed water surface elevations to door sill elevations. However, a high-level assessment of flood risk, including the number of buildings inundated by flood depths greater than 0.8 m has been included in the Project File Report.
Components of the Study	Concerns that no costs have been considered for the alternatives	A cost benefit analysis was completed as part of the study. Conceptual design and construction costs are documented in the Project File Report.
	Additional information required on the data used for modelling (i.e., the period of time captured in historical climate data)	Using Historical Climate Data: The 100-year flood map is based on the intensity, duration, and frequency (IDF) rainfall curves generated using data collected at the Toronto Bloor Street station, which has continuous rainfall data for the last 50 years. The Hurricane Hazel flood map is generated using a rainfall distribution based on the named 1954 storm, which is the largest storm on record in Southern Ontario.
	Additional information required on the parameters and climate model scenarios used in the modelling	The 100-year climate change scenario looks at rainfall intensity, duration and frequency

Category	Summary of comments received	How they were considered in the project
		(IDF) under the 100-year design storm conditions, adjusted with statistics based on the Intergovernmental Panel of Climate Change (IPCC) Representative Concentration Pathways (RCP) 8.5 scenario for the 2080 -2100 time period. RCP 8.5 refers to the greenhouse gas concentration (GHG) trajectory and represents the highest projected GHG concentrations resulting from "business as usual" emissions without mitigation. The 100-year climate change adjusted IDF curve values were generated using the IDF-Climate Change Tool (Version 2) developed at the Facility for Intelligent Decision Support at Western University.
	Climate change to be considered as part of the study. For example, the potential for Hurricanes to occur more frequently and major storm events to occur more frequently	Climate change has been considered as part of the study as noted above.
Recreational facilities	Potential extension of the trail along Joshua's Creek north of Constance Drive	This is outside of the study scope. The Town has provided other resources including the opportunity to discuss the potential extension with a member of the Town's Parks Department.
Subject Matter Expertise	Concerns that the study does not include any information from experts in this area	Consultation with agencies is required as part of the Environmental Assessment Process and experts on floodplain and environmental management have been consulted. Conservation Halton is the local expert on floodplain management for Halton Region and are fully engaged in the study process.
Public Information Centre #2		
Concerns regarding potential damming	Concerns with the state of the ravine between Brookmill Road and the Constance Drive Bridge,	This comment is outside of the scope of the study, as such it has not directly been considered in

Category	Summary of comments received	How they were considered in the project
	specifically the potential for damming against the Brookmill bridge as a result of the debris deposited by public members in the ravine. Suggested a cleanup of the ravine and in the short-term, a letter sent to all residents along Joshua Creek to remind them not to dump into the ravine.	the study. However, creek maintenance to address debris jams is carried out on a routine basis and in response to calls received by the public. In response to the comment the Town's Operations group was notified.
Study Scope	Inquired if the scope of this study included the effects of the deforestation and paving over of green space for the proposed Amazon parking lot on Cornwall Road.	The study looks at both existing and future land use (in accordance with the Town's official plans and zoning) when assessing flood risk. All new development must be designed to control post-development site runoff to pre-development levels to mitigate downstream flood risk.
Possible contaminated sites within the study area	A resident brought to attention three sites thought to be past dumping sites that abut Joshua's Creek which in case of a flood could result in contaminating Lake Ontario with carcinogens. The resident noted his concern regarding the Town's and MECP's continued inaction and unwillingness to recognize the very existence of the dumps. MECP has not identified the property in question as a past dump site, as such the resident wanted to know who owned the property. It was also noted that since the existence of the dumps is not formally recognized a series of problematic events will be faced with the ultimate release of toxins into Lake Ontario, our main water source (water supply for 30 percent of Ontario).	The effectiveness of the alternatives in terms of reducing the risk of water quantity and water quality (i.e., pollution by any potential contaminated lands) impacts was incorporated into the evaluation process.
	It was also stated that the environmental summary for the study does not include the newer Ford Motor dump.	On the left channel bank, the Regional flood line is confined to the channel corridor on the north side of South Service Road, and is confined to the channel and parking lot on the south side of South Service Road, near the intersection with Ford Drive.

Category	Summary of comments received	How they were considered in the project
Flood Modeling	A resident provided a model to demonstrate potential flood scenarios that they believe could result in possible impacts to contaminated sites and the possible release of hazardous materials into the environment. The resident asked to speak to this matter in a public form and asked that it be published in with any other resident comments.	All comments received will be a part of the public record through filing of this report.
Concern with Town by-law amendment	Questioned the amendment to the 100-year flood by-law that allowed the development north of Dundas. Stating the review has nothing to do with 100-year situations and surely more like 10-year storms of which there are many more.	This study has considered more frequent storm events (i.e., 2-year to 50-year storms). The resulting flood inundation maps for these events are presented in **Appendix A** of this report. The flows were calculated by applying future development conditions, including increased build-out and further development of existing conditions. The hydrologic modelling assumptions are described in more detail in Section 2 of the Joshua's Creek Flood Mitigation Opportunities Study in **Appendix B** of this report.
Concerns with current and future development	Resident feels the study completed is inadequate as it does not recognize the severe runoffs which could occur from the over development the Joshua's Creek watershed	*See above response*.
	Feels strongly that the solution to flooding should be to shut down all development plans in all watersheds above Dundas. Specifically, concerns were related to the following items, which he thought the public should also be made aware of: • The almost complete removal and alteration of the Joshua's Creek watershed and • The council's voting to allow high density development north of Dundas and • The presence of the 3 large industrial hidden toxic dumps	All new and future development north of Dundas Street must meet the requirements as dictated in the North Oakville Creeks Subwatershed Study. Stormwater management for development utilizes end of pipe controls such as stormwater management ponds that are sized to control the Regional storm peak flows, which are roughly 2 times greater than the 100 year peak flows. This provides the necessary protection to prevent any increases in flooding due to the development in the north.

Category	Summary of comments received	How they were considered in the project
	which lie abutting Joshua's Creek	
	Noted that information provided does not include the over development and paving of 70 percent of Joshua's Creek watershed due to the by-law changes, etc.	*See response above.*
	Comment was received regarding the new building zone parameters in Oakville north of Dundas in Joshua's Creek area. Requested the information available for the 100-year flood. Noted that they believe that Council relaxed its development constraints so that a 100-year flood condition no longer needs to be the controlling constraint. Inquired about the new development rules and how the changes are passed down to developers.	*See response above*.
	When you pave over 70 precent of a 3 km by 5 km watershed, and replace it with large storm water sewer systems and stormwater ponds, the rainwater and/or melt water will collect almost as fast as the water materializes and end up in Joshua's Creek, the only exit, all at once. There is no buffer.	*See response above*.
	Comment received regarding the proposed Amazon development.	Comment noted.
Public participation	Resident requested to prepare a wish video presentation to be included in the PIC #2.	It was noted that PIC's are not a forum for the public to make presentations.
	There has been limited public engagement and most citizens are completely unaware of what has been going on.	The consultation completed for this project have followed the requirements for a MCEA.
	A resident stated that the following items should be included in the ad requesting citizen participation in mitigating Joshua's Creek: • The expected new flooding below Upper Middle Road (UMR) will have little to do with global warming and next-to-nothing about what citizens could do to prevent it.	*See responses above*.

Category	Summary of comments received	How they were considered in the project
	Only smart planning can do that • Recent changes to former restrictive development by-laws (e.g., 100-year storms) applying above Dundas were relaxed by Council to allow development which would otherwise never have proceeded • The Joshua's Creek watershed and wetlands of approximately 3 km by 5 km will be destroyed by paving over 60% to 70% of its natural environment • With the loss of the land's ability to "hold" water, that water will be rushed via the storm sewer system down Joshua's Creek through East Oakville's mansions to Lake Ontario, our water supply • Water flow calculations show that a wall of water 100 feet wide by 10 feet high could result flowing at 30 feet/second along the Joshua's Creek channel • Joshua's Creek, both above and below Upper Middle Road, abuts huge hidden untested industrial dumps which the violent water flow will rip open, picking up the dumps/land-fills contents • The contents contain benzene, toluene, paint sludge and other carcinogenic chemicals placed (legally, according to laws of that time) by Ford Motor Co. into the dumps between 1953 and in some point in the 1970s • These chemicals have probably been leaching into Joshua's Creek since the 1930's from older dumps • The Ninth Line Dump (known to MECP) is now shared and co-owned by Oakville and	

Category	Summary of comments received	How they were considered in the project
	Infrastructure Ontario (IO) and the Ford Dump (unknown to MECP) at Ford Drive and The South Service Road is owned by Ford Motor Co on land ceded to it secretly by Ontario • Oakville permitted dumping by Ford Motor Co. onto IO lands (The Parkway) when its original Ninth Line Dump was full, thereby creating huge legal liabilities for polluting public lands • IO and Oakville, secretly, planned for 10+ years to develop commercial and residential housing on top of 2 dumps (in The Parkway) to hide the dumps 'forever' • None of the dumps have been properly tested for contents and leachates and the minimal results (or supposed results) have been purposefully misrepresented and/or withheld to/from the public • The main focus of the study should be on what has been done above Upper Middle Road, and not just below UMR, because that is the area where 90 percent of the causes for flooding will originate	
	A public member voiced concerns regarding the public's ability to comment on the flooding issues if they do not have all the available information, specifically the public member stated that there is a much bigger story being, including three unmonitored dump sites.	*See responses above*.
	The following comments/questions were provided regarding public participation: • Seeking clarification on acceptable format for public comments for this project	The consultation completed for this project have followed the requirements for a MCEA. Comments received are summarized in this report and copies of the original comments are in included in **Appendix F**.

Category	Summary of comments received	How they were considered in the project
	• Confirming comments received for this study will become a part of the public record • Public members should be aware of other people's comments on this project • Concern that COVID is being used as an excuse to prevent public participation	
Governance	The Study Terms of Reference do not appear to have established best practices with regard to effective governance. The Town and its consultants who report to Town staff under the direction of the Town's senior leadership team do not appear to have created any arms-length evaluation process that is transparent for public consultation. In my personal opinion, this is very poor from a governance perspective as the evaluation criteria are established by this in-house team including consultants and then evaluated by the same individuals. As a consequence, the study process may not be credible in the eyes of the public. A copy of the study organizational leadership team including the study's sponsor was requested.	A description of project governance has been added to Section 1 of the report, which will be available for a 30-day public review period.
Lack of study information and supporting documentation	Slide deck presentations provided do not include supporting documentation, making an already challenging assessment by lay stakeholders even more challenging, especially given that there are no actual order-of-magnitude capital and ongoing operational costs (dollar values) provided to be able to measure the cost-benefit of potential solutions.	Comment noted. The full Project File Report, which will be made available for 30-day review will include additional information and supporting documentation. In addition, several riverine flood mitigation studies either have been completed or are nearing completion within the next 6 to 12 months, which will have recommendations that will also have budgetary demands on the capital flood mitigation program. These studies include Munn's Creek, Fourteen Mile /McCraney Creek, Lower Morrison and Wedgewood Creek and Joshua's Creek. Once all studies are

Category	Summary of comments received	How they were considered in the project
		completed, a prioritization of flood mitigation works will be carried out and implemented with consideration of level of risk, return on investment and funding availability.
	Although the study has eliminated **Alternative 4 - Install Relief Culvert under Royal Windsor Drive; Alternative 5 - Provide Flood Storage and Alternative 7 - Construct Flow Diversion** from further study consideration, given the dearth of study information, and pending receipt of a more fulsome study including supporting documentation, it is premature to eliminate these alternatives.	*See response above.*
Request for independent third party review	It was recommended that the Town should undertake an independent third-party peer review given the complex technical nature of the study.	Conservation Halton provided a technical and advisory review at key milestones in the study as described in Section 1.3 of the Project File Report.
Alternative Methods	A person noted that it is incomprehensible that **Alternative 8 - Emergency Preparedness Plan** was proposed as the preferred option as a last line of defense. They view it as the Town study is pushing the problem down the road instead of taking action to mitigate health and safety risks.	Multiple preferred alternatives have been selected for implementation including Alternative 8 in the short-term and Alternative 2 in the long-term. Alternative 2 is contingent on acceptance from Metrolinx. It is the most effective alternative in terms of mitigating riverine flood risk during the Regional storm event; however, several drawbacks reduced its score in the evaluation process, including ownership, high capital cost, and constructability. Alternative 2 could become a viable option in the future when the structure is scheduled for replacement as discussed in Section 5 of this report. The selection of the preferred alternative solutions considers jurisdictional authority, return on investment, funding availability, and level of risk, including the probability of occurrence of the flood events that show impacts to the surrounding environment.

Category	Summary of comments received	How they were considered in the project
	The Town needs to identify a clear path forward with solutions that are do-able now as a Regional event could occur at any time.	*See response above.*
	The Joshua Creek Residents' Association (JCRA) board is disappointed that the only flood mitigation option recommended by this study is Option #4 Emergency Preparedness. This option does not appear to be sufficiently robust to be the only recommendation for flood mitigation of Joshua Creek for the below reasons: • Effectiveness of the options was not included as an evaluation criterion. • The reliance on individual residents to implement flood mitigation measures at their own discretion is poor public policy. • Emergency Preparedness appears to have come out of the evaluation criteria as the best option based on Constructability. • The need for multiple options to reduce flood risk is a reasonable and logical conclusion given the statement on Options #2 and #3 "Flood risk to the residential area is reduced, but not eliminated"; however, the study has recommended a single option. • The study does not appear to provide supporting evidence that Option #4 will eliminate flood risk. • There is no financial information included in the presented material. • There is no reference to working with external stakeholders so that a more robust flood mitigation plan	Alternative 8 is recommended and Alternative 2 has been recommended for a long-term solution based on its effectiveness in terms of reducing flood risk. The timing and implementation of Alternative 2 is contingent on acceptance from Metrolinx. The Town is always looking for funding and cost sharing opportunities, which may include partnership with Metrolinx in regard to Alternative 2.

Category	Summary of comments received	How they were considered in the project
	can be undertaken with shared costs. • There is no reference to best practices in other municipalities, including Burlington and Toronto where significant flooding resulted from massive storms in the 2014, 2013 and 2018. • Reducing Risk of Contamination in the creek system was not included in the study. <u>JCRA suggestions:</u> • Add Effectiveness of each option as a Key Evaluation Criteria, including effectiveness at reducing risk of possible contamination in a flood scenario. • Consideration of external partners to share costs with Town. Consider combining multiple options to create a more robust action plan to reduce flood risk.	
Impact to property values	Resident requested that their property not be included in the flood risk area as not matter the rain frequency or intensity they have never had any flooding. Requested that the flooding area be limited to the absolute necessary regions to avoid any significant non-necessary negative impact on homeowners' property values	The study is not intended to produce an update of the regulatory floodplain mapping for Joshua's Creek, which is under the jurisdiction of CH pursuant to the *Conservation Authorities Act*.
	The proposed flood area once approved would have a significant negative impact on their property values, tens of thousands, and in some cases exceeding more than half a million. Requested that the proposed plan be modified it in a way that would have the least impact on the number of residents, and less impact for those who would be impacted.	*See response above*.

8. Conclusion and Next Steps

This report documents the Joshua's Creek Flood Mitigation Opportunities MCEA study, including the problem/opportunities definition, problem statement, list of feasible alternative solutions, project schedule selection, inventory of the environment, evaluation of alternatives, selection of the preferred alternative, and public consultation with respect to the comments received on the Notice of Study Commencement and at two PICs.

The preferred flood mitigation alternatives recommended for implementation in the Joshua's Creek watershed are a combination of Alternative 8 in the short-term, with future consideration for implementation of Alternative 2. Alternative 8 calls for the implementation of non-structural flood mitigation measures, specifically an emergency preparedness plan. Emergency preparedness plans are appropriate flood mitigation measures in highly developed areas, such as the Study Area, where structural flood control measures are not as feasible to construct. Alternative 2 includes the replacement of the Metrolinx crossing of Joshua's Creek with a higher capacity hydraulic structure and the construction of a floodwall on the right creek bank, downstream of Constance Drive. The implementation of Alternative 2 depends on acceptance by Metrolinx as it is outside of the Town's jurisdictional authority to replace or make improvements to the existing structure. The viability of Alternative 2 is also contingent on cost-sharing opportunities. The selection of the preferred alternative solutions considered return on investment, available funding, and level or risk.

The next steps in this MCEA study are listed below:

- Posting of the Project File Report for a 30-day review period and consultation with review agencies
- Implementation of the preferred alternative with mitigation options (if applicable)

9. References

Bat Conservation International. 2020. Bat Profiles. URL: https://www.batcon.org/about-bats/bat-profiles/

Boland, G.J., J. Ambrose, B. Husband, K.A. Elliott and M.S. Melzer. 2012. Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 43 pp.

Brennan, L.A. 1999. Northern Bobwhite (*Colinus virginianus*) The Birds of North America Online (A. Poole, Ed.). Ithica: Cornell Lab of Ornithology. URL: http://bna.cornell.edu/bna/species/397.

Brown, C.R. and M.B. Brown. 1999. Barn Swallow (*Hirundo rustica*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. URL: http://bna.birds.cornell.edu/bna/species/452.

Cadman, M.D., D.A Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier (eds.), 2007. Atlas of Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp. URL: https://www.birdscanada.org/birdmon/onatlas/main.jsp.

Canada. *Fisheries Act* (R.S.C., 1985, c. F-14). URL: https://laws-lois.justice.gc.ca/PDF/F-14.pdf

Canada. *Migratory Birds Convention Act,* 1994 (S.C. 1994, c. 22). URL: https://laws-lois.justice.gc.ca/PDF/M-7.01.pdf

Canada. Migratory Birds Regulations. 2014. (C.R.C., c. 1035). URL: https://laws.justice.gc.ca/PDF/C.R.C._c._1035.pdf

Canada. *Species at Risk Act*, SC 2002, c 29. URL: http://laws-lois.justice.gc.ca/PDF/S-15.3.pdf

COSEWIC. 2007. COSEWIC assessment and status report on the Chimney Swift *Chaetura pelagica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp.

COSEWIC. 2007. COSEWIC assessment and update status report on the Peregrine Falcon *Falco peregrinus* (*pealei* subspecies – *Falco peregrinus* and *pealei anatum/tundrius* – *Falco peregrinus anatum/tundrius*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 45 pp.

COSEWIC. 2008. COSEWIC assessment and status report on the Snapping Turtle *Chelydra serpentina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 47 pp.

COSEWIC. 2009. COSEWIC assessment and status report on the Whip-poor-will *Caprimulgus vociferus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp.

COSEWIC. 2010. COSEWIC assessment and status report on the Monarch *Danaus plexippus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 43 pp.

COSEWIC. 2011. COSEWIC assessment and status report on the Barn Swallow *Hirundo rustica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 37 pp.

COSEWIC. 2011. COSEWIC assessment and status report on the Henslow's Sparrow *Ammodramus henslowii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 37 pp.

COSEWIC. 2012. COSEWIC assessment and status report on the Eastern Wood-pewee *Contopus virens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 39 pp.

COSEWIC. 2012. COSEWIC assessment and status report on the Northern Map Turtle *Graptemys geographica* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 63 pp.

COSEWIC. 2012. COSEWIC assessment and status report on the Wood Thrush *Hylocichla mustelina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 46 pp.

COSEWIC. 2013. COSEWIC assessment and status report on the Grasshopper Sparrow *pratensis* subspecies *Ammodramus savannarum pratensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 36 pp.

COSSARO. 2012. COSSARO Candidate Species at Risk Evaluation for Northern Myotis (*Myotis septentrionalis*) [formerly Northern Long-eared Bat]. Committee on the Status of Species at Risk in Ontario. Toronto. 18 pp.

Crins, W.J., McIlveen, W.D., Goodban, A.G., O'Hara, P.G. 2006. Halton Natural Areas Inventory 2006: Volume 2 Species Checklists (The Vascular Plants of Halton Region, Ontario: Species Checklist).

Environment and Climate Change Canada (ECCC). 2018. Recovery Strategy for the Northern Bobwhite (*Colinus virginianus*) in Canada. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. ix +38 pp.

Farrar, J.L. 1995. Trees in Canada. Fitzhenry & Whiteside Limited, Markham, Ontario and Canadian Forest Service, Natural Resources Canada, Ottawa, Ontario. 502 pp. ISBN: 1-55041-199-3.

Fisheries and Oceans Canada (DFO). 2020. Aquatic species at risk map. URL: https://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html

Gabhauer, M.A. 2007. Bobolink, pp. 586-587 in Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.T. Couturier, eds. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources and Ontario Nature, Toronto, xxii + 706 pp.

Garrison, B.A. 1999. Bank Swallow (*Riparia riparia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. URL: http://bna.birds.cornell.edu/bna/species/414

GHD. 2020a. Joshua's Creek Flood Mitigation Opportunities Study. Hydrotechnical Modelling Report.

GHD. 2020b. 2D Hydraulic Modelling of Joshua's Creek.

Lacki, M.J., Hayes, J.P. and A. Kurta. 2007. Bats in Forests: Conservation and Management. Johns Hopkins University Press. 329 pp.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and Its Application. Ontario Ministry of Natural Resources. Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 2008. Southern Ontario Ecological Land Classification Vegetation Type List (Draft).

Linton, J. 2015. Recovery Strategy for the Mottled Duskywing (*Erynnis martialis*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario. v + 38 pp.

Martin, S.G. and T.A. Gavin. 1995. Bobolink (*Dolichonyx oryzivorus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. URL: http://bna.birds.cornell.edu/bna/species/176

Mills, A. 2007. Whip-poor-will, pp. 312-313 in Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier, eds. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

Ministry of Environment, Conservation and Parks (MECP). 2020. Species at risk in Ontario. URL: https://www.ontario.ca/page/species-risk-ontario

Ministry of Natural Resources and Forestry (MNRF). 2010. Aquatic Resource Area Data. URL: https://geohub.lio.gov.on.ca/datasets/aquatic-resource-area-survey-point

Ministry of Natural Resources and Forestry (MNRF). 2002. Technical River & Stream Systems: Flooding Hazard Limit.

Ministry of Natural Resources and Forestry (MNRF). 2017. Survey Protocol for Species at Risk Bats within Treed Habitats: Little Brown Myotis, Northern Myotis & Tri-Colored Bat. Guelph District MNRF. April 2017.

Ministry of Transport Ontario (MTO). 2008. Highway Drainage Design Standards.

Natural Heritage Information Centre (NHIC). 2020. Provincial status of plants, wildlife and vegetation communities database. URL: http://www.mnr.gov.on.ca/MNR/nhic/nhic.html. OMNR, Peterborough.

Ontario Nature. 2020. Ontario's Reptile and Amphibian Atlas. URL: http://www.ontarionature.org/protect/species/herpetofaunal_atlas.php.

Ontario. 2017. Greenbelt Plan (2017). Prepared and approved under the *Greenbelt Act, 2005*. May 2017. URL: https://files.ontario.ca/greenbelt-plan-2017-en.pdf

Ontario. *Conservation Authorities Act,* R.S.O. 1990, c. C.27. URL: https://www.ontario.ca/laws/statute/90c27

Ontario. *Endangered Species Act*, SO 2007, c. 6. URL: https://www.ontario.ca/laws/statute/07e06

Poissant, J.A., Broders, H.G. and G.M. Quinn. 2010. Use of lichen as a roosting substrate by *Perimyotis subflavus*, the tricolored bat, in Nova Scotia. Ecoscience. 17(4): 372-378

Regional Municipality of Halton. 2015. Halton Region Official Plan [2009]: Interim Office Consolidation of the Regional Official Plan. September 28, 2015. URL: https://www.halton.ca/Repository/Interim-Office-Consolidation-of-the-Regional-Offic

Regional Municipality of Halton. 2018. Map 1G: Key Features within the Greenbelt and Regional Natural Heritage Systems. June 19, 2018. URL: https://www.halton.ca/Repository/ROP-%E2%80%93-June-19,-2018-Office-Consolidation-%E2%80%93-Maps-(A

Roseberry, J. L. and W. D. Klimstra. 1970. The nesting ecology and reproductive performance of the Eastern Meadowlark. Wilson Bull. 82:243-267.

Sandilands, A. 2007. Common Nighthawk, pp. 308-309 in Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier, eds. Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources and Ontario Nature, Toronto, xxii + 706 pp.

Toronto Entomologists' Association. 2020. Ontario Butterfly Atlas Online. URL: https://www.ontarioinsects.org/atlas/.

Town of Oakville. 2009. Livable Oakville: Town of Oakville Official Plan 2009. Office Consolidation. Last updated: August 28, 2018. URL:

https://www.oakville.ca/assets/2011%20planning/2018-08-28_Livable_Oakville_Office_Consolidation_full.pdf

Varga, S., editor. 2005. Distribution and status of the vascular plants of the Greater Toronto Area. Ontario Ministry of Natural Resources, Aurora District. 96 pp.

Voss, E.G. and A.A. Reznicek. 2012. Field Manual of Michigan Flora. The University of Michigan Press, Ann Arbor, Michigan. 990 pp.

All of Which is Respectfully Submitted,

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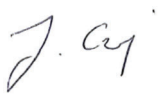

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GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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