TRANSPORTATION ENVIRONMENTAL STUDY REPORT (GWP 4060-11-00)

Planning, Preliminary Design and Class Environmental Assessment – Highway 401 Planning Study from Cobourg to Colborne

G.W.P. 4060-11-00

Prepared for:
Eastern Region
Ministry of Transportation

Prepared by:
Stantec Consulting Ltd.

Final

July 29, 2025

HIGHWAY 401 PLANNING STUDY FROM COBOURG TO COLBORNE
GWP 4060-11-00

FINAL
JULY 2025

Ministry of Transportation Ontario
Design and Engineering Branch
Engineering Program Delivery East

Transportation Environmental Study Report

TRANSPORTATION ENVIRONMENTAL STUDY REPORT

Highway 401 Planning Study from Cobourg to Colborne

July 2025

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THE PUBLIC RECORD
ONTARIO MINISTRY OF TRANSPORTATION
HIGHWAY 401 PLANNING STUDY FROM COBOURG TO COLBORNE (GWP 4060-11-00) TRANSPORTATION ENVIRONMENTAL STUDY REPORT

This Transportation Environmental Study Report (TESR) is available for public comment from Tuesday, July 29, 2025, to Tuesday, September 9, 2025, on the study website (highway401cobourgcolborne.ca).

This project is being carried out in accordance with the requirements of the 2000 *Class Environmental Assessment (EA) for Provincial Transportation Facilities*, a process that has been accepted and approved under Ontario's *Environmental Assessment Act*. This project is classified as a Group 'B' project, which includes major improvements to existing transportation facilities including highway improvements over land or water that provide a significant increase in traffic capacity or cause a significant widening of the "footprint" beyond the roadbed of an existing highway. The Class EA process is for projects of a defined scope and magnitude, where the impacts can be effectively determined and mitigated. This TESR fulfills the documentation requirements of the Class EA. In accordance with the requirements of the Class EA, this report is being submitted for a 30-day public comment period from Tuesday, July 29, 2025, to Tuesday, September 9, 2025.

Interested persons are encouraged to review this TESR and provide written comments to the study team by September 9, 2025. All comments and concerns should be sent directly to the study email address (comments@highway401cobourgcolborne.ca) or one of the following study team members:

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In addition, a request may be made to the Ministry of the Environment, Conservation and Parks (MECP) for an order requiring a higher level of study (i.e., requiring an individual/ comprehensive environmental assessment approval before being able to proceed), or that conditions be imposed (e.g., requiring 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.

Requests should include the requester's contact information, full name, and specify what kind of order is being requested (request for conditions or a request for an individual/comprehensive environmental assessment), how an order may prevent, mitigate or remedy potential adverse impacts on Aboriginal and treaty rights, and any information in support of the statements in the request. This will ensure that the MECP is able to efficiently begin reviewing the request.

The request should be sent in writing or by email to the below MECP contacts, as well as copied to MTO:

Minister of the Environment, Conservation and Parks
Ministry of Environment, Conservation and Parks
777 Bay Street, 5th Floor
Toronto, ON M7A 2J3
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135 St. Clair Ave. W, 1st Floor
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If no concerns or issues are outstanding by the end of the 30-day public comment period, the project is considered to have met the requirements of the Class EA, and MTO may proceed to design stage, subject to the commitments documented in the TESR, and obtain any outstanding environmental approvals.

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TRANSPORTATION ENVIRONMENTAL STUDY REPORT (GWP 4060-11-00)

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Executive Summary

General Description of Project

The Ontario Ministry of Transportation (MTO) retained Stantec Consulting Ltd. (Stantec) to undertake a Planning, Preliminary Design and Class Environmental Assessment (Class EA) Study on Highway 401 for the replacement and rehabilitation of structures, interchange modifications, establishing the footprint of future six and eight lanes on the highway to address current and future transportation needs, and commuter parking lot expansions, from 2 km east of Nagle Road to 800 m east of Percy Street (approximately 18 km).

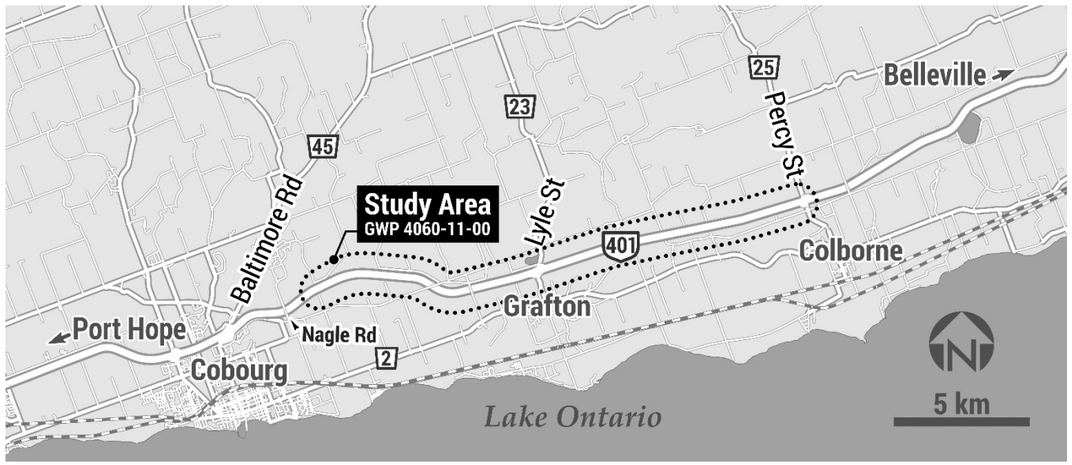

Figure 1: Study Area Location Plan

This Transportation Environmental Study Report (TESR) documents the decision-making process undertaken to identify the Recommended Plan, including a description of the project and its purpose; the existing natural, social, economic, and cultural environment; an assessment and evaluation of alternatives that were considered; the consultation activities carried out; the Recommended Plan; the anticipated environmental effects associated with this undertaking, and the proposed mitigation measures and commitments to future work.

ENVIRONMENTAL ASSESSMENT PROCESS

This study was completed as a “Group B” project under the Class Environmental Assessment (Class EA) for Provincial Transportation Facilities (2000), which includes major improvements to existing transportation facilities including highway improvements over land or water that provide a significant increase in traffic capacity or cause a significant widening of the “footprint” beyond the roadbed of an existing highway. The Class EA process is for projects of a defined scope and magnitude, where the impacts can be effectively determined and mitigated. A Transportation Environmental Study Report (TESR) fulfills the documentation requirements of the Class EA.

CONSULTATION

The consultation process provided an opportunity to present and discuss the study process with the public, property owners, external agencies, and stakeholders.

The process aims to notify all interested parties of the project and to provide an opportunity for input to the study and decision-making processes. This was accomplished by presenting the findings of each stage of work to the public, and through ongoing discussions with various government agencies and ministries, non-government interest groups and property owners.

Stakeholders, Rights Holders and the public were formally contacted four times throughout the study process. To make sure that all interested members of the public and stakeholders were contacted, a Consultation Plan was developed at the start of the project and included the following consultation components:

- Notice of Study Commencement – May 3, 2018
- Communication with external agencies in order to obtain pertinent technical information and identify the requirement for legislative or regulatory approvals related to the undertaking
- Indigenous Communities consultation program, including individual meetings with Indigenous Communities
- Meetings with Municipal Advisory Committee (MAC) that included municipal staff and Council (Township of Hamilton, Town of Cobourg, Township of Alnwick/Haldimand, Township of Cramahe, and Northumberland County), school transportation services, emergency service providers, and conservation authorities
- Meetings with the Ministry of Natural Resources and Forestry, and Ministry of Environment, Conservation and Parks
- Communication with adjacent property and business owners where work proposed is likely to have an impact on the property, including personalized letters and property impact plans, telephone conversations, and organization virtual meetings with members of the project team
- Two Public Information Centres (PICs) (September 18, 2019, and August 27, 2020)
- Notice of Study Completion/TESR public comment period (July 29, 2025, to September 9, 2025)

In addition, a project website (highway401cobourgcolborne.ca) was developed and has been maintained for this project. The website functions as an interactive tool to provide study updates, and an opportunity for stakeholders to submit comments at any time during the study.

Public input was received at and following two PICs, and continuously during the study through correspondence and emails. Public consultation was undertaken in accordance with the *Class EA for Provincial Transportation Facilities* (2000) for "Group B" projects.

Additional information on the consultation for this project is provided in Section 8.0.

EVALUATION OF ALTERNATIVES

The purpose of this project was to identify a Recommended Plan that addresses current and future transportation needs of Highway 401.

The Class EA process requires that "reasonable alternatives" are considered to address the identified problems. Four "Alternatives to the Undertaking" were developed which include the Screened-out alternatives "Do Nothing", "Transportation Demand Management", and "Improve Adjacent Road Systems", and the Carried Forward alternatives "Improve Provincial Transportation Facility".

Two alternatives were developed to expand the highway, both were evaluated. Four interchange alternatives were developed for both the Lyle Street and Percy Street Interchanges. This long list was screened down to a short list of three alternatives which were further evaluated to select the Preferred Plan. Two to three alternatives were developed for the replacement of the Danforth Road underpass, Gully Road underpass, Shelter Valley Road/Creek overpass, Vernonville Road overpass and Boyce Road overpass. Four alternatives were developed for structural culvert improvements and each location was evaluated individually.

Following a complete evaluation of alternatives, a Recommended Plan was selected.

Additional details on the evaluation of alternatives is provided in Section 5.0.

RECOMMENDED PLAN

The Recommended Plan is to expand Highway 401 to the outside with 3:1 grading max for cut and fill slopes are to mitigate against the native highly erodible soils.

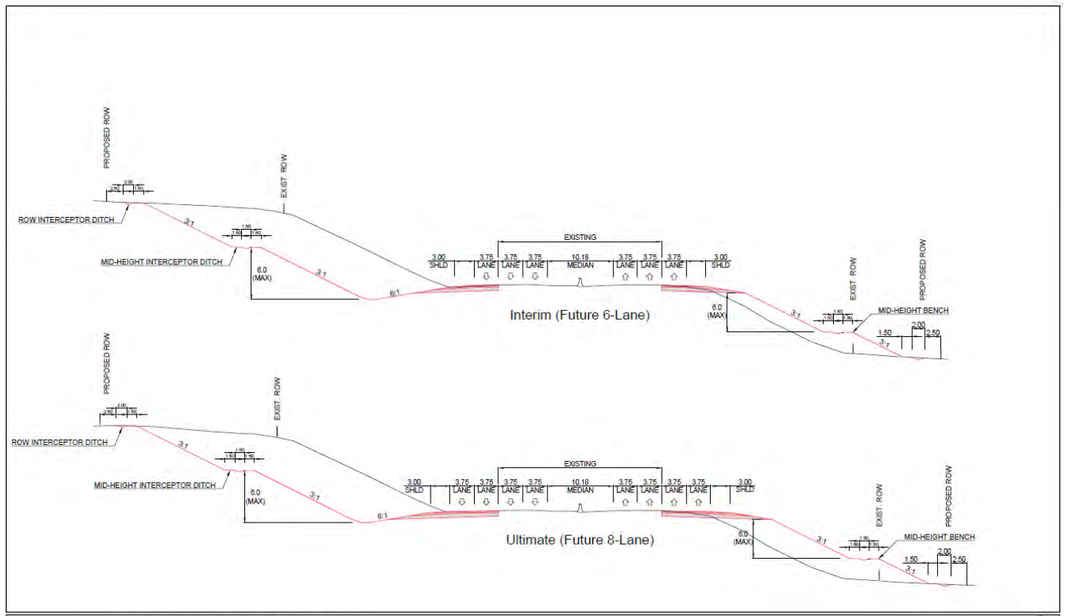

Figure 2: Typical Sections

The Lyle Street interchange will be reconfigured to a Parclo A2 configuration with the option to expand to a Parclo A4 in the future. The Lyle Street bridge will be relocated to the east to maintain traffic during construction. A new cul-de-sac will be constructed to maintain access to private properties in the southwest quadrant. Access to the existing MTO Patrol Yard and new carpool lot will be provided at the south ramp terminal.

The Percy Street interchange will be reconfigured to a Parclo A3 configuration with the option to expand to a Parclo A4 in the future. The new Percy Street bridge will be relocated to the east to maintain traffic during construction. Bicycle lanes will extend from Purdy Road/Orchard Road to the north ramp terminal. The carpool lot will be relocated to the northeast quadrant of the interchange.

The Recommended Plan also includes the rehabilitation and/or replacement of the Danforth Road Underpass, Gully Road Underpass, Shelter Valley Road Overpass, Vernonville Road Overpass, and Boyce Road Overpass, as well as drainage culverts.

Additional details on the Recommended Plan are provided in Section 6.0.

PROPERTY

The Recommended Plan will result in the full acquisition of two properties. Table 1-1 summarizes the total property impacts associated with the Recommended Plan.

Table 1-1: Summary of Property Impacts

	Interim (6-Lane)		Ultimate (8-lane)	
Property Type	**Number**	**Area (ha)**	**Number**	**Area (ha)**
Business	15	22.2	12	3.0
Private	79	31.0	71	10.6
Public	56	6.7	52	2.0
Total	150	59.9	135	15.6

1.0 Overview of the Undertaking

1.1 Introduction

Highway 401 is a 400-Series Controlled Access Highway that connects southwestern Ontario (Windsor) to Quebec, a total of 830 km. Within the study area, Highway 401 and the structures along it were built in the 1950s and 1960s. Locally, Highway 401 connects the communities of Cobourg, Grafton, Colborne and Brighton.

The Ontario Ministry of Transportation (MTO) retained Stantec Consulting Ltd. (Stantec) to undertake a Planning, Preliminary Design and Class Environmental Assessment (Class EA) Study on Highway 401 for the replacement and rehabilitation of structures, interchange modifications, establishing the footprint of future six and eight lanes on the highway to address current and future transportation needs, and commuter parking lot expansions, from 2 km east of Nagle Road to 800 m east of Percy Street (approximately 18 km).

1.2 General Description of the Project

The purpose of the study was to identify a Recommended Plan for improvements as part of the Ministry's ongoing review of safety and operational needs for the provincial highway network. The improvements include bridge replacements, culvert and drainage improvements, interchange improvements, highway improvements, and new carpool parking facilities.

This study was carried out as a 'Group B' project under the MTO Class Environmental Assessment (EA) for Provincial Transportation Facilities (2000). As part of this Class EA, the study team has undertaken a review of existing conditions, environmental and engineering field investigations, and developed and evaluated a range of reasonable alternatives to determine the most appropriate improvement plan, and has sought input from the public, local municipalities, external ministries/agencies, Indigenous Communities, and businesses. A Recommended Plan was selected and will be designated (protected) at the completion of the study.

The Ministry of Transportation will continue to monitor the facility and may implement certain components of the plan when needed to meet provincial transportation needs.

1.3 Study Area

The study limits include Highway 401 from 2 km east of Nagle Road to 800 m east of Percy Street (approximately 18 km). The study area traverses the following municipalities within Northumberland County: Township of Hamilton, Town of Cobourg, Township of Alnwick/Haldimand, and the Township of Cramahe. The study area is shown in Figure 3.

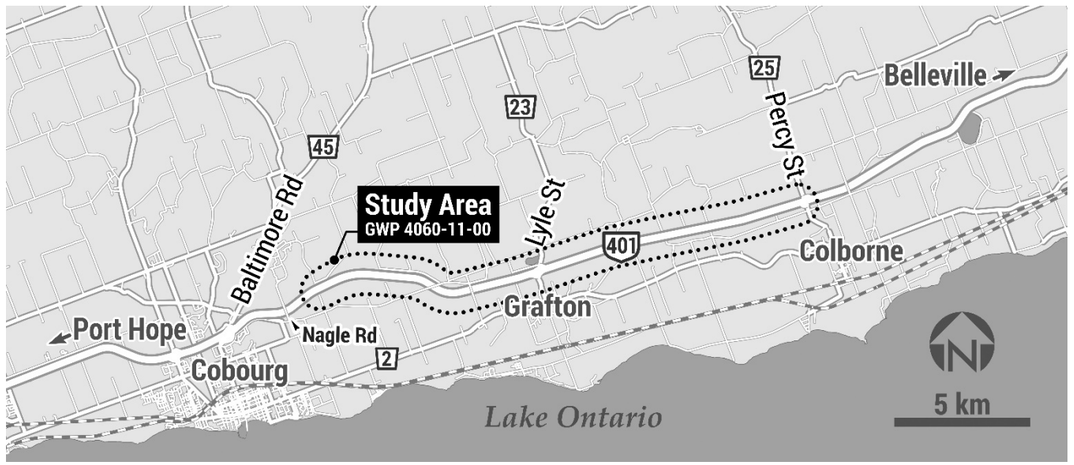

Figure 3: Study Area

1.4 Related and Adjacent Projects

A Preliminary Design and Class EA Study for the proposed expansion of Highway 401 from Highway 28 to 2 km east of County Road 45, including the reconfiguration of the County Road 45 interchange was completed in 2002 (GWP 205-00-00). The detail design for the proposed expansion of Highway 401, from Burnham Street to 2 km east of Nagle Road (GWP# 205-00-00), including the reconfiguration of County Road 45 interchange was completed in 2014. The study recommended expanding the Highway 401 footprint to 6 lanes, within the existing Highway 401 right-of-way (ROW), to address an increase in traffic volumes brought about by recent and anticipated development in the vicinity of the Highway 401 corridor. The study also included bridge and culvert rehabilitations, extensions and replacements. The detail design was completed in 2014.

A detail design and Class EA Study was completed for the rehabilitation of the Shelter Valley Creek Culvert at Highway 401 in November 2015. The study recommended that the culvert be repaired and refaced and that the retaining walls on the north side be removed and rebuilt and that new concrete headwalls be built along the rim of the barrel on both north and south sides.

In addition to the above, a Preliminary Design and Class EA Study for Highway 401 improvements from west of Wallbridge Loyalist Road to 5 km east of Highway 62 is currently underway. The study has recommended Highway 401 improvements including replacement of all Highway 401 structures, interchange improvements at Wallbridge-Loyalist Road,

Highway 62, and Highway 37, and provision for future 6-laning (interim) and 8-laning (ultimate) of Highway 401.

1.5 Purpose of the Transportation Environmental Study Report

This Transportation Environmental Study Report (TESR) documents the decision-making process, and includes a description of the project purpose; the existing technical, natural, social, economic, and cultural environmental factors; identification and evaluation of alternatives that were considered; consultation activities, including a record of the comments received and how they were considered; the Recommended Plan; anticipated environmental effects and proposed mitigation measures; and commitments to future work and monitoring.

The TESR fulfills the documentation requirements of the Class EA process for a Group 'B' project and is filed for a 30-day public comment period.

If you have any questions and/or concerns regarding this study, please contact either one of the following individuals:

Mr. Gregg Cooke, P.Eng.
Consultant Project Manager
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200-835 Paramount Drive
Stoney Creek ON L8J 0B4
Tel: (905) 381-3227
comments@highway401cobourgcolborne.ca

Mr. Muhammad Waseem, P.Eng.
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Ministry of Transportation Eastern Region
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Tel: (613) 449-2615
Toll-Free: 1-800-267-0295 Ext. 4701
comments@highway401cobourgcolborne.ca

Interested persons are encouraged to review the TESR and provide comments to the study team by **September 9, 2025.** All comments and concerns should be sent directly to the contacts listed above.

In addition, a request may be made to the Minister of the Environment, Conservation and Parks for an order requiring a higher level of study (i.e., requiring an individual/comprehensive environmental assessment approval before being able to proceed), or that conditions be imposed (e.g., requiring 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.

Requests should include the requester's contact information, full name, and specify what kind of order is being requested (request for conditions or a request for an individual/comprehensive environmental assessment), how an order may prevent, mitigate, or remedy potential adverse impacts on Aboriginal and treaty rights, and any information in support of the statements in the request. This will ensure that the Minister of Environment, Conservation and Parks is able to efficiently begin reviewing the request.

The request should be sent in writing or by email to the following Ministry of Environment, Conservation and Parks (MECP) contacts, as well as copied to MTO:

Minister of the Environment, Conservation and Parks
Ministry of Environment, Conservation and Parks
777 Bay Street, 5th Floor
Toronto, ON M7A 2J3
Minister.mecp@ontario.ca

Director, Environment Assessment Branch
Ministry of Environment, Conservation and Parks
135 St. Clair Ave. W, 1st Floor
Toronto, ON M4V 1P5
EABDirector@ontario.ca

If a concern/objection is raised during the 30-day public comment period, the Minister of Environment, Conservation and Parks will make a decision in regard to the objection. If no concerns or issues are outstanding by the end of the 30-day public comment period, the Minister of the Environment, Conservation and Parks has an additional 30 days from the end of the public comment period set out in the Notice of Completion to review the project and make a Section 16 Order on their own initiative. If no concerns, the project is considered to have met the requirements of the Class EA, and MTO may proceed to detail design, subject to the commitments documented in the TESR, and obtain any outstanding environmental approvals.

The potential exists for final design plans completed during the next stage of design to identify design modifications or refinements that may result in environmental benefits or impacts that were not anticipated or identified in this TESR. Any changes that result in design modifications will be discussed with affected external agencies, interested stakeholders and property owners during the next project phase and documented in a Design and Construction Report (DCR) that will be made available for public comment. If significant changes are made to the project following the completion of the TESR and eligibility for Environmental Clearance, a TESR Addendum may be required to document the project changes.

1.6 Environmental Clearance

If there are no significant concerns following the public comment period, or once the Minister of the Environment, Conservation and Parks has reviewed and considered any Order Requests, the project will be eligible for Environmental Clearance and continue to move forward, provided there are no outstanding concerns. This will permit MTO to:

- Negotiate temporary and permanent property acquisition, consistent with the project needs (including ROW designation)
- Relocate utilities
- Initiate subsequent study stages (i.e., detail design and contract preparation) for the Recommended Plan

2.0 Class Environmental Assessment Process

2.1 Classification of Project

This Preliminary Design and Class EA Study was carried out under the requirements of the 2000 MTO Class EA document. Based on the nature and extent of the project, the MTO Class EA document specifies different groups under which projects may be planned, and the assessment process required for each. Provided that this process is followed, and its requirements are met for a project, the requirements of the Ontario *Environmental Assessment Act* are considered to be met. This project is being carried out following the requirements of the Class EA for a Group 'B' project. Group 'B' projects include major improvements to existing transportation facilities including highway improvements over land or water that provide a significant increase in traffic capacity or cause a significant increase of the footprint beyond the roadbed of an existing highway.

For additional information on the MTO Class EA process, the public may contact the MTO (contact information provided in Section 1.5). In addition, the following documents are available to assist with understanding the process:

- Class Environmental Assessment for Provincial Transportation Facilities, MTO, July 2000
- Environmental Reference for Highway Design, MTO, 2006, updated in June 2013
- Code of Practice for Preparing, Reviewing, and using Class Environmental Assessments in Ontario, MOE, January 2014

These publications are available from the MTO Research Library Online Catalogue (library.mto.gov.on.ca/) and from Publications Ontario (publications.gov.on.ca).

The study process for a Group 'B' undertaking, as applicable to this project, is illustrated in Figure 4.

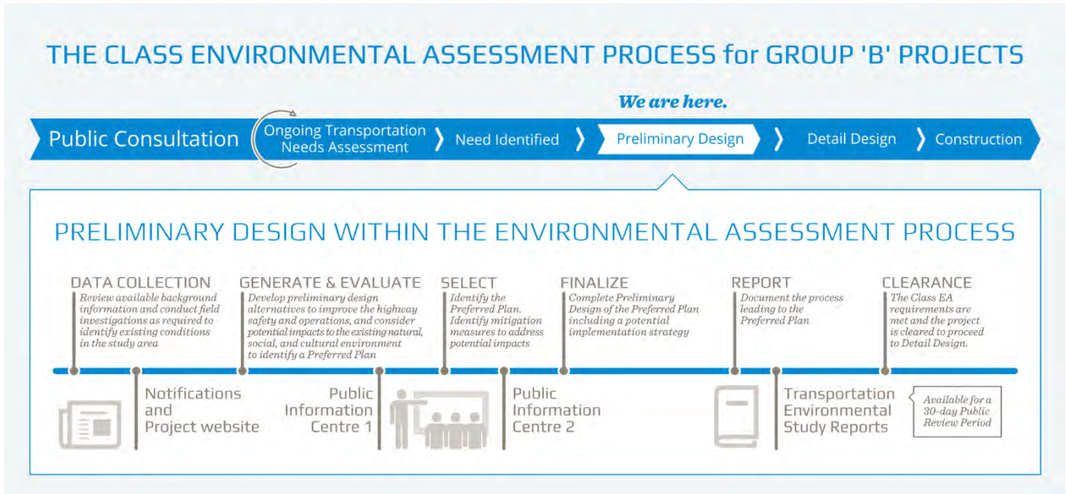

Figure 4: Class Environmental Assessment Process

2.2 Environmental Assessment Approval Regulations

A Preliminary Design and Class EA Study of this type must be carried out in accordance with applicable environmental legislation and the current government policies and procedures. The policies and legislation that apply to this study are described below.

2.2.1 Ontario Environmental Assessment Act

The Ontario *Environmental Assessment Act* (EAA) governs the conduct of planning studies in the province of Ontario. The purpose of the EAA is to make sure that:

- A reasonable and traceable planning process is followed
- The need for the project is demonstrated
- The public has input into the process and investigations
- The study includes a review of a full range of alternatives
- The selected alternative minimizes any environmental impacts or provides mitigation strategies to minimize impacts resulting from the improvements

2.2.2 Canadian Impact Assessment Act

The *Canadian Impact Assessment Act*, 2019 (IAA 2019) and its regulations establish the legislative basis for the federal environmental assessment process. Under IAA 2019, an EA is only required for projects included in the list of "designated projects". These types of projects are likely to have significant adverse environmental effects and therefore may be subject to a federal EA.

A proponent is not required to complete the federal EA process if a project is not on this list. This project does not fall under the list of designated projects.

2.2.3 Permits and Approvals

Undertaking a Class EA also requires consideration of other approvals and review agencies, as outlined below.

Federal Review Agencies

- Department of Fisheries and Oceans (DFO) – MTO Fisheries Protocol, Fisheries Act (FA), Species at Risk Act (SARA) for aquatic species
- Environment and Climate Change Canada (ECCC) – Species at Risk Act (SARA), Migratory Birds Convention Act (MBCA)

Provincial Review/Policy Requirements

- Provincial Policy Statement (PPS 2020)
- Ministry of the Environment, Conservation and Parks (MECP) – EAA, Environmental Protection Act, Ontario Water Resources Act, Permits to Take Water, Endangered Species Act, 2009 (ESA)
- Ontario Access and Privacy Office – Freedom of Information and Protection of Privacy Act and Accessibility for Ontarians with Disabilities Act
- MTO Fisheries Protocol, Ontario Wetlands Policy
- Ministry of Citizenship and Multiculturalism (MCM)

Municipal Policy

While MTO is not required to obtain approvals or exemptions for municipal Official Plans, bylaw exemptions and/or or policies, municipal policies and plans are considered as part of the Class EA study process.

2.2.4 Indigenous Rights

Ontario, as the Crown, has a legal obligation to consult with Indigenous peoples where it contemplates decisions or actions that may adversely impact asserted or established Aboriginal or treaty rights. Ontario is committed to meeting its duty to consult with First Nations and Métis communities.

3.0 Transportation Needs Assessment

The Transportation Needs Assessment process is part of the ongoing management and administration of the transportation systems by the Province. Assessment of needs can result in a number of recommendations, including initiating a study, initiating major or minor improvements, initiating routine maintenance, monitoring a situation, or doing nothing. Given the range of potential outcomes, the transportation needs assessment process includes the following:

- Identifying transportation problems and opportunities
- Evaluating and selecting reasonable alternatives, including 'do nothing'
- Developing potential transportation study objectives
- Initiating the study process

This section of the report provides an overview of the transportation problem and opportunity and assessment of Alternatives to the Undertaking that led to the initiation of this study.

3.1 Provincial Responsibilities

The MTO has a mandate to provide transportation services for the people of Ontario. This mandate is to:

- Preserve the safety and efficiency of Ontario's provincial highway network and the Ontario government's investment in highway infrastructure
- Provide a safe and efficient transportation system that is critical to Ontario's quality of life, a strong economy, and a clean and healthy environment

The Ministry's actions are guided by the transportation policies found under both the Transportation Systems and Transportation and Infrastructure Corridors sections of the Ontario Provincial Policy Statement (PPS) 2020. These policies include, but are not limited to:

- Providing transportation systems that are safe, energy efficient, facilitate the movement of people and goods, and are appropriate to address projected needs
- Making efficient use of existing and planned infrastructure
- Maintain connectivity within and among transportation systems
- Minimize the length and number of vehicle trips and support current and future use of transit and active transportation
- Planning for and protecting corridors and rights-of-way for transportation, transit, and infrastructure facilities to meet current and projected needs
- Protect major goods movement facilities and corridors

The Transportation Needs Assessment for this study was carried out within the context of the MTO responsibilities and requirements of the PPS, and to meet the requirements of the Class EA process.

3.2 Existing Conditions

Highway 401 is a 400-Series Controlled Access Highway that connects southwestern Ontario (Windsor) to Quebec, a total of 830 km. Within the study area, Highway 401 and the structures along it was built in the 1950s and 1960s. Locally, Highway 401 connects the communities of Cobourg, Grafton, Colborne and Brighton.

Highway 401 within the project limits is classified as an east-west, four-lane, divided freeway.

The posted speed limit on Highway 401 is 100 km/h and the design speed is 120 km/h.

3.3 Transportation Problem and Opportunity

The purpose of this study was to identify a recommended plan that addresses current and future transportation needs in the study area as part of the Ministry's ongoing review of safety and operational needs for the provincial highway network. The study was initiated to address the following problems and opportunities:

Problems

- Many of the bridges and structural culverts in the study area are nearing the end of their service life and will require rehabilitation and/or replacement in the near future
- The existing Highway 401 platform cannot accommodate the traffic staging required to rehabilitate or replace the bridges and structural culverts

Opportunities

- The study will assess the existing bridges and structural culverts and develop appropriate rehabilitation or replacement strategies to maintain the safe operation of the Highway 401 corridor for the current and future planning horizons
- For structural planning purposes, establish the future Highway 401 footprint for six and eight lanes, to ensure an appropriate design of the replacement bridges

3.4 Alternatives to the Undertaking

The Class EA process requires that ‘reasonable alternatives’ be considered in addressing the identified problems and/or opportunities. This involves two levels of analysis. The Alternatives to the Undertaking considers a broad range of alternatives that could address the project needs. Once the best alternative is selected, the Alternative Methods of Carrying out the Undertaking are studied in greater detail.

The Alternatives to the Undertaking identified for this study are outlined below.

3.4.1 Do Nothing

Maintains the status quo of transportation infrastructure and services. No changes to Highway 401, its bridges, structural culverts and/ interchanges within the study area.

3.4.2 Transportation Demand Management (TDM)

TDM shifts demands on the highway network by shifting demands to the time periods outside of the critical congestion periods and shift demands to alternative modes of transportation.

3.4.3 Improve Adjacent Road Systems

Expansion of existing municipal and regional road networks.

3.4.4 Improved Provincial Transportation Facilities

Replace existing bridges and structural culverts to accommodate the Highway 401 future footprints of interim six and ultimate eight lanes.

3.4.5 Preliminary Assessment of Alternatives to the Undertaking

A preliminary assessment of the alternatives to the undertaking was completed to identify the alternatives that best address the transportation problem and opportunity, as described in Section 3.3.

The alternatives are screened to select only the most reasonable alternatives to be carried forward for more detailed study. This process allows for the elimination of alternatives which do not meet the transportation problem and opportunity in advance of the detailed evaluation stage.

The preliminary assessment of the alternatives to the undertaking uses the following screening criteria:

- Does the option realistically address all the problems and opportunities?
- Does the option make a significant contribution towards realistically addressing all of the problems and opportunities?

Only those alternatives that satisfy at least one of the above criteria were carried forward for further study.

Preferred Transportation Undertaking

The findings of the screening assessment indicated that improving transportation facility alternatives is preferred. The results of the screening assessment of Alternatives to the Undertaking are summarized in Table 3-1.

Table 3-1: Screening Assessment of Alternatives to the Undertaking

Alternatives to the Undertaking	Does it address the Transportation Problems?	Carried Forward?
Do Nothing Maintains the status quo of transportation infrastructure and services. No changes to Highway 401, its bridges, structural culverts and/ interchanges within the study area.	• Bridges and structural culverts require rehabilitation and/or replacement • Cannot accommodate traffic staging required to rehabilitate or replace bridges and structural culverts • Does not establish future Highway 401 footprints for six and eight lanes	No The “Do Nothing” alternative does not address the identified transportation problems.
Transportation Demand Management (TDM) Shift demands on the highway network by shifting demands to the time periods outside of the critical congestion periods and shift demands to alternative modes of transportation.	• Bridges and structural culverts require rehabilitation and/or replacement • Can reduce traffic volume and ease traffic staging required to rehabilitate or replace bridges and structural culverts • Does not establish future Highway 401 footprints for six and eight lanes	No TDM alternative does not address the identified transportation problems as a standalone alternative.
Improve Adjacent Road Systems Expansion of existing municipal and regional road networks.	• Bridges and structural culverts require rehabilitation and/or replacement • Provides alternative route to accommodate traffic staging required to rehabilitate or replace bridges and structural culverts • Increases traffic volume on adjacent road systems • Provides less direct route for travellers • Does not establish future Highway 401 footprints for six and eight lanes	No Improving Adjacent Road Systems does not address the identified transportation problems as a standalone alternative.

Alternatives to the Undertaking	Does it address the Transportation Problems?	Carried Forward?
Improved Provincial Transportation Facility Expansion, operational and safety improvements including establishing the footprint of future six and eight lanes on the highway to address current and future transportation needs of Highway 401, interchange improvements, and structure replacements to optimize the movement of people and goods.	• Rehabilitates/Replaces bridges and structural culverts • Expansion will accommodate traffic staging required • Establishes future Highway 401 footprints for six and eight lanes	Yes Improving the Provincial Transportation Facility addresses the identified transportation problems.

4.0 Existing Conditions

Background studies and site-specific field investigations were carried out for archaeology, cultural heritage, contamination, air quality, erosion and sediment control, noise, fish and fish habitat, terrestrial resources, groundwater, landscape and land use. All work was carried out in accordance with the requirements of the Environmental Reference for Highway Design (2006), which provides standards for scope of work, evaluation of potential impacts and proposed mitigation measures for MTO undertakings.

The background reviews were initiated in the spring of 2017 to identify existing conditions within the study area. Significant environmental features identified as a result of the background studies were documented as constraints that were considered during the development and evaluation of alternatives.

4.1 Natural Environment

An inventory of natural environment features within the study area was undertaken based on a review of previous and relevant studies, field investigations and information received from external agencies and the public during the course of this study. The findings of this inventory are documented within a Terrestrial Ecosystems Existing Conditions Report and Fish and Fish Habitat Existing Conditions Report, copies of which are provided within Appendix A and Appendix B, respectively. A summary of the findings of this inventory is also documented within Sections 4.1.5 and 4.1.6.

4.1.1 Physiography, Geology and Soils

The study area falls within the Iroquois Plain and South Slope physiographic region. The topography of the study area is generally flat or rolling along the length of the Highway 401 ROW. The physiographic regions are detailed below.

South Slope

The South Slope physiographic region is a gently sloping strip of land between the low-lying Iroquois Plain and the Oak Ridges Moraine. The surficial soil of the South Slope is composed predominantly of sandy till materials in the east and clay rich materials in the west. The till is calcareous and contains a large portion of fine and silty material. Two regional till deposits have been identified in the South Slope: Halton Till, which is a sheet of silt till deposited by the last major glacial advance in the area, and Newmarket Till (also known as the Northern Till), which is a deposit of sandy silt till, interpreted to extend below the Oak Ridges Moraine, that is stratigraphically older than the Halton Till. The Newmarket Till is believed to be correlative with the till deposits north of the Oak Ridges Moraine.

The northwestern portion of the South Slope region consists of scattered, long and thin, drumlins that point directly toward the slopes of the Oak Rides Moraine. Streams flow directly and rapidly down the South Slope and erode sharp valleys into the tills. Numerous gullies have also been cut by intermittent drainage so that east-west side roads in the surrounding area cross a succession of valleys.

Iroquois Plain

The Iroquois Plain physiographic region is a plain of glaciolacustrine deposits situated south of the former Glacial Lake Iroquois shoreline. It lies between modern-day Lake Ontario and the South Slope region. In the shoreline area of the former Glacial Lake Iroquois, sand and gravel were deposited in beaches, bars, and spits due to wave action. The deposits grade into massive and laminated silts and clays to the south that define the lower lake plain area. In some areas of the southern Trent River watershed, the abandoned Lake Iroquois shoreline is well defined by cliffs and beach material, and in certain areas its position can be inferred from the presence of lacustrine materials and altitude.

Ontario Geological Survey (OGS) (2010) surficial geology mapping indicates that the surficial geology within the study area is predominantly composed of littoral, foreshore and basinal coarse textured glaciolacustrine deposits of sand, gravel with minor silt and clay. Some minor occurrences of stone poor sandy silt to silty sand till and modern alluvial deposits of clay, silt, sand and gravel are found adjacent to Nagle Road, Old Gully Road and Shelter Valley Road and are typically associated with watercourses.

Based on a review of the MECP Water Well Records (WWRs), the depth to top of bedrock ranges from 20 m below ground surface (BGS) to approximately 100 m BGS across the study area. A review of overburden thickness mapping indicated the shallow overburden is predominantly located along the western portion of the study area near Cobourg. Based on the OGS paleozoic geology mapping, overburden in the study area is underlain by limestone of the Lindsay Formation.

4.1.2 Soil Capabilities for Agriculture

The majority of the agricultural land in the study area is divided between an agricultural soil capability of Class 6 (Capable only of producing perennial forage crops) and Class 3 (moderately severe limitations that restrict the range of crops), (Agriculture and Agri-Food Canada 1998). The soil series found throughout the study area include: Bondhead loam and sandy loam, Brighton sandy loam, Colborne sandy loam, Dundonald sandy loam, Granby sandy loam, Guerin loam, Lyons loam, Matson silt loam, Percy fine sandy loam, Pontypool sand, and Trent fine sandy loam (Hoffman and Acton 1974). These soil types display a variety of slope and drainage characteristics, with all but the Granby, Lyons and Trent soils being good to excellent for agricultural use.

4.1.3 Drainage, Surface Water, Groundwater, and Source Water Protection

A desktop Groundwater Overview Assessment was undertaken as part of this study to review existing hydrogeological conditions in the study area through a review of MECP water well records (WWRs), regional geological maps and groundwater studies, and source water protection information for the Ganaraska Source Protection Area and Lower Trent SPA. The findings of this review are documented within the Groundwater Overview Assessment Memorandum provided in **Appendix C** and summarized herein.

Water sources are abundant within the study area and surrounding region. In addition to large primary water sources, such as Lake Ontario, there are numerous other primary and secondary sources of potable water. The study area falls within the Ganaraska Region and Lower Trent Conservation Authorities which protect and manage development activities within their respective watersheds. This includes Shelter Valley Creek, Midtown Creek East, Brook Creek East/West, Barnum House Creek/Grafton Creek and other unnamed watercourses/tributaries.

Drainage and Surface Water

Portions of the study area intersect environmentally sensitive areas that may be dependent on groundwater recharge or discharge to function, such as the Provincially Significant Wetland (PSW) Cranberry (Little) Lake wetland, located just west of Country Road 23 on the north side of Highway 401, and unevaluated wetlands generally located along the north and south portions of the study area. Several surface water features having cold water regime were also noted to intersect portions of the study area. Cold water thermal regimes indicate the potential for groundwater discharge that supports aquatic habitat.

A detailed review of existing drainage system (i.e., culverts, ditching and other drainage infrastructure) was completed for the study area in 2018 and documented within a Preliminary Drainage Report, a copy of which is provided in **Appendix D**. Based on the findings of this review, existing highway drainage generally consists of a median storm sewer conveying drainage within the interchanges and across road embankments for overpasses. The nearby ponds and watercourses provide water quality and/or erosion control prior to discharge to downstream systems. Generally, roadside drainage flows east and west along the roadside ditches towards the crossing culverts.

Groundwater

Based on a review of aerial imagery, and the MECP water well records (WWRs) for the study area, there are approximately 38 WWRs for water supply wells mapped within 100 m of the existing ROW, approximately 11% of which are shallow wells (i.e., less than 12 m deep). In addition, static water levels recorded in these wells reportedly ranged from 0.3 m to 4.0 m below ground surface (bgs).

Source Water Protection

The study area lies within the Trent Conservation Coalition Source Protection Region (TCCSPR). In accordance with Clean Water Act (2006), the TCCSPR completed a source water protection assessment for the Ganaraska and Lower Trent Source Protection Areas (SPAs). As part of the assessment process, vulnerable areas within the source water areas were defined. A summary of source water protection features within the study area is provided herein.

The Town of Cobourg obtains its drinking water supply from a surface water intake in Lake Ontario, and the communities of Grafton and Colborne obtain their drinking water supply from municipal groundwater wells.

Vulnerability is measured on a 10-point scale based on how quickly water can move from the ground surface to the aquifer. A high vulnerability area has a score of 8 to 10. Well Head Protection Area (WHPA)-A is the area immediately adjacent to a well. Activities such as the handling and storage of fuel are deemed significant drinking water threats in these areas. WHPA-B, WHPA-C and WHPA-D are delineated based on the amount of time it takes water to travel horizontally through the aquifer towards the well. These three WHPAs represent two-, five-, and twenty-five-year times of travel, respectively.

The study area intersects WHPA-B and WHPA-C of the Colborne Municipal Well Field, which is situated at the eastern end of the study area and includes vulnerability scoring of 2 to 8, where there are varying sources of drinking water which may easily be impacted by the release of pollutants on the ground surface. WHPA-A is located approximately 200 m downgradient of the study area within Colborne.

Other WHPA's in the vicinity of the study area, listed from west to east include the Creighton Heights Municipal Well Field located approximately 2.7 km north of the study area and the Grafton Municipal Well Field located approximately 100 m north of the study area. The Creighton Heights and Grafton Well Fields are both located upgradient of the study area. In addition, portions of the study area are classified as Highly Vulnerable Aquifer (HVA) and Significant Groundwater Recharge Area (SGRA) with a score of 6, where low to moderate drinking water threats may be present.

4.1.4 Potential Contaminated Property

A Contamination Overview Study (COS) was completed to identify areas and/or activities that have the potential to impact subsurface soil and/or groundwater conditions within the study area based on a review of available historical records, data, mapping, etc.as well as the observations made at the time of a windshield survey undertaken in July 2018.

Based on the findings of the COS, several potential sources of contaminating activities were identified, including records of historical spills, historic and current waste storage, generation and handling, historical and current vehicle maintenance, and fill material. In total,

approximately 9 (nine) properties were identified as having low, moderate, or high potential for environmental concern within and/or in the vicinity of the study area. More detailed information is documented within the COS report, a copy of which is provided in Appendix E.

4.1.5 Designated Areas

Designated Areas have special or unique value and are defined by government authorities and/or the public, and through legislation, policies, or approved management plans. These areas may have a variety of ecological, recreational, or aesthetic features and functions that are highly valued. Designated Areas include but are not limited to: Provincially Significant Areas of Natural and Scientific Interest (ANSI), Provincially Significant Wetlands (PSW), heritage rivers and national and provincial parks.

The Barnum House Creek Conservation Area is a municipally designated Natural Habitat Area located southwest of the Highway 401 at the Lyle Street interchange in the Township of Alnwick/Haldimand. Nineteen (19 hectares of this conservation area was deeded to Lower Trent Conservation from the Ministry of Natural Resources and Forestry in 1978, and includes dense woodland, mixed shrubland, and Barnum House Creek, a coldwater stream.

The Cranberry (Little) Lake PSW, a candidate ANSI, is also located in the northwest quadrant of the Highway 401 and Lyle Street interchange. There are no existing provincial parks located within the study area.

4.1.6 Terrestrial and Aquatic Ecosystems

Terrestrial and aquatic ecosystem conditions were assessed as part of this study based on a review of existing/available information and field investigations undertaken in spring/summer and fall of 2017, including supplemental terrestrial ecosystem conditions field assessment undertaken in spring/summer 2019. Background information was also obtained from the MNRF and published resources. The findings of these investigations are documented within the Terrestrial Ecosystems Existing Conditions Report and Fish and Fish Habitat Existing Conditions Report, copies of which are provided in Appendix A and Appendix B, respectively. All field investigations were conducted according to the MTO *Environmental Reference for Highway Design* (2013) and the MTO *Environmental Guide for Fish and Fish Habitat* (2009), which were applicable at the time of the field investigations.

Fish and Fish Habitat

Lakes, rivers, streams, ponds, and many wetlands provide fish habitat. Intermittent and seasonally flooded areas can also provide important habitat for some fish species at certain times of the year. In-water structures such as logs, stumps and other woody debris, pools and riffle areas, riparian and aquatic vegetation, and groundwater recharge/discharge areas also provide fish habitat. Fish habitat includes watercourses that act as corridors that allow fish to move from one area to another.

The study area includes portions of the East Lake Ontario watershed, Barnum House/Shelter Valley watershed and Lake Iroquois Plain Tributaries watershed. The primary natural watercourses in the study area are Shelter Valley Creek and Grafton Creek. There are numerous additional watercourses and municipal drains.

Among the 14 potential watercourse crossings investigated within the study area, direct fish habitat was documented at 11 sites within the Highway 401 ROW. Indirect habitat was documented within two sites, and one site did not provide fish habitat within the Highway 401 ROW. Most of the watercourse crossings in the study area are natural, coldwater watercourses that generally drain southerly to Lake Ontario and provide Brook Trout habitat. Three additional culverts within the study area have the potential to support fish habitat; however, these were not included in Stantec's 2017 field surveys (i.e., Sites 21X-0468/C0, 21X-0469/C0 and Culvert 000904010086).

Based on species lists provided in background data sources and the findings of Stantec's field surveys, fish communities within the 11 study area sites that directly provide fish habitat have a permanent flow regime. Twelve common fish species were captured during field surveys that were undertaken in 2017. Based on the findings of these field surveys, the most common species were Brook Trout, Rainbow Trout, Creek Chub and Blacknose Dace.

Additional details including photographic records of the surveys, field data sheets, and tabular summaries of existing conditions for fish and fish habitat are provided in the Fish and Fish Habitat Existing Conditions Report, provided in Appendix B.

Aquatic Species at Risk

According to information provided by MNRF in 2017, one aquatic Species at Risk (SAR), American Eel, has been recorded in Shelter Valley Creek. However, there are no records of aquatic SAR mapped by DFO within the study area.

American Eel is Endangered and protected by the ESA, 2007. As part of the provincially legislated recovery process, the MNRF released the *Recovery Strategy for American Eel in Ontario*. The Recovery Strategy states that, in Ontario, American Eel is at the northern extreme of its range. The Ontario population represents a large (and therefore important) portion of the spawning biomass of the global population.

In-stream vegetation and the interstitial spaces formed by rock piles and woody debris provide cover for American Eel during the day. The Recovery Strategy recommends protecting these areas as habitat. No in-stream vegetation was observed within the surveyed reach of Shelter Valley Creek. However, there were numerous large boulders, some overhanging vegetation and a fallen cedar tree that could provide cover for American Eel.

In correspondence with the MNRF, Lake Sturgeon was identified within 5 km of the study area. Lake Sturgeon are present in Lake Ontario, but there are no records for the species, and no

suitable habitat, in the study area. In the Great Lakes, Lake Sturgeon is an Endangered species, protected by the ESA, 2007.

Terrestrial Ecosystems

Within the study area, existing land use is primarily rural agricultural land, and the study area has been heavily influenced by human activity including agricultural activities, residential and commercial land use. The Highway 401 right-of-way (ROW) is primarily grassed and travels through a variety of landscapes including active row crop agricultural, forested wetlands and urban areas.

A Terrestrial Ecosystems Existing Conditions Report was completed to document existing and sensitive vegetation communities and wildlife habitats in the study area. For the purposes of this study, this study area includes the area within 120 m of the existing Highway 401 ROW and within 400 m surrounding the Highway 401 intersections situated between 2 km east of Nagle Road to 800 m east of Percy Street.

Vegetation Communities

The study area is situated within Ecoregion 6E (Lake Simcoe-Rideau Ecoregion), and more specifically the Ecodistrict of 6E-13. Detailed vegetation community mapping and botanical inventories were conducted using the Ecological Land Classification (ELC) system for southern Ontario (Lee et al. 1998). Vegetation communities were delineated on aerial photographs and then verified in the field. Investigations were conducted from within the existing highway ROW and publicly accessible lands.

The study area generally consists of meadow, thicket, forest, plantation, swamp, and marsh vegetation communities. A detailed inventory of the vegetation communities observed within the study area at the time of the 2017 and 2019 field investigations are discussed within the *Terrestrial Ecosystems Existing Conditions Report*, a copy of which is provided in Appendix A.

Common Reed, also known as Invasive Phragmites (*Phragmites australis australis)* was abundant within the marsh communities identified along the ROW.

Species of Conservation Concern

Significant species are considered at a number of levels, including globally, nationally, and provincially. In Ontario, significant species include species that are provincially rare (with a Provincial S rank of S1 to S3) or listed as Endangered, Threatened, or Special Concern on the Species at Risk in Ontario list (SARO) and/or Schedule 1 of the federal *Species at Risk Act* (SARA).

The Ontario *Endangered Species Act, 2007* prohibits harm or harassment to Threatened or Endangered species, and damage or disturbance to their habitat. The ESA applies on all private and Crown owned lands in Ontario. Habitat protection under the ESA typically includes all habitats that directly or indirectly support SAR.

Federally protected Endangered, Threatened and Special Concern species are listed in Schedule 1 of the *Species at Risk Act, 2002* and apply to federally owned lands and to aquatic species. Migratory bird species are protected under the *Migratory Birds Convention Act*, which are afforded protection on all lands.

Provincial ranks (S-ranks) are used by the NHIC to set protection priorities for rare species and vegetation communities. They are based on the number of occurrences in Ontario and are not legal designations. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation needs can be determined. Species with provincial ranks of S1 to S3, and those tracked by the MNRF, are considered species of conservation concern. Provincial S-ranks are defined as follows:

- S1: Critically imperiled-usually fewer than 5 occurrences
- S2: Imperiled- usually fewer than 20 occurrences
- S3: Vulnerable- usually fewer than 100 occurrences
- S4: Apparently secure- uncommon but not rare, usually more than 100 occurrences
- S5: Secure- common, widespread, and abundant
- S-rank followed by a “?” indicates that the rank is uncertain

The probability that a Significant Species may be present within the study area was assessed by comparing preferred habitat types to existing conditions documented within the background review and during the June 2019 field investigations. Significant Species with preferred habitat in the study area were considered likely to be present. Significant Species with no preferred habitat in the study area were assumed to be absent.

Based on a review of the background databases, 13 SAR and 8 SOCC may be present within the study area. The detailed findings of the background review are documented within the *Terrestrial Ecosystems Existing Conditions Report*, a copy of which is provided in Appendix A.

Rare Vegetation

Rare vegetation was identified and documented during the field investigations, including the scientific plan names, species statuses and locations. A total of 218 vascular plants were recorded, 137 of which are native to Ontario, and 81 of which are exotic species not native to Ontario. The species recorded included:

- 124 native species have a provincial rank of S5, indicating they are common with a secure population in Ontario
- 12 native species have a provincial rank of S4, indicating they are uncommon, but not rare in the province and populations are apparently secure

- 1 native species is provincially rare with a rank of S3, indicating it is rare in the study area and considered vulnerable in the province
- 3 highly sensitive native species with a high coefficient of conservatism value or 8 or 9 were observed

No Butternut or other SAR flora were observed in the study area.

Wildlife and Wildlife Habitat

Twenty-two bird (17 migratory), five mammal, two amphibian, one reptile, 16 butterfly and 15 dragonfly species were recorded in the study area. Most species that were observed were common species which were expected in their respective habitat types. Two wildlife SAR and one SOCC were observed during field investigations.

Migratory Bird Nests

Two Eastern Phoebe (*Sayornis phoebe*) nests were found within the study area. No other bird nests were observed on structures in the study area.

Significant Natural Areas

There is one provincially significant natural area located within 1 km of the study area – Cranberry Lake PSW. This PSW is located at the northwest quadrant of the Highway 401 and Lyle Street interchange and is approximately 55 hectares in area.

Significant Wildlife Habitat

Significant Wildlife Habitat (SWH) is defined as habitat that is ecologically important in terms of features, functions, representation, or amount of contribution to the quality and diversity of an identifiable geographic area or Natural Heritage System and is protected under the *PPS* 2020.

SWH includes habitats that fall within any of the following four categories:

- Seasonal concentration areas, such as moose aquatic feeding and wintering areas, deer winter yards, colonial bird nesting sites, reptile hibernacula, and heronries
- Rare vegetation communities and specialized habitats for wildlife, such as old-growth forest, areas known to support an unusually high diversity of species or vegetation communities, raptor nesting habitat, areas with concentrations of cavity trees, and moose or bear foraging areas
- Habitats for species of conservation concern, such as special concern species or species ranked provincially S1-S3, excluding the habitats of endangered and threatened species
- Animal movement corridors

The following candidate SWH features were investigated in the study area:

- Seasonal Concentration Areas: deer yards, snake and bat hibernacula, waterfowl staging and moulting areas, raptor roosts, bird nesting colonies, shorebird staging areas, and passerine migration concentrations Rare Vegetation Communities – Sand barren, alvar, cliffs and talus slopes, prairie and savannah, old growth forest, other rare vegetation communities
- Specialized Habitat for Wildlife: waterfowl nesting areas, Bald Eagle and Osprey nesting/foraging and perching habitat, Woodland raptor nesting habitat, turtle nesting areas, seeps and springs, amphibian breeding habitat (woodland and wetland), woodland area sensitive breeding bird habitat
- Habitat for Species of Conservation Concern: open country bird breeding habitat, shrub/early successional bird breeding habitat, marsh bird breeding habitat, terrestrial crayfish, Special Concern and provincially rare (S1-S3) wildlife
- Wildlife Movement Corridors: amphibian movement corridors, deer movement corridors

Seasonal Concentration Areas

Seasonal concentration areas are those sites where large numbers of a species gather at one time of the year, or where several species congregate. Such areas include, but are not limited to deer yards, snake and bat hibernacula, waterfowl staging and moulting areas, raptor roosts, bird nesting colonies, shorebird staging areas, and passerine migration concentrations. Only the best examples of these concentration areas are usually designated as SWH. Areas that support a SAR, or areas where a large proportion of the population may be lost if the habitat is destroyed, are examples of seasonal concentration areas which should be designated as significant.

The following candidate and confirmed habitat for seasonal concentration areas was identified within the study area during field investigations:

- Waterfowl Stopover and Staging Areas (Candidate): evidence of annual spring flooding from meltwater or runoff. Species can be found in aquatic habitats such as ponds, marshes, lakes, bays, and watercourses during migration, including large marshy wetlands. Cranberry Lake PSW may be suitable habitat.
- Raptor Wintering Areas (Candidate): species may be present in habitat with a combination of fields and woodlands greater than 20 ha, present within the study area.
- Bat Maternity Colonies (Candidate): species can be found in mixed and deciduous forests and swamps with large diameter dead or dying trees with cavities. Suitable woodland habitat is present in the study area.

- Reptile Hibernaculum (Candidate): may be present at rock piles or slopes, stone fences and crumbling foundations. Rock piles and rocky slips observed in the study area.
- Turtle Wintering Area (Candidate): species can generally be found in permanent waterbodies and large wetlands with sufficient dissolved oxygen; man-made ponds are not considered SWH. Suitable habitat was observed.
- Colonially Nesting Bird Breeding Habitat (Bank/Cliff) (Candidate): species can be located near eroding banks, sandy hills, steep slopes, rock faces or piles. Steep slopes may be associated with valleylands beyond the ROW.
- Colonially Nesting Bird Breeding Habitat (Tree/Shrub) (Candidate): Cranberry Lake PSW may provide suitable habitat, with dead trees in large marshes and lakes, flooded timber and shrubs, with nests of colonially nesting heron species.
- Migratory Butterfly Stopover Areas (Candidate): the study area is within 5 km of Lake Ontario and contains combination field and forest greater than 10 ha.
- Landbird Migratory Stopover Areas (Candidate): the study is within 5 km of Lake Ontario and contains woodlands greater than 10 ha.
- Deer Wintering Area (Confirmed): deer wintering area (Stratum 2) confirmed within the study area.

Rare Specialized Habitat

Rare or Specialized habitats are two separate components. Rare habitats are those with vegetation communities that are considered rare in the province. Specialized habitats are microhabitats that are critical to some wildlife species. The SWH Criteria Schedules for Ecoregion 6E identifies a number of habitats that could be considered specialized habitats, such as habitat for area-sensitive species, forests providing a high diversity of habitats, amphibian woodland breeding ponds, turtle nesting habitat, highly diverse sites, seeps and springs. The following candidate habitats for rare or specialized habitat were identified within the study area:

- Waterfowl Nesting Area (Candidate): multiple wetlands observed in the study area, providing upland habitats adjacent to wetlands for species.
- Bald Eagle and Osprey Nesting, Foraging and Perching Habitat (Candidate): species can be found in treed communities adjacent to rivers, lakes, ponds, and other wetlands with stick nests.
- Turtle Nesting Habitat (Candidate): suitable nesting habitat observed along road shoulders, which do not qualify as SWH, but natural nesting sites may be present along watercourses within the study area. Species may be present in habitat with exposed soil, including sand and gravel in open sunny areas near wetlands.
- Amphibian Breeding Habitat (Candidate): multiple wetlands observed in the study area providing treed uplands with vernal pools and wetland ecosites where species may be present.
- Seeps and Springs (Candidate): one seep was observed during initial field investigations and may be present where there is forested area with groundwater at the surface within the headwaters of a stream or river system.

Habitat for Species of Conservation Concern

Habitat for SOCC is a category of SWH, however these results are presented alongside habitat assessments for SAR. In addition to candidate habitat for SOCC, broad habitat types with the potential to support multiple SOCC may be considered SWF (i.e., marsh bird breeding habitat, open country bird breeding habitat). Candidate habitats found in the study area are:

- Marsh Bird Breeding Habitat (Candidate): marshes observed in the study area may present suitable habitat, with wetlands with shallow water with emergent aquatic vegetation.
- Shrub/Early Successional Bird Breeding Habitat (Candidate): habitat may be present where large field areas succeeding to shrub and thicket are greater than 10 ha. Regenerating thickets were observed in the study area.

Wildlife Movement Corridors

Candidate Amphibian Movement Corridors occur in the study area. The SWH Region 6E Criterion identifies amphibian movement corridors when wetland breeding amphibian habitat is confirmed. Documentation of amphibian movement corridors was beyond the scope of this study. Targeted amphibian breeding surveys are required to confirm amphibian movement corridors.

The study area crosses two large natural corridors, Barnum House Creek/Grafton Creek (including Barnum House Creek Conservation Area south of Highway 401) and Shelter Valley, as well as numerous smaller wooded valleys with watercourses. MNRF identified Barnum House Creek/Grafton Creek and Shelter Valley, as well as a wooded valley along an unnamed tributary west of the Danforth Road underpass, as key locations for wildlife passage. Deer wintering areas have been identified by MNRF to the north and south of the study area indicating that deer are likely to move across the highway in response to seasonal habitat and foraging needs.

Vehicle-Wildlife Collision History

Wildlife collision data collected over a four-year period (i.e., between 2012 and 2016) along Highway 401 within the limits of the study area was provided by MTO in 2019. Based on the data reviewed, 51 wildlife-vehicle collisions were primarily recorded along Highway 401 in the vicinity of Danforth Road, Gully Road, Lyle Street, Boyce Road and Percy Street.

Summary of Key Terrestrial and Aquatic Ecosystem Features

Detailed terrestrial and aquatic studies have been conducted as part of this study to confirm information gathered from secondary sources. In general, the study area consists of predominantly Linear Meadow, Coniferous/Deciduous/Mixed Regeneration area, Coniferous/Mixed/Deciduous Forests, Coniferous/Mixed/Deciduous Plantations, Thicket/ Coniferous/Mixed/Deciduous Swamp, Marshes. Other key ecological characteristics include:

- Iroquois Plain physiographic region
- Potential Significant valleylands – in absence of published maps/criteria, The Gully and Shelter Valley Creek treated as significant valleylands
- Significant woodlands – approximately 234 hectares, based on minimum size criterion of 50 hectares
- Key hydrological features – approximately 48 ha, including Cranberry Lake (PSW), unevaluated wetlands, and watercourses
- Natural, coldwater watercourses – majority of watercourse crossings in study area drain southerly to Lake Ontario and provide Brook Trout habitat
- Invasive plant species (Phragmites) – abundant within marsh communities along existing ROW
- Highly sensitive native flora species – Red Pine, Butterfly Milkweed and Grey-headed Coneflower
- Potential presence of aquatic SAR – historical/MNRF record of American Eel
- SWH – seasonal concentration areas, rare/specialized habitat, habitat for SOCC, and wildlife movement corridors
- Candidate habitat for SOCC -Snapping Turtle, Northern Map Turtle, Red-headed Woodpecker, Eastern Wood-Pewee, Wood Thrush, Grasshopper Sparrow, Canada Warbler
- Potential or confirmed habitat for SAR – Blanding's Turtle, Eastern Whip-poor-will, Chimney Swift, Least Bittern, Bank Swallow, Barn Swallow, Louisiana Waterthrush, Bobolink, Eastern Meadowlark, Little Brown Myotis, Small-footed Myotis, Northern Myotis, Tri-Coloured Bat
- Migratory bird nests – Eastern Phoebe

4.2 Socio-Economic Environment

4.2.1 Land Uses

The study area traverses the following municipalities within Northumberland County: Township of Hamilton, Town of Cobourg, Township of Alnwick/Haldimand, and Township of Cramahe. Existing land use within the study area is primarily agricultural, rural residential and commercial. The study area has been heavily influenced by human activity including agricultural, and commercial and aggregate extraction operations.

Communities

Township of Hamilton

The west portion of the study area is located within the Township of Hamilton, which has a population of approximately 10,942 residents. The Township borders the Town of Cobourg and includes the communities of Baltimore, Precious Corners, Camborne, Bewdley, and Gore's Landing.

Town of Cobourg

The west limit of the study area is located approximately 1 km east of the northeast limit of the Town of Cobourg. Cobourg has a population of approximately 19,440 residents. It is the largest town in Northumberland County.

Township of Alnwick/Haldimand

The central portion of the study area is located within the Township of Alnwick/Haldimand, which has a population of approximately 6,869 residents. This Township is located between the Townships of Hamilton and Cramahe, and includes the communities of Brookside, Grafton, Lakeport, Wicklow, Vernonville, Eddystone, Centreton and Camel.

Township of Cramahe

The eastern portion of the study area is located within the Township of Cramahe, which has a population of approximately 6,355 residents. The Township includes the communities of Colborne, Salem, Dundonald, Castleton, and Shiloh.

Official Plan

The Northumberland County Official Plan (2016) outlines existing and future land use designations within its region at a broad level. In addition, its lower-tier municipalities have their own Official Plans which further define current and future land use designation and policy direction within their respective jurisdictions, including: Township of Hamilton Official Plan, dated November 2010; Alnwick/Haldimand Township Official Plan, dated December 2015; and

the Township of Cramahe Official Plan, dated 2014. The land uses bounding the Highway 401 corridor within the limits of the study area are briefly described herein.

Commercial Land/Employment Land

There are three designated Employment Districts situated in the vicinity of the study area: 1) in proximity to Nagle Road within the Town of Cobourg; 2) to the east of Cranberry Lake Wetland; and 3) at the southeast end of the study area within the Township of Colborne. Designated commercial uses are also identified at the southwest quadrant of County Road 25 and Highway 401. No other commercial or employment land designations were noted to be present in the vicinity of the study area.

Residential/Rural Residential Land

Within the study area, there are both urban settlement areas, and rural settlement areas with residential buildings and infrastructure. The nearby Town of Cobourg is designated as an Urban Settlement Area, and within the study area is the Township of Cramahe – Colborne Urban Settlement Area. In addition, the Township of Alnwick/Haldimand includes the designated Grafton Rural Settlement Area located south of Highway 401 and adjacent to County Road 23, nearby the community of Grafton.

4.2.2 Student Transportation/Education Facilities

The study area is located within four school boards, including the Kawartha Pine Ridge District School Board, the Peterborough Victoria Northumberland Clarington Catholic District School Board, the Conseil Scolaire Catholique MonAvenir and Conseil Scolaire Viamonde. All boards are serviced by the Student Transportation Services of Central Ontario.

4.2.3 Emergency Services

Emergency Services are comprised of police, fire, and medical response providers. Police service in the study area is provided by the Ontario Provincial Police (OPP) – Northumberland Detachment. The OPP Detachment office is located in Cobourg, with satellite offices located within the communities of Grafton and Brighton.

Fire services are provided by the Township of Hamilton Volunteer Fire Department (Baltimore Fire Station), Alnwick/Haldimand Fire Rescue (Grafton, Centreton and Roseneath Fire Stations) and the Township of Cramahe Fire Department (Colborne Fire Hall, Castleton Fire Hall). Dispatching services are provided through the Peterborough Fire Service for all fire departments in Northumberland County.

Emergency Medical Services are provided by the Northumberland Paramedics, with stations located in the surrounding areas of Port Hope, Cobourg, Roseneath, Colborne, Brighton and Campbellford.

There are no emergency service facilities with direct entrances to Highway 401 within the study area; however, the Alnwick/Haldimand Fire Rescue station is just north of the Highway 401 and Lyle Street interchange.

4.2.4 Aggregates

Developed and undeveloped aggregate sources are present within the study area. There are six aggregate operations located within 1 km of the study area. The western portion of the project is within an area of deposits of high mineral aggregate resources as per the Township of Hamilton's Official Plan.

4.2.5 Mining

At the time of preparing this TESR, there were no operating mines or existing mining claims identified by the Ministry of Northern Development and Mines in the study area.

4.2.6 Parks and Trails

There are no provincial parks located within the study area; however, Barnum House Creek Conservation Area is located immediately south of Highway 401 and west of the community of Grafton within the Township of Alnwick/Haldimand. There is also a plot of crown land north of Highway 401, adjacent to Vernonville Road; however, this area is located beyond the limits of the study area.

Cycling Routes

The County of Northumberland developed a Cycling Master Plan in July 2014 to establish a long-range plan for a County-wide cycling network. The master plan includes developing a network of on- and off-road cycling facilities, along with providing clear and consistent guidelines, standards and specifications for cycling facilities to be incorporated into capital and operational improvements over time. As part of the master plan, it is recognized that Highway 401 presents a challenge in terms of connecting portions of their north-south cycle routes and a list of suitable on road cycle routes over and beneath Highway 401 is documented. Within the study area, Gully Road, Danforth Road East, Shelter Valley Road, and Vernonville Road, are identified as recommended and/or acceptable routes. The Ganaraska Freewheelers and Cobourg Cycling Club have mapped cycle routes online which include the above-mentioned crossings within the study area.

The Greenbelt Route, developed by the Waterfront Regeneration Trust, is part of 27 municipal active transportation plans and is owned and maintained by those municipalities. The Greenbelt Route crosses the study area on Danforth Road East and is part of the Rice Lake Ramble trail promoted by the County of Northumberland Tourism.

Cycling facilities (signed and paved shoulder) are present on Percy Street south of the Highway 401 structure.

Snowmobile Trails

The study area is located within District 3 of the Ontario Federation of Snowmobile Clubs (OFSC). The Great Pine Ridge Snowmobile Association maintains the snowmobile trails located approximately 10 km north of the study area; however, there are no trails within the study area.

4.2.7 Transit and Commuter Parking Facilities

Commuter lots are present in the study area at Lyle Street and Percy Street interchanges with Highway 401. The commuter lot located at the southeast quadrant of the Lyle Street interchange with highway has parking capacity for approximately 19 vehicles. The commuter parking lot located at the southeast quadrant of the Percy Street interchange with the highway has parking capacity for approximately 51 vehicles.

4.3 Cultural Heritage Environment

4.3.1 Archaeology

A Stage 1 Archaeological Assessment was completed in accordance with the provincial standards and guidelines set out in the Ministry of Citizenship and Multiculturalism (MCM) 2011 Standards and Guidelines for Consultant Archaeologists to determine the potential presence of archaeological resources within the study area.

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property and can be determined based on proximity to previously identified archaeological sites, distance to various types of water sources, soil type, and topography. Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and considered alone, may result in a determination of archaeological potential. However, any combination of two or more other criteria, such as well-drained soils or topographic variability, may also indicate archaeological potential. Soil texture can be an important determinant of past settlement, usually in combination with other factors such as topography. Several different types of soil are present in the study area. Six of these soils either have good drainage or are well-drained, and the remaining five have imperfect or poor drainage. Only three of the soils (Granby, Lyons, and Trent) were unsuitable for agricultural purposes.

It should be noted that extensive land disturbance can eradicate archaeological potential.

The findings of the assessment indicated that the study area retained potential for the recovery of archaeological resources due to proximity to water sources, quality of soils, and distance to historic roadways. In addition, a windshield survey conducted in 2018 indicated that much of the study area, beyond the existing Highway 401 right-of-way, consists of undeveloped wood lot, agricultural field, or scrubland. Areas identified as having no or low archaeological potential were limited to the footprints of existing roadways and buildings (21%), existing poorly drained areas (0.5%), and steep slopes (0.7%). When the above listed criteria area applied to the study area, the potential for the recovery of pre-Contact, post-Contact, and Euro-Canadian archaeological resources is considered moderate to high.

Based on the findings of the Stage 1 Archaeological Assessment, approximately 81% of lands within the study area have moderate to high potential for the identification and recovery of archaeological resources. A copy of the Stage 1 Archaeological Assessment report is provided in Appendix F.

4.3.2 Cultural Heritage Resource Assessment

A Cultural Heritage Resource Assessment (CHRA) Report was completed in 2019 to identify heritage resources, including built heritage and cultural heritage landscapes, present within the study area. It should be noted that, for the purposes of the CHRA, a 50 m buffer zone was generally established around the study area, which is defined as the existing highway right-of-way.

To help identify currently protected properties, relevant staff representing the MCM, Ontario Heritage Trust, Township of Hamilton, Township of Alnwick/Haldimand, and Township of Cramahe were consulted. As a result of the consultation, three protected heritage properties were identified in relation to the study area, none of which were within a 50 m buffer of the study area limits. In addition, properties with the potential to have cultural heritage value and/or interest were identified based on historical research conducted at Western University, London Public Library, and supplemented by a review of material obtained through available online resources. A field visit was also undertaken in 2018 to further investigate the findings of the desktop review and historical research. During the field visit, potential heritage properties were photographed from the public right-of-way.

A total of 32 properties were identified as having heritage potential, each of which were reviewed against Ontario Regulation (O. Reg. 9/06) criteria. As part of this initial screening analysis, each potential heritage resource was considered both as an individual structure and as a potential component of a cultural heritage landscape. Following evaluation, five cultural heritage resources were identified within a 50 m buffer zone of the study area (please refer to Table 4-1):

Table 4-1: Identified Cultural Heritage Resources Within an Approximately 50 m Buffer of the Study Area

Feature Number and Feature Type	Location	Identified Attributes
BHR 2	2247 Van Luven Road	Residence
CHL-1	305 Gully Road	Residence, barn, and agricultural fields
CHL-4	Cherry Hill Road	Undetermined
CHL-8	Union Cemetery	Grave markers
BHR-18	170 Percy Street North (County Road 25)	Residence

A copy of the CHRA report is provided in Appendix G.

4.3.3 Cultural Heritage Evaluation Reports

Structural Culverts and Bridges

Stantec completed separate Cultural Heritage Evaluation Reports (CHERs) for the two structural culverts and the bridges within the study area to determine if these structures retained cultural heritage value or interest. Where cultural heritage value or interest is identified, the CHER includes a description of heritage attributes and a Statement of Cultural Heritage Value.

Grafton Creek and Shelter Valley Creek culverts and the Eagleson Road Underpass, Gully Road Underpass, Lyle Street Underpass, Vernonville Road Overpass, Boyce Road Overpass, and Percy Street Underpass were subjected to an assessment of potential cultural heritage value or interest in accordance with the *Ontario Heritage Bridge Guidelines* and O. Reg.10/06.

Based on the findings of the CHERs, the following was noted:

- Grafton Creek Culvert is located in the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Highway 401 over Grafton Creek. The culvert was constructed in 1958 to serve as an overpass on the newly developed Highway 401. The culvert is a single-span reinforced cast-in-place concrete arch culvert.

- Shelter Valley Creek Culvert is located in the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Highway 401 over Shelter Valley Creek. The culvert was constructed in 1959 to serve as an overpass on the newly developed Highway 401. The culvert is a single-span open footing reinforced cast-in-place concrete arch culvert.

- Eagleson Road Underpass is located in the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Eagleson/Danforth Road spanning Highway 401. The bridge was constructed in 1959 to serve as an underpass as part of the newly developed Highway 401 for local traffic within the Township of Alnwick/Haldimand. The bridge is a single-span post-tensioned cast-in-place concrete bridge. It carries two lanes of traffic on Eagleson/Danforth Road over Highway 401.

- Gully Road Underpass is located in the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Gully Road spanning Highway 401. The bridge was constructed in 1959 to serve as an underpass as part of the newly developed Highway 401 for local traffic within the Township of Alnwick/Haldimand. Gully Road Underpass is a three-span T-Beam reinforced cast-in-place concrete bridge. It carries two lanes of traffic on Gully Road over Highway 401.

- Lyle Street Underpass is located in the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Lyle Street spanning Highway 401. The bridge was constructed in 1958 to serve as an underpass as part of the newly developed Highway 401 for local traffic within the Township of Alnwick/Haldimand. Lyle Street Underpass is a three-span box beam reinforced concrete bridge. It carries two lanes of traffic on Lyle Street over Highway 401.

- Vernonville Road Overpass is located within the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Highway 401 over Vernonville Road. The bridge was constructed in 1959 to serve as an overpass on the newly developed Highway 401 for local traffic within the Township of Alnwick/Haldimand. Vernonville Road Overpass is a single-span reinforced cast-in-place concrete rigid frame slab bridge. It carries four lanes of Highway 401 traffic over Vernonville Road.

- Boyce Road Overpass is located within the former Township of Haldimand, now the Township of Alnwick/Haldimand and forms part of Highway 401 over Boyce Road. The bridge was constructed in 1959 to serve as an overpass on the newly developed Highway 401 for local traffic within the Township of Alnwick/Haldimand. Boyce Road Overpass is a single-span reinforced cast-in-place concrete rigid frame slab bridge. It carries four lanes of Highway 401 traffic over Boyce Road.

- Percy Street Underpass is located within the Township of Cramahe and forms part of Percy Street spanning Highway 401. The bridge was constructed in 1960 to serve as an underpass as part of the newly developed Highway 401. Percy Street Underpass is a three-span reinforced cast-in-place concrete beam/girder bridge with a box beam. It carries two lanes of traffic on Percy Street over Highway 401.

Based on the findings of the CHERs, the Grafton Creek Culvert and Shelter Valley Creek Culvert do not have cultural heritage value. In addition, none of the bridges were determined to have cultural heritage value or interest according to O. Reg. 10/06.

Following the confirmation of the Recommended Plan and its potential impacts, an additional CHER was also completed for 170 Percy Street (BHR-18) to further investigate its cultural

heritage value or interest, and to determine if specific mitigation measures would be required. The CHER for BHR-18 is further discussed in Section 7.3.2.

Copies of the CHERs are provided in Appendix H.

4.3.4 Highway of Heroes

Highway 401, from Canadian Forces Base Trenton to Toronto, has been dedicated as the Highway of Heroes in commemoration of the route fallen soldiers take after repatriation. There are many aspects to the commemoration of the Highway of Heroes, including the Highway of Heroes Tree Campaign which endeavors to create a living tribute to the Canadian Armed Forces by planting trees along Highway 401 from Windsor to Cornwall. As part of this campaign, it is understood that the Highway of Heroes organization seeks to design commemoration sites with the appropriate mix of native species; increase wildlife habitat; and positively impact the pollinator populations along Highway 401 and associated interchanges.

4.4 Transportation Conditions

This section of the report documents the existing conditions along Highway 401, from 2.0 km east of Nagle Road easterly to 0.8 km east of Percy Street (County Road 25).

4.4.1 Highway Classification

Highway 401 within the project limits runs east-west and is classified as a rural, four-lane, divided freeway (RDF – 120) and connects the communities of Cobourg, Grafton, and Colborne.

4.4.2 Posted and Design Speed

The posted speed limit on Highway 401 is 100 km/h and the design speed is 120 km/h.

4.4.3 Traffic

A Preliminary Design and Class Environmental Assessment – Calibration and Validation of Microsimulation Model Report and P*reliminary Design and Class Environmental Assessment – Road Safety Report* have been prepared as part of this study and are on file with MTO. The report details the existing traffic operations and collision statistics within the study areas. A summary of these reports is provided herein.

Traffic Volume Data

The 2016 traffic data and annual average growth factors were obtained from the MTO's Traffic Volume Data website (https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tvSplash.aspx).

Traffic data was obtained for the categories of annual average daily traffic (AADT), summer average daily traffic (SADT), average annual growth rate, percentage of commercial vehicles (% Comm.) and design hour volume (DHV), along three segments of Highway 401 which either partially or fully fall within the study area. The existing highway is operating a LOS C based on the 2016 AADT.

Highway Collisions

The collision history review indicated a predominance of Single Motor Vehicle Collisions in the study area mainline sections, representing 65% of total collisions. Potential contributing factors include reduced visibility conditions (40% of collisions occurred under non-daylight conditions, higher than the Provincial average of 29%) and winter related road surface conditions (34% of collision occurred on ice/snow/slush, higher than the Provincial average of 24%). These proportions tend to be higher on horizontal and vertical curves with substandard geometric design elements. No clear patterns were noted for collisions at ramps and ramp terminals within the study area.

Traffic Field Investigation

In addition to the collision review, a field investigation was undertaken in August 2018 to collect additional data and aid further analysis on road safety. Due to recent changes in road conditions, a direct comparison between collision history and road conditions could not be provided. However, general deficiencies such as missing advisory signage, deficient guiderail systems and sources of traffic conflicts were identified.

4.4.4 Horizontal Alignment

The existing horizontal alignment of Highway 401 was reviewed to identify geometric deficiencies.

Horizontal Curves

The minimum design radius for horizontal curves with 6% superelevation rate and design speed 120 km/h is R=750 m, and the minimum length of horizontal curve should be 3 times the design speed (i.e., L=360 m), as identified in the *Chapter 3 – Alignment and Lane Configuration – TAC, Geometric Design Guide for Canadian Roads, April 2020*.

There are six existing horizontal curves on Highway 401 within the study limits. All existing curves exceed the minimum design standard radius (i.e., R=750 m). Two curves do not satisfy the requirements to achieve standard superelevation. Three curves do not satisfy the minimum length of L-360 m.

The horizontal curve deficiencies are summarized below:

- Curve #3 – between Danforth Road and Gully Road has a deficient super elevation between 3.3%-4.5%.
- Curve #4 – 0.8 km west of Lyle Street has a curve length of 133 m. For the design speed the curve should be 5238 m
- Curve #5 – 0.4 km west of Shelter Valley Road has a curve length of 204 m. For the design speed the curve should be 5238 m
- Curve #6 -2.4 km west of Percy Street has a superelevation of 3.1%-3.7% for the radii and design speed the superelevation should be 3.7%

Sight Distance at Horizontal Curves

The minimum clearance from the centerline of the inside lane to an obstruction is an important consideration to ensure that adequate sight distance on a horizontal curve is available

Horizontal Curves #2 and #3 do not have enough lateral clearance to the median tall wall barrier to meet the minimum stopping sight distance requirement for a design speed of 120 km/h. The existing lateral clearance provides a sight distance that is slightly deficient and satisfies a design speed of approximately 115 km/h.

The cross referencing of collision and geometric design data suggests that the limited stopping sight distance on Curve #2 may contribute to a higher frequency of rear end and sideswipe collisions. It is possible that the proximity to Curve #3 (which has substandard superelevation) has some influence on the collision frequency. In fact, 19 out of the 29 collisions (65%) on Curve 2 occurred in the westbound direction, where vehicles exit from Curve 3.

4.4.5 Vertical Alignment

The Highway 401 vertical alignment has independent profiles for the eastbound and westbound lanes from approximately Station 23+000 Township of Hamilton to approximately Station 10+300 Haldimand Township (approximately 2.4 km). The Highway 401 vertical alignment has relatively the same profile for both eastbound and westbound lanes from Station 10+300 Haldimand Township to the east study limits based on provided photogrammetric data.

Vertical Curves

The minimum K-values for vertical curves with a design speed of 120 km/h are: crest curve K-100, sag curve K-70. It is also desirable that the length of the vertical curve should not be less than the design speed in km/h.

There are 38 vertical curves on Highway 401 within the project limits, including 23 crest and 15 sag curves. Thirteen of the 38 vertical curves (Curves #5, 6, 9, 10, 11, 16, 17, 21, 22, 25, 27, 28, and 35) do not meet the minimum K-value for the design speed of the highway (120 km/h). However, ten of these exceed the minimum K-value for the posted speed of the highway (100 km/h). There are three vertical curves on Highway 401 that do not satisfy the design standard required for the posted speed. These three sag curves (Curves #6, 25, and 35) satisfy a design speed of 90 km/h.

Historical road-user collision data provided by the Ministry for the years 2012 – 2016, indicate there were no collisions reported at six vertical curves (Curves #5 EB & WB, 6, 9,17,28). There were two vertical curves (Curves #22 and 25), which had only three and six collisions, respectively. Of the remaining curves, curve #21 collision data indicates the only apparent driver action reported was “driving properly”, which may indicate a more substantial contribution of the substandard geometry. Although this sag curve at Shelter Valley Road satisfies a design speed of 105 km/h. All the vertical curve lengths exceed the desirable length.

Profile Grades

The maximum profile grade for a freeway with a design speed of 120 km/h is 3%. The existing profile of Highway 401 within the study area is generally flat to rolling, and grades range from 0.15% to a maximum grade of 3.0%.

4.4.6 Cross-Section

The cross-section characteristics of Highway 401 within the study limits are summarized in Table 4-2.

Table 4-2: Summary of Cross-Section Elements

	Median Type	
	Grass Median with Steel Beam Guide Rail	**Paved Median with Concrete Tall Wall Barrier**
Cross-Section Element	**Width (m)**	**Width**
Lane Width	4 x 3.66 (2 EBL, 2 WBL)	4 x 3.66 (2 EBL, 2 WBL)
Median Width	18.3	10.2
Median Shoulder Width	Varies (Typically 2.50 – 2.80)	Varies (Typically 4.62 – 4.78)
Outside Shoulder Width	3.0	3.0
ROW Width	Varies (91.3 minimum)	Varies (91.3 minimum)

From the west study limits (Station 23+050 Hamilton Township) to Station 24+900 Hamilton Township, the highway has a grass median while the remainder of the highway to the east study limits (Station 12+500 Cramahe Township) has a tall wall median barrier.

4.4.7 Interchanges

There are two interchanges on Highway 401 in the study area that provide access to the local road network and existing communities.

The Lyle Street interchange provides access to County Road 23 and the community of Centerton to the north, and to Lyle Street and the community of Grafton to the south.

The Percy Street interchange provides access to County Road 25 and the community of Castleton to the north, and to Percy Street and the community of Colborne to the south.

4.4.8 Existing Structures

There are six bridges (four underpasses, two overpasses) and eight structural culverts within the study limits. Table 4-3 summarizes the existing bridge and culvert structures within the study limits.

Table 4-3: Summary of Existing Structures

Structure ID	Name	Type	Year Constructed
Bridges			
21-268	Danforth Road	Underpass	1959
21-269	Gully Road	Underpass	1959
21-271	Lyle Street (County Road 23)	Underpass (IC 487)	1958
21-274	Vernonville Road	Overpass	1959
21-275	Boyce Road	Overpass	1959
21-276	Percy Street (County Road 25)	Underpass (IC 497)	1960
Culverts			
21-467/C	Unnamed	Box Culvert	1959
21-468/C	Unnamed	Box Culvert	1958
21-469/C	Unnamed	Box Culvert	1958
21-270/C	Grafton Creek	Arch Culvert	1958
21-470/C	Northumberland Culvert	Box Culvert	1958
21-272/C	Shelter Valley Creek	Arch Culvert	1959
21-273/C	Shelter Valley Road (Haldimand Twp Bridge #15)	Arch Culvert	1958
21-576/C	Boyce Road	Box Culvert	1958

4.4.9 Drainage

Culvert inspections have been prepared as part of this study. A field inspection was undertaken in July and December 2018. A completed report with additional details on the existing culverts is provided in a *Preliminary Drainage Report*, provided in Appendix D. Since the time that investigations were completed, it is understood that some improvements have been made to the drainage infrastructure.

Centreline Culverts

Within the project limits, there are a total of 33 centreline culverts. Of these 33 culverts:

- 7 are structural culverts (five concrete box culverts: two concrete arch culverts)
- 10 are non-structural concrete box culverts
- 2 are circular concrete culverts lining original smooth walled, steel culverts
- 12 are corrugated steel pipe (CSP) circular culverts (some lined with plastic)
- 2 are corrugated steel pipe (CSP) arch culverts

Each culvert was assessed to determine their current condition.

- 8 culverts were evaluated to be in good condition
- 5 culverts were evaluated to be in fair condition
- 16 culverts were evaluated to be in poor condition

Interchange Culverts

Within the project limits, there are two interchanges: Lyle Street and Percy Street. Each of these interchanges contain a combination of storm sewers and culverts to properly drain the interchange. Storm sewers were not examined as part of this contract and therefore only the culverts within the interchanges were documented. Within the two interchanges, a total of ten culverts were assessed.

There is a total of four CSP pipes at the Lyle Street Interchange and five CSP and one concrete pipe at the Percy Street Interchange.

Other Drainage Infrastructure

Outside of the centreline culverts, the existing highway drainage system generally consists of a median storm sewer system outletting to the roadside ditch; sideroad culverts and sewers conveying ditch drainage across road embankments; and interchange culverts and storm sewers draining the two interchanges within the study area. There are also several ponds and step pools within the study area that appear to provide some level of water quality and/or erosion control prior to discharge to downstream systems.

Recent roadwork in the study area involved several areas of ditching that had been cleaned out as well as uncovering pipes and storm sewer outlets that were likely buried or poorly draining prior to the upgrades. As per MTO maintenance comments, storm sewer outlets throughout this area are prone to sedimentation and clogging, which will be taken into consideration during the proposed storm sewer design.

4.4.10 Crossing Roads

There are seven roads that cross Highway 401 within the project limits. Four roads cross over Highway 401 (underpass) and three roads cross under Highway 401 (overpass).

Posted and Design Speed

The posted speed limit and design speed on each crossing road are listed in Table 4-4. It has been assumed that the design speed is 20 km/h above the posted speed limit.

Table 4-4: Crossing Road Posted and Design Speed

Crossing Road	Structure Type	Posted Speed (km/h)	Design Speed (km/h)
Danforth Road	Underpass	60	80
Gully Road	Underpass	70	90
Lyle Street (County Road 23)	Underpass (Interchange)	80	100
Shelter Valley Road	Overpass	70	90
Vernonville Road	Overpass	60*	80
Boyce Road	Overpass	60*	80
Percy Street (County Road 25)	Underpass (Interchange)	60	80

Note: (*) A field investigation (July 2018) determined that there were no Regulatory Speed Limit signs on these two crossing roads within or near to the study limits. A posted speed limit of 60 km/h has been assumed.

Horizontal Alignment

The horizontal alignment of each crossing road within the study limits was reviewed to identify geometric deficiencies. There is one horizontal curve on Lyle Street that is below the minimum design standard, which does not meet the requirements for the posted speed of 80 km/h. Shelter Valley Road has one horizontal curve south of Highway 401 which is below design standard.

Vertical Alignment

The vertical alignment of each crossing road within the study limits was reviewed to identify geometric deficiencies. Table 4-5 identifies the minimum K-value for various design speeds for both crest and sag curves, as identified in *Chapter 3 – Alignment and Lane Configuration – TAC, Geometric Design Guide for Canadian Roads*, April 2020.

Table 4-5: K Factors to provide Stopping Sight Distance on Vertical Curves

Design Speed (km/h)	Crest Curve K Value	Sag Curve K Value
50	7	13
60	11	18
70	17	23
80	26	30
90	39	38
100	52	45

Vertical Curves

The crossing roads with Highway 401 underpass structures include: Danforth Road, Gully Road, Lyle Street (County Road 23), and Percy Street (County Road 25). Improvements to the deficient vertical curves on these roads should be considered when investigating bridge replacement options at these locations.

The crossing roads with Highway 401 overpass structures include: Shelter Valley Road, Vernonville Road, and Boyce Road. Rehabilitation or replacement of these structures will likely not require crossing road profile changes, as deficiencies are located away from the structures and not directly impacted by the structure.

Profile Grades

The maximum profile design grade for all crossing roads within the study area is 6-8%. Each crossing road has a maximum profile grade which satisfies the design requirements, with the exception of Vernonville Road. The south end of Vernonville Road has a profile grade of approximately 10.3% which satisfies the requirement for the posted speed of 60 km/h. Rehabilitation or replacement of the Vernonville Road structure will likely not require improvements to the vertical road profile, as the deficient vertical curve is located approximately 160 m south of Highway 401 and is not directly impacted by the structure.

Cross-Section

The cross-section characteristics of each crossing road within the study limits are summarized in Table 4-6.

Table 4-6: Summary of Crossing Road Cross-Section Elements

Crossing Road	Approx. Lane Width (m)	Approx. Shoulder Width (m)
Danforth Road	2 x 3.25	1.0 – 1.5
Gully Road	2 x 3.00	0.5 – 1.0
Lyle Street (County Road 23)	2 x 3.35	2.0 – 2.5
Shelter Valley Road	2 x 3.00	1.5 – 2.0
Vernonville Road	2 x 3.00	1.0 – 1.5
Boyce Road	2 x 3.00	1.0 – 1.5
Percy Street (County Road 25) North of Highway 401	2 x 3.35 & 3.0 right-turn lane	2.5 – 3.0
Percy Street (County Road 25) South of Highway 401	2 x 3.35 & 3.8 left-turn lane	2 x 1.5 bike lane with curb

4.4.11 Utilities

Utility companies with plants within the study area were requested to provide information on the location and type of the existing utility plant. Union Gas, Lakefront Utilities, Hydro One, Bell Canada and MTO all have plants within the study limits.

5.0 Generation and Evaluation of Alternatives

A range of potential drainage, bridge, interchange and highway improvement alternatives that correspond to the Preferred Transportation Undertaking were developed and subjected to a screening assessment based on their potential to address the structural replacement needs and accommodate the future footprint of Highway 401, while minimizing environmental and community related impacts.

Figure 5 displays the locations of the drainage, bridges, interchanges and highway cross-section area identified for improvements within the project limits. The screening assessment of preliminary improvement alternatives is summarized herein.

5.1 Highway 401 Alternatives

In establishing the future footprint for the interim six and ultimate eight lane configuration of Highway 401, the following highway cross section alternatives were developed and subjected to a detailed evaluation:

- Alternative 1 – Maintain Cross-Section, Widen to the Outside
- Alternative 2 – Shift to Inside and Widen to the Outside

The highway cross section alternatives evaluated as part of this study were presented at Public Information Centre (PIC) 1 (please refer to Appendix Q.3).

5.1.1 Evaluation Process

These alternatives were subjected to a comparative evaluation process in consideration of transportation benefits and environmental effects for each alternative. The process includes: a) identifying evaluation criteria through input received from the public and stakeholders during this study, the project team's experience in projects of this nature, provincial guidelines and existing study area conditions; b) applying a weight percentage to each factor/criterion, which was based on the project team and stakeholder assessment of the importance of the factor; c) applying a reasoned argument approach to the evaluation in consideration of the net environmental effects of each alternative (qualitative assessment) and evaluating the Short List of Highway 401 Cross-Section Alternatives based on the total calculated scores (quantitative assessment); and, d) identifying a Preliminary Preferred Highway 401 Cross-Section, as described herein. A comprehensive evaluation approach was undertaken to identify a Preferred Plan that addresses current and future transportation needs in the study area. The Highway 401 Cross-Section Alternatives were subjected to a comparative evaluation process to provide the basis for selection of the Preferred Plan.

The process includes identifying evaluation criteria through input received during this study, the project team's experience in projects of this nature, provincial guidelines and existing study area conditions. A weight percentage was applied to each factor/criterion, which was based on the project teams and stakeholder assessment of the importance of the factor.

The next step in the process includes evaluating alternatives. A comparative analysis of transportation benefits and environmental effects for each alternative is undertaken based on the criteria. A reasoned argument approach was also applied to the evaluation which considered the net environmental effects of each alternative.

In the final step in the evaluation process, the Highway 401 Cross-Section Alternatives were evaluated based on the total calculated scores. This is the basis for ranking the alternatives and, along with a reasoned argument assessment approach, helps to identify the overall Recommended Plan for the project.

Evaluation Criteria

The evaluation criteria were grouped into highway engineering, social and cultural environment, and natural environment, as outlined in Table 5-2 to Table 5-4.

Criteria Weighting

The criteria are independent variables, each of which may contribute a positive or negative influence on the overall suitability of an alternative based on the factors considered within each criterion and the scoring methodology. Table 5-1 presents the weighting for each evaluation category.

Table 5-1: Weighting for Each Evaluation Category

Category	Weight
Highway Engineering	50.0%
Community	30.0%
Natural Environment	20.0%

Table 5-2 to Table 5-4 set out the evaluation criteria for the Highway 401 Alternatives for the future widening including the factors considered for each criterion, and the methodology and measurement for the scoring of each factor.

Table 5-2: Engineering Evaluation Criteria

Engineering		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Geometrics and Safety	Geometrics	Measure of the shoulder width (m) in comparison to design standards
	Driver expectation	Identify if cross-section and median width are consistent with the 6-lane Highway 401 to the west (yes/no)
Constructability	Staging complexity and detours	Pairwise comparison based on whether a crown shift is required and impacts to traffic during construction
Pavement	Pavement Strategy	Identify whether paving could be completed independently to highway reconstruction or require full reconstruction
Cost	Cost	Cost estimate based on material quantities ($M)

Table 5-3: Community Evaluation Criteria

Community		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Property	Potential to impact property	Pairwise comparison based on anticipated impacts to property
Noise & Air Quality	Relative proximity to sensitive receptors	Pairwise comparison based on proximity to sensitive receptors for each alternative
Cultural Heritage	Potential to affect cultural heritage resources	Number and scale of impact to cultural heritage features
Archaeology	Potential impacts to areas having archaeological potential	Pairwise comparison based on potential impact to areas with archaeological potential
Contamination	Potential to encounter contaminated soils/groundwater	Pairwise comparison based on potential to encounter contaminated soils/groundwater

Table 5-4: Environment Evaluation Criteria

Environment		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Terrestrial Ecosystem	Potential to impact significant wildlife areas/ trees	Pairwise comparison based on anticipated area of wildlife habitat impacted
Species of Special Concern	Potential to impact potential SAR habitat	Pairwise comparison based on anticipated area of impact to potential rare or Species-at-Risk habitat
Fish and Fish Habitat	Number of watercourse crossings	Count of the number of watercourse crossings impacted
	Impacts to fish and fish habitat	Identify if there will be impacts to fish habitat (yes/no)

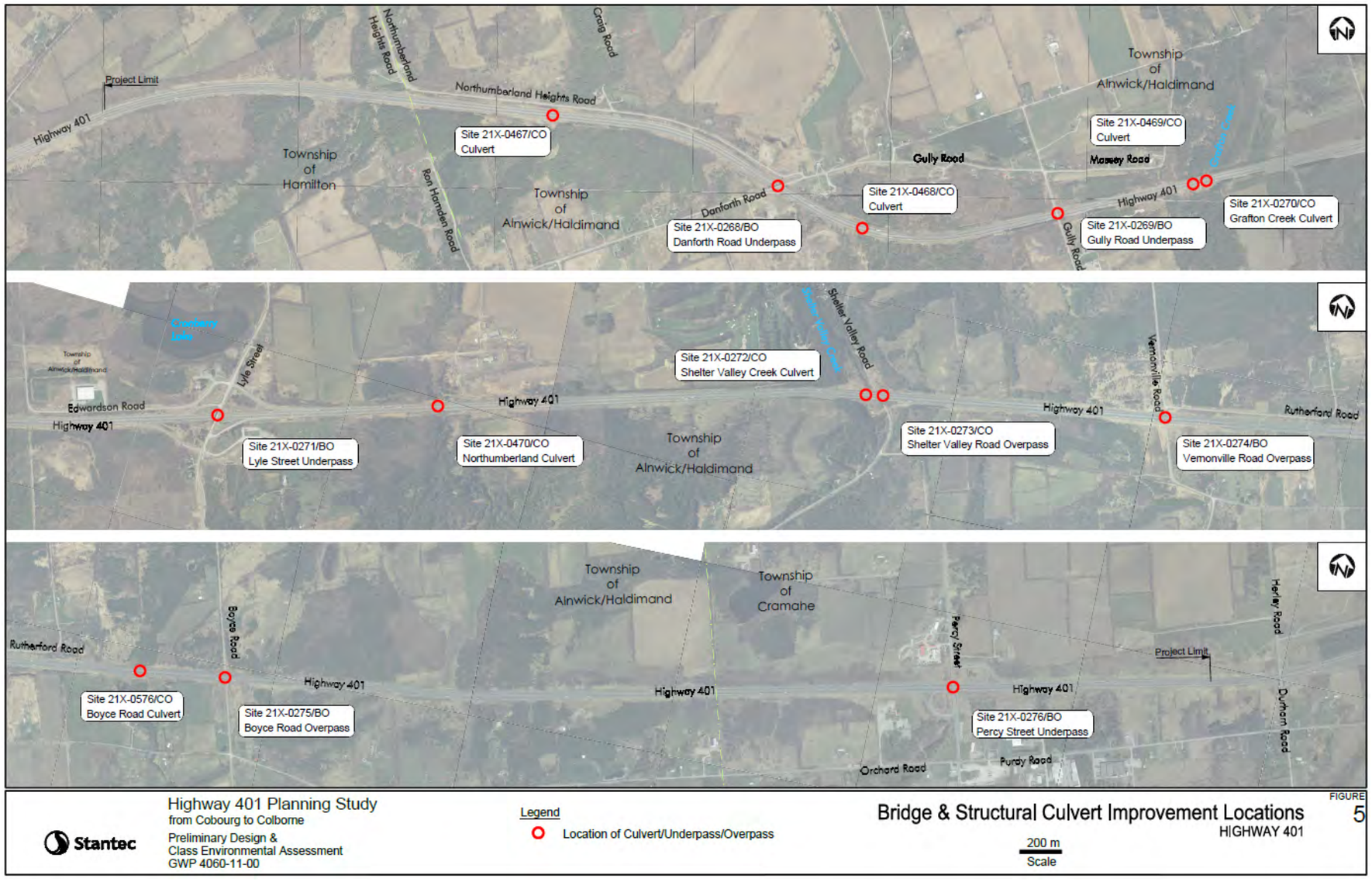

Figure 5: Approximate Location of Infrastructure Improvements Within Project Limits

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5.1.2 Evaluation of Highway 401 Alternatives

A qualitative assessment of the Highway 401 Cross-Section Alternatives was completed by tabulating the advantages and disadvantages of each alternative based upon the evaluation criteria developed and the scale of potential impacts for each criterion. Advantages and disadvantages are identified by plus sign (+) and minus sign (-), respectively. Otherwise, a bullet sign (•) identifies a neutral comment where there is no clear advantage or disadvantage.

In addition, a quantitative assessment was undertaken for each alternative, and was based on following methodology:

- For each evaluation category, each alternative was given a score from 0 to 5
- The evaluation category weightings were applied to the scores for each alternative
- The total score for each alternative was obtained and the alternatives were ranked according to the total score

Table 5-5 sets out the scoring legend for the quantitative assessment of alternatives.

Table 5-5: Scoring Legend

Preference of Alternative	Score
Most Preferred	4
More Preferred	3
Equally Preferred	2
Less Preferred	1
Least Preferred	0

The results of the quantitative assessment of the alternatives (i.e., the weighted score) is summarized in Table 5-6 The final score for each alternative is provided at the end of each table which takes into account the evaluation category weightings.

The evaluation of Highway 401 Cross-Section Alternatives is summarized in Table 5-6.

Alternative 1, **Widen to Outside** is preferred because:

- Construction to the outside only is simpler and less costly than widening inside and outside
- Maintains the existing shoulder width, which exceeds the minimum standards
- Does not require a shift in the crown of the lanes
- It minimizes traffic lane shifts during construction, which minimizes impacts to traffic flow and driver expectations
- The cross-section is consistent with the Highway 401 cross-section to the west (i.e., previously widened to the outside)
- Can be completed independently of future highway reconstruction

Table 5-6: Evaluation of Highway 401 Cross-Section Alternatives

Category (Weight)	Criteria	Factor	Alternative 1 – Widen to Outside	Alternative 2 – Shift to Inside and Widen to Outside
Highway Engineering (50%)	**Geometrics & Safety**	Geometrics	+ Maintains existing shoulder width, which exceeds minimum standards	• Provides standard shoulder width
		Driver Expectation	+ The cross-section and median width are consistent with the 6-lane Highway 401 section to the west	– The cross-section and median width are not consistent with the 6-lane Highway 401 section to the west
	Constructability	Complexity of staging and detours	+ No crown shift required + Minimizes impact to traffic during construction	– Requires crown shift – Requires extensive traffic staging
	Pavement	Paving Strategy	+ Can be completed independently to highway reconstruction	– Requires full reconstruction
	Cost	Construction Cost	+ Lower construction cost when compared to Alternative 2	– Higher construction cost when compared to Alternative 1
Highway Engineering Summary (Weighted Score)			**Most Preferred (4)**	**Least Preferred (1)**
Community (30%)	**Property**	Potential to impact property	– Impacts to more property anticipated, when compared to Alternative 2	+ Impacts to less property anticipated, when compared to Alternative 1
	Air/Noise	Relative proximity to sensitive receptors	– New ROW closer to existing sensitive receptors, when compared to Alternative 2 • Appropriate mitigation (e.g., noise walls, etc.) would be implemented, where warranted • Additional noise and air quality assessment required to confirm impacts if any	+ New ROW further from existing sensitive receptors, when compared to Alternative 1 • Appropriate mitigation (e.g., noise walls, etc.) would be implemented, where warranted • Additional noise and air quality assessment required to confirm impacts, if any
	Cultural Heritage	Potential to affect cultural heritage resources	• No direct impacts to properties identified as known or potential cultural heritage resource expected • No significant difference between alternatives	
	Archaeology	Potential to impacts areas having archaeological potential	–Potential to impact a greater area of land having potential for recovery of archaeological resources, when compared to Alternative 2 • Additional archaeological assessment activities would be required to confirm impacts and/or mitigation, if required	+Potential to impact a smaller area of land having potential for recovery of archaeological resources, when compared to Alternative 1 • Additional archaeological assessment activities would be required to confirm impacts and/or mitigation, if required

Category (Weight)	Criteria	Factor	Alternative 1 – Widen to Outside	Alternative 2 – Shift to Inside and Widen to Outside
	Contamination	Potential to encounter contaminated soils/groundwater	• No significant difference between alternatives • Both alternatives have similar potential to encounter contaminated soils/groundwater • Additional environmental site assessment activities required to confirm presences of subsurface contamination, if any	
Community Summary (Weighted Score)			**Less Preferred (1)**	**More Preferred (3)**
Natural Environment (20%)	**Terrestrial Ecosystems**	Potential to impact significant wildlife areas /trees	–Anticipated to impact a greater area of wildlife habitat and/or significant trees, when compared to Alternative 1 • Some impacts can be mitigated through design/restoration	+Anticipated to impact a smaller area of wildlife habitat and/or significant trees, when compared to Alternative 1 • Some impacts can be mitigated through design/restoration
	Species of Special Concern	Potential to impact potential SAR habitat	–Anticipated to impact a greater area of potential SAR habitat, when compared to Alternative 2 • Some impacts can be mitigated through design/restoration	+Anticipated to impact a smaller area of potential SAR habitat, when compared to Alternative 1 • Some impacts can be mitigated through design/restoration
	Fish and Fish Habitat	Number of watercourse crossings Impacts to fish and fish habitat	• Traverses approximately 14 watercourses, 11 of which consist of coldwater fish habitat –Greater area of impact to fish habitat expected, when compared to Alternative 2 • Impacts can be mitigated through design/restoration	• Traverses approximately 14 watercourses, 11 of which consist of coldwater fish habitat +Reduced area of impact to fish habitat expected, when compared to Alternative 1 • Impacts can be mitigated through design/restoration
Natural Environment Summary (Weighted Score)			**Less Preferred (1)**	**More Preferred (3)**
Overall Assessment (Overall Weighted Score)			**More Preferred (2.5)**	**Less Preferred (2.0)**

5.2 Interchange Alternatives

The existing interchanges at Lyle Street and Percy Street will need to be reconfigured to accommodate the Highway 401 future footprints for interim six and ultimate eight lanes. The Preferred Plan is selected as the aggregate of Preliminary Design alternatives that achieve the best overall balance of transportation engineering, individual environmental factor impacts, and overall environmental impact, taking into consideration the net environmental effects by applying conceptual mitigation measures. A comprehensive evaluation approach was undertaken for the Lyle Street and Percy Street Interchanges to help identify a Preferred Plan that addresses current and future transportation needs in the study area.

5.2.1 Evaluation Process

To identify a preferred interchange design that could accommodate the future footprint of Highway 401 while minimizing environmental and community related impacts, a 3-staged evaluation process was used, and consisted of the following stages. The evaluation process for Lyle Street and Percy Street is described in Sections 5.2.2 and 5.2.3, respectively.

Screening Assessment: identify and assess bridge replacement alignment alternatives at each interchange to preliminarily assess the advantages and disadvantages of alignment alternatives and identify suitable bridge alignment alternatives to carry forward for further design development and evaluation.

Develop and Assess a Long List of Interchange Design Alternatives: Develop and assess new interchange designs for Lyle Street and Percy Street based on the preferred realignment identified in the Screening Assessment and identify a Short List of Interchange Design Alternatives to carry forward for more detailed evaluation.

Evaluate a Short List of Interchange Design Alternatives: Subject the Short List of Interchange Design Alternatives to a comparative evaluation process in consideration of transportation benefits and environmental effects for each alternative. The process includes: a) identifying evaluation criteria through input received during this study, the project team’s experience in projects of this nature, provincial guidelines and existing study area conditions; b) applying a weight percentage to each factor/criterion, which was based on the project team and stakeholder assessment of the importance of the factor; c) applying a reasoned argument approach to the evaluation in consideration of the net environmental effects of each alternative (qualitative assessment) and evaluating the Short List of Interchange Design Alternatives based on the total calculated scores (quantitative assessment); and, d) identifying a Preliminary Preferred Interchange Design.

Evaluation Criteria

The evaluation criteria were grouped into highway engineering, community, and natural environment categories. The criteria are independent variables, each of which may contribute a positive or negative influence on the overall suitability of an Interchange Design Alternative based on the factors considered within each criterion and the scoring methodology.Table 5-7 to Table 5-9 set out the evaluation criteria for the Interchange Design Alternatives including the factors considered for each criterion, and the methodology and measurement for the scoring of each factor.

Table 5-7: Engineering Evaluation Criteria

Engineering		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Traffic Operations	LOS	LOS for each alternative and future capacity of the interchange design
Geometrics and Safety	Expected number of collisions	The expected number of collisions at the ramp, ramp terminal and along the highway mainline segment within 1 km in either direction of the ramp terminal
	Accommodates LCVs	Measure of the ramp radii (m)
	Local road connectivity*	Pairwise comparison based on connectivity to Old Lyle Street/ Patrol Yard Entrance intersection and Edwardson Road Intersection
	Crossing road grade at ramp terminal	Measure of the crossing road (Nagle Road) grade (%)
Constructability	Staging Complexity and detours	Pairwise comparison based on construction staging complexity for each alternative
Utilities	Length of impacts to utilities	A measure of the length of utilities impacted (m)
Cost	Construction cost	Cost estimate based on material quantities ($M)

* – Only applies to Lyle Interchange

Table 5-8:Community Evaluation Criteria

Community		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Property	Area of impact to private property	Measure of the area of private properties impacted (ha)
	Number of private properties potentially impacted by construction activities	Measure of the number of private properties impacted
Noise & Air Quality	Number of residential dwellings within 600 m of interchange	Measure of the number of residential dwellings within 600 m of interchange alternative
Cultural Heritage	Potential to affect cultural heritage resources	Number and scale of impact to cultural heritage features
Archaeology	Possible impacts to areas having archaeological potential	The area of impact to areas with archaeological potential and sites (ha)
Contamination	Potential to encounter contaminated soils/groundwater	The number of properties encroached that have potential for contamination

Table 5-9: Environment Evaluation Criteria

Environment		
Criteria	**Factor**	**Method of Measurement/ Scoring**
Terrestrial Ecosystem	Area of impact to wildlife habitat	Identify area of wildlife habitat impacted (ha)
	Area of impacts to any significant treed areas	Identify significant treed areas impacted (ha)
Species of Conservation Concern	Area impacts to potential SAR habitat	Identify area of impact to potential rare or Species-at-Risk habitat (ha)
Fish and Fish Habitat	Number of watercourse crossings	Count of the number of watercourse crossings impacted
	Impacts to fish habitat	Identify if there will be impacts to fish habitat (yes/no)

Criteria Weighting

Each criterion was assigned a weight factor. A weight percentage was applied to each factor, which was based on the project teams and stakeholder assessment of the importance of the factor. The level of importance assigned to the factor/criterion was relative to other factors/criteria. As such, the higher the level of importance, the higher the associated weight value assigned. Table 5-10 presents the weight percentage applied to each factor.

Table 5-10: Weighting for Each Evaluation Category

Category	Weight
Highway Engineering	50.0%
Community	30.0%
Natural Environment	20.0%

Qualitative Assessment

A qualitative assessment of the alternatives was completed by tabulating the advantages and disadvantages of each alternative based upon the evaluation criteria developed and the scale of potential impacts for each criterion. Within Table 5-14, the advantages and disadvantages are identified by plus sign (+) and minus sign (-), respectively. Otherwise, a bullet sign (●) identifies a neutral comment where there is no clear advantage or disadvantage.

Quantitative Assessment

A quantitative assessment was undertaken for each alternative, and was based on the following methodology:

- For each evaluation category, each alternative was given a score from 0 to 5
- The evaluation category weightings were applied to the scores for each alternative
- The total score for each alternative was obtained and the alternatives were ranked according to the total score

Table 5-11 sets out the scoring legend for the quantitative assessment of alternatives.

Table 5-11: Scoring Legend

Preference of Alternative	Score
Most Preferred	4
More Preferred	3
Equally Preferred	2
Less Preferred	1
Least Preferred	0

The results of the quantitative assessment of the alternatives (i.e., the weighted score) for the Lyle Street and Percy Street Interchange Design Alternatives is summarized in 5.2.2 and 5.2.3. The final score for each alternative is provided at the end of each table which considers the evaluation category weightings.

5.2.2 Evaluation of Lyle Street Interchange Alternatives

Screening Assessment

The results of the assessment of each alignment alternative for the Lyle Street bridge are summarized in Table 5-12.

Table 5-12: Lyle Street Bridge Replacement Alignment Alternatives

Alignment Alternative	Advantages/Disadvantages
1 New Alignment – East	**Advantages** • Minimizes property impacts • Can be constructed with minimal impacts to traffic • Improves the alignment of Lyle Street **Disadvantages** • Requires alignment shift • Significant higher cost than replacing on existing alignment
2 Existing Alignment	**Advantages** • Significantly lower cost to keep on existing alignment • Reduces property impacts on existing alignment **Disadvantages** • Requires closure of the crossing road • May significantly impact traffic operation • Does not provide opportunity to improve the alignment of Lyle Street.
3 New Alignment – West	**Advantages** • Can be constructed with minimal impacts to traffic **Disadvantages** • Requires alignment shift • Significant higher cost than replacing on existing alignment • Significant property and utility impacts • Undesirable alignment of Lyle Street

Based on the findings of the Stage 1 assessment of alignment alternatives, Alternative 1: replacing the bridge on a new alignment to the east is preferred because:

- It minimizes impacts to adjacent properties
- Can be constructed with minimal impacts to traffic
- Improves the alignment of Lyle Street

Develop and Assess Long List of Interchange Alternatives

A Long List of Interchange Design Alternatives for Lyle Street was developed and assessed. This included four new interchange designs for each location that were generated based on an eastern realignment of the existing north-south roadway. Table 5-13 presents the assessment of the Long List of Lyle Street Interchange Alternatives. A copy of the interchange alternative designs is provided in Appendix I.

Table 5-13: Assessment of the Long List of Lyle Street Interchange Alternatives

Alternative	Advantages/Disadvantages
1 Diamond	**Advantages** • Requires less property than Parclo interchanges • Lower construction cost when compared to a Parclo interchanges • Does not impact Cranberry Lake Provincially Significant Wetland **Disadvantages** • Lower traffic capacity than a Parclo interchange • Potential for “wrong-way” movements from side road to exit ramps • Increased traffic conflicts at ramp intersections with Lyle Street • Impacts an existing utility building in the southeast quadrant of the interchange • Requires relocation of existing carpool lot
2 Parclo A4	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to other interchange alternatives • Interchange is a standard configuration with inherent safety features (i.e., minimal conflicts) • Does not impact Cranberry Lake Provincially Significant Wetland **Disadvantages** • Higher construction costs when compared to a Diamond interchange • Requires more property than a Diamond interchange • Impacts an existing utility building in the southeast quadrant of the interchange • Impacts an existing hydro substation in the northeast quadrant of the interchange • Requires relocation of existing carpool lot

Alternative	Advantages/Disadvantages
3 Parclo B4	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to a Diamond interchange **Disadvantages** • Requires more property than other interchange alternatives • Loop ramp exits on freeways are less desirable than direct ramps • Impacts MTO Patrol Yard and Fire and Rescue Station • Typically higher construction costs than other interchange alternatives • Impacts Cranberry Lake Provincially Significant Wetland • Impacts an existing utility building in the southeast quadrant of the interchange • Impacts an existing hydro substation in the northwest quadrant on the interchange • Requires relocation of existing carpool lot
4 Parclo A2	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to a Diamond interchange • Interchange is a standard configuration with inherent safety features (i.e., minimal conflicts) • Can be expanded to Parclo A4 configuration in the future, if required • Minimizes property impacts in the northwest and southeast quadrants of the interchange • Does not impact Cranberry Lake Provincially Significant Wetland **Disadvantages** • Requires more property than a Diamond interchange • Higher construction costs and requires more property compared to a Diamond interchange • Lower traffic capacity and safety compared to a Parclo A4 or B4 interchange • Impacts an existing utility building in the southeast quadrant of the interchange • Requires relocation of existing carpool lot

Based on the assessment of the Long List of Lyle Street Interchange Design Alternatives, Alternative 3 was screened out from further consideration because it has significant property impacts in the northwest and southeast quadrants, and it is less desirable to have exit loop ramps on Highway 401. Alternatives 1, 2 and 4 are carried forward for detailed evaluation of the Short List of Lyle Street Interchange Design Alternatives.

Evaluation of Short List of Interchange Design Alternatives

The evaluation of the Short List of Lyle Street Interchange Design Alternatives is provided in Table 5-14.

Table 5-14: Evaluation of Short List of Lyle Street Interchange Design Alternatives

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative2 Parclo A4**	**Alternative4 Parclo A2**
Highway Engineering (50%)	**Traffic Operations**	Level of Service (LOS)	– Performs at a good LOS (i.e., minimal traffic delays) but inherently has less traffic capacity than the Parclo A interchange alternatives	+ Performs at an excellent LOS (i.e., minimal traffic delays) but inherently has more traffic capacity than the other alternatives	• Performs at an excellent LOS (i.e., minimal traffic delays) but inherently has more traffic capacity than the Diamond interchange alternative and less than the Parclo A4 interchange alternative
	Geometrics & Safety	Collisions	+ Lowest expected total number of ramp collisions + Highest number of ramp terminal collisions – Interchange design has the highest number of conflict points between traffic movements and does not provide any free-flow traffic movements from the crossing road to the ramps	– Highest expected total number of ramp collisions + Lowest number of ramp terminal collisions + Interchange design has the least number of conflict points between traffic movements and provides free-flow operations for most of the movements	• Slightly higher total number of expected ramp collisions when compared to the Diamond interchange + Lowest number of ramp terminal collisions • Interchange design has a fewer number of conflict points between traffic movements than a Diamond interchange, but does not provide as much free-flow operation as a Parclo A4 interchange
		Accommodates Long Combination Vehicles (LCVs)	+ No significant difference between alternatives + LCVs are accommodated by each design alternative		
		Local Road Connectivity	– The Old Lyle Street/Patrol Yard Entrance intersection is located 85 m from the south ramp terminal, resulting in an additional intersection that does not meet MTO separation requirements from a ramp terminal – The Edwardson Road intersection is located 80 m from the north ramp terminal, resulting in an additional intersection that does not meet MTO separation requirements from a ramp terminal	+ The Old Lyle Street/Patrol Yard Entrance intersection and Edwardson Road intersection are integrated into the interchange design, which reduces overall number of intersections	+ The Old Lyle Street/Patrol Yard Entrance intersection and Edwardson Road intersection are integrated into the interchange design, which reduces overall number of intersections
		Crossing road grade at ramp terminal	+ Crossing road grade within desirable limits		
	Constructability	Complexity of staging and detours	+ Lowest complexity of traffic staging	– Highest complexity of traffic staging	• Moderate complexity of traffic staging
	Utilities	Length of impact	+ Minimizes utility impacts for a new alignment		

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative2 Parclo A4**	**Alternative4 Parclo A2**
	Total Cost	Construction Cost	+ Lowest initial construction cost when compared to other alternatives	– Highest initial construction cost when compared to other alternatives	• Moderate initial construction when compared to other alternatives
Highway Engineering Summary (Weighted Score)			**Less Preferred (1)**	**Most Preferred (4)**	**More Preferred (3)**
Community (30%)	**Property**	Area of impact to private property Number of private properties potentially impacted by construction activities	+ Impacts approximately 1.29 ha of private property + Portions of approximately 9 private properties impacted by construction activities • Impacts will be confirmed during detail design	– Impacts approximately 2.89 ha of private property – Portions of approximately 12 private properties impacted by construction activities • Impacts will be confirmed during detail design	• Impacts approximately 2.49 ha of private property • Portions of approximately 11 private properties impacted by construction activities • Impacts will be confirmed during detail design
	Air/Noise	Number of residential dwellings within 600 m of alternative	• No significant difference between alternatives • 62 residential dwellings within 600 m of alternative		
	Cultural Heritage	Potential to affect cultural heritage resources	• No significant difference between alternatives • May impact 2 properties identified as potential cultural heritage resources • Additional cultural heritage assessment activities would be required to confirm cultural heritage value/interest, as well as impacts and mitigation, where warranted		
	Archaeology	Possible impacts to areas having archaeological potential	+ Potential to impact an approximately 11.32 ha area having archaeological potential • Additional archaeological assessment (AA) activities will be carried to confirm impacts, if any	– Potential to impact an approximately 15.45 ha area having archaeological potential • Additional AA activities will be carried to confirm impacts, if any	• Potential to impact an approximately 11.6 ha area having archaeological potential • Additional AA activities will be carried to confirm impacts, if any
	Contamination	Potential to encounter contaminated soils/groundwater	– May impact a portion of property identified as having high potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any	– May impact a larger portion of property identified as having high potential for contamination, when compared to the Diamond interchange – May encroach onto property having low potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any	– May impact a larger portion of property identified as having high potential for contamination, when compared to the Diamond interchange – May encroach onto property having low potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative2 Parclo A4**	**Alternative4 Parclo A2**
Community Summary (Weighted Score)			**Most Preferred (4)**	**Less Preferred (1)**	**More Preferred (3)**
Natural Environment (20%)	**Terrestrial Ecosystem**	Area of impact to wildlife habitat Area of impacts to any significant treed areas	• Impacts 9.11 ha of wildlife habitat + Impacts 3.25 ha of significant treed areas • Some impacts may be mitigated through restoration/design	– Impacts 11.71 ha of wildlife habitat – Impacts 3.81 ha of significant treed areas • Some impacts may be mitigated through restoration/design	+ Impacts 8.44 ha of wildlife habitat • Impacts 3.4 ha of significant treed areas • Some impacts may be mitigated through restoration/design
	Species of Conservation Concern	Area impacts to potential SAR habitat	• No significant difference between alternatives • No impacts to potential SAR habitat		
	Fish & Fish Habitat	Number of watercourse crossings Impacts to fish habitat	• No significant difference between alternatives • 2 watercourse crossings required • Potential to impact fish habitat • Impacts can be mitigated through restoration/design		
Natural Environment Summary (Weighted Score)			**More Preferred (3)**	**Less Preferred (1)**	**Most Preferred (4)**
Overall Assessment (Overall Weighted Score)			**Less Preferred (2.3)**	**More Preferred (2.5)**	**Most Preferred (3.2)**

The Preliminary Preferred Interchange Design for the Highway 401 and Lyle Street Interchange is to build a new crossing slightly east of the existing crossing to facilitate construction and reconfigure the interchange to Alternative 4- Parclo A2, with the option to expand to a Parclo A4 in the future. This alternative will:

- Provide sufficient traffic capacity for the long-term operation needs
- Provide free-flow traffic movements for the dominant south and west movements
- Impacts a smaller area of private property and lands having archaeological potential, than the Parclo A4 interchange
- It has the potential to impact the smallest area of natural environment features, when compared to the other alternatives

5.2.3 Evaluation of Percy Street Interchange Alternatives

Screening Assessment

The results of the assessment of each alignment alternative for the Percy Street bridge replacement alternatives are summarized in Table 5-15.

Table 5-15: Percy Street Bridge Alignment Alternatives

Alternative	Advantages/Disadvantages
1 New Alignment – East	**Advantages** • Minimizes property, utility and cemetery impacts compared to the alignment to the west • Minimal impacts to traffic during construction **Disadvantages** • Higher construction cost when compared to keeping on existing alignment
2 Existing Alignment	**Advantages** • Lower construction cost keeping on existing alignment • Fewer property or utility impacts **Disadvantages** • Requires closure of crossing road and significant impacts to traffic
3 New Alignment – West	**Advantages** • Minimal impacts to traffic during construction **Disadvantages** • Significant property, utility and cemetery impacts when compared to alignment to the east • Higher construction cost when compared to keeping on existing alignment

Based on the findings of the Stage 1 assessment of alignment alternatives, Alternative 1: replacing the bridge on a new alignment to the east is preferred because:

- Impacts to property, utilities and a cemetery are minimized compared to the west alignment
- Minimal impacts to traffic are expected during construction

Develop and Assess Long List of Interchange Design Alternatives

A Long List of Interchange Design Alternatives for Percy Street was developed and assessed. This included four new interchange designs for each location that were generated based on an eastern realignment of the existing north-south roadway. Table 5-16 presents the Percy Street interchange alternatives considered. A copy of the interchange design alternatives is provided in Appendix I.

Table 5-16: Long List of Percy Street Interchange Alternatives

Alternative	Advantages/Disadvantages
1 Diamond	**Advantages** • Requires less property than Parclo interchanges • Lower construction cost when compared to Parclo interchanges **Disadvantages** • Lower traffic capacity than a Parclo interchange • Potential for “wrong-way” movements from side road to exit ramps • Increased traffic conflicts at ramp intersections with Percy Street • Requires relocation of existing carpool lot

Alternative	Advantages/Disadvantages
2 Parclo A4	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to other interchange alternatives • Interchange is a standard configuration with inherent safety features (i.e., minimal conflicts) **Disadvantages** • Higher construction costs when compared to a Diamond interchange • Requires more property than a Diamond interchange • Requires relocation of existing carpool lot
3 Parclo B4	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to a Diamond interchange **Disadvantages** • Loop ramp exits on freeways are less desirable than direct ramps • Typically higher construction costs than other interchange alternatives • Significant impacts to commercial properties • Requires more property than other interchange alternatives • Requires relocation of existing carpool lot
4 Parclo A2	**Advantages** • Higher traffic capacity and minimal traffic conflicts when compared to Alternatives 1 and 3 • Interchange is a standard configuration with inherent safety features (i.e., minimal conflicts) • Can be expanded to Parclo A4 configuration in the future, if required **Disadvantages** • Requires more property than a Diamond interchange • Higher construction costs and requires more property compared to a Diamond interchange • Lower traffic capacity and safety compared to a Parclo A4 or B4 interchange • Requires relocation of existing carpool lot

Based on the findings of the Evaluation of the Long List of Interchange Design Alternatives, Alternative 3 was screened out from further consideration because it is expected to have significant property impacts in the northwest and southeast quadrants of the interchange, and it is less desirable to have exit loop ramps on Highway 401. Alternatives 1, 2 and 4 were carried forward for detailed evaluation of the Short List of Percy Street Interchange Design Alternatives.

Evaluation of Short List of Interchange Design Alternatives

The evaluation of the Short List of the Percy Street Interchange Design Alternatives is provided in Table 5-17.

Table 5-17: Evaluation of the Short List of Percy Street Interchange Design Alternatives

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative 2 Parclo A4**	**Alternative 4 Parclo A2**
Highway Engineering (50%)	**Traffic Operations**	Level of Service (LOS)	– Performs at a good Level of Service (i.e., minimal traffic delays) but inherently has less traffic capacity than the Parclo A interchange alternatives	+ Performs at an excellent Level of Service (i.e., minimal traffic delays) but inherently has more traffic capacity than the other alternatives	• Performs at an excellent Level of Service (i.e., minimal traffic delays) but inherently has more traffic capacity than the Diamond interchange alternative and less than the Parclo A4 interchange alternative
	Geometrics & Safety	Expected # of collisions	+ Lowest expected total number of ramp collisions – Highest number of collisions at ramp terminals – Interchange design has the highest number of conflict points between traffic movements	– Highest expected total number of ramp collisions + Lowest number of collisions at ramp terminals + Interchange design has the least number of conflict points between traffic movements and provides free-flow operations for most of the movements	• Slightly higher total number of expected collisions when compared to the Diamond interchange + Lower number of collisions at ramp terminals • Interchange design has a fewer number of conflict points between traffic movements than a Diamond interchange, but does not provide as much free-flow operation as a Parclo A4 interchange
		Accommodates Long Combination Vehicles (LCVs)	+ No significant difference between alternatives + LCVs are accommodated by each design alternative		
		Crossing road grade at ramp terminal	+ No significant difference between alternatives + Crossing road grade within desirable limits		
	Constructability	Complexity of staging and detours	+ Lowest complexity of traffic staging	– Highest complexity of traffic staging	• Moderate complexity of traffic staging
	Utilities	Length of impact	+ Minimizes utility impacts for a new alignment		
	Total Cost	Construction Cost	+ Lowest initial construction cost when compared to other alternatives	– Highest initial construction cost when compared to other alternatives	• Moderate initial construction cost when compared to other alternatives
Highway Engineering Summary (Weighted Score)			**Less Preferred (1)**	**Most Preferred (4)**	**More Preferred (3)**

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative 2 Parclo A4**	**Alternative 4 Parclo A2**
Community (30%)	**Property**	Area of impact to private property	• Impacts approximately 2.6 ha of private property	– Impacts approximately 3.2 ha of private property	+ Impacts 2.2 ha of private property
		Number of private properties potentially impacted by construction activities	– Portions of approximately 10 private properties impacted by construction activities	• Portions of approximately 9 private properties impacted by construction activities	+ Portions of approximately 6 private properties impacted by construction activities
	Air Noise	Number of residential dwellings within 600 m of alternative	• 28 residential dwellings within 600 m of alternative	– 30 residential dwellings within 600 m of alternative	+ 23 residential dwellings within 600 m of alternative
	Cultural Heritage	Potential to affect cultural heritage resources	– Adjacent to property identified as Cultural Heritage Landscape (Union Cemetery) – Potential to encroach onto identified Built Heritage Resource property • Additional cultural heritage assessment activities would be required to confirm cultural heritage value/interest, as well as impacts and mitigation, where warranted • Direct impacts to Union Cemetery would be avoided	– Adjacent to property identified as Cultural Heritage Landscape (Union Cemetery) – Potential to encroach onto identified Built Heritage Resource property • Additional cultural heritage assessment activities would be required to confirm cultural heritage value/interest, as well as impacts and mitigation, where warranted • Direct impacts to Union Cemetery would be avoided	– Adjacent to property identified as Cultural Heritage Landscape (Union Cemetery) – Potential to encroach onto identified Built Heritage Resource property • Additional cultural heritage assessment activities would be required to confirm cultural heritage value/interest, as well as impacts and mitigation, where warranted • Direct impacts to Union Cemetery would be avoided
	Archaeology	Possible impacts to areas having archaeological potential	• Potential to impact an approximately 10.7 ha area of land having archaeological potential • Additional archaeological assessment (AA) activities required to confirm impacts, if any	– Potential to impact an approximately 14.7 ha area of land having archaeological potential • Additional archaeological assessment (AA) activities required to confirm impacts, if any	+ Potential to impact an approximately 10.1 ha area of land having archaeological potential • Additional archaeological assessment (AA) activities required to confirm impacts, if any
	Contamination	Potential to encounter contaminated soils/groundwater	– Traverses portion of 1 property identified as having high potential for contamination – May encroach onto 1 property having moderate potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any	– Traverses portion of 1 property identified as having high potential for contamination – May encroach onto 1 property having moderate potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any	• Avoids properties identified as having moderate and/or high potential for contamination • Additional environmental site assessment activities required to confirm on-site soil/groundwater contamination, if any
Community Summary (Weighted Score)			**Less Preferred (1)**	**Least Preferred (0)**	**Most Preferred (4)**

Category (Weight)	Criteria	Factors	Alternative		
			Alternative 1 Diamond	**Alternative 2 Parclo A4**	**Alternative 4 Parclo A2**
Natural Environment (20%)	**Terrestrial Ecosystem**	Area of impact to wildlife habitat Area of impacts to any significant treed areas	+ Potential to impact approximately 4.5 ha of wildlife habitat + Potential to impact approximately 0.6 ha of significant treed areas • Some impacts may be mitigated through restoration/design	– Potential to impact approximately 6.3 ha of wildlife habitat – Potential to impact approximately 0.9 ha of significant treed areas • Some impacts may be mitigated through restoration/design	+ Potential to impact approximately 4.5 ha of wildlife habitat – Potential to impact approximately 0.9 ha of significant treed areas • Some impacts may be mitigated through restoration/design
	Species of Conservation Concern	Area impacts to potential SAR habitat	+ Potential to impact approximately 0.5 ha of bird SAR habitat • Some impacts may be mitigated through restoration/design	– Potential to impact approximately 0.6 ha of bird SAR habitat • Some impacts may be mitigated through restoration/design	– Potential to impact approximately 0.6 ha of bird SAR habitat • Some impacts may be mitigated through restoration/design
	Fish & Fish Habitat	Number of watercourse crossings Impacts to fish habitat	• No significant difference between alternatives • 1 crossing of watercourse required • Potential to impact permanent coldwater watercourse that supports fish and fish habitat • Impacts can be mitigated through restoration/design		
Natural Environment Summary (Weighted Score)			**Most Preferred (4)**	**Less Preferred (1)**	**More Preferred (3)**
Overall Assessment (Overall Weighted Score)			**Less Preferred (1.6)**	**More Preferred (2.2)**	**Most Preferred (3.3)**

The Preliminary Preferred Interchange Design for the Highway 401 and Percy Street Interchange is the Parclo A2, which will move the crossing to facilitate construction, then reconfigure to Alternative 4 Parclo A2 interchange, with the option to expand to a Parclo A4 in the future. This alternative will:

- Provide sufficient capacity for long-term traffic operation needs
- Provide free-flow traffic movements for the dominant south and west movements
- Impacts the smallest area of private property and lands having archaeological potential
- Impacts a smaller area of natural environment features when compared to the other alternatives.

5.3 Bridge Alternatives

The Danforth Road, Gully Road, Shelter Valley Road, Vernonville Road, Boyce Road, Lyle Street and Percy Street bridges within the study area are approaching the end of their service life and will need to be rehabilitated or replaced. The bridges will also need to accommodate the future Highway 401 footprints for interim six and ultimate eight lanes.

5.3.1 Evaluation Process

A range of reasonable bridge improvement alternatives for each bridge were initially developed and subjected to a screening process to preliminarily assess the advantages and disadvantages of each alternative and identify suitable alternatives to carry forward for further evaluation. A summary of the assessment of bridge improvement alternatives is outlined within the following subsections. It should be noted that the ‘Do Nothing’ alternative for each bridge was screened out during the preliminary screening of the bridge alternatives as it did not accommodate the short-term or long-term structure needs.

The bridge alternatives are displayed in the Public Information Centre displays, provided in Appendix Q.3 and Q.4.

5.3.2 Evaluation of Danforth Road Bridge Alternatives

The structure is approximately 62 years old and is in good condition. The existing structure span can accommodate the 6-laning of Highway 401, but this would require reducing the shoulders to about 2.1 m and shifting the Highway 401 crown. This is undesirable; therefore, the structure should be replaced with the 6-lane highway widening unless it is required to be replaced sooner. The new underpass will be designed to accommodate the ultimate eight lane highway configuration.

The bridge alignment alternatives generally included: replace on existing alignment; replace on new alignment to the west; replace on new alignment to the east. The results of the assessment of each alignment alternative identified for the Danforth Road bridge are summarized in Table 5-18.

Table 5-18: Danforth Road Bridge Alternatives

Alternative	Advantages and Disadvantages
1a Replace on Existing Alignment Bridge Closed with Detour	**Advantages** • Retains existing alignment of Danforth Road • No property required • Fewer utility impacts compared to Alternatives 2 and 3 • Faster method of construction when compared to staged construction with single lane on crossing road • Lower construction staging cost compared to keeping bridge open during construction **Disadvantages** • Up to 8.3 km of out-of-way travel for the detour
1b Replace on Existing Alignment Bridge Open with Single Lane	**Advantages** • Retains existing alignment of Danforth Road • No property required • Fewer utility impacts compared to Alternatives 2 and 3 **Disadvantages** • Minor delays to traffic • Longer construction schedule when compared to closing the crossing road • Higher construction staging cost when compared to closing the crossing road

Alternative	Advantages and Disadvantages
2 Replace on New Alignment – West Bridge Open with Two Lanes	**Advantages** • No delays to traffic • Similar construction schedule as closing crossing road • Similar construction staging cost as closing the crossing road **Disadvantages** • Requires alignment shift on Danforth Road • Requires property • Impacts utilities • Requires improvements at Northumberland Heights Road • Significantly higher cost when compared to replacing on existing alignment
3 Replace with New Alignment – East Bridge Open with Two Lanes	**Advantages** • No delays to traffic • Similar construction schedule as closing crossing road • Similar construction staging cost as closing the crossing road **Disadvantages** • Requires alignment shift on Danforth Road • Requires property • Impacts utilities • Requires improvements at Northumberland Heights Road • Significantly higher cost when compared to replacing on existing alignment

Based on the assessment of Danforth Road improvement alternatives, **Alternative 1a Replace on Existing Alignment and Bridge Closed with Detour** is preferred because:

- It retains the existing alignment of Danforth Road, which minimizes environmental, property, and utility impacts
- The construction method is faster when compared to staged construction with a single lane of traffic open on crossing road
- The construction staging cost is lower when compared to keeping the bridge open during construction

5.3.3 Evaluation of Gully Road Bridge Alternatives

The structure is approximately 62 years old and is in good condition. The existing structure centre span can accommodate the 6-laning of Highway 401, but this would require reducing the shoulders to about 1.8 m and shifting the Highway 401 crown. This is undesirable; therefore, the structure should be replaced in conjunction with the 6-lane highway widening unless it is required to be replaced sooner. The new underpass will be designed to accommodate the ultimate eight lane highway configuration.

The bridge alignment alternatives generally included: replace on existing alignment; replace on new alignment to the west; replace on new alignment to the east. The results of the assessment of each replacement alternative for the Gully Road bridge are summarized in Table 5-19.

Table 5-19: Gully Road Bridge Alternatives

Alternative	Advantages and Disadvantages
1a Replace on Existing Alignment Bridge Closed with Detour	**Advantages** • Retains existing alignment of Gully Road • No property required • Fewer utility impacts compared to Alternatives 2 and 3 • Faster method of construction when compared to staged construction with single-lane traffic open on crossing road • Lower construction staging cost when compared to keeping the bridge open during construction **Disadvantages** • Introduces up to 8.3 km of out-of-way travel for traffic for the detour
1b Replace on Existing Alignment Bridge Open with Single Lane	**Advantages** • Retains existing alignment of Gully Road • No property required • Fewer utilities impacted compared to Alternatives 2 and 3 **Disadvantages** • Minor delays to traffic • Longer construction schedule when compared to closing the crossing road • Higher construction staging cost when compared to closing the crossing road

Alternative	Advantages and Disadvantages
2 Replace with New Alignment – west Bridge Open with Two Lanes	**Advantages** • No delays to traffic • Similar construction schedule as closing crossing road • Similar construction staging cost as closing the crossing road **Disadvantages** • Requires alignment shift on Gully Road • Requires property • Impacts utilities • Significantly higher cost compared to replacing on existing alignment
3 Replace with New Alignment – east Bridge open with two lanes	**Advantages** • No delays to traffic • Similar construction schedule as closing crossing road • Similar construction staging cost as closing the crossing road **Disadvantages** • Requires alignment shift on Gully Road • Requires property • Impacts utilities • Significantly higher cost when compared to replacing on existing alignment

Based on the assessment of improvement alternatives, **Alternative 1a: Replace on Existing Alignment and Bridge Closed with Detour** is preferred because:

- It retains the existing alignment of Gully Road, which minimizes environmental, property, and utility impacts
- The construction method is faster when compared to staged construction with a single lane of traffic open on crossing road
- The construction staging cost is lower when compared to keeping bridge open during construction

5.3.4 Evaluation of Shelter Valley Road and Creek Bridge Alternatives

The culvert was constructed circa 1959, and consists of a reinforced concrete arch culvert with a span of 15.2 m, height of 7.7 m. and length of 102.7 m. The culvert has a 33.0° skew to the direction of Highway 401. There is approximately 7 m of fill over the crown of the culvert. The ends of the road culvert are perpendicular to road alignment and there is a concrete retaining wall at all four quadrants; the orientation of the retaining walls is at an angle off the road centreline.

The arch structure is approximately 63 years old and is in relatively good condition. Based on its current condition and with future regular maintenance, the remaining life of the culvert is estimated to be approximately 35 years. Based on a life cycle cost analysis, and the condition of the existing structure, it is recommended to rehabilitate the existing structure plus build a retaining wall to accommodate an extra lane in each direction at the interim stage coinciding with 6-laning of Highway 401.

Culvert replacement will be required at the ultimate 8-laning, at which time, the structure will be approximately 96 years old. The results of the assessment of each replacement alternative for the Shelter Valley Road bridge are summarized in Table 5-20.

Table 5-20: Shelter Valley Road Bridge Alternatives

Alternative	Advantages/Disadvantages
1 New Bridge Over Roadway and Creek	**Advantages** • Minimizes impacts to Shelter Valley Creek when compared to Alternatives 2 and 3 • No property required • Minimizes impacts to Shelter Valley Road when compared to Alternatives 2 and 3 • Lower construction cost when compared to Alternative 3 **Disadvantages** • Requires extensive excavation • Higher construction cost when compared to Alternative 2
2 New Creek Culvert and Extension Lining; and New Bridge Over Roadway	**Advantages** • Lower construction costs compared to other alternatives **Disadvantages** • Requires property • Culvert lining will permanently impact fish habitat in Shelter Valley Creek • Requires grade raise to Shelter Valley Road • Increases the flood water elevation • Shorter service life of creek culvert since it is only being lined and not replaced

Alternative	Advantages/Disadvantages
	• Significant impacts to Shelter Valley Creek during construction • Difficult to construct while maintaining creek flow
3 New Creek Culvert and New Bridge Over Roadway	**Advantages** • Minimizes impacts to Shelter Valley Road **Disadvantages** • Requires property • Requires realignment of Shelter Valley Creek, which may temporarily impact fish habitat. • Higher construction cost when compared to Alternative 1 and Alternative 2 • Requires retaining walls at Shelter Valley Road

Based on the assessment of improvement alternatives, **Alternative 1: New Bridge over Roadway and Creek** is preferred because:

- It retains existing alignment of Shelter Valley Road, which minimizes environmental, property, and utility impacts
- It minimizes impacts to Shelter Valley Creek when compared to other alternatives, and it has the lowest potential to impact fish and fish habitat
- It provides a potential future opportunity for a wildlife crossing of Highway 401

5.3.5 Evaluation of Vernonville Road Bridge Alternatives

The structure is approximately 62 years old and is in good condition. Based on the current bridge condition and with future regular maintenance, the remaining life of the overpass is estimated to be approximately 35 years. Based on a life cycle cost analysis, it is recommended to rehabilitate the existing structure plus widen to accommodate an extra lane in each direction at the interim stage coinciding with 6-laning of Highway 401.

A replacement structure will be built to coincide with the ultimate 8-laning as, at that time, the original overpass will be over 97 years old. The results of the assessment of each replacement alternative for the Vernonville Road bridge are summarized in Table 5-21.

Table 5-21: Vernonville Road Bridge Alternatives

Alternative	Advantages/Disadvantages
1a Replace on Existing Alignment Crossing road closed with detour	**Advantages** • No complex staging required • Lower construction cost when compared to keeping the crossing road open • Shorter construction duration because crossing road is closed to traffic **Disadvantages** • Introduces up to 10.8 km of out-of-way travel for traffic for the detour
1b Replace on Existing Alignment Crossing road kept open	**Advantages** • No out-of-way travel **Disadvantages** • Higher construction cost when compared to closing the road • Longer construction duration because crossing road is open • Minor delays to traffic during construction • Requires reduced lane widths and lane shifts on Vernonville Road during construction

Based on the assessment of improvement alternatives, **Alternative 1a: Replace on Existing Alignment, Crossing Road Closed with Detour** is preferred because:

- The construction method is faster when compared to staged construction with a single lane of traffic open on crossing road, and
- The construction staging cost is lower when compared to keeping bridge open during construction

5.3.6 Evaluation of Boyce Road Bridge Alternatives

The results of the assessment of each replacement alternative for the Boyce Road bridge are summarized in Table 5-22.

Table 5-22: Boyce Road Bridge Alternatives

Alternative	Advantages/Disadvantages
1a Replace on Existing Alignment Crossing road closed with detour	**Advantages** • No complex staging required • Lower construction cost when compared to keeping the crossing road open • Shorter construction duration because crossing road is closed to traffic **Disadvantages** • Introduces up to 7.8 km of out-of-way travel for traffic for the detour
1b Replace on Existing Alignment Crossing road kept open	**Advantages** • No out-of-way travel **Disadvantages** • Higher construction cost when compared to closing the road • Longer construction duration because crossing road is open • Minor delays to traffic during construction • Requires reduced lane widths and lane shifts on Boyce Road during construction

Based on the assessment of improvement alternatives, **Alternative 1a: Replace on Existing Alignment, Crossing Road Closed with Detour** is preferred because:

- The construction method is faster when compared to staged construction with a single lane of traffic open on crossing road
- The construction staging cost is lower when compared to keeping bridge open during construction

5.4 Structural Culvert Alternatives

Seven large (i.e., greater than 3 m wide) structural culverts are present within the study area, each of which are approaching the end of their service life and will need to be rehabilitated or replaced. In addition, the culverts will need to accommodate the future Highway 401 footprints for the interim six and ultimate eight lanes.

5.4.1 Evaluation Process

Each culvert was assessed on a case-by-case basis to understand the advantages and disadvantages of the interim and ultimate alternatives solutions. Based on the findings of the assessment, the preferred improvements for each culvert are summarized below.

The drainage improvement strategies developed as part of this study and the associated advantages and disadvantages of each alternative are summarized in Table 5-23.

Table 5-23: Drainage Improvement Strategies and Assessment

Alternative	Advantages and Disadvantages
Replace with New Culvert	**Advantages** • Long-term strategy • Accommodates interim 6-lane and ultimate 8-lane Highway 401 **Disadvantages** • Culverts can be very long in high fill locations
Rehabilitate and Extend Culvert	**Advantages** • Accommodates interim 6-lane Highway 401 • Potential short-term strategy **Disadvantages** • Does not accommodate ultimate 8-lane Highway 401 • Culverts can be very long in high fill locations • Not a long-term strategy
Replace with Bridge	**Advantages** • Long-term strategy • Accommodates interim 6-lane and ultimate 8-lane Highway 401 • Suitable for high fill locations
Rehabilitate Culvert and Add Retaining Walls	**Advantages** • Potential short-term strategy • Accommodates interim 6-lane Highway 401 **Disadvantages** • Does not accommodate ultimate 8-lane Highway 401 • Not a long-term strategy • Requires retaining walls

The drainage strategies were further developed specifically for each culvert site. The alternatives and the preferred plan for each culvert are described in the following sections.

5.4.2 Evaluation of Culvert 21X-0467/C0 (Unnamed) Alternatives

The culvert was constructed circa 1959 and consists of a rigid frame box with a span of 3.1 m, height of 1.8 m and length of about 146 m. The culvert is continuous across Highway 401 and Northumberland Heights Road at the north. It has a 30° skew to the direction of Highway 401. There is approximately 10.0 m of fill over the top slab beneath Highway 401 and approximately 6 m at the municipal road. The existing culvert should be scheduled for replacement in the next ten years. To take advantage of the traffic staging, it is recommended that replacement be scheduled to coincide with widening of Highway 401 to six lanes.

Three alternative solutions have been developed for replacement of this culvert, namely: replacement with a bridge; replacement with a culvert installed by open cut; and replacement with a culvert by trenchless methods. For the purpose of undertaking an evaluation of the alternatives, we have assumed that the trenchless method will involve lining of the existing culvert and installation of a new overflow culvert.

Culvert replacement by trenchless methods is the preferred option. It offers improved durability and less maintenance as compared to a bridge, avoids the constructability challenges associated with open cut replacement, has minimal impacts to traffic during construction, and is significantly less costly than the other alternatives.

5.4.3 Evaluation of Culvert 21X-0468/C0 (Unnamed) Alternatives

The structure is approximately 63 years old and is in relatively good condition. Based on the current culvert condition and with future regular maintenance, the remaining life of the culvert is estimated to be in excess of 30 years. Based on a life cycle cost analysis, and with consideration of the condition of the existing structure, it is recommended to rehabilitate the existing structure and build retaining walls at the interim stage coinciding with 6-laning of Highway 401. A replacement structure will be built to coincide with the ultimate 8-laning, at which time, the existing culvert will be nearing 100 years old.

Three alternative solutions have been presented for replacement of this culvert, namely: replacement with a bridge; replacement with a culvert installed by open cut; and replacement with a culvert by trenchless methods.

Culvert replacement by open cut methods is the preferred option. It offers optimum durability and less maintenance as compared to a bridge, avoids the constructability challenges associated with tunneling, and is significantly less costly than the other alternatives.

5.4.4 Evaluation of Culvert 21X-0469/C0 (Unnamed) Alternatives

The culvert was constructed circa 1958, and consists of a rigid frame box with a span of 3.7 m, height of 1.8 m and length of 91.5 m. The culvert is normal to the direction of Highway 401 (i.e., has zero skew).

The structure is approximately 63 years old and is in fair to good condition. There is approximately 12.0 m of fill over the top slab. There is a concern with longitudinal cracking that exists at the top slab and the belief that it is related to flexural forces imposed by the high fills. Since it is being proposed that the highway profile be raised in conjunction with 6-laning to address sag curve deficiencies, the loads on the culvert will increase. Therefore, unless a structural evaluation undertaken during detailed design can confirm the culvert's ability to support the additional load, it is recommended that the culvert be replaced in conjunction with 6-laning of the highway.

Four replacement options were evaluated for the culvert replacement, namely: line the existing culvert; replace culvert by open cut with shoring; replace culvert by trenchless methods; and replace culvert with an overpass structure.

The most suitable option is to install an arch liner inside the existing culvert. This option has the lowest construction cost with more than $2.0 m difference compared to the second cheapest option (replacement via trenchless methods). The liner will be 91.5 m in length to accommodate the widened highway cross-section.

5.4.5 Evaluation of 21X-0270/C0 (Grafton Creek) Alternatives

The culvert was constructed 1958, and consists of a reinforced concrete arch culvert with a span of 9.0 m, height of 4.5 m and length of 85.0 m. It has an 18.7° skew to the direction of Highway 401. There is approximately 10 m of fill over the crown of the arch.

The structure is approximately 64 years old and is in relatively good condition. Based on the current culvert condition and with future regular maintenance, the remaining life of the culvert is estimated to be approximately 35 years. Based on a life cycle cost analysis, and the condition of the existing structure, it is recommended to rehabilitate the existing structure plus build retaining walls to accommodate an extra lane in each direction at the interim stage coinciding with 6-laning of Highway 401. A replacement structure will be built to coincide with the ultimate 8-laning as, at that time, the structure will be over 97 years old.

Stantec, with collaboration with MTO Regional and Bridge offices, generated and evaluated several replacement options, namely: line and extend existing culvert; replace culvert by trenchless techniques; replace culvert by open cut; and replace culvert with a bridge.

Significant shoring would be required to replace the culvert which could encounter constructability complications and challenging soil conditions. In addition, the area has a history of wildlife-vehicle collisions and is identified as an excellent opportunity for an eco-

passage that aligns with a key natural corridor. A new bridge over the creek has fewer constructability concerns, provides an open natural channel, and has a lower construction cost. It is, therefore, selected as the preferred alternative.

5.4.6 Evaluation of 21X-0470/C0 (Northumberland Culvert) Alternatives

The culvert was constructed circa 1958, and consists of a rigid frame box with a span of 3.1 m, height of 1.8 m and length of 91.6 m. It has a 10° skew to the direction of Highway 401. There is approximately 11.0 m of fill over the top slab.

The structure is approximately 63 years old and is in fair to poor condition. There is considerable leakage through cracks and construction joints, and this is leading to corrosion of the reinforcing steel. It will be difficult to perform an effective rehabilitation that would significantly extend the life of the culvert. Further, the culvert is likely unable to support the proposed loads and strengthening would be required. For these reasons, rehabilitation is not considered to be a viable option and the culvert should be scheduled for replacement. Based on the current culvert condition, the remaining life is estimated to be approximately 10 years.

Three alternative solutions have been developed for replacement of this culvert, namely: replacement with a bridge; replacement with a culvert installed by open cut; and replacement with a culvert by trenchless methods. For the purpose of undertaking an evaluation of the alternatives, we have assumed that the trenchless method will involve lining of the existing culvert and installation of a new overflow culvert.

Culvert replacement by trenchless methods is the preferred option. It offers improved durability and less maintenance as compared to a bridge, avoids the constructability challenges

associated with open cut replacement, has minimal impacts to traffic during construction, and is significantly less costly than the other alternatives.

5.4.7 Evaluation of 21X-0272/C0 (Shelter Valley Creek) Alternatives

The culvert was constructed circa 1959, and consist of reinforced concrete arch culverts with a span of 15.2 m, height of 7.7 m. and length of 100.6 m. The culvert is normal to the direction of Highway 401 (i.e., has zero skew). There is approximately 12 m of fill over the crown of the culvert. The ends of the culvert are sloped and there is a concrete retaining wall at all four quadrants; the orientation of the retaining walls is approximately parallel to the highway centreline.

The arch structure is approximately 63 years old and is in relatively good condition. Based on its current condition and with future regular maintenance, the remaining life of the culverts is estimated to be approximately 35 years. Based on a life cycle cost analysis, and the condition of the existing structure, it is recommended to rehabilitate the existing structure plus build a retaining wall to accommodate an extra lane in each direction at the interim stage coinciding with 6-laning of Highway 401. Culvert replacements will be required at the ultimate 8-laning as, at that time, the structures will be about 96 years old.

A new bridge spanning Shelter Valley Road and Shelter Valley Creek is the preferred replacement strategy, as discussed in Section 5.3.4.

5.4.8 Evaluation of 21X-576/C0 (Boyce Road Culvert)

The culvert was constructed circa 1958, and consists of a rigid frame box with a span of 3.05 m, height of 2.44 m and length of 81 m. It has a 6° skew to the direction of Highway 401. There is approximately 8.0 m of fill over the top slab.

The structure is approximately 63 years old and is in fair to good condition. There is some leakage through cracks and construction joints, and this appears to be causing corrosion of the reinforcing steel. Further, there are wide longitudinal cracks in the soffit, suggesting that the culvert is overloaded in flexure. Rehabilitation and strengthening will be required if the culvert life is to be extended beyond 10 to 15 years.

Three alternative solutions have been presented for replacement of this culvert, namely: replacement with a bridge; replacement with a culvert installed by open cut; and replacement with a culvert by trenchless methods. For the purpose of undertaking an evaluation of the alternatives, we have assumed that the trenchless method will involve lining of the existing culvert and installation of a new overflow culvert.

Culvert replacement by trenchless methods is the preferred option. It offers improved durability and less maintenance as compared to a bridge, avoids the constructability challenges associated with open cut replacement, has minimal impacts to traffic during construction, and is significantly less costly than the other alternatives.

5.5 Retaining Wall Alternatives

Two properties were identified as requiring a possible retaining wall or other treatment to minimize or eliminate property impacts. These included the Shelter Valley Pines Golf Club and a residential property on the south side of Highway 401.

Four retaining wall options were developed for these two locations and evaluated to select the Recommended Plan at each property. A detailed evaluation of treatment options was carried out for each property, the findings of which are summarized herein. The detailed results are documented under separate cover and on file with MTO.

Based on the findings of the evaluation of retaining wall treatments at the Shelter Valley Pines Golf Club property, a Retaining Wall at Highway Clear Zone was selected as it avoids impacts to private property, provides the recommended clear zone, and because construction activities could be undertaken without impacting highway traffic operations.

In addition, based on the evaluation of retaining wall treatments for the residential property, a No Wall – 2.25:1 Grading option was selected as it provides the recommended clear zone, incurs the lowest cost, and it does not require a retaining wall while maintaining the function of the existing property and avoiding impacts to its outbuilding.

6.0 Recommended Plan

This section of the report provides a description of the Recommended Plan for improvements to Highway 401 from 2.0 km east of Nagle Road easterly to 0.8 km east of Percy Street (County Road 25) within the County of Northumberland, Township of Hamilton, Township of Haldimand and Township of Cramahe. A complete set of drawings showing the Recommended Plan is available in Appendix J.

The Recommended Plan includes the following proposed work:

- Replacement and rehabilitation of existing bridges and structural culverts
- Interchange modifications at Lyle Street and Percy Street
- Future widening of Highway 401 to six lanes (Interim) and 8-lanes (Ultimate)
- Relocation of existing commuter parking lots at Lyle Street and Percy Street

6.1 Design Criteria

Highway 401 within the project limits is classified as a four-lane Rural Freeway Divided (RFD) highway. The posted speed limit on this section of the highway is 100 km/h and the design speed is 120 km/h.

There are seven municipal roads that cross Highway 401 within the project limits. Four underpasses (Highway 401 passes beneath the crossing road) and three overpasses (Highway 401 passes over the crossing road). The functional classification of each crossing road along with its posted speed and design speed is shown in Table 6-1.

Table 6-1: Crossing Road Posted and Design Speed

Crossing Road	Structure Type	Functional Highway Classification	Posted Speed (km/h)	Design Speed (km/h)
Danforth Road	Underpass	RLU 80	60	80
Gully Road	Underpass	RLU 90	70	90
Lyle Street (County Road 23)	Underpass (Interchange)	RAU 80	80	100
Shelter Valley Road	Overpass	RLU 90	70	90
Vernonville Road	Overpass	RLU 80	60	80
Boyce Road	Overpass	RLU 80	60	80
Percy Street (County Road 25)	Underpass (Interchange)	RLU 80	60	80

6.2 Highway 401

6.2.1 Horizontal Alignment

The existing horizontal alignment for Highway 401 will be maintained with the exception of improvements at two locations.

There are minor deficiencies related to stopping sight distance on the outside of horizontal Curve #2 (Sta.11+395 Township of Haldimand, 0.6 km west of Danforth Road) and Curve #3 (PI Sta. 12+580 Township of Haldimand, between Danforth Road and Gully Road). The Recommended Plan includes expanding the platform of the eastbound lanes to the outside and shifting the median barrier to provide a larger median shoulder for the westbound lanes. Increasing the median shoulder width will allow for better visibility around the curve and provides the required stopping sight distance for the westbound direction. Similarly, to improve the stopping sight distance for the eastbound lanes at Curve #3, the westbound platform will be expanded to the outside and the median barrier shifted. This would result in a centreline radius of R-1200 for both the westbound lanes on Curve #2 and the eastbound lanes on Curve #3.

6.2.2 Vertical Alignment

The minimum requirements for vertical curves with a design speed of 120 km/h are K-95 for the crest curves and K-63 for the sag curves. Additionally, the maximum profile grade for a freeway with a design speed of 120 km/h is 3%.

As discussed in Section 4.4.5 there are 23 crest curves and 15 sag curves on Highway 401 within the project limits. Of the 38 vertical curves, 13 do not meet the minimum K-value for the design speed of the highway (120 km/h). All deficient vertical curves will be improved to meet the 120 km/h design speed.

6.2.3 Cross-Section

The Highway 401 cross-section within the study limits includes future widening of the highway to 6-lanes initially (Interim) and 8-lanes ultimately (Ultimate). The existing median width will be

maintained with exception of the two horizontal curve improvements as discussed in Section 6.2.1). All widening will occur to the outside of the road platform. The cross-section elements of Highway 401 within the project limits are summarized in Table 6-2.

Table 6-2: Recommended Highway 401 Cross-Section Elements

Cross-Section Element	Median Type & Location	
	Grass Median with Steel Beam Guide Rail (Station 23+050 to Station 24+900 Hamilton Township)	**Paved Median with Concrete Tall Wall Barrier (Station 24+900 Hamilton Township to Station 12+500 Cramahe Township)**
	Width (m)	**Width (m)**
Pavement Width	6 x 3.75 m (3 EBL, 3 WBL) [Interim] 8 x 3.75 m (4 EBL, 4 WBL) [Ultimate]	6 x 3.75 m (3 EBL, 3 WBL) [Interim] 8 x 3.75 m (4 EBL, 4 WBL) [Ultimate]
Shoulder Width	2.5 – 2.80 (Lt) 3.0 m (Rt)	4.62 – 4.78 m (Lt) 3.0 m (Rt)
Shoulder Rounding	1.0 m	1.0 m
Median Width	18.3 m	10.2
ROW Width	110 m (minimum) Wider in other areas to accommodate grading (high fills, deep cuts) beyond the minimum width	110 m (minimum) Wider in other areas to accommodate grading (high fills, deep cuts) beyond the minimum width

Grading beyond the pavement structure will follow the freeway guidelines as outlined in Section 2.3.2 of the MTO *Roadside Design Manual*, *May 2020*, Section 2.3.2 Slopes and applicable OPSDs.

However, based on experience along the Highway 401 corridor to the west, 3:1 cut slopes and fill slopes are recommended to minimize the potential for erosion. Interceptor ditches and intermediate berms are also recommended. In deep cut locations, intermediate benching and interceptor ditches are recommended at 6 m intervals to reduce the quantity of sheet flow drainage along the face of the cut slopes. In high fill areas, 2 m wide benching will be provided as per Ontario Provincial Standard Drawing (OPSD) 202.010.

An Erosion and Sediment Overview Risk Assessment (ESORA) was completed as part of this study, a copy of which is provided in Appendix K.

A retaining wall will be provided adjacent to the Shelter Valley Pines Golf Club to minimize property impacts at this location.

During detail design, additional foundation investigations and design will be required at high fill, deep cut, and retaining wall areas to confirm the final grading limits.

Typical Highway 401 cross-sections are shown in Figure 6.

6.3 Interchanges

This section of the report provides a description of improvements to the Lyle Street interchange and Percy Street interchange to accommodate future widening of Highway 401 and the projected future traffic volumes.

6.3.1 Lyle Street Interchange

A Parclo A2 configuration interchange at Lyle Street is recommended to improve the interchange configuration and to maintain access to Edwardson Road in the northwest quadrant and the existing MTO Patrol Yard in the southeast quadrant. The interchange includes standard R-55 m loop ramps in the northeast and southwest quadrants. The interchange will also be protected for future direct ramps in the northwest and southeast quadrants to accommodate potential future traffic or long combination vehicles (LCV), if required.

Lyle Street will be realigned to the east to maintain traffic across the existing bridge during construction. The realignment of Lyle Street includes a 1000 m radius curve at the south tie-in, and a 1500 m radius curve at the north tie-in. The revised horizontal and vertical alignments will improve sight distance to the south ramp terminal and across Highway 401.

The cross-section of Lyle Street includes two 3.5 m lanes and 2.5 m shoulders with 1.0 m rounding. A 3.5 m direct taper lane is provided across the bridge to the S-W and N-E ramps.

Minor realignments of Edwardson Road and the MTO Patrol Yard entrance are required to connect to the realigned Lyle Street.

A cul-de-sac on Lyle Street in the southwest quadrant is required to provide access to existing properties. At the time of preparing this TESR, an application for a future development was received by the Township of Alnwick/Haldimand for a new residential subdivision (i.e., Grafton Heights) consisting of 40 single detached lots and a common element condominium. It is assumed that the road realignment and reconfiguration of the Lyle Street interchange will be constructed in

advance of the development, in which case the developer will be responsible for extending the cul-de-sac to the entrance of the new development. However, should the development occur in advance of implementation of the road realignment and reconfiguration of the Lyle Street interchange, it is understood that MTO will be responsible for these works.

The Bell communication building in the southeast quadrant will also require relocation.

All interchange ramps are single lane ramps with a 4.75 m wide lane, a 1.0 m wide fully paved left shoulder, a 2.5 m wide fully paved right shoulder, and 1.0 m shoulder roundings.

The reconfiguration of the interchange will require relocation of the existing commuter parking lot as discussed in Section 6.8.

The recommended plan for the Lyle Street Interchanges is shown in Figure 7.

6.3.2 Percy Street Interchange

A Parclo A3 configuration interchange is recommended at Percy Street to improve the interchange configuration and to minimize property impacts in the northwest quadrant. The interchange will also be protected for a future direct ramp (Ramp N-W) in the northwest quadrant to accommodate potential future traffic or Long Combination Vehicles (LCV), if required. The inner loop in the southwest quadrant is a standard 55 m radius curve. A larger radius cannot be accommodated because of the proximity to the cemetery in the southwest quadrant of the interchange. However, a 75 m radius curve is provided in the northeast quadrant to accommodate LCVs.

Percy Street will be realigned to the east to maintain traffic across the existing bridge during construction. The realignment includes a 950 m radius curve at the north tie-in, and a 1500 m radius curve at the north tie-in. The revised horizontal and vertical alignments will provide the required sight distance to the ramp terminal intersections and across Highway 401.

The cross-section of Percy Street from the south intersection to the north ramp terminal is an urban cross-section with two 3.5 m wide lanes, two 1.5 m wide bike lanes that act as the shoulder with curb. North of the north ramp terminal the cross-section is rural with 3.5 m lanes and 2.5 m shoulder and no bike lanes. An urban cross-section with curb and gutter will be provided from Purdy Street to the north ramp terminal. A rural cross section with 1.0 m roundings and ditches will be provided north of the north ramp terminal.

A new municipal road and cul-de-sac will be required to provide access to the relocated carpool lot and to maintain access to the property in the northeast quadrant. A new driveway will be provided from the cul-de-sac to the existing entrance location.

In the northwest quadrant of the interchange, three existing driveways for one property will be consolidated into a single driveway. The property immediately north of the interchange on the west side of Percy Street will be acquired as a driveway is not possible across from the ramp terminals or with a future direct N-W ramp.

All interchange ramps are single lane ramps with a 4.75 m wide lane, a 1.0 m wide fully paved left shoulder, a 2.5 m wide fully paved right shoulder, and 1.0 m shoulder roundings.

A retaining wall is required along the right side of Ramp E-N/S to minimize impacts to the adjacent property.

The reconfiguration of the interchange will require relocation of the existing commuter parking lot as discussed in Section 6.8.

The recommended plan for the Percy Street Interchanges is shown in Figure 8.

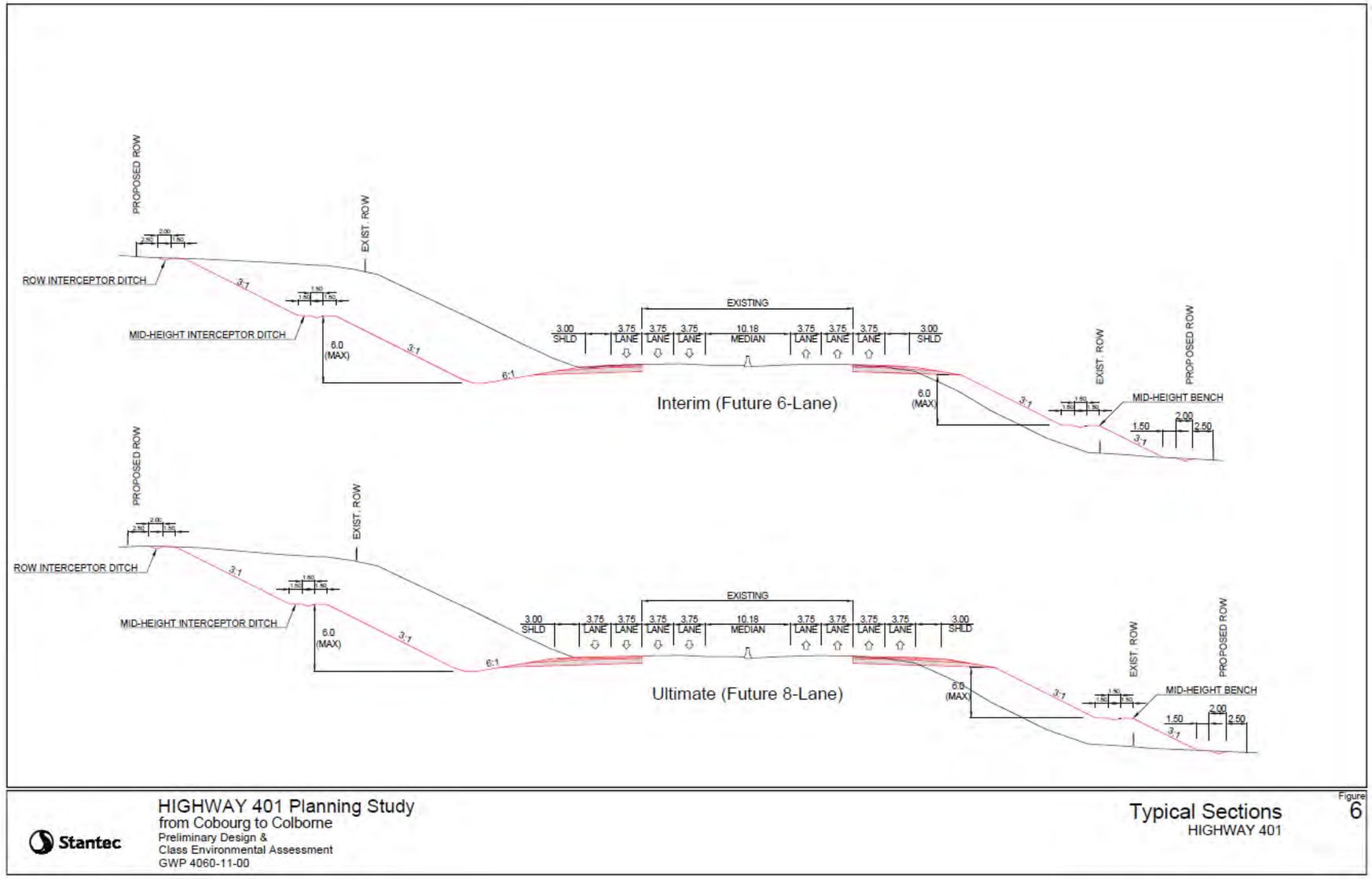

Figure 6: Highway 401 Typical Sections

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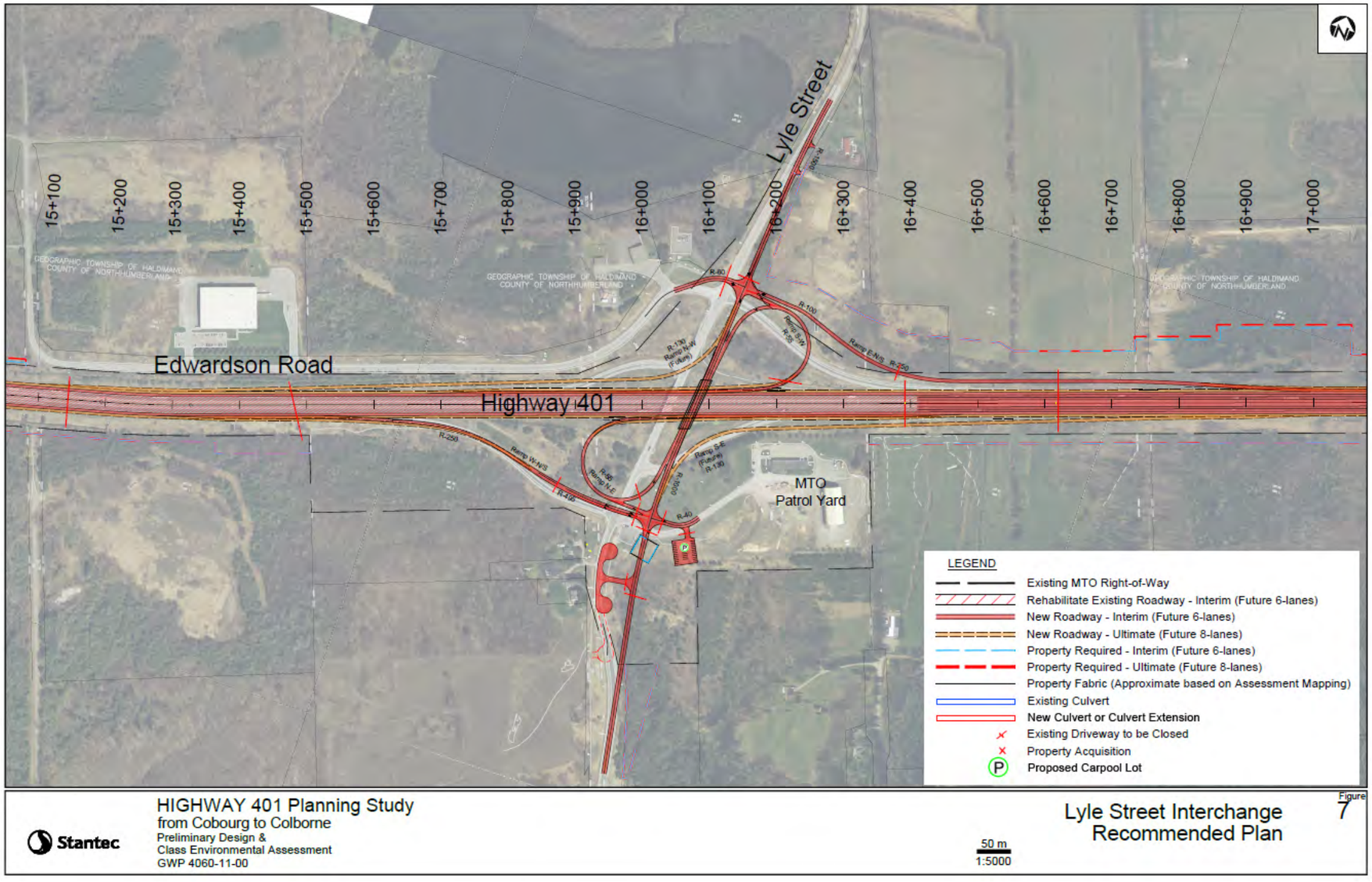

Figure 7: Lyle Street Interchange

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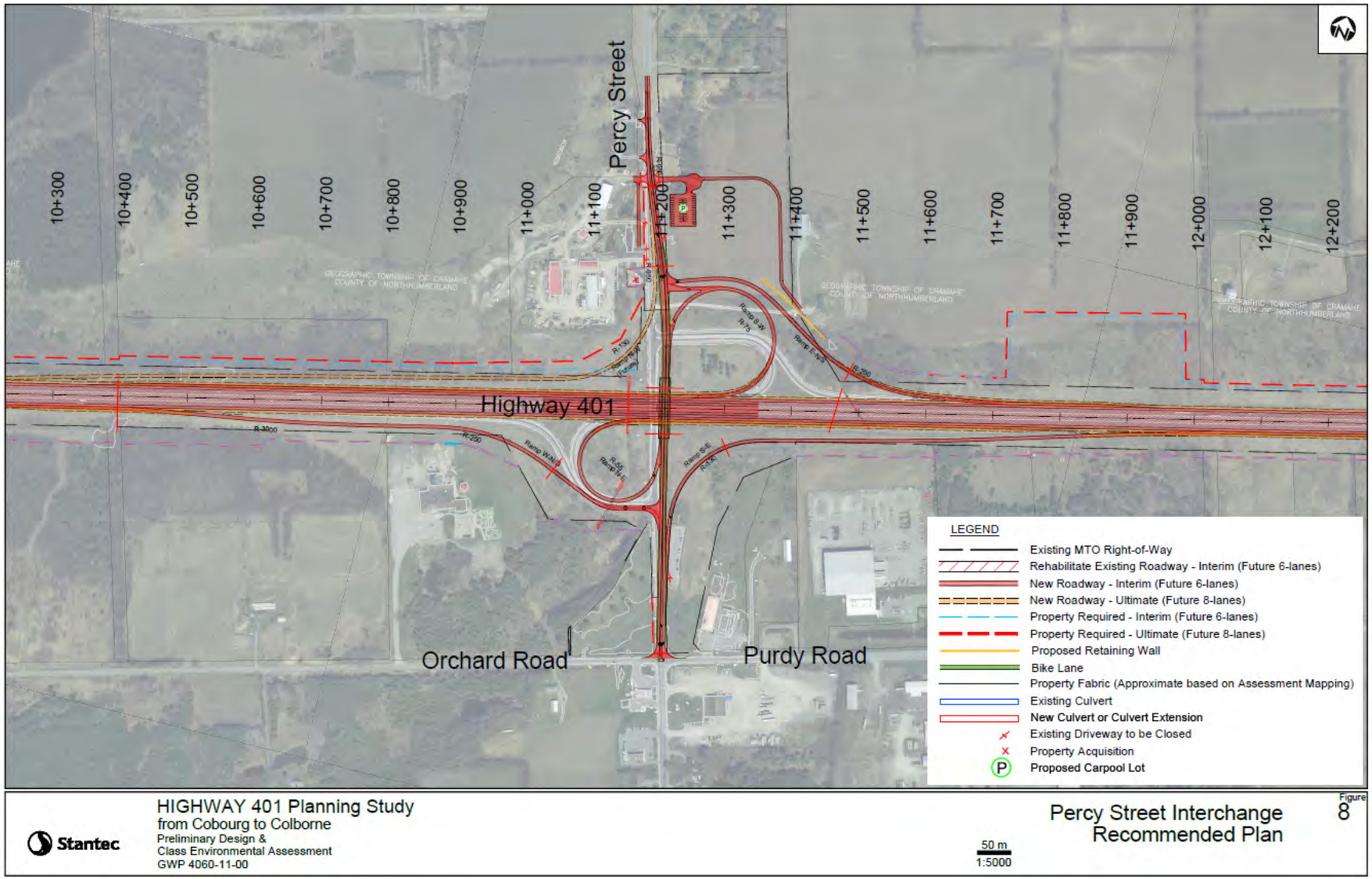

Figure 8: Percy Street Interchange

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6.4 Structures

The Recommended Plan includes the rehabilitation and/or replacement of seven existing roadway structures and six existing structural drainage culverts. The recommended rehabilitation and/or replacement strategies for each site are discussed in the following sections.

6.4.1 Culvert 21X-0467/C0 (Unnamed)

It is anticipated that Culvert 21X-0467/CO will be replaced at the same time as the 6-laning of Highway 401. The recommended culvert replacement strategy includes slip-lining the existing culvert and construction of a new 1.5 m diameter parallel overflow culvert. The total culvert length, assuming ultimate 8-lane highway and 3:1 embankment slopes, is about 179 m.

Structure replacement is recommended to be undertaken in conjunction with the 6-lane highway widening. Two lanes of traffic can be maintained in each direction during construction but will be shifted into the median to facilitate embankment widening at the outside. This will allow for the construction of access roads from the highway to the work area and for the moving of equipment and materials to the culvert ends. Stream flow and fish passage will be maintained through the existing culvert while constructing the new culvert. Large access pits will be required at both ends for the installation. This will result in disturbance of the natural environment and the need for additional property. Consultation and cost sharing agreements should be undertaken with the municipality considering that the culvert extends under a municipal road.

6.4.2 Danforth Road Underpass

It is anticipated that the Danforth Road bridge will be replaced in advance of, or at the same time as the 6-laning of Highway 401. The recommended bridge type is a two-span slab on girder structure. The structure will be either skewed with two 40 m spans, semi-integral abutments, and precast concrete NU girders; or squared (non-skewed) with two 50 m spans, integral abutments, and steel box girders. A bridge width of 11.1 m is recommended to accommodate a 10.40 m roadway width (2-3.50 m wide lanes, 2-1.70 m wide shoulders). The deck width can accommodate future staged rehabilitation. The spans will accommodate the ultimate 8-lane Highway 401 cross-section.

It is recommended to build the new Danforth Road Underpass on the same alignment by closing Danforth Road to traffic throughout the construction duration. The underpass replacement is anticipated to be completed in one construction season. The construction can be accelerated by utilizing precast elements. The highway lanes will be reduced to 3.5 m and shifted away from the median to accommodate the construction of the median pier and footings.

This structure can be constructed with minimum disturbance to Highway 401 traffic. Full closure of Highway 401 is anticipated on two separate occasions: firstly, during the demolition of the existing structure (approximately 12-hour duration); secondly, (rolling closures) to erect the NU girders.

6.4.3 Culvert 21X-0468/C0 (Unnamed)

Culvert 21X-0468/CO will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The rehabilitation of the culvert is assumed to include patching of deteriorated concrete and crack injection in the culvert barrel. A detailed concrete deterioration survey will be required to confirm the scope of the rehabilitation. A 2 m high retaining wall will be required at both sides to contain the grades of the widened highway fills.

It is anticipated that Culvert 21X-0468/CO will be replaced in advance of, or at the same time as 8-laning of Highway 401.The recommended structure is a 3.1 m x 2.4 m concrete box culvert. The length of the culvert, assuming ultimate 8-lane highway and 3:1 embankment slopes, will be 95.3 m.

Two stage construction will be required to build the new culvert. The number of lanes will be reduced from three to two lanes in each direction. The culvert replacement will be undertaken in two stages by utilizing temporary construction barriers/protection systems to maintain two lanes of traffic in each direction. Stage 1 will involve shifting the traffic to the median and replacing the outside (north and south) portions of the culvert. Traffic will then be switched to the outside (north and south) portions in Stage 2 to complete the replacement of the middle portion of the culvert. The construction can be accelerated by utilizing precast box culvert segments. It is recommended that the culvert replacement work be carried out during dry periods and that flow be maintained via temporary flow diversions through the work area, such that the flow is not disrupted. The temporary flow pipe can be placed on the side of the replaced culvert and then diverted through next stage culvert opening at the shoring walls.

6.4.4 Gully Road Underpass

It is anticipated that the Gully Road bridge will be replaced in advance of, or at the same time as the 6-laning of Highway 401. The recommended bridge type is a two-span, slab on girder structure, with two 33 m spans, integral abutments, and precast concrete NU girders. A bridge width of 11.1 m is recommended to accommodate a 10.4 m roadway width (2-3.50 m wide lanes, 2-1.70 m wide shoulders). The deck width can accommodate future staged rehabilitation. The spans will accommodate the ultimate 8-lane Highway 401 cross-section.

It is recommended to build the new Gully Road Underpass on the same alignment by closing Gully Road to traffic throughout the construction duration. The underpass replacement is anticipated to be completed in one construction season. The construction can be accelerated by utilizing precast elements. The highway lanes will be reduced to 3.5 m and shifted away from the median to accommodate the construction of the median pier and footings. The vertical

alignment of the highway crest curve cannot be lowered until the existing structure is demolished.

This structure can be constructed with minimum disturbance to Highway 401 traffic. Full closure of Highway 401 is anticipated on two separate occasions: firstly, during the demolishing of the existing structure (approximately 12-hour duration); secondly, (rolling closures) to erect the NU girders.

6.4.5 Culvert 21X-0469/C0 (Unnamed)

Culvert 21X-0469/CO will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The recommended strategy is to place a steel arch liner inside the existing culvert. A corrugated steel culvert liner arch, with dimensions of 3.31 m x 1.31 m is recommended. The annular space will be filled with non-shrink grout. The length of the liner is 91.5 m.

To accommodate highway widening to 8-lanes, the culvert will be extended by an additional 26.5 m and 30.0 m at the north and south end, respectively. The culvert extension will match the shape of the steel liner. The total new culvert length is 147.6 m.

It is recommended that the culvert lining and extension work be carried out during dry periods and that flow be maintained via temporary flow diversions (i.e., CSP pipe inside existing culvert), such that the flow is not impeded. This avoids the need for a Permit-To-Take-Water.

The culvert replacement can be performed in one construction season. The installation of a steel arch liner consists of constructing concrete footings on the existing bottom slab, installing segments of the arch liner at each end and then pushing them along the footings through the existing culvert opening. Construction work would not involve significant impacts to Highway 401 traffic and can be performed during the highway widening.

6.4.6 Culvert 21X-0270/C0 (Grafton Creek)

Culvert 21X-0270/CO will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The work consists of rehabilitating the existing arch culvert and building a retaining wall on each side to adjust the grades of the highway fills adjacent to the shoulder of the 6-lane arrangement. An approximately 2.0 m high retaining wall is required at each side. The rehabilitation of the arch culvert is assumed to include replacement of struts, placement of streambed material, patching deteriorated concrete in culvert barrel and retaining walls, and crack injection. A detailed concrete deterioration survey will be required to confirm the scope of the rehabilitation.

It is anticipated that Culvert 21X-0270/CO will be replaced with a bridge in advance of, or at the same time as 8-laning of Highway 401. The recommended bridge type is a single span, slab on girder structure, with a 57 m span, integral abutments, and steel I-girders.

The new bridge will be built using top-down construction methods by building the bridge first, then excavating beneath it for culvert removal. Two stage construction will be required to build the bridge. At the time of construction, the 6-lane highway will be reduced to two lanes in each direction. The first stage will move Highway 401 traffic to the median while providing two 3.5 m lanes with shoulders in each direction. A roadway protection system is then placed next to the outside lanes to facilitate excavation of the top fill and to build the outer portions of the bridge. In the second stage the traffic will be shifted to the new bridge (maintaining similar lane and shoulder widths) while excavation, culvert removal and construction of the inner part of the bridge is performed. The new bridge construction can be completed outside of the watercourse and does not require a temporary flow passage system. The only in-water work required is for the removal of the existing culvert and any associated channel improvement work. The duration of this work is expected to be relatively short and should be carried out during dry periods.

6.4.7 Lyle Street Underpass

It is anticipated that the Lyle Street bridge will be replaced in advance of, or at the same time as the 6-laning of Highway 401. The recommended bridge type is a two-span, slab on girder structure, with 45 m and 40 m spans, integral abutments, and steel box girders. A bridge width of 15.4 m is recommended to accommodate 2-3.50 m wide lanes, 2-1.75 m wide shoulders, and variable width speed change lanes for the interchange ramps. The spans will accommodate the ultimate 8-lane Highway 401 cross-section.

It is recommended to maintain Lyle Street traffic at all times, and build a new underpass to the east of the existing underpass. The construction of the new underpass and the removal of the existing are anticipated to be completed in one construction season. The construction can be accelerated by utilizing precast elements. The highway lanes and ramps will be reduced to 3.5 m and shifted away from the median to accommodate the construction of the median pier and footings.

This structure can be constructed with minimum disturbance to Highway 401 traffic. Full closure of Highway 401 is anticipated on two occasions: firstly, to erect the girders (rolling closures); secondly, during the demolition of the existing structure (approximately 12-hour duration).

6.4.8 Culvert 21X-0470/C0 (Northumberland Culvert)

It is anticipated that Culvert 21X-0470/CO will be replaced in advance of, or at the same time as the 6-laning of Highway 401. The recommended culvert replacement strategy includes slip-lining the existing culvert with a 1.4 m by 2.7 m arch and construction of a new 1.2 m diameter parallel overflow culvert. The total culvert length, assuming ultimate 8-lane highway and 3:1 embankment slopes, is about 135 m.

Structure replacement is recommended to be undertaken in conjunction with the 6-lane highway widening. Two lanes of traffic can be maintained in each direction during construction but will be shifted into the median to facilitate embankment widening at the outside. This will allow for the construction of access roads from the highway to the work area and for the moving of equipment and materials to the culvert ends. Stream flow and fish passage will be maintained through the existing culvert while constructing the new culvert. Large access pits will be required at both ends for the installation. This will result in disturbance of the natural environment and the need for additional property.

6.4.9 Shelter Valley Road Overpass

The existing Shelter Valley Road culvert will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The work consists of rehabilitating the existing arch culvert and building a retaining wall adjacent to the edges of the highway above the Shelter Valley Creek culvert to adjust the grades of the highway fills adjacent to the shoulder of the 6-lane cross-section. About 2.0 m (south) and 1.0 m (north) high retaining walls are required. The rehabilitation of the arch culvert is assumed to include patching deteriorated concrete in culvert barrel and retaining walls, and crack injection. A detailed concrete deterioration survey will be required for both culverts to confirm the scope of the rehabilitation.

It is anticipated that the Shelter Valley Road bridge will be replaced in advance of, or at the same time as 8-laning of Highway 401.The recommended bridge type is twin two-span, slab-on-girder structures that span Shelter Valley Road and Shelter Valley Creek. The structures will have staggered abutments and spans of 65 m and 58 m (total span length of 123 m) for the westbound structure and spans of 60 m and 62 m (total span length of 122 m) for the eastbound structure. The Preferred Plan also includes removal of the existing Shelter Valley Road culvert.

6.4.10 Culvert 21X-0272/C0 (Shelter Valley Creek)

The existing Shelter Valley Road culvert will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The work consists of rehabilitating the existing arch culvert and building a retaining wall adjacent to the edges of the highway above the creek culvert to adjust the grades of the highway fills adjacent to the shoulder of the 6-lane cross-section. About 2.0 m (south) and 1.0 m (north) high retaining walls are required. The rehabilitation of the arch culvert is assumed to include patching deteriorated concrete in culvert barrel and retaining walls, and crack injection. A detailed concrete deterioration survey will be required for both culverts to confirm the scope of the rehabilitation.

The future replacement of this culvert with a bridge spanning Shelter Valley Road and Shelter Valley Creek is discussed in Section 6.4.9. The Preferred Plan also includes removal of the existing Shelter Valley Creek culvert, and realignment of the Shelter Valley Creek channel.

The new overpass structures will be built using top-down construction methods by building the overpasses first, then excavating for culvert removal. Two stage construction will be required to build the overpasses. At the time of construction, the number of lanes will be reduced to two lanes in each direction. The first stage will move Highway 401 traffic to the median while providing two 3.5 m lanes with 1.0 m shoulders in each direction. A roadway protection system is then placed next to the outside lanes to facilitate excavation of the top fill and to build the outer portions of the overpasses. In the second stage the traffic will be shifted to the new bridges (maintaining similar lane and shoulder widths) to construct the inner part of the bridges. The excavation under the new bridge superstructures and the existing road culvert removal can also take place during the second stage. Once the creek is diverted to the new alignment, the ends of the existing creek culvert outside the new bridge embankment can be removed. The remaining of the culvert will be filled with a mix of granular material at the base and low strength concrete. Another option would be to brace the culvert and remove the exposed portions plus fill the rest of the culvert from the arch crown.

The traffic on Shelter Valley Road will not be impacted during the majority of the construction duration. A full closure of Shelter Valley Road will be required during the removal of the arch culvert and any roadway improvements. A detour route is available via Vernonville Road. The closure will be confirmed with the municipality during the next stage of design.

Creek flow will be maintained through the existing culvert until embankment excavation and construction of the new channel. The creek diversion will take place once the new creek alignment becomes ready. The creek diversion should be carried out during dry periods.

6.4.11 Vernonville Road Overpass

The existing Vernonville Road bridge will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The work consists of rehabilitating the existing bridge and widening to both sides to accommodate the Highway 401 6-lane cross-section. A 3.4 m widening is required at each side and will consist of a single span rigid frame structure matching the existing bridge. The width of the bridge will increase from 33.0 m to about 39.7 m. New retaining walls will be required at each quadrant of the widened structure. The rehabilitation of the existing bridge is assumed to include patch, waterproof and pave the bridge deck, replacement of the barrier walls, addition of approach slabs, and repairs to the soffit and abutments. A detailed condition survey will be required to confirm the scope of the rehabilitation.

It is anticipated that the Vernonville Road bridge will be replaced in advance of, or at the same time as 8-laning of Highway 401. The preferred bridge type is a single-span, rigid frame structure. A span of 12.2 m is proposed to accommodate a road width of 9.0 m (2-3.50 m wide lanes, 2-1.0 m wide shoulders).

The overpass replacement can be performed by utilizing two stages of construction by utilizing a median crossover or by moving Highway 401 traffic to the median then outsides. Both

options can accommodate two 3.5 m lanes plus shoulders in each direction and will require a roadway protection system between the stages. There will be minimal impacts to local traffic anticipated during the closure of Vernonville Road due to relatively low traffic volumes and rural land use. Roadway protection systems will be required during staged replacement of the bridge.

A full closure of Vernonville Road is recommended during construction in order to improve worker safety. Detour routes via Boyce's Road or Shelter Valley Road are available. The closure shall be confirmed with the municipality.

6.4.12 Culvert 21-576/C0 (Boyce Road Culvert)

The preferred strategy for the Boyce Road Culvert is to rehabilitate and strengthen it in conjunction with 6-laning of Highway 401 and to replace the culvert at the time of 8-laning.

The rehabilitation work consists of rehabilitating the existing arch culvert and building a retaining wall adjacent to the edges of the highway above the creek culvert to adjust the grades of the highway fills adjacent to the shoulder of the 6-lane cross-section. About 3.0 m high retaining walls are required at each side. The rehabilitation of the arch culvert is assumed to include strengthening the culvert, patching deteriorated concrete in culvert barrel and retaining walls, and crack injection. A detailed concrete deterioration survey and structural evaluation will be required to confirm the scope of the rehabilitation.

The preferred culvert replacement method involves trenchless installation using either a Tunnel Boring Machine or pipe jacking / ramming. Further study and foundation investigations are required to establish the most suitable tunneling method. The preferred option for replacement of the culvert at this site involves trenchless techniques. There are a variety of trenchless methods that may be appropriate but identifying the most suitable option would require a comprehensive study that is beyond the scope of this assignment.

The culvert should be replaced in conjunction with 8-laning of Highway 401. The recommended culvert replacement strategy includes slip-lining the existing culvert with a 1.4 m by 2.7 m arch and construction of a new 1.5 m diameter parallel overflow culvert. Assuming 3:1 embankment slopes, the length of the new culvert will be approximately 127 m.

Traffic would be reduced to two lanes of traffic in each direction during construction and will be shifted into the median to facilitate embankment widening at the outside. This will allow for the construction of access roads from the highway to the work area and for the moving of equipment and materials to the culvert ends. Stream flow and fish passage will be maintained through the existing culvert while constructing the new culvert. Large access pits will be required at both ends for the installation. This will result in disturbance of the natural environment and the need for additional property. Tunneling will require modifications to the configuration of the watercourse at the inlet and outlet. The new culvert will be offset about 3 m to the west of existing.

6.4.13 Boyce Road Overpass

The existing Boyce Road bridge will be rehabilitated in advance of, or at the same time as the 6-laning of Highway 401. The work consists of rehabilitating the existing bridge and widening to both sides to accommodate the Highway 401 6-lane arrangement. A 3.5 m widening is required at each side and will consist of a single-span rigid frame structure matching the existing bridge. The width of the bridge will increase from 32.7 m to about 39.7 m. New retaining walls will be required at each quadrant of the widened structure. The rehabilitation of the existing bridge is assumed to include patch, waterproof and pave the bridge deck, replacement of the barrier walls, addition of approach slabs, and repairs to the soffit and abutments. A detailed condition survey will be required to confirm the scope of the rehabilitation.

It is anticipated that the Boyce Road bridge will be replaced in advance of, or at the same time as 8-laning of Highway 401. The preferred bridge type is a single-span, rigid frame structure. A span of 12.2 m is proposed to accommodate a road width of 9.0 m (2-3.50 m wide lanes, 2-1.0 m wide shoulders).

The overpass replacement can be performed by utilizing two stages of construction. By utilizing a median crossover or by moving Highway 401 traffic to the median then outsides. Both options can accommodate two 3.5 m lanes plus shoulders in each direction and will require a roadway protection system between the stages. There will be minimal impacts to local traffic anticipated during the closure of Boyce's Road due to relatively low traffic volumes and rural land use. Roadway protection systems will be required during staged replacement of the bridge.

A full closure of Boyce's Road is recommended during construction in order to minimize the lowering of the road and improve worker safety. Detour route via Vernonville Road is available. The closure shall be confirmed with the municipality.

6.4.14 Percy Street Underpass

It is anticipated that the Percy Street bridge will be replaced in advance of, or at the same time as the 6-laning of Highway 401. The recommended bridge type is a two-span, slab on girder structure, with 37 m and 34 m spans, integral abutments, and steel box girders. A bridge width of 13.7 m is recommended to accommodate 2-3.50 m wide lanes, 2-1.50 m wide bicycle lanes, and 2-1.75 m wide shoulders. The spans will accommodate the ultimate 8-lane Highway 401 cross-section.

It is recommended to maintain Percy Street traffic at all times and build a new underpass to the east of the existing underpass. The construction of the new underpass and the removal of the existing are anticipated to be completed in one construction season. The construction can be accelerated by utilizing precast elements. The highway lanes and ramps will be reduced to 3.5 m and shifted away from the median to accommodate the construction of the median pier and

footings. The vertical alignment of the highway sag curve cannot be raised until the existing structure is demolished.

This structure can be constructed with minimum disturbance to Highway 401 traffic. Full closure of Highway 401 is anticipated on two occasions: firstly, to erect the girders (rolling closures); secondly, during the demolition of the existing structure (approximately 12-hour duration).

6.4.15 Shelter Valley Pines Golf Club Retaining Wall

As discussed in Section 6.2.3, a retaining wall is required between Station 18+900 and 19+120 to avoid impacts to the Shelter Valley Pines Golf Club. The wall will be located parallel to Highway 401 and outside of the clear zone.

A Reinforced Soil Slope (RSS) retaining wall is recommended at this location because of its relatively low cost when compared to other retaining wall types. The average wall height is 3.6 m, with a maximum wall height of 4.3 m, and a footing depth of 0.8 m below finished ground. There is sufficient space within the right-of-way to excavate behind the wall location and place strapping as required. The location of the retaining wall will accommodate the ultimate 8-lane Highway 401 cross-section.

6.5 Crossing Roads

6.5.1 Horizontal Alignment

The Recommended Plan does not include horizontal alignment improvements at the non-interchange crossing roads which include Danforth Road, Gully Road, Shelter Valley Road, Vernonville Road and Boyce Road. Existing horizontal alignments at these crossing roads will be maintained.

6.5.2 Vertical Alignment

The new crossing road profiles and new structures will provide for the minimum vertical clearance of 5.1 m from the underside of the structure to the recommended profile elevation of Highway 401.

The recommend vertical curves for each crossing road are summarized in Section 6.2.2.

6.5.3 Cross-Section

The cross-section elements of the crossing roads within the project limits are summarized in Table 6-3.

Table 6-3: Summary of Recommended Cross-Section Elements on Crossing Roads

Crossing Road	Lane Width (m)	Shoulder Width (m)	Shoulder Rounding (m)	ROW Width (m)
Danforth Road	2 x 3.5	1.5 (a)	0.5	20.1
Gully Road	2 x 3.5	1.0	0.5	20.1
Shelter Valley Road	2 x 3.5	1.5	0.5	20.1
Vernonville Road	2 x 3.5	1.0	0.5	18.3
Boyce Road	2 x 3.5	1.0	0.5	20.1

Notes:

a. Danforth Road is part of the Northumberland County cycling network, and the shoulder will be 1.5 m for cyclists

6.5.4 Active Transportation

As noted previously Danforth Road and Shelter Valley Road are designated bike routes in Northumberland County. To accommodate cyclists crossing Highway 401, 1.5 m shoulders should be provided on both roadways.

6.6 Intersections

The Recommended Plan will impact eight existing at-grade intersections on local roads within the study limits. The following sections address the impacts.

6.6.1 Northumberland Heights Road at Danforth Road

The replacement of the Danforth Road bridge will require a grade raise of Danforth Road at Highway 401, which results in a minor grade raise on Danforth Road at the intersection on Northumberland Heights Road. Short-term closure of this intersection will be required during construction.

6.6.2 Lyle Street Interchange Intersections

The recommended interchange at Lyle Street will reduce the intersections on Lyle Street from four to three by modifying the interchange configuration. The new alignment of Lyle Street to the east will require a new intersection south of the interchange to maintain access to four properties on Old Lyle Street. The intersections are as follows:

- Ramps W-N/S and S-E/ MTO Patrol Yard Entrance

- Ramps E-N/S Ramp and S-W / Edwardson Road
- Old Lyle Street (Station 10+283 new Lyle Street)

The Recommended Plan requires the Lyle Street alignment to be shifted to the east to allow for the construction of the new Lyle Street bridge and roadway, while maintaining traffic on the existing alignment.

6.6.3 Percy Street Interchange Intersections

The existing interchange has three at-grade intersections on Percy Street which include the following:

- Ramp W-N/S / Ramp N/S-E
- Ramp E-N/S / Ramp N/S-W
- Orchard Road / Purdy Road

The Recommended Plan will maintain three intersections on Percy Street to the east of the existing alignment as such:

1. Ramp W-N/S
2. Ramp E-N/S / Ramp N/S-W
3. Orchard Road / Purdy Road

With the Percy Street alignment shifted to the east of the existing, construction staging will be required to maintain traffic through this interchange. The construction staging for these improvements are discussed in Section 6.14.

6.7 Entrances on Local Roads

The Recommended Plan will impact thirteen existing at-grade intersections on local roads within the study limits. Table 6-4 below provides a summary of impacted entrances.

Table 6-4: Summary of Entrances on Local Roads

Road Name	Entrance Type	Location	Impact
Danforth Road	Business	Station 10+170 left	Maintain existing with minor grade adjustments
Gully Road	Residential	Station 10+171 right	Maintain existing with minor grade adjustments
Lyle Street	Residential	Station 9+580 left	Maintain existing with minor grade adjustments
	Residential	Station 10+262 right	These two entrances will be removed from the new Lyle Street alignment and will be accessed from a new intersection at Station 10+280
	Residential	Station 10+321 right	
	Residential	Station 9+571 right	Maintain existing with minor grade adjustments
		Station 9+627 right	Maintain existing with minor grade adjustments
Percy Street	New Carpool Lot/ Residential	Station 9+655 left	New carpool lot entrance (shared with residential property east of carpool lot)
	Business	Station 9+955 right	Maintain existing with minor grade adjustments
	Business	Station 9+724 right	Entrance closed; access to property from entrance at Station 9+955
	Business	Station 9+763 right	Entrance closed; access to property from entrance at Station 9+955
	Residential	Station 9+780 right	Entrance closed; property buyout
	Field	Station 9+746 left	Entrance closed; access from entrance at Station 9+655
	Existing Carpool Lot	Station 10+251 left	Entrance and Lot closed

6.8 Commuter Parking Lots

There are two existing commuter parking lots within the study limits that will be impacted by the Recommended Plan. One is located at the southeast quadrant of the Lyle Street interchange and the other is located at the southeast quadrant of the Percy Street interchange.

6.8.1 Lyle Street Commuter Parking Lot

The Recommended Plan requires the removal of the existing 19 space parking lot, and the construction of a new parking lot in the southeast quadrant of the new interchange, with

access from the realigned MTO Patrol Yard entrance. The new commuter parking lot will have the following features:

- Approximately 35 parking spaces (with provision for expansion)
- 2 accessible spaces
- Asphalt parking surface
- Illuminated entrance
- Located on MTO property

The location of the recommended Lyle Street Commuter Parking Lot is shown in Appendix J.

6.8.2 Percy Street Commuter Parking Lot

The Recommended Plan requires the removal of the existing 50 space parking lot, and the construction of a new parking lot in the north-east quadrant of the new interchange, with access from the Percy Street. The new commuter parking lot will have the following features:

- Approximately 60 parking spaces (with provision for expansion)
- 2 accessible spaces
- Asphalt parking surface
- Illuminated entrance
- Located on MTO property

The location of the recommended Lyle Street Commuter Parking Lot is shown in Appendix J.

6.9 Drainage and Hydrology

The proposed drainage conditions are summarized below, as recommended in the *Preliminary Drainage Report*, a copy of which is provided in Appendix D.

6.9.1 Hydrologic Analysis

A detailed surface water assessment was completed to quantify surface drainage characteristics of lands contributing drainage within the study area to assess the performance of the drainage system.

6.9.2 Centreline Culverts

The proposed highway improvements within the study area include highway widening, median sewer replacement, commuter parking lot expansions, rehabilitation of the pavement structure, and improving the overall operational characteristics of Highway 401. Catchment areas were considered to be generally the same under existing and proposed conditions as there is no significant modifications in the road alignment under proposed conditions. The catchment areas determined for the existing and proposed conditions analysis were conservatively bounded by the downstream edge of the highway.

Given the large size of the catchments, the marginal increase in impervious coverage resulting from the highway widening has a negligible impact on flows at the upstream face of the centerline culverts. Flows are not increased throughout the catchments but rather within the right-of-way, representing a small portion of each catchment. Any significant increase in flows caused by the highway widening within the right-of-way will be mitigated by directing median storm sewer drainage to SWM controls on the downstream side of the highway. Therefore, the increase in peak flows will not occur at the face of the culvert and will be mitigated prior to discharging to the downstream system.

Five existing culverts within the study area are considered for abandonment in the interest of reducing costs and risk associated with installation and maintenance. Flows conveyed by the existing culverts considered for abandonment would be redirected to nearby downstream culverts. The successful redirection of flows depends on whether ditch grading can be modified to adequately convey flows to the proposed outlets. This report assumes these culverts can be successfully abandoned when determining flows and culvert sizes. An analysis of whether abandonment of these culverts is possible from a grading perspective will need to be conducted at the detail design stage when detailed survey information is available.

The culverts identified as having potential for abandonment and the existing culverts that flow would be redirected to are as follows:

- CV-0401-002059 redirected to CV-0401-001882
- CV-0401-001855 redirected to 21-468/C
- CV-0401-001791/825 redirected to 21-270/C
- CV-0401-001721 redirected to CV-0401-001885/824
- CV-0401-001906 redirected to CV-0401-001907

6.9.3 Interchange Culverts

Changes related to the interchanges at Lyle Street and Percy Street include improved access and egress to and from the Highway 401, involving the construction and/or realignment of new

ramps. Under proposed conditions, flow patterns generally remain the same as existing conditions with minor changes due to expansion of the interchanges. Design and check flows used to size and analyze interchange culverts were determined by the transposition of flood discharges from catchments adjacent to or surrounding interchange catchments. This method works by transposing a known discharge from a particular catchment to another area on the same watercourse or in a nearby catchment with similar characteristics.

6.9.4 Hydraulic Analysis

In accordance with MTO HDDS, all culverts should accommodate the design flow. Throughout the study area, Highway 401 is classified as a rural freeway under existing and proposed conditions.

6.9.4.1 Centreline Culverts

This section of the report identifies the Highway 401 centreline culvert replacement requirements based on observed conditions and hydraulic analysis. Of the 32 existing centreline culverts, 11 do not meet MTO standards and are proposed for replacement due to inadequate capacity. There are seven additional non-structural culverts that require replacement due to their poor condition alone, which are proposed to be replaced with the same size as existing and bring the total number of proposed replacements of non-structural culverts to 18. This number does not include the structural culvert sites, which are documented in Structural Planning Reports. All the existing structural culverts meet MTO hydraulic requirements. One site, 21-469/C, is proposed to be lined and extended with a 3.4m x 1.8m CSP arch within the existing box culvert structure, which will reduce the hydraulic capacity but still meet all MTO criteria. The other structural culverts are assumed to maintain the same or larger cross-sectional area under proposed conditions and have not been included in the table.

6.9.4.2 Interchange Culverts

No significant changes to existing drainage patterns and flows occur within the Lyle Street or Percy Street interchanges. All culverts replaced as a part of this contract will have a minimum diameter of 800 mm to satisfy sizing requirements for interchanges on freeways. In locations where the existing culvert is larger than 800 mm diameter, the replacement culvert will be the same size or larger than the existing culvert. Where applicable, culverts larger than the required minimum of 800 mm shall be at least as large as any upstream culvert on the same watercourse/flow path. Interchange culverts have been modelled assuming a depth of cover of 1 m and the minimum required slope of 0.5%.

Eleven new culverts are proposed at the Lyle Street interchange and the immediate surrounding area, including a carpool lot. The minimum culvert diameter of 800 mm is sufficient for all nine of the culverts proposed at Lyle Street.

Ten culverts are required to adequately drain the Percy Street interchange and immediate surrounding area, which also includes a carpool lot. The minimum culvert diameter of 800 mm is sufficient for five of the proposed culverts at Percy Street, but larger culverts are required in areas with larger catchments, or locations that are up or downstream of larger box culverts centreline to Highway 401.

6.9.5 Culvert Recommendations

Of the 32 Highway 401 centreline culverts assessed within the study limits:

- Eight culverts are proposed to be retained
- Four culverts are proposed to be retained without repairs
- Four culverts are proposed to be retained after repairs are completed
- 17 culverts are proposed to be replaced
- Eight Culverts to be replaced based on both condition and capacity
- Seven culverts to be replaced based on condition alone
- Two culverts to be replaced based on capacity alone
- Seven are structural culverts with recommendations provided in Section 5.4. All existing culverts meet MTO standards
- Site 21-469/C is proposed to be lined and extended with a 3.4 m x 1.3 m arch within the existing box culvert, which will reduce the hydraulic capacity, but still meet all MTO hydraulic criteria
- All remaining sites will either be replaced or retained/rehabilitated and extended with a structure of similar or increased hydraulic capacity

Nine new culverts are proposed to service the Lyle Street interchange, while 11 culverts are proposed to service the Percy Street interchange. All culverts satisfy MTO hydraulic criteria and will need to have depth of cover and related parameters determined at detail design.

6.10 Stormwater Management (SWM)

6.10.1.1 General Information

Widening of the highway and interchange reconfiguration will increase flows and pollutant runoff from the highway. The 6-lane scenario will result in an approximately 50% increase in paved area from the current 4-lanes of traffic. Interchanges are assumed to remain

approximately the same and no significant increase in paved area is anticipated in these areas.

Any outlet not located directly on a natural watercourse has some potential drainage risk such as downstream flooding, erosion, or scour which could be attributed to MTO. Natural watercourses typically have a defined bed, banks, and floodplain that provide stability and resilience against seasonal or storm-based fluctuation in flow. Culverts discharging to natural watercourses do not pose a risk as those systems convey water year-round and can adapt to minor changes in hydraulic condition. Where culverts outlet to a non-watercourse the potential for flood damage depends on the downstream receiver. Unimproved lands (wetland and forests) have generally reached a steady state and are resistant to further damage. Improved lands (agricultural land or lawns) are often not in a steady state (with active farming / plowing). The improved lands also tend to be actively monitored where flood damage (erosion and property flooding) is readily visible.

Most complaints resulting from MTO drainage onto adjacent property tend to be from non-watercourse outlets onto improved land.

6.10.1.2 Proposed Stormwater Management Design Strategy

The proposed SWM strategy was designed to meet SWM design guidelines and policies as outlined in the MTO *Drainage Management Manual* (1997), the Ministry of the Environment *Stormwater Management Planning and Design Manual* (2003) and the *MTO Highway Drainage Design Standards* (HDSS) (2008).

Water quantity controls should be considered for locations that experience a significant increase in peak flows resulting from the proposed highway widening and associated increase in impervious area. End-of-pipe dry and/or wet facilities are typically required at locations where the highway widening has caused flows to increase by a significant amount (>10%). Hydrologic modelling was performed to quantify the increase in runoff resulting from highway widening within the median and the ditches.

In total, eight locations requiring SWM controls were identified within the study area. Seven locations were identified as having significant increases in peak flow (>10%) that require quantity controls. One of these seven locations is a site that would receive flow diverted from an abandoned culvert (Culvert 000904010071/44 at Haldimand Township Station 15+480, includes flows from the abandoned CV-0401-001721).

An additional site (Culvert CV-0401-001914 at Haldimand Township Station 22+480) experiences a 9% increase in peak flow due to highway widening and was noted to be upstream of agricultural/improved land. Outlets discharging to non-watercourse receivers can present risks associated with potential damage to downstream properties during high flows. The outlet at Station 22+480 – Haldimand has been included in the areas proposed for SWM control due to these circumstances.

Aerial imagery shows that there are existing SWM facilities within the study area. Known SWM facilities are located at Station 14+660 (Culvert ID 00904010065/46) and within the interchanges at Lyle Street North (Within the E-N/S ramp and N/S-E ramp) and potentially one dry facility on the west side of the E – N/S ramp at Percy Street. Details on exact limits or design of these existing facilities was not available at the time of this report, however, will be confirmed during detail design.

Each facility was designed to use the available space efficiently and reduce the amount of land to be acquired. Typically, facilities assume a long and narrow footprint with a low slope to fit in the right-of-way. There are some locations where steep slopes within the existing topography do not allow for this configuration and the facilities must be made wider to produce sufficient storage volume to reduce peak flows. If local topography does not provide sufficient gradient to meet the minimum 0.5% slope, wet ponds may need to be considered at a future design stage.

Some of the proposed SWM facilities receive highway drainage from only one side of the outlet, while others receive drainage from both sides of the outlet (east and west). Facilities that receive drainage from only one direction require a single SWM facility upstream of the main outlet to control peak flows from that portion of the highway. Areas that receive drainage from both directions are proposed to have SWM facilities on either side of the main outlet to adequately control peak flows and avoid routing highway drainage across existing culverts, channels, or other flow paths.

Additional area is required to accommodate service and maintenance access areas, grading, and other potential requirements to satisfy regulatory and design criteria in addition to the area required for flow storage. Precise dimensions and the configuration of each facility will need to be refined at a future design stage.

The dry facilities are all proposed to exist within the ditch parallel to Highway 401 with the exception of the facility at Station 23+330 (Township of Hamilton) at culvert CV-0401-001882. The facility at Station 23+330 (Township of Hamilton) will be located parallel and to the east of the receiving watercourse, perpendicular to the ditches alongside Highway 401 to avoid complications with steep topography sloping south away from the highway.

The proposed facility at Station 12+720 (Township of Haldimand) at culvert CV-0401-001855 is not required if this culvert is abandoned. Since the area to this culvert is relatively small, the increase in flows from the highway widening is more significant. If abandoned and redirected to the nearby structural culvert, the increase in flow is minimal since the upstream catchment to the structural culvert is so large. This facility has been included in the table above to provide the option for if this culvert is not able to be abandoned down the line.

6.11 Foundations

Foundations for the bridges and structural culverts range from shallow foundations to driven pile foundations, and trenchless culvert installation is considered feasible. Due to the limited

scope of foundations work and the limited subsurface data available a “Low Understanding” of the native soils has been adopted for this preliminary design stage. Additional subsurface investigations are required during detail design.

6.12 Pavement

Pavement analysis has been completed for the Highway 401 mainline, crossing roads and interchange ramps. All pavement structures will be confirmed during detail design.

6.13 Illumination

Illumination may be provided at Highway 401 interchange decision points, ramp terminal intersections with sideroads, and the carpool lots at Lyle Street and Percy Street. The electrical design will be confirmed during detail design.

6.14 Implementation Plan

Traffic modelling was completed to estimate when there is a need to expand the highway to the interim 6-lane cross-section and ultimate 8-lane cross-section. The data in Table 6-5 suggests that 6-laning will be required in 2025, and 8-laning will be required beyond 2044. The Ministry will continue to monitor the operations of Highway 401 to confirm when expansion will be required.

Table 6-5: Future LOS

Year	Capacity Scenario	Directional DHV (WB) veh/h	LOS
2020	4-lane Cross-Section	3,416	E
2025	4-lane Cross-Section	3,809	F
2031	6-lane Cross-Section	4,340	D
2038	6-lane Cross-Section	5,054	E
2041	6-lane Cross-Section	5,395	E
2044	6-lane Cross-Section	5,759	F

Construction of the Recommended Plan has been separated into two distinct timeline improvement plans to address safety and operational concerns on the highway, including:

- Structure rehabilitations and replacements (Interim)
- Highway 401 widening to six lanes (Interim)
- Highway 401 widening to eight lanes (Ultimate)

The Ministry of Transportation will continue to monitor the facility and may implement certain components of the plan when needed to meet provincial transportation needs. The following timeline for implementing the recommended improvements will assist the Ministry, municipalities, businesses, and private landowners with future planning and development within the study area.

6.14.1 Interim Strategy

It is anticipated that the following bridges and culverts will require rehabilitation or replacement in advance of the need for 6-laning or in conjunction with widening to six lanes:

- Danforth Road Underpass (Replace to accommodate 8-lanes)
- Gully Road Underpass (Replace to accommodate 8-lanes)
- Lyle Street Underpass (Replace to accommodate 8-lanes)
- Vernonville Road Overpass (Rehabilitate and widen to accommodate 6-lanes)
- Boyce Road Overpass (Rehabilitate and widen to accommodate 6-lanes)
- Percy Street Underpass (Replace to accommodate 8-lanes)
- Culvert 21X-0467/CO; Sta 10+712 Haldimand Twp (Replace to accommodate 8-lanes)
- Culvert 21X-0468/CO; Sta 12+426 Haldimand Twp (Rehabilitate to accommodate 6-lanes)
- Culvert 21X-0469/CO; Sta 14+138 Haldimand Twp (Rehabilitate to accommodate 6-lanes)
- Grafton Creek Culvert 21X-0270/CO; Sta 14+198 Haldimand Twp (Rehabilitate to accommodate 6-lanes)
- Northumberland Culvert 21X-0470/CO; Sta 17+170 Haldimand Twp (Replace to accommodate 8-lanes)
- Shelter Valley Creek Culvert 21X-0272/CO; Sta 19+345 Haldimand Twp (Rehabilitate to accommodate 6-lanes)
- Shelter Valley Road Culvert 21X-0273/CO; Sta 19+406 Haldimand Twp (Rehabilitate to accommodate 6-lanes)
- Boyce Road Culvert 21X-0576/CO; Sta 22+125 Haldimand Twp (Rehabilitate to accommodate 6-lanes)

After the bridges and structures have been rehabilitated or replaced, Highway 401 can be expanded to six lanes including, improvements to deficient horizontal and vertical curves. The interchange improvements at Lyle Street and Percy Street will be constructed at the same time as the replacement of the underpass structures at theses locations.

6.14.2 Ultimate Strategy

It is anticipated that the following bridges and culverts will require rehabilitation or replacement in advance of the need for 8-laning or in conjunction with widening to eight lanes:

- Danforth Road Underpass (Rehabilitate)
- Gully Road Underpass (Rehabilitate)
- Lyle Street Underpass (Rehabilitate)
- Vernonville Road Overpass (Replace)
- Boyce Road Overpass (Replace)
- Percy Street Underpass (Rehabilitate)
- Culvert 21X-0467/CO; Sta 10+712 Haldimand Twp (Rehabilitate)
- Culvert 21X-0468/CO; Sta 12+426 Haldimand Twp (Replace)
- Culvert 21X-0469/CO; Sta 14+138 Haldimand Twp (Replace)
- Grafton Creek Culvert 21X-0270/CO; Sta 14+198 Haldimand Twp (Replace with bridge)
- Northumberland Culvert 21X-0470/CO; Sta 17+170 Haldimand Twp (Rehabilitate)
- Shelter Valley Creek Culvert 21X-0272/CO; Sta 19+345 Haldimand Twp (Replace with bridge over Shelter Valley Creek/Road)
- Shelter Valley Road Culvert 21X-0273/CO; Sta 19+406 Haldimand Twp (Replace with bridge over Shelter Valley Creek/Road)
- Boyce Road Culvert 21X-0576/CO; Sta 22+125 Haldimand Twp (Replace)

After bridges and structures have been rehabilitated or replaced, Highway 401 can be widened to 8-lanes.

Interchange improvements at both Lyle Street and Percy Street can be undertaken prior to widening Highway 401 to 6-lanes, as each bridge replacement is on a new horizontal alignment.

6.15 Municipal Road Closures and Detours

Municipal Road closures across Highway 401 and detours using the existing municipal road network will be required during construction. The duration of the road closure scenarios is summarized in Table 6-6.

Table 6-6: Potential Road Closure Durations

Category	Approximate Duration	Typical Scenario
Overnight closure	12-18 hours	Highway 401 closures related to bridge demolitions and girder placements for new bridges
Short-term closure	1-30 days	Interchange ramp closures
Long-term closure	4-18 months	Municipal road bridge closures

The number of overnight closures and the duration of short-term and long-term closures will be confirmed during detail design. For long-term closures, it has been assumed that a GIGO (Get-In, Get-Out) bridge replacement can occur, which should limit the closure to between one and four months. If this accelerated construction technique is not possible and more a more conventional construction of the bridge replacement is required, the closure has the potential to be approximately 12-18 months in duration.

6.15.1 Overnight Closures and Detours

Overnight closures of Highway 401 are anticipated for some bridge demolitions and girder placements for new underpass structures. The anticipated overnight closures are summarized in Table 6-7.

Table 6-7: Overnight Closures

Structure Replacement	Detour Route (Colour)	Closure Requirement	Construction Activity
Danforth Road Bridge	Red	Highway 401 EB/WB between Division Street (County Road 45) and Lyle Street	Existing Danforth Road bridge demolition and potential girder placement for new bridge
Gully Road Bridge	Red	Highway 401 EB/WB between Division Street (County Road 45) and Lyle Street	Existing Gully Road bridge demolition and potential girder placement for new bridge

Structure Replacement	Detour Route (Colour)	Closure Requirement	Construction Activity
Lyle Street Bridge	Blue	Highway 401 EB from Lyle Street (County Road 23) to Percy Street (County Road 25)	Existing Lyle Street bridge demolition and potential girder placement for new bridge
	Red	Highway 401 WB from Lyle Street (County Road 23) to Division Street (County Road 45)	Existing Lyle Street bridge demolition and potential girder placement for new bridge
Percy Street Bridge	Yellow	Highway 401 EB from Percy Street (County Road 25) to County Road 30	Existing Percy Street bridge demolition and potential girder placement for new bridge
	Green	Highway 401 WB from Percy Street (County Road 25) to Lyle Street (County Road 23)	Existing Percy Street bridge demolition and potential girder placement for new bridge

Each overnight closure of Highway 401 will require a detour route along the existing municipal road network to maintain traffic along Highway 401. The anticipated detour routes are shown in Figure 9.

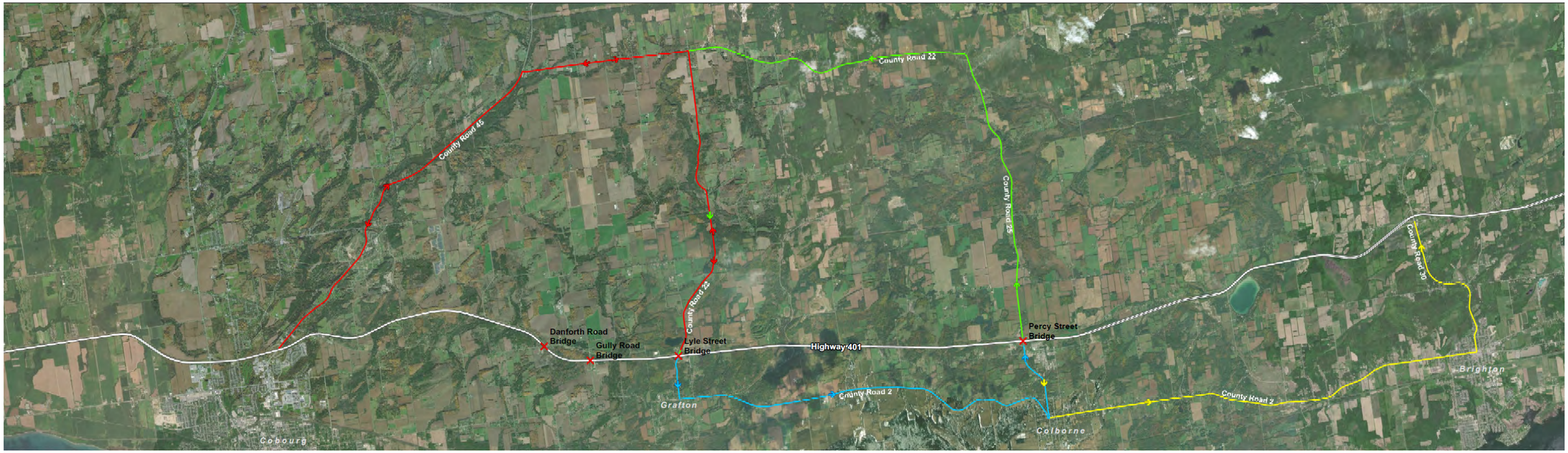

Figure 9: Overnight Closure Detour Routes

Based on a preliminary traffic analysis of the Highway 401 closures, it is anticipated that these closures will occur independently (i.e., not at the same time) in the Fall season when Highway 401 traffic volumes are lowest. It is also anticipated that temporary flagging or directing of traffic by police will be required at some intersections.

Further analysis of the overnight detour routes will be completed during detail design.

6.15.2 Short-Term Closures and Detours

Short-term closures of some interchange ramps will be required to accommodate construction of the Lyle Street and Percy Street interchanges. The anticipated ramp closures are summarized in Table 6-8.

Table 6-8: Short-Term Ramp Closures

Structure Replacement	Closure Requirement	Construction Activity
Lyle Street Interchange Ramps	Lyle Street Ramp W-N/S Lyle Street Ramp N/S-E	Remove existing ramps; Construct new ramps
Percy Street Interchange Ramps	Percy Street Ramp N/S-W Percy Street Ramp N/S-E Percy Street Ramp W-N/S	Remove existing ramps; Construct new ramps

Each overnight ramp closure will require a detour route along the existing municipal road network to maintain access to Highway 401. The anticipated detour routes are shown in Figure 10 and Figure 11.

Figure 10: Lyle Street Detour Routes

Figure 11: Percy Street Detour Routes

Based on a preliminary traffic analysis of the detour routes, the traffic diverted by the short-term ramp closures is not expected to adversely impact the traffic operations on the adjacent municipal road network.

Further analysis of the short-term detour routes will be completed during detail design.

6.15.3 Long-Term Closures and Detours

Long-term closures of the municipal roads under Highway 401 will be required to accommodate construction of the overpass structures. The anticipated road closures are summarized in Table 6-9.

Table 6-9: Long-Term Closures

Structure Replacement	Closure Requirement	Construction Activity
Danforth Road Bridge	Danforth Road	Existing bridge demolition and construction of new bridge
Gully Road Bridge	Gully Road	Existing bridge demolition and construction of new bridge
Shelter Valley Road Bridge	Shelter Valley Road	Existing bridge demolition and construction of new bridge
Vernonville Road Bridge	Vernonville Road	Existing bridge demolition and construction of new bridge
Boyce Road Bridge	Boyce Road	Existing bridge demolition and construction of new bridge

Each long-term closure of the municipal roads under Highway 401 will require a detour route along the existing municipal road network to maintain access across Highway 401. The anticipated detour routes are shown in Figure 12.

Figure 12: Long-Term Closure Detour Routes

Based on a preliminary traffic analysis of the detours, the traffic diverted by the long-term road closures across Highway 401 is not expected to adversely impact the traffic operations on the adjacent municipal road network.

Further analysis of the long-term detour routes will be completed during detail design.

6.16 Utilities

Utility relocations will be required to accommodate the Highway 401 widening to 8-lanes and the associated structure replacements and interchange improvements. A Utility Conflict Plan has been completed as part of this project as in on file with MTO. Relocation plans for utilities will be confirmed in detail design.

6.17 Property

The Recommended Plan will result in impacts to a total of 153 properties initially (Interim – 6 lanes), and 137 properties (Ultimate – 8 lanes). Two properties will require full acquisition: one property is residential and is located on the west side of Percy Street, north of the interchange; the other property is owned by Bell Canada and sits on the new Lyle Street alignment, south of the interchange.

As described in 6.2.3, based on MTO experience along the Highway 401 corridor to the west, 3:1 cut slopes and fill slopes are recommended to minimize the potential for erosion. Intermediate berms on the fore slope at an interval of 6 m are also recommended. This conservative grading has resulted in additional property impacts and a wider right-of-way in several locations along the corridor. The preliminary property requirements are illustrated on the preliminary design plans, which are included in Appendix J. A preliminary Property Request Plan has been prepared for this study and is on file with MTO.Table 6-10 summarizes the property impacts associated with the Recommended Plan.

Table 6-10: Summary of Property Impacts

	Interim (6-Lane)		Ultimate (8-lane)	
Property Type	**Number**	**Area (ha)**	**Number**	**Area (ha)**
Business	15	22.2	12	3
Private	79	30.3	71	10.6
Public	59	7.5	54	2
Total	153	60	137	15.6

A Temporary Limited Interest (TLI) property requirement has also been included as part of the plan.

7.0 Environmental Impacts and Mitigation

In accordance with the *Class EA for Provincial Transportation Facilities* (2000) and the *Environmental Reference for Highway Design* (2006), a description of the anticipated impacts associated with the Recommended Plan, and appropriate mitigation at a Preliminary Design level of detail, is described herein. The details of the Recommended Plan will be refined and finalized during detail design, subsequent to this Class EA.

7.1 Indigenous Rights and Interests

Engagement with Indigenous Communities will be initiated early in the detail design stage for this project.

7.2 Natural Environment

Impacts to the natural environment have been minimized in part, by minimizing footprint impacts to undisturbed natural environments. Impacts and mitigation to major components of the ecological system and the study area are described in the following sections.

Although the Recommended Plan will have direct impacts to wildlife habitat and vegetation, impacts at the larger watershed and ecosystem scale are not expected to be significant.

7.2.1 Erosion and Sediment Overview Risk Assessment

An Erosion and Sediment Overview Risk Assessment (ESORA) was completed as part of this study in accordance with the MTO Erosion and Sediment Control Guide to determine which Erosion and Sediment Control (ESC) approach is best suited for the anticipated construction works. Given the moderate to high erosion and sedimentation potential associated with this project, flatter slopes, intercept ditches and mid-height benches have been included in the design and a conservative approach to ESC is recommended. As such, it is recommended that Approach 3: Two Part Erosion and Sediment Control Plan (ESCP) – Main and Supplemental be implemented for the sites during detail design, in accordance with MTO Guidelines. This approach provides the contractor with the ability to adapt the ESCP should the site conditions found during construction differ than conditions assumed during detail design.

A copy of the ESORA memorandum is provided in Appendix K.

7.2.2 Drainage, Surface Water, Groundwater, and Sourcewater

Construction activities (i.e., structural replacements, highway widening) are not expected to include any significant below ground excavation of more than 2 m bgs, with the exception of culvert installation and several deeper cuts with a proposed depth of up to 10 m bgs (located just east of Lyle Street, west of Shelter Valley Creek and east of Boyce Road/Heron Road).

Based on the proposed depth elevations of the deeper cuts and study area groundwater elevations provided in the MECP Water Well Records (WWR) database, groundwater dewatering may be required. In addition, an Environmental Activity and Sector Registry (EASR) shall be obtained from the MECP for groundwater dewatering in excess of 50,000 L/day while a Permit to Take Water (PTTW) should be obtained from the MECP for groundwater dewatering in excess of 400,000 L/day. Detailed dewatering calculations and an assessment of site-specific conditions would need to be completed during detail design to further evaluate whether an EASR or a PTTW would be required for the deep cuts. An EASR or groundwater PTTW would not be required for the shallow works and any localized dewatering in support of culvert installation would be detailed and included in a surface water PTTW, if required. The need for a private well monitoring program shall be reviewed during detail design, including in the vicinity of deeper cuts that may be identified as part of detail design.

The handling or storage of Dense Non-Aqueous Phase Liquid (DNAPL) (i.e., paint stripper, pharmaceuticals, aerosols, fats, oils, resins, etc.) of any quantity is a significant threat to groundwater within Well Head Protection Area (WHPA)-B areas, and under source water protection policies, no handling or storage of DNAPLs of any quantity are permitted within the WHPA-B. DNAPLs are not expected to be required for the proposed construction of the project; however, construction should avoid handling and storage of DNAPL. There are no other significant threats expected due to the construction of the project within the WHPA-C, SGRA or HVA Areas; however, low to moderate threats may exist and this should be confirmed during detail design. During detail design, mitigation measures should be developed to minimize the risk of water quality impacts to the municipal production wells.

There is potential for impacts to surface water and groundwater as a result of construction activities and disturbance of contaminated soils, leaks and accidental spills during construction. Any construction activity in the vicinity of environmentally sensitive areas such as PSWs or cold water thermal regime watercourses may require additional monitoring to minimize the risk of water quality and/or surface water or groundwater interaction impacts

Protection and mitigation measures for surface water and groundwater impacts will be confirmed during detail design, and once construction methods and activities are identified. In the interim, preliminary proposed protection and mitigation measures include:

- Complete drainage design to provide appropriate drainage capacity
- Direct runoff and overland flow away from working areas and areas of exposed soils
- Store all oils, lubricants and other chemicals in suitable containers and handle them in accordance with applicable regulations

- Do not permit refueling within 30 m of a watercourse
- During construction, identify best management practices for fuel management including secondary containment of temporary fuel storage
- Identify spill response plan for construction and clean up all spills immediately and dispose of contaminated materials in an approved manner. The MECP will be informed of reportable spills.

Protection and mitigation measures for surface water and groundwater impacts will be confirmed during detail design once construction methods and activities are identified.

A copy of the Groundwater Memorandum is provided in Appendix C.

7.2.3 Potential Contaminated Property

A Contamination Overview Study (COS) was completed to assess if evidence of potential and actual environmental contamination exists as a result of current and past activities within the study area or adjacent/neighbouring properties. The COS study is on file with MTO.

Based on the findings of the COS, approximately nine properties were identified as having potential sources of contamination within the study area. In addition, further on-site investigations are recommended at these properties during the next stage of design to confirm or refute the presence of contaminated subsurface soil and/or groundwater. In addition, the following mitigation measures are recommended:

- If building demolition will be required, designated substance surveys will be completed for buildings or structures prior to demolition
- Further assessment, including Phase 1 and/or Phase 2 Environmental Site Assessment activities, may be required to investigate the potential for contamination
- The selection of soil for analysis should include consideration and observations of unusual odours, staining, or debris/waste in the recovered material.
- Excess soils will be managed in accordance with O. Reg. 406/19 (On-Site and Excess Soil Management) made under the Environmental Protection Act, R.S.O. 1990, c. E.19, as well as the MECP's *Rules for Soil Management and Excess Soil Quality Standard*, dated 2020.
- Should excess water be generated during construction, water quality analysis should be conducted to determine appropriate management methods. This work should be done by a Qualified Person.
- Should evidence of soil or water impacts be identified during construction, samples should be collected for laboratory analysis to confirm concentrations of potential contaminants to develop appropriate handing and health and safety guidelines.

A copy of the COS is provided in Appendix E.

7.2.4 Designated Areas

For MTO Class EA projects, the study process for Designated Areas includes identifying boundaries, understanding the feature and potential impacts of the project on the feature, attempting to avoid impacts, and mitigating any potential residual impacts. Where Designated Areas cannot be avoided as demonstrated by the Environmental Assessment approval process, transportation and highway design will be done in a manner that minimizes the extent of intrusion, minimizes visual impacts, maintains access to Designated Areas, and buffers adjacent to Designated Areas (*MTO Environmental Standards and Practices for Designated Areas*).

The Recommended Plan impacts the Barnum House Creek Conservation Area. The conservation area (19 ha) was deeded to Lower Trent Conservation from the Ministry of Natural Resources and Forestry and includes dense woodland, mixed shrubland, and Barnum House Creek, a coldwater stream. The Recommended Plan will impact approximately 0.78 hectares of the property and impacts will be located directly adjacent to the existing Highway 401.

7.2.5 Fish and Fish Habitat

As described in Section 4.1.6, among the 14 potential watercourse crossings investigated within the study area, direct fish habitat was documented within 11 sites within the Highway 401 ROW. In addition, indirect habitat was documented at two sites, and one site did not provide fish habitat. Most of the watercourse crossings are natural, coldwater watercourses that generally drain southerly to Lake Ontario and provide Brook Trout habitat.

Twelve common fish species were captured during the aquatic surveys undertaken in 2017; the most common of which were Brook Trout, Rainbow Trout, Creek Chub and Blacknose Dace.

It should be noted that following the completion of field investigations undertaken in 2017 and reported within the *Fish and Fish Habitat Existing Conditions Report* prepared by Stantec in 2018 (please refer to Appendix B), changes to the federal *Fisheries Act* came into force in August 2019. The 2020 *MTO Protocol for the Protection of Fish and Fish Habitat on Provincial Undertakings* (the Protocol) and the 2020 *Environmental Guide for Fisheries* (the Fish Guide) were revised and updated in 2020.

The Recommended Plan includes the replacement, extension or rehabilitation of bridges and culverts within the study area at watercourses that support or may support fish habitat. A summary of the preliminary design plan for each culvert is provided in Table 2 of the of the Fish and Fish Habitat Preliminary Impact Assessment Report and provided within Appendix L.

Applicability of Best Management Practices and Self-Assessment

In consultation with DFO, MTO has developed the *Best Management Practices Manual for Fisheries*, dated 2020, and a table of Routine MTO Works for activities within the MTO ROW that are not within a waterbody (i.e., Table 2 of the Protocol). The Best Management Practices (BMPs) and Table 2 of the Protocol were developed for routine activities in or near water with minimal to no impacts to fish and fish habitat. If a project is located within 30 m of the high-water level of a waterbody and the activity is listed in Table 2 of the Protocol, it can proceed without a fisheries assessment (i.e., Step 1 of the Protocol). Mitigation measures must be implemented to reduce the risk of the death of fish and the harmful alteration, disruption or destruction (HADD) of fish habitat.

The BMPs streamline the regulatory review process for routine highway activities and provide mitigation measures to reduce the risk of the death of fish and HADD of fish habitat. A project can proceed without DFO review if the conditions and mitigation measures outlined in a BMP can be met (i.e., Step 3 of the Protocol). Where a BMP is used, an MTO Project Notification Form is completed and filed by MTO (i.e., Step 5 of the Protocol).

If a project cannot meet the conditions of a BMP at Step 3 of the Protocol, a fisheries assessment is conducted to determine the likelihood of the HADD of fish habitat (i.e., Step 4 of the Protocol). Projects proceed to Step 5 when there are no federally listed SAR and it is determined that HADD of fish habitat is not likely. Where HADD is likely and/or where federally listed SAR are present, the project proceeds to Step 6 of the Protocol, where a Request for Review Application Form is submitted to DFO for review under the *Fisheries Act*.

The applicability of Table 2 of the Protocol should be determined during the detail design phase of the project for work that occurs within 30 m of fish habitat. Where activities in Table 2 of the Protocol do not apply, the applicability of BMPs should be determined for work in or within 30 m of water crossings where fish habitat was identified in the study area and at additional water crossings where habitat is identified during detail design (if applicable). Based on the preliminary design of the Recommended Plan, and general arrangement drawings for structural culvert replacements, the following BMPs should be considered at Step 3 of the Protocol during detail design:

- Like-for-Like Culvert Replacement – this BMP will not be applicable if the final design confirms that the new culverts will be longer than under existing conditions. Other conditions and constraints of the BMP must also be met.
- Clear Span Bridges – this BMP is not applicable to the replacement of culverts with bridges.
- Ditch Maintenance within 30 m of a Waterbody – the nature and extent of ditch maintenance is not known and should be assessed during Detail Design.
- Temporary Water Crossing – the need for temporary crossings has not been identified; however, this BMP may be applicable when construction access routes have been determined.

To be in compliance with the *Fisheries Act* and the Protocol, the design and construction of work in or near fish habitat must be undertaken in accordance with operational conditions, constraints and the protection measures provided in the BMPs.

Preliminary Aquatics Effects Assessment

Where fish habitat was identified (and at additional sites that may be identified during detail design), an aquatics effects assessment will likely be required during detail design to assess the risk of the project to result in the death of fish or HADD of fish habitat. At sites that provide fish habitat, the spatial extent of fish habitat directly affected by the project will need to be determined once culvert length, culvert dimensions / details of culvert liners, need for rock protection (areal extent, aggregate size) and channel realignments and the details of other activities that may affect fish and fish habitat have been confirmed.

Detail Design Considerations

Factors that shall be considered during detail design are summarized in **Table 7-1**. These shall be read in conjunction with Table 1 offered within the *Fish and Fish Habitat Preliminary Impact Assessment Report* provided in Appendix L.

Table 7-1: Detail Design Considerations Summary

Factors to Consider	Design Considerations
Fish Passage	• Migratory fish species are present (Rainbow Trout, Brook Trout, potential for Atlantic Salmon, Coho Salmon). • The maintenance of fish passage must be considered during detail design (i.e., determine changes to fish passage due to potential changes in water velocity and culvert length).
Significant Fish Habitat	• Potential Brook Trout spawning habitat is identified at specific locations. The final design and contract should consider reducing impacts to potential spawning areas by: – Avoiding the use of rock protection in the bed of the waterbodies identified as Significant Habitat – Avoid adding geotextile to the creek bed and banks.

Factors to Consider	Design Considerations
Constraints and Opportunities	• Where culverts are being replaced, remove perched conditions and/or other barriers to fish passage. • Address erosion, retain vegetation as per site-specific Constraints and Opportunities. • Protect groundwater upwelling areas, • Where feasible, direct stormwater runoff to ditches or other treatment and not directly to centreline culverts identified as fish habitat.
Other Considerations	Shelter Valley Creek: • The relocation/realignment of Shelter Valley Creek will require review by DFO due to the potential for the HADD of fish habitat. • The need for DFO to review proposed work at other locations will be determined during detail design. • MECP shall be consulted to determine if there is additional information with respect to the range of American Eel. If presence of American Eel is confirmed, design and construction must consider the species and its habitat. The MECP shall be consulted to determine the potential need for a permit under the ESA. Other Watercourses: • The culverts and mapped watercourse at Sites 21X-0468/C0 and 21X-0469/C0 and Culvert 000904010086 shall be assessed during detail design to determine if the future highway footprint may affect fish and fish habitat at this location • If fish habitat is identified at Site 21X-0468/C0, Site 21X-0469/C0, design must consider fish passage, opportunities and constraints, as applicable. • If fish habitat is identified at Culvert 000904010086 and in-water work is required, design must consider fish passage, opportunities and constraints, as applicable.

In addition to the above, the following measures should be incorporated into the project design to reduce the risk of impacts to fish and fish habitat:

- Where channel relocation is required (e.g., Shelter Valley Creek), apply natural channel design principles in the design of the replacement watercourse in order to convey expected flows while maintaining or enhancing fish habitat and fish passage
- Design drainage systems to reduce changes in drainage to watercourses that provide fish habitat
- Design and plan activities and works such that loss of fish habitat or disturbance to fish habitat is reduced to the extent possible
- Design stormwater management measures to reduce effects on watercourses that provide fish habitat to the extent possible
- Design a rehabilitation/re-vegetation plan for long-term stability of the areas disturbed during construction
- Reduce the need for rock protection in the creek beds to the extent possible; particularly at locations identified as Significant Habitat (please refer to Table 1 of the Fish and fish Habitat Preliminary Impact Assessment Report provided in Appendix L). Where rock protection is required below the normal high-water level, use appropriately sized material and install at a similar slope to the existing, maintain a uniform bank/shoreline, and maintain a natural bank/shoreline alignment such that it does not interfere with fish passage or alter the bankfull channel profile

Construction Timing

Works in watercourses that provide fish habitat or have the potential to support fish habitat are restricted to timing windows to reduce the risk of construction related impacts to fish during their most sensitive / vulnerable life cycles (i.e., during reproduction and early development stages).

Within the study area, in-water construction activities at locations that support fish and fish habitat are permitted from July 1 to September 30 inclusive (i.e., in-water work is not permitted from October 1 to June 30. The timing window does not apply to work above the ordinary high-water level.

Ontario Provincial Standard Specifications

The following OPSSs may be applicable to the project:

- OPSS.PROV 180 – General Specification for the Management of Excess Materials
- OPSS.PROV 182 – General Specification for Environmental Protection for Construction in and Around Waterbodies and on Waterbody Banks
- OPSS.PROV 517 – Construction Specification for Dewatering
- OPSS.PROV 803 – Construction Specification for Vegetative Cover (issued in April 2021 to replace the former OPSS.PROV 804)
- OPSS.PROV 804 – Construction Specification for Temporary Erosion Control (issued in April 2021 to replace the erosion control components of former OPSS.PROV 805)

- OPSS.PROV 805 – Construction Specification for Temporary Sediment Control (issued in November 2020 to replace the sediment control components of former OPSS.PROV 805)
- OPSS.PROV 825 – Construction Specification for Placement of Aggregates in Waterbodies
- OPSS.PROV 1005 – Material Specification for Aggregates – Waterbody

The following OPSSs are applicable to the following general activities:

- **Equipment Use** – Use of equipment shall be in accordance with OPSS 182.
- **Fish Salvage** – Fish salvage operations shall be conducted in accordance with OPSS.PROV 182.
- **Dewatering and the Use of Pumps** – Dewatering activities and the use of pumps shall be conducted in accordance with OPSS.PROV 517 and OPSS.PROV 182.
- **Preservation of Riparian Vegetation** – Removal of riparian vegetation shall be in accordance with OPSS.PROV 182.
- **Erosion and Sediment Control** – The installation, monitoring, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS.PROV 182, OPSS.PROV 804, and OPSS.PROV 805.
- **Placement of Aggregates in Waterbodies** – Use of aggregate in waterbodies shall be according to OPSS.PROV 825 and OPSS.PROV 1005.
- **Restoration of Disturbed Areas** – Vegetation protection and rehabilitation shall be in accordance with OPSS.PROV 182, OPSS.PROV 803, and OPSS.PROV 804.
- **Management of Excess Materials** – All excess material shall be managed in accordance with OPSS.PROV 180 and Ontario Regulation 406/19.

Additional site-specific mitigation measures may be required pending final design details for the project.

7.2.6 Terrestrial Environment

7.2.6.1 Potential Impacts

The Recommended Plan improvements will occur primarily within the existing ROW and disturbance to vegetation cover and terrestrial habitat is anticipated, including temporary loss of areas disturbed during construction.

Potential impacts associated with culvert replacements, interchange improvements, and road widening could include soil compaction, siltation of nearby wetland communities, terrestrial habitat loss and vegetation removal, disturbance to wildlife species, spills of deleterious substances into natural communities, and noise disturbance. All these impacts, except terrestrial habitat loss, are expected to be short term and localized to the study area during construction activities and lessened through the application of appropriate construction techniques and mitigation measures. Some terrestrial habitat will be permanently lost due to vegetation clearing and future footprint of Highway 401. Further discussion regarding potential impacts is detailed within the Terrestrial Ecosystems Preliminary Impact Assessment Report provided in Appendix M and summarized herein.

Loss of Terrestrial Habitat

The proposed culvert replacements, interchange improvements, and road widening will require vegetation removal, earth clearing, and grading and will result in the loss of approximately 217 hectares of terrestrial habitat within the study area. The majority of the proposed works will occur within the ROW and require little disturbance to natural vegetation cover and terrestrial habitat to accommodate construction activities. However, due to the steep slopes along, and adjacent to the ROW, construction activities in some areas will extend beyond the current ROW and require extensive vegetation removal and earth grading which will result in the loss of natural vegetation communities, in particular forested communities. The study area contains approximately 234 hectares of significant woodland of which 25 hectares will be impacted by the project. The terrestrial habitat impacted within the study area is listed in Table 7-2.

Table 7-2: Approximate Area of Impacted Terrestrial Habitat

Vegetation Community	Total Impacted Area (ha) by Vegetation Community
Meadow	80.72
Regeneration Thicket	8.54
Forest	27.30
Plantation	4.79
Swamp	1.26
Marsh	2.11
Open Water	0.08
Agriculture	6.32
Developed	84.13
Disturbed	1.07
Total Impacted	217.03

Potential Disturbance to Wetlands

Cranberry Lake PSW is located north and west of the Lyle Street interchange; however, is outside the area of proposed impact. Additional wetlands identified during field investigations are located both within and beyond the ROW. Approximately 3.4 ha of wetland and marsh will be directly impacted by the project. The spread of invasive Phragmites during construction could also displace native wetland vegetation.

Standard Sediment and Erosion Control methods are recommended along all wetland communities and near watercourse boundaries. Vegetation protection measures and invasive species management measures are also recommended to reduce indirect impacts to wetlands.

Potential Interference with Migratory Birds

Two Eastern Phoebe nests were observed during the field investigations. There is also potential for ESA (e.g., Barn Swallow) or MBCA protected birds to establish nests on bridge or culvert structures in the study area during subsequent breeding seasons. Any work near active bird nests that are encountered has the potential to disturb nesting behaviour or damage/ destroy the nests, particularly during vegetation clearing within the ROW during the active breeding bird window (i.e., April 1 – August 31).

The active breeding season for Barn Swallow is defined in Ontario Regulation (O. Reg.) 242/08 of the *Endangered Species Act* (2007) as May 1 to August 31, which prohibits vegetation clearing and work on existing structures that could disturb protected nests.

Potential Disturbance to Significant Wildlife Habitat

With the exception of Deer Wintering Areas, no significant wildlife habitat features are present within the study area. Woodlands within the ROW may be of lower quality for deer wintering habitat due to proximity to a major highway and general level of human disturbance. By minimizing woodland clearing and with proper forest edge management, impacts to deer wintering may be reduced.

Interference with Wildlife Movement

Wildlife movement corridors are also assumed to be present within the study area, with the potential for existing culverts beneath Highway 401 to connect habitats to the north and south of the roadway.

Potential Disturbance to Species at Risk and Species of Conservation Concern

A conservative approach was undertaken as part of this study to assess potential impacts to SAR and SOCC. Suitable habitat is based on records of occurrence and/or (Ecological Land Classification) ELC surveys and wildlife habitat assessments conducted for the study area. Table 7-3 presents the SAR and SOCC identified as having potential to occur in the study area.

Table 7-3: SAR and SOCC

Species Name	Direct Impacts
Wetland	
Blanding's Turtle	Interactions with construction activities could result in direct mortality. Turtles may be particularly vulnerable during peak activity periods (April 1 to October 31), including movement between wintering and nesting sites, nesting in the road shoulder and basking or foraging in the ROW. Least bittern may be directly impacted by construction activity through the destruction of their nest and breeding habitat or indirectly impacted by disturbances (i.e., noise, lights) which could result in adults abandoning their nest and/or young. Approximately 2.1 hectares of wetland habitat will be removed during construction.
Northern Map Turtle	
Snapping Turtle	
Least Bittern	
Forest	
Canada Warbler	Forest breeding birds may be directly impacted by construction activities through the destruction of their nest and breeding habitat during vegetation removal. Breeding
Eastern Wood-pewee	
Eastern Whip-poor-will	

Species Name	Direct Impacts
Louisiana Waterthrush	birds may abandon their nests and/or young as a result of indirect impacts due to disturbances (i.e., noise, lights, vibrations) associated with construction activities. Approximately 27 hectares of forest habitat will be removed during construction.
Red-headed Woodpecker	
Wood Thrush	
Meadow	
Bobolink	Meadow breeding birds may be directly impacted by construction activities through the destruction of their nest and breeding habitat during vegetation removal. Encounters with vehicles or heavy equipment could result in direct mortality for adults sitting on the nest or young that haven't fledged. Breeding birds may abandon their nests and/or young as a result of indirect impacts due to disturbances (i.e., noise, lights, vibrations) associated with construction activities. Grey-headed coneflower was observed near the Danforth Road East overpass on the south side of the highway and may be impacted through vegetation removal in this area. Approximately 81 hectares of meadow habitat will be removed during construction. Given the small area of grassland habitat within the work zone relative to the availability in the local landscape, negligible long-term loss of grassland habitat is anticipated as a result of the proposed project.
Eastern Meadowlark	
Grasshopper Sparrow	
Monarch	
Grey-headed Coneflower	
Species-Specific	
Bank Swallow	Bank Swallow may be directly impacted by construction activities in valleylands if there are exposed earth banks that may be used as nesting habitat for a colony.
Barn Swallow	Barn Swallow may be directly impacted by the removal, replacement, or construction on any culverts or bridges in the ROW that may be used as nesting habitat. No active Barn Swallow nests were observed during initial field investigations, but Barn Swallows may establish nests in the future.
Small-footed Myotis	Small-footed Myotis may be directly impacted by construction activities if rocky features, including rock piles at culvert and bridge locations, are disturbed.
Little Brown Myotis	The removal of large diameter trees and/or tree snags may result in the direct loss of maternity colonies and/or roosting habitat. Disturbances (i.e., noise, lights, vibrations) associated with construction activities may result in bats avoiding foraging and roosting habitat in the study area.
Northern Myotis	
Tri-coloured Bat	

7.2.6.2 Mitigation Measures

Migratory Birds

If a nest is located, a designated buffer will be delineated within which no activity will be allowed while the nest is active. The radius of the buffer will be determined by a qualified professional. Once the nest is determined to be inactive (e.g., the young have fledged to nest), clearing and other activities in the area may proceed.

If construction activity that may disturb or disrupt birds nesting on the bridges is required during the restricted period, exclusionary measures such as pre-tarping of the structure before April 1 could be employed to deter birds from nesting on the bridges, following the MNRF *Best Management Practices for Excluding Barn Swallows and Chimney Swifts from Buildings and Structures.*

Pileated Woodpecker

Under the Migratory Bird Regulations within the MBCA, Pileated Woodpecker nests are protected year-round. A search for Pileated Woodpecker nests shall be undertaken prior to construction. If a Pileated Woodpecker nest is determined to be empty of live birds or viable eggs, then the nest must be registered under the Environment and Climate Change Canada's (ECCC) Abandoned Nest Registry, at which time the prescribed period of inactivity (i.e., 36 months) shall begin before any action can be taken towards the nest.

Significant Wildlife Habitat

Targeted field investigations at detail design are required to evaluate candidate SWH features. Feature-specific mitigation measures are provided to reduce impacts to wetland habitats, woodland habitats, and habitats for reptiles and amphibians. Protection from indirect impacts such as sedimentation and erosion will be addressed through standard environmental protection measures and vegetation measures.

Wildlife

The following environmental mitigation and protection measures for wildlife and wildlife habitat are recommended:

- Construction equipment and vehicles are to yield to wildlife.

- Inform construction personnel to not threaten, harass or injure wildlife.
- If wildlife are encountered during construction, personnel are required to move away from the animal and wait for the animal to move off the construction site. If slow-moving wildlife (e.g., turtles, snakes) are observed on the road and in danger, and if safe to do so, they should be moved off the road by gently guiding the individual in the direction it was traveling. Handling of SAR is not permitted without ESA authorization.

Species at Risk/Species of Conservation Concern

Further field investigations, including targets surveys, should be undertaken at the next stage of planning and design to confirm the presence of SAR or SOCC and their habitat. Handling SAR to relocate them out of harm's way is not permitted under the ESA 2007. Therefore, the following mitigation provides recommendations to proactively reduce risk to SAR and SOCC through avoidance of habitat features, timing windows and observations of potential refuges.

General mitigation to reduce impacts to SAR or SOCC and their habitats include:

- Inform on-site personnel of the potential presence of the SAR and/or SOCC identified in the study area, obligations under the ESA (2007), and recommended actions in the event of an encounter.
- Species listed as endangered or threatened on the SARO List that are present in the study area must be protected from harm and harassment.
- Any SAR individual that is incidentally encountered in the study area must be allowed to leave of its own accord. Activities within 20 m should cease until the individual disperses. Construction machinery/equipment must maintain a minimum operating distance of 20 m from the individual until it disperses from the work zone of its own accord.
- Should on-site personnel be unable to allow an incidentally encountered SAR individual to disperse from the active construction area under its own ability, MECP must be contacted immediately for additional guidance.
- Any SAR individual that is encountered in the work zone should be reported to the MECP staff within 48 hours of the observation or the next working day, whichever comes first.
- If an injured or deceased SAR is found, the specimen must be placed in a non-airtight container that is maintained at an appropriate temperature and MECP must be contacted immediately for additional guidance.
- Temporary alterations to SAR habitat must be limited to the duration and spatial extent possible and be remediated upon completion of activity and monitored as necessary.

Reptiles and Amphibians

The peak active season for reptiles and amphibians, from approximately April 1 to October 31, cannot be avoided during construction. Installation of wildlife exclusion fencing will occur before May 15 or after September 15 (i.e., outside of key breeding period) to define Work Zones and restrict the movement of reptiles and amphibians into the working area. If it is not possible to isolate a nest from construction, work will be delayed until it is determined that the nest no longer includes viable eggs (hatchlings have emerged, or eggs were predated).

Potential snake hibernation sites (rock outcroppings or stumps extending below-grade, or animal burrows) will not be distributed during the hibernation period (November 1 to March 31). If removal of above-ground habitat features (rock slabs, piles or brush) is needed, returned post-construction to the same or a nearby location.

During ditching and grading activities undertaken between April 1 and October 31, disturbance will be limited to the greatest extent possible to protect reptiles or amphibians that may be present. A spotter could be used to identify individuals present in the work area.

Grassland Birds

Habitat for Eastern Meadowlark may also support Bobolink and Grasshopper Sparrow. Construction activities with the potential to harm habitat of grassland breeding bids should not be undertaken between April 1 and August 31. Work adjacent to confirmed breeding habitat should be limited during the breeding season as much as possible to avoid harassment to these species.

The limits of construction within grassland habitat should be reduced to the extent possible and delineated and flagged/staked in the field prior to construction to assist with the demarcation of the construction area. The delineated limits of construction will be reviewed by a qualified ecologist.

Grassland habitat disturbed temporarily should be remediated to pre-existing conditions as soon as possible before the beginning of the next nesting period.

Monarch

Construction activities with the potential to harm Monarch eggs, caterpillar, or pupae (e.g., vegetation clearing in meadow areas) should not be undertaken during the larval period which is approximately May 1 to September 30.

If vegetation clearing will proceed when Monarch larvae may be present (May 1 to September 30), inspection of milkweed plants is recommended to locate Monarch larvae. If larvae are present, they may be moved to a location that Is suitable and safe under the direction of a qualified professional. Monarch caterpillars may be moved to other milkweed plants; for other larval stages (i.e., eggs and chrysalis), entire milkweed plants should be transplanted.

Milkweed and nectar producing plants should be included in seed mixes for areas restored to meadow to provide habitat for Monarch.

Bank Swallow

To prevent Bank Swallow colonization of the work zone during construction, work that involves the modification of natural exposed earthen banks or stockpiling of silt or sandy materials (e.g., soil stockpiles, excavations, trenches, aggregate areas) will not be left with vertical faces during the Bank Swallow breeding season. Slope faces will be reduced to 70 degrees or less. This can be achieved by sloping off stockpiles, using an excavator to create the desired slopes or contouring faces or piling material on the face. Slope management will be completed by mid-April and slopes will be maintained daily throughout the nesting season (i.e., until the end of August) to meet the 70 degrees or less target.

Barn Swallow

Barn Swallow nests could be established on structures in the study area in any given year prior to construction. At the time of issuing this TESR, Barn Swallow and its habitat (i.e., nesting structures) are protected from harm or harassment under general habitat regulations of the MBCA.

For an activity that has the potential to damage nests or interfere with breeding activity that is required to take place within the Barn Swallow nesting period, exclusionary measures (i.e., pre-tarping) will be installed on the structure before April 1 to dissuade Barn Swallow from nesting.

For construction activities that are timed to take place outside of the Barn Swallow nesting period (May 1 to August 31), inactive nests that have the potential to be damaged or destroyed on the structure must be removed prior to commencement of construction and prior to April 1.

Bats

To reduce the risk of accidental harm to bats, removal of trees > 10 cm DBH or structures/rocky habitat providing suitable roosting habitat should occur outside the period when bats occupy maternity roosts (May 1 to August 31). If removal of, or work on, potential maternity roost habitat is required within this window, maternity exit surveys may be conducted prior to construction to determine if bats are using the trees or structures. Maternity exit surveys are conducted during the evening and should include visual and acoustic surveys using accepted protocols. Consultation with MECP is recommended prior to any tree removals in order to receive up-to-date guidance on appropriate surveys and mitigation measures to remain compliant under the ESA.

Wildlife Movement Corridors

Approximately 27% of the Ecodistrict in which the study area is located consists of natural forest cover (deciduous, coniferous, and mixed forests). Valleys generally run from north to south toward Lake Ontario. The study area crosses two large natural corridors, Barnum House Creek/Grafton Creek (including Barnum House Creek Conservation Area south of highway 401) and Shelter Valley, as well as numerous smaller wooded valleys with watercourses. MNRF identified Barnum House Creek/Grafton Creek and Shelter Valley, as well as a wooded valley along an unnamed tributary west of the Danforth Road underpass, as key locations for wildlife passage. One provincially significant wetland (Cranberry Lake) is within the study area, north of Highway 401 near the interchange of County Road 23. Deer wintering areas have been identified by MNRF to the north and south of the study area indicating that deer are likely to move across the highway in response to seasonal habitat and foraging needs. Potential SAR and species of conservation concern (SOCC) in the study area which may benefit from the availability of ecopassages include Snapping Turtle, Painted Turtle, and Blanding's Turtle.

Two existing large open-bottom arch culverts (10 m and 15 m width) are present in the study area and cross the two most significant natural corridors: Barnum House Creek/Grafton Creek (21X-0270/C0) and Shelter Valley (21X-0272/C0). Given the large size of these culverts and the presence of Deer Wintering Areas northwest and south of the highway in the vicinity of these locations), they likely support movement of both small and large wildlife under Highway 401. Both structures are proposed for replacement by bridges as part of the long-term strategy and represent the best opportunity in the study area for wildlife movement across Highway 401.

The function of these culverts could be improved through installation of fencing to direct wildlife toward the culvert openings. The length and placement of fencing in the study area should be determined by the Project priorities, such as a reduction in deer-vehicle collisions on Highway 401 or facilitating movement of small wildlife (reptiles, amphibians, and small mammals) across the highway. Additional improvements for wildlife movement are expected as part of the long-term strategy where these two large culverts will be replaced by bridges. These recommendations shall be further reviewed during the detail design stage of the project, pending funding and approvals.

Erosion and Sediment Control

Mitigation measures for sedimentation, erosion, and dust control are recommended to prevent sediment and dust from entering sensitive natural areas (i.e., watercourses and wetlands). The primary principles associated with sedimentation and erosion protection measures are to:

- Reduce the duration of soil exposure
- Retain existing vegetation, where feasible
- Encourage re-vegetation

- Divert runoff away from exposed soils
- Keep runoff velocities low
- Trap sediment as close to the source as possible

To address these principles, the following mitigation measures are recommended:

- Silt fencing and/or barriers are recommended along the Work Zone where there is potential for sedimentation of watercourses or wetlands, or inadvertent encroachment of construction vehicles into natural areas.
- Avoid entering any natural areas beyond the barrier fencing with equipment and avoid excess vegetation removal.
- Stabilize exposed soil areas (native seed mixes; sourced locally if possible) and re-vegetate through the placement of seed and mulching or seed and an erosion control blanket, promptly upon completion of construction activities. All disturbed substrates are recommended to be re-vegetated using seed mixes of species that are native to the site and suitable for site conditions. Introduce seed to disturbed substrates as soon as feasible following construction, and sediment fencing is recommended to remain in place until vegetation cover is re-established.
- Re-fuel equipment 30 m away from watercourses to reduce potential impacts if an accidental spill occurs.
- In addition to any specified requirements, make additional silt fence available on site, prior to grading operations, to provide a contingency supply in the event of an emergency.
- Monitor all sediment and erosion controls daily and properly maintain as required. Remove controls only after the soils of the construction area have been stabilized and adequately protected or until cover is re-established.
- Monitor limits of construction adjacent to natural features during construction (along with sediment and erosion control measures) to maintain limits with respect to vehicular traffic and soil or equipment stockpiling.
- Avoid stockpiling excess materials on site.
- Restore any disturbed natural areas to pre-construction conditions.

Vegetation Protection

Precise limits of vegetation removal will be confirmed during the next stage of planning of design and are anticipated to be smaller than the estimates listed in Table 7-2. Sediment fencing should be used to clearly mark and separate work areas from sensitive natural features (e.g., wetlands and watercourses). Sediment fencing will minimize the release of sediments and other deleterious substances into adjacent areas of natural vegetation.

Topsoil and organic matter should be salvaged and reused in areas disturbed during construction, as appropriate. Replaced soils will contain native seed bank, which will help facilitate successful revegetation. Post-construction seeding of the disturbed ROW should be done with a suitable native seed mix and in consideration of Monarch habitat. Seed mixes should include fast-growing, short-lived perennial cover crop to stabilize soil and reduce competition from weedy exotics. native cover crops are preferred. New seed should be introduced to disturbed substrates as soon as feasible following construction (within 15 days for areas less than 200 m from a watercourse, and 45 days for other areas), and sediment fencing should remain in place until vegetation cover is re-established. Seeded areas shall receive water either through precipitation or irrigation after every seven successive days without rainfall for the first two months after seeding.

A landscape restoration plan should be developed for all areas disturbed during construction, as well as any proposed compensation areas, and incorporated into the next stage of planning and design package. The plan would include recommendations for use of native species in restoration planting as well as methods for management of invasive species.

Invasive Phragmites Management

The invasive common reed (Phragmites) is a ‘restricted’ plant species regulated by the Ontario Invasive Species Act (2015), and under the Act it is illegal to import, deposit, release, grow, buy, sell, lease or trade this species. Phragmites were identified throughout marshes in the study area. If Phragmites control is required, further field studies during detail design should be completed. A clean equipment protocol may be required for machinery entering riparian areas to prevent the spread of invasive species into the feature.

7.3 Socio-Economic Environment

7.3.1 Land Use

Land use designations in the study area are not expected to change as a result of the Recommended Plan.

Policy Direction

The Recommended Plan supports Regional and Provincial Growth Planning policies by providing the transportation infrastructure required to maintain a high level of service on the provincial highway system for the movement of people and goods.

Property

Potential impacts to private properties and appropriate protection and mitigation measures are discussed in Section 6.17.

It should be noted that property at some locations may be required in the interim to accommodate the future ultimate footprint (i.e., 8-lanes) for the Recommended Plan.

Mitigation

Based on significant direct impacts identified at two separate private properties as part of the preferred plan, additional investigations were carried out to identify appropriate mitigation strategies to reduce or avoid impacts to the extent possible. As noted previously, a retaining wall will be constructed to mitigate the property impacts at one property, and a revised shoulder design and steeper backslopes will be used to reduce the property impact at the other.

Traffic Operations

The Recommended Plan will require detours (please refer to Section 6.15) and temporary closures of the following roads: Danforth Road, Gully Road, Shelter Valley Road, Vernonville Road, and Boyce Road. Temporary closures of the Lyle and Percy Street bridges and interchange ramps will also be required for the construction of the interchange improvements. Delays are expected to be minor during construction of the Recommended Plan, but construction staging plans will be confirmed during the design stage of this project. Residents in the study area may experience minor temporary delay during construction, however potential impacts are expected to be very minor and not result in significant impacts. Therefore, no mitigation measures are proposed at this time. Construction staging plans will be confirmed during design and access to private entrances and sideroads will be maintained, wherever possible in the construction staging plans. Stakeholders (including EMS and school boards) and the public will have an opportunity to provide input on construction staging plans during design. Emergency service providers will be notified of the start of design and once construction staging plans are developed in order to minimize delays in emergency response times during and after construction.

Student Transportation

There may be potential minor delays to student transportation activities during construction of the Recommended Plan. The Recommended Plan will require detours (Section 6.15) and temporary closures due to the long-term closures of the following roads: Danforth Road, Gully Road, Shelter Valley Road, Vernonville Road, and Boyce Road. Temporary closures of the Lyle and Percy Street bridges and interchange ramps will also be required for the construction of the interchange improvements as part of the Recommended Plan. Delays are expected to be minor during construction of the Recommended Plan, but construction staging plans will be confirmed during design, in consultation with affected student transportation services.

Commercial

The Recommended Plan is not anticipated to have any negative impacts to local businesses within or surrounding the study area. Access throughout the study area and associated communities will be maintained during construction of the Recommended Plan. All existing roadside signage for tourist attractions and businesses will be temporarily removed during construction and relocated to accommodate the ultimate Recommended Plan.

Emergency Services

Temporary closures of the Lyle and Percy Street bridges and interchange ramps will also be required for the construction of the interchange improvements as part of the Recommended Plan. Delays are expected to be minor during construction of the Recommended Plan, but construction staging plans will be confirmed during design, in consultation with emergency service providers. Additional details of road closure delays during construction are provided in Section 6.15.

Municipal Services

There are no direct impacts to municipal services as a result of the Recommended Plan.

7.3.2 Agriculture

The majority of the agricultural land in the study area is divided between an agricultural soil capability of Class 6 (Capable only of producing perennial forage crops) and Class 3 (moderately severe limitations that restrict the range of crops). The Recommended Plan will impact agricultural lands located both north and south of the study area. In addition, the temporary closures of roadways may temporarily impact the movement of agricultural equipment between properties.

7.3.3 Aggregates

The Recommended Plan does not directly impact any aggregate extraction facilities.

7.3.4 Mining

The Recommended Plan does not impact any mining operations or facilities.

7.3.5 Recreation and Tourism

The Recommended Plan supports regional tourism and recreational growth by replacing aging infrastructure, and improving safety and traffic operations within the study area; and by avoiding impacts to crown land, impacts to businesses and recreational facilities.

It should be noted that approximately 0.95 hectares of the Shelter Valley Golf Course property are expected to be impacted by the Recommended Plan; however, impacts to the golf course and associated greens have been avoided through the design of a retaining wall at this location.

Trails and Active Transportation

The MTO is committed to sustainable transportation and active transportation as outlined in the MTO *Statement of Environmental Values* (2008). The Recommended Plan does not affect any identified trails in the study area.

Snowmobile Trails

The Ministry's practice is to accommodate existing Trans Ontario Provincial Snowmobile (TOPS) and Regionally Significant Trails in the final design of highway improvement projects in the vicinity of existing crossings. Snowmobiles are not permitted to operate within the right-of-way of a Controlled Access Highway or within interchange areas. There will be no direct impacts to any TOPS snowmobile trails as a result of the Recommended Plan and therefore no mitigation measures are required or proposed.

7.3.6 Utilities

Potential impacts to utilities are discussed in Section 6.16.

7.3.7 Air Quality and Greenhouse Gas Assessment

Operational Air Quality

An Air Quality and Greenhouse Gas Assessment was completed as part of this study to characterize existing air pollutant emissions (2016) and predict air quality effects within the study area after implementation of the project in the future interim build (2031) and ultimate build (2041) scenarios. A copy of this report is provided in Appendix N. The contaminants of potential concern (CoPCs) for the study were based on the most relevant transportation-related contaminants as listed in the MTO *Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects (*MTO Guide), and include nitrogen dioxide (No_2), carbon monoxide (CO), particulate matter with diameter less than 10 micrometres (PM_{10}), particulate matter with a diameter less than 2.5 micrometres ($PM_{2.5}$), acrolein, benzene, 1,3-butadiene, benzol(a)pyrene (B(a)P), acetaldehyde and formaldehyde. Greenhouse gas (GHG) emissions in the form of CO2e were also quantified. The following principal conclusions were made from the air quality and greenhouse gas impact assessment:

- Maximum predicted Project ground level concentrations (GLCs) of CoPCs other than B(a)P are below their relevant Ambient Air Quality Criteria (AAQC) and/or Canadian Ambient Air Quality Standard (CAAQS) at all sensitive receptors for all release scenarios.
- Maximum predicted cumulative GLCs of CoPCs other than B(a)P are below their relevant AAQC and/or CAAQS at all sensitive receptors for all release scenarios.
- Maximum predicted cumulative $PM_{2.5}$ concentrations are below but approaching the annual average CAAQS for all scenarios but are mainly attributable to background concentrations.
- Maximum predicted cumulative benzene concentrations are below but approaching the annual average AAQC for all scenarios but are also mainly attributable to background concentrations.
- Measured concentrations of benzene and $PM_{2.5}$ across Ontario have shown decreasing trends between 2008 and 2017. It is likely that background levels of these contaminants will continue to improve in the future and therefore the background concentrations used in the assessment are conservative.
- Predicted cumulative concentrations of B(a)P exceed the 24-hour and annual AAQCs at all special receptor locations with background concentrations already representing 6% and 130% above the 24-hour and annual average AAQC, respectively. Maximum concentrations from the project alone, are however predicted to be below the applicable criteria in the future scenarios, with the background levels being the major contributor to the cumulative exceedances. The concentrations are predicted to decrease in the future ultimate build and ultimate no build scenarios.
- During Project construction, best management practices should be followed to minimize emissions.

Releases of GHGs from the project are expected to be insignificant in comparison to the 2017 Canada and Ontario totals and the 2030 emissions targets.

Air Quality During Construction

During construction of the project, dust will be the primary CoPC. Other CoPCs such as NO_2 and VOCs will also be emitted from equipment used during construction. As the construction activities will be short-term and intermittent, emissions are expected to be minor provided adequate mitigation measures are implemented. The ECCC guideline "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" provides recommendations for mitigation measures to reduce construction emissions. These measures include material wetting or use of chemical suppressants to reduce dust, use of wind barriers and limiting exposed areas which may be a source of dust, and equipment washing. It is recommended that these best management practices be followed during Project construction.

7.3.8 Noise Impact Assessment

Operational Noise

A Noise Impact Assessment was carried out in accordance with the MTO's 2008 *Environmental Guide for Noise* (MTO guideline) to measure the anticipated change in operational noise (traffic noise) impacts from the project. A copy of this report is provided in Appendix O. The following two scenarios (dates are for analysis purposes and may not represent actual construction timing) were considered in this assessment:

1. Interim (Year 2031): includes the future interim footprint of Highway 401 from 4 lanes to 6 lanes and the subsequent reconfiguration of the interchanges at Lyle Street and Percy Street.

2. Ultimate (Year 2041): includes the future ultimate footprint of Highway 401 from 6 lanes to 8 lanes and the minor adjustments to ramps required at the interchanges at Lyle Street and Percy Street.

To help to assess the change in future noise levels, Points of Reception (PORs) are identified as Noise Sensitive Areas (NSAs), including land uses such as residences, hospitals and/or nursing homes for the aged that have outdoor living areas associated with them, that surround the project area. If the sound levels measured at the identified PORs are predicted to be less than 65 dBA and generate less than a 5dB increase over the "no build" scenario, an investigation of noise mitigation is not warranted. Based on the results of the assessment, a total of 43 representative PORs, including two future developments, are identified as NSAs (i.e., residential dwellings).

The noise impact assessment completed for this project identified that the Recommended Plan will likely result in an increase in sound levels of up to 2db. Sound levels were modelled for the interim (Year 2031), and ultimate scenarios (Year 2041). A total of 12 modelled receptors in the interim scenario predicted sound levels are expected to be higher than 65 dBA. An additional one modelled receptor also predicted sound levels to be higher than 65 dBA for the ultimate scenarios.

While 13 PORs were assessed, only 9 noise barriers were considered as a noise mitigation option for the identified receptors, given that some of the barriers could be expected to mitigate noise levels for multiple PORs. Based on the assessment, only one receptor met MTO's technical and economical feasibility requirements for mitigation. However, the location of this receptor was situated within a future development area and will be assessed and designed by the developer as part of a future Planning Act application process. Given that the technical and economic feasibility of noise barriers was ruled out for the balance of the identified receptors, no noise mitigation is recommended for this project.

Construction Noise

Construction noise impacts are temporary in nature, and largely unavoidable. With adequate controls, impacts can be minimized. It should be noted that MTO is legally exempt from the requirements of municipal noise bylaws and does not apply for bylaw exemptions and get permits. However, MTO recognizes that construction noise can have impacts on communities and will ensure clear and frequent communication with the municipalities to work within the spirit of the municipal noise bylaws. MTO will make all reasonable attempts, including public notification and mitigation measures, to reduce construction noise impact. Typical construction equipment can be operated in compliance with the MECP limits. Once equipment and construction schedules are finalized, the equipment noise data should be reviewed during detail design to confirm that noise emissions are below the permissible limits. If the sound levels are higher than the limits, noise control options may be explored.

To minimize the potential for construction noise impacts, it is recommended that the following be carried out:

- All equipment should be properly maintained to limit noise emissions. As such, all construction equipment should be operated with effective muffling devices that are in good working order.

- The Contract Documents should contain a provision that any initial noise complaint will trigger verification that the general noise control measures agreed to are in effect.

- In the presence of persistent noise complaints, all construction equipment should be verified to comply with MECP NPC-115 guideline.

- In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measures may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration should be given to the technical, administrative and economic feasibility of the various alternatives.

7.4 Cultural Heritage Environment

7.4.1 Archaeology

The Recommended Plan does not directly impact any registered archaeological sites. However, the findings of the Stage 1 archaeological assessment indicated that approximately 343 ha (73%) of the study area retains a moderate to high potential for the identification and recovery of archaeological resources. As such, Stage 2 archaeological assessment is required for these areas, in accordance with the MCM *Standards and Guidelines for Consultant Archaeologists*.

The Stage 1 Archaeological Assessment Report was filed with the MCM for concurrence and endorsement through a Letter of Review and entry into the *Ontario Public Register of Archaeological Reports*. Once the Stage 2 Archaeological Assessment report is completed it will be filed with the MCM for concurrence and endorsement.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48(1) of the *Ontario Heritage Act* (Government of Ontario 1990b). The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48(1) of the *Ontario Heritage Act* (Government of Ontario 1990b).

The *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (Government of Ontario 2002) requires that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Government and Consumer Services.

The Stage 2 archaeological assessment will be completed during later study stages. The Stage 2 archaeological assessment will include test pit survey at 5 m intervals in areas not accessible for ploughing (i.e., woodlot, meadow), as outlined in Section 2.1.2 Standard 1f of the MCM 2011 Standards and Guidelines for Consultant Archaeologists (Government of Ontario 2011). The MCM standards require that each test pit be approximately 30 cm in diameter, excavated to at least 5 cm into subsoil, and have all soil screened through 6 mm hardware cloth to facilitate the recovery of any cultural material that may be present. Prior to backfilling, each test pit will be examined for stratigraphy, cultural features, or evidence of fill.

7.4.2 Built Heritage and Cultural Landscapes

Based on the findings of the Cultural Heritage Resource Assessment (CHRA), 3 properties were identified as Cultural Heritage Landscapes (CHLs) and located within 50 m of the Recommended Plan, including:

- Private property on Gully Road (CHL-1)
- Cherry Hill Road (CHL-4)
- Union Cemetery (CHL-8)

Potential impacts to these properties should be reviewed during detail design to confirm that these properties are avoided. As per the MTO Environmental Guidelines, the following avoidance measures are recommended for these properties during construction, and will be confirmed during detail design:

- No removal or changing of cultural heritage landscape resources should occur.
- No land-disturbing or vegetation-disturbing activities should be carried out in or near cultural heritage landscapes.

In addition to the above, direct impacts to one building having potential heritage value or interest are expected in association with the Recommended Plan. Specifically, the new Highway 401 interchange with Percy Street and associated realignment and new Carpool lot are expected to displace one building (i.e., Built Heritage Resource (BHR)-18). As such, a CHER was recommended for this property, as described below.

Built Heritage Resource-18

A CHER was undertaken for Built Heritage Resource (BHR) 18 (170 Percy Street), located within the northwest quadrant of the Highway 401/Percy Street interchange, to further investigate its cultural heritage value or interest, and to determine if specific mitigation measures would be required, given that this property has the potential to be directly impacted by the Recommended Plan. As noted in Section 4.3.2, the CHRA undertaken as part of this study identified BHR-18 as a built heritage resource.

Based on the findings of the CHER, the property was identified as containing a one- and one-half story residence that dates to the mid-19th century. Based on the Recommended Plan, this property will be displaced to accommodate the future footprint of the Highway 401 and Percy Street interchange and associated modifications. Given the direct impacts identified to this property and following MTO's *Environmental Guide for Built Heritage and Cultural Heritage Landscapes* (MTO 2007), a stand-alone Cultural Heritage Evaluation Report (CHER) was prepared for the property.

Following evaluation according to O. Reg 9/06 and O. Reg 10/06, BHR-18 did not satisfy criteria from O. Reg 9/06 or O. Reg 10/06 and therefore does not have cultural heritage value or interest. As such, no further cultural heritage assessment for this property is required.

7.4.3 Landscape Planting

There will be visual impacts to the existing landscape associated with the Recommended Plan, including temporary impacts such as those caused by vehicle lights, which will fluctuate based on usage; permanent impacts based on the crossing structure, associated structures, and changes to site lighting; and views to/from the existing interchanges to and from the surrounding area, features and points of interest. The visual impacts associated with the future footprint of Highway 401 are not expected to be significant.

Restoration and Compensation

Strategic coordination of the restoration of vegetation communities is encouraged for consideration in the detail design phase, such as focusing forest and woodlot compensation around watercourses to increase their benefit to cold water streams.

Visual Screening

A small amount of visual screening is recommended for the north end of the Colborne Union Cemetery. Visual screening is not anticipated to be required for the Lyle Street interchange; however, it should be considered during detail design.

Visual screening plantings should be carried out in coordination with the affected residents and maintain positive landscape viewsheds where possible. The possibility of saline soils and salt spray should be considered as an important species selection constraint during the design development of possible vegetative screens.

It is recommended that a cultural heritage expert be consulted on the appropriate design of screenings and naturalization plantings on or adjacent to the Union Cemetery, Barnum House National Heritage Site, and Barnum House Creek Conservation Area.

Highway of Heroes Tree Campaign

Collaboration with the Highway of Heroes Tree Campaign is recommended where trees are being planted for visual screening or naturalization. The design of commemoration sites with native species, wildlife habitat, and pollinator populations along Highway 401 and associated interchanges are goals of the campaign. Furthermore, the development of commemoration sites may develop cultural connections to the landscape in this area.

A copy of the Conceptual Landscape Plan, which includes potential opportunities for Highway of Heroes tree plantings, is provided in Appendix P.

8.0 Consultation

The main objective of consultation in the Class EA process is to ensure that project information is shared in a meaningful way, and that consideration is given to all aspects of the environment from the earliest stages of planning. Communication with potentially impacted and/or interested parties is key in the planning process and provides a mechanism for the proponent to define and respond to issues prior to key decisions being made. Recognizing this, the study team initiated a comprehensive program from the onset of the study, as described herein.

All interested parties were offered early and ongoing opportunities to review study information and provide input to the decision-making process. To achieve this, a variety of communication strategies were used to engage the public, agencies, private property and business owners, other stakeholders, and Indigenous Communities. As a first step, a Consultation Plan was developed and described the following elements:

- Study notifications (Notices of Study Commencement, Public Information Centre (PIC 1), Online PIC 2 and TESR Completion)
- Communication with external agencies to obtain pertinent technical information and identify the requirement for legislative or regulatory approvals related to the undertaking
- Meetings with a Municipal Advisory Committee (MAC) that included municipal staff and Council (Township of Hamilton, Town of Cobourg, Township of Alnwick/Haldimand, Township of Cramahe, and Northumberland County), school transportation services, emergency service providers, and conservation authorities (May 16, 2019, and April 15, 2020).
- Meetings with the Ministry of Natural Resources and Forestry and the Ministry of the Environment, Conservation and Parks
- Communication with adjacent and/or impacted property owners where work proposed is likely to have an impact on the property, including personalized letters and property impact plans, telephone conversations, and organized virtual meetings with members of the project team
- Two PICs (September 18, 2019, and August 27, 2020, through October 2, 2020)
- Notice of Study Completion/TESR public comment period (July 29, 2025, to September 9, 2025)

All input received was incorporated into the project findings and recommendations, as appropriate, and responses were provided to all input received.

All project correspondence to/from the public was collected in accordance with the *Freedom of Information and Protection of Privacy Act.* Accordingly, with the exception of personal information, all public comments form part of the public record.

A summary of the feedback received from the public and associated response and/or action taken by the study team is provided in Table 8-1.

8.1 Project Website

A project website (highway401cobourgcolborne.ca) was developed at the onset of the study to provide the public with easy access to project information, which was maintained throughout the study process, including background, project team member contact information, PIC materials links to project-specific documentation (i.e., study notifications, relevant legislation, TESR) and supplementary information.

8.2 Project Email Address

A dedicated study email address (comments@highway401cobourgcolborne.ca) was established at study onset and was provided on all public consultation materials (notifications, PIC displays, and the project website). The project website also featured an online comment form (secured with certified encryption) which allowed interested parties to contact the project team directly.

8.3 Public Consultation

As noted, four study notifications have been prepared and issued as part of this study, including Ontario Government Notifications (OGNs), to notify the public, federal, provincial, and municipal agencies, Indigenous Communities, local community members and other interested persons of the study at key points in the Class EA process. Notices were posted in the Northumberland News and Brighton Independent newspapers. Letter notice, along with a copy of the OGN, was also provided to agencies, key stakeholders, and Indigenous Communities, as described in the subsequent sections.

A copy of all OGNs is provided in Appendix Q1.

8.3.1 Notice of Study Commencement

The purpose of the Notice of Study Commencement was to introduce the study to the public, agencies, stakeholders and Indigenous Communities and to gather initial feedback.

The notice provided the purpose of the study, a brief overview of the Class EA process, a map of the study area, and offered project team contact information for members of the public to provide comments and/or questions about the study.

The Notice of Study Commencement was issued via newspaper advertisements in the *Northumberland News* and the *Brighton Independent* on May 3, 2018. A Canada Post marketing mailing (AdMail) was used to send a copy of the notice in flyer format to properties within Canada Post's delivery routes in the vicinity of the study area on April 26, 2018. In addition, individual cover letters were sent to agencies, area businesses, Indigenous Communities, and stakeholder groups expected to have an interest in the study, on April 26, 2018. A cover letter accompanied the notice to agencies and requested information concerning environmental features and/or constraints in the study area, and their initial input on the project.

A total of 21 letters, emails, and phone calls were received following the Notice of Study Commencement up to, and beyond the requested submission date of Friday, June 8, 2018. General comments included requests to be added to the project mailing list, concerns associated with potential impacts to groundwater, surface water, the existing floodplain and management plans, and to the natural environment.

A copy of the Notice of Study Commencement materials and initial public comments received is provided in Appendix Q2.

8.3.2 Public Information Centre 1

A Public Information Centre (PIC) was held to present and solicit public feedback on the preliminary improvement alternatives and existing conditions in the study area. PIC 1 was held on Wednesday, September 18, 2019, from 4:00 PM to 8:00 PM, at the Cobourg Lions Community Centre, located at 157 Elgin Street East, Cobourg. Given that this study was being planned in parallel to the Nagle Road Interchange Study (GWP 4060-11-00), this PIC was held in conjunction with PIC 1 for that study.

External agencies and municipal staff were invited to attend an External Agency Drop-In Meeting from 3:00 PM to 4:00 PM, in advance of the public session. External agencies and stakeholders that were represented at the PIC included the Town of Cobourg, Ontario Provincial Police, Cramahe Township, Willow Beach Field Naturalists, Township of Hamilton, Cramahe Township, and Northumberland County.

The PIC was a 'drop-in' style session where representatives from the project team were available to discuss the study, answer questions, and receive input on the existing conditions in the study area.

The PIC was advertised in the *Northumberland News, and* the *Brighton Independent* on Thursday, September 5, 2019. The Notice was also posted on the project website in advance of the meeting.

In addition, notification letters were mailed to Indigenous Communities, external agencies, stakeholders, property owners and the general public on Tuesday, September 4, 2019. AdMail was used to send the notice to properties generally surrounding the study area (where available) and was delivered on September 4, 2019. A copy of the PIC notice is included in Appendix Q.1. In addition to the Notice of PIC 1, potentially impacted property owners were sent a separate letter on Thursday, September 4, 2019, noting that one or more of the alternative design concepts may directly affect their property. Potentially impacted property owners were encouraged to attend the PIC to review the alternatives and potential impacts to their properties, as well as discuss any questions or concerns they may have directly with members of the project team.

The following information was displayed at the PIC:

- Welcome
- About the Project
- Problem and Opportunity
- Alternatives to Undertaking
- Environmental Assessment Process
- Evaluation Process / Preliminary evaluation criteria
- Project Overview
- Drainage Improvements
- Bridge and Culvert Improvement Strategies – Danforth Road, Gully Road, Shelter Valley Road & Creek, Vernonville Road and Boyce Road
- Interchange Alternatives – Percy Street, Lyle Street
- Highway 401 (widening)
- Thank You

In total, representatives from approximately 12 external agencies, and 18 members of the public signed into the PIC.

A total of 13 comment sheets, and emails were received at and following the PIC, by the requested submission date of October 18, 2019. All names and addresses from the comment sheets and visitor register were added or updated on the project mailing list.

A copy of the PIC 1 Summary Report is provided in Appendix Q.3.

8.3.3 Online Public Information Centre 2

Public Information Centre (PIC) 2 was held from Thursday, August 27, 2020, to Friday, October 2, 2020, to present and solicit feedback on the evaluation of alternatives, the preliminary preferred plan, the preliminary assessment of the anticipated environmental impacts and mitigation measures, and preliminary construction detour routes. Due to COVID-19 and associated physical

distancing requirements, PIC was hosted online through the project website (www.highway401cobourgcolborne.ca) via a recorded presentation.

The PIC was advertised in the *Northumberland News* and the *Brighton Independent* on Thursday, August 13, 2020. The Notice was also posted on the project website in advance of the meeting.

In addition, notification letters were mailed to Indigenous Communities, external agencies, stakeholders, business owners and directly impacted and adjacent property owners on Monday, August 10, 2020. It should be noted that AdMail notification was not used for the purpose of notifying the public about this PIC, as it was determined that, given the rural nature of the study area, the Admail routes primarily served property addresses surrounding the Nagle Road Interchange Study area, which was no longer being held in parallel to this study. The studies were separated as the Town of Cobourg recognized the importance of providing an in-person forum for the community to participate in, the scheduling of PIC 2 was delayed due to the COVID-19 pandemic and associated physical distancing requirements.

PIC 2 was held online via the project website and included a recorded presentation and comment form on which to provide feedback. The recorded presentation included a narration of each slide to provide both a visual and audio experience, and a transcript of the narration was provided as part of the presentation. The Articulate Storyline platform was used to record the presentation and encouraged interaction by allowing users to pause the presentation, or move forwards and backwards to sections of the presentation that interested them most. Links were embedded within the presentation for users to access high resolution displays of the evaluations, figures and the preliminary preferred plan.

The following information was displayed as part of online PIC 2:

- Welcome to Public Information Centre 2
- About the Project
- Environmental Assessment Process
- Class Environmental Assessment Process, Group ‘B’ Projects
- Public Information Centre 1 – Summary
- Project Overview
- Existing Environment
- Evaluation of Alternatives (Process and Evaluation Criteria)
- Evaluation of Interchange Alternatives
- Evaluation of Lyle Street Interchange Alternatives
- Evaluation of Percy Street Interchange Alternatives
- Evaluation of Highway 401 Cross-Section Alternatives
- Preferred Bridge Improvement Alternatives (Danforth Road)
- Preferred Bridge Improvement Alternatives (Gully Road)
- Preferred Bridge Improvement Alternatives (Shelter Valley Road & Creek)
- Preferred Bridge Improvement Alternatives (Vernonville Road)
- Preferred Bridge Improvement Alternatives (Boyce Road)
- Preferred Drainage Improvement Strategy
- Preferred Plan
- Potential Detour Routes

The project website was visited approximately 1,799 times (total number of unique visitors) during the Online PIC 2 comment period (i.e., between August 27 and October 2, 2020). A total of 111 letters and emails were received during and following the PIC comment period.

All online PIC 2 participants were encouraged to provide their feedback by October 2, 2020. Throughout and following the comment period, the project team was available to answer concerns and questions submitted through the comment form on the project website, as well as those received via mail, phone and email.

In general, comments received from the public were related to potential impacts to business operations, private property, the natural environment, as well as potential changes in traffic operations and noise levels in the study area.

A copy of PIC 2 Summary Report is included in Appendix Q.4.

8.3.4 Public Correspondence

Numerous comments, questions and/or concerns were received from the public in relation to potential property impacts, detours, noise impacts, environmental impacts, and business operations impacts. Table 8-1 provides a summary of the key comment themes, and associated responses provided by the project team. A copy of correspondence carried out between the project team and the public during the course of this study is provided within Appendix Q.5.

Table 8-1: Summary of Public Comments and Associated Responses/Action Taken

Comment	Response Provided and/or Action Taken
Property Impacts	
Negative impacts to property, including use and enjoyment of property	Property requirements have not been confirmed at this time. Several design alternatives have been developed and will be evaluated as part of this Preliminary Design study to identify the Recommended Plan. As part of the evaluation process, property impacts will be considered and avoided/minimized where possible. Once the Recommended Plan is selected, property plans will be developed which will identify properties required for acquisition during future study stages.
	The Ministry of Transportation (MTO) is currently completing this Preliminary Design, and Class Environmental Assessment (EA) Study to address the long-term replacement and/or rehabilitation needs for the aging bridges and structures. As part of this study, the ministry is establishing the footprint of future six and eight lanes so that the new structures can be designed appropriately. The Highway 401 widening will happen in the distant future, the timing of which is currently unknown. The ministry is currently focusing on replacement of bridges and structures which will not impact your property. However, the ministry does acquire properties well ahead of construction so that the future Highway 401 Right of Way can be designated (protected). Currently, the anticipated time frame for property acquisitions to commence would be after the environmental assessment (EA) clearance is secured, which is tentatively scheduled for early next year. Once EA clearance is secured, the ministry will contact you next year or beyond to start the property acquisition process. MTO is committed to working with property owners to help to ensure that they understand the property acquisition process and entitlements. If you would like to discuss the future acquisition process, please contact MTO's Property Supervisor, Jennifer Molleson at 613-331-2500 or by email: jennifer.molleson@ontario.ca.
Negative impacts to business operations	The proposed design is a balance between the criteria of minimizing socio-economic & environmental impacts and maximizing the highway safety by applying provincial highway standards. As part of the preliminary preferred plan, the highway right-of-way will be established in both directions for future six and eight lanes. Shifting the entire highway south to avoid impacts to the property is not feasible as it would require the complete reconstruction of the existing highway, median barrier, drainage structures, etc., at a considerable cost. Shifting the highway to the south would also result in additional property impacts on the south side of Highway 401 that would extend further west and east of the immediate area. However, based on the feedback received, the ministry is able to better understand the impacts at some locations along the corridor and is examining some localized design options to determine if we can reduce or mitigate the property impacts. The ministry will be prioritizing bridge and culvert replacement and rehabilitation. Some localized widening will be required for construction staging. The future widening of Highway 401 does not have a planned timeline at this point and a number

Comment	Response Provided and/or Action Taken
	of activities are required to occur before any construction can happen which will include environmental approvals, property acquisition, utility relocation, obtaining funding, and detail design. In light of the property impact concerns raised by the property owner, additional studies were completed to support the reduction of property impacts. The project team completed a Stage 2 Archaeological Assessment, Geotechnical Drilling, and a Topographic Survey. A retaining wall will be built to reduce the impacts of the expansion on the property
	Action Taken: Where possible, impacts to property were minimized to the extent possible. As described in Section 5.5, impacts to two properties were minimized and/or avoided via a retaining wall or other treatment. Additional intrusive investigation was carried out to review alternative approaches, and a comprehensive evaluation was completed to select a preferred approach.
Detours	
Concerns regarding the impact of potential detour routes through the village Concerns regarding distance of detour Mention of some side roads not having the ability to sustain large truck movements (low-hanging overhead wires, unpaved roads)	In general terms, closures of Highway 401 and municipal roads will be required at various times to construct the project, which will require the use of the municipal road network for detours. In the vicinity of Colborne, it is anticipated that a 12-to-18-hour overnight closure of Highway 401 will be required to accommodate the demolition of the Lyle Street and Percy Street bridges and potential girder placements for a new bridge. During this time, Highway 401 traffic will be diverted to the local road network, as shown on the Potential Detours Plan (http://highway401cobourgcolborne.ca/pdfs/Potential_Detour_Routes.pdf). However, significant traffic delays are not anticipated within the surrounding area because this work will be completed overnight when traffic volumes are relatively low. The need for additional flagging operations and a police presence to assist with traffic flow at specific locations, including the village of Colborne, will be determined during detail design. It is also anticipated that a 1-to-4-week closure of the existing Highway 401 ramps at Percy Street and Lyle Street will be required to accommodate the reconstruction of some of the interchange ramps. During this time, access to and from Highway 401 will be via local roads (including County Road 2) and adjacent interchanges, as shown in black on the Potential Detours Plan (http://highway401cobourgcolborne.ca/pdfs/Potential_Detour_Routes.pdf). Minimal traffic impacts are anticipated from these ramp closures because ramp traffic volumes are relatively low. While local roads are not always constructed to accommodate truck traffic, County Road 2 is a designated Emergency Detour Route, which has been designed to accommodate heavy trucks if required.
Safety / Traffic / Noise	
Concerns regarding increases in traffic noise levels	As part of this study, an Acoustics Study is being completed in accordance with the provincial guidelines. As such, noise impacts are being assessed based on the anticipated change in traffic noise levels associated with implementation of the project. According to the Guidelines, if the projected traffic noise levels associated with the proposed improvements result in a change in noise levels above 5dBA, or the projected noise level is equal to or greater than 65 dBA, then the feasibility

Comment	Response Provided and/or Action Taken
	of noise mitigation measures will be investigated. The noise barriers also have to meet economic feasibility criteria to be implemented. At this time, the final Acoustics Study report has not been completed; however, the findings of the assessment, including any recommendations for noise mitigation measures, will be available for your review as part of the Transportation Environmental Study Report (TESR).
	Action Taken: As part of this study, an Acoustics Study was completed in accordance with provincial guidelines to assess the anticipated change in traffic noise levels associated with implementation of the project. According to the provincial guidelines, if the projected traffic noise levels associated with the proposed improvements result in a change in noise levels above 5dBA, or the projected noise level is equal to or greater than 65 dBA, then the feasibility of noise mitigation measures will be investigated. The noise barriers also must meet economic feasibility criteria to be implemented. The final Acoustics Study report determined that sound levels are expected to increase between 0-2dB. No noise mitigation is required.
Cultural Heritage	
Concerns with potential impacts to designated heritage property	The Criteria for Evaluation Potential for Built Heritage Resources and Cultural Heritage Landscapes will be completed and included in final environmental documentation at the end of the studies. Built heritage and cultural heritage landscapes will be considered during the evaluation of alternatives and determination of the Recommended Plans. Efforts will be made to avoid/minimize the impacts to these resources, and mitigation measures for heritage resources will be recommended for the Recommended Plans. Cultural Heritage Assessment Reports (CHAR) have been completed as required by the Environmental Guide for Built Heritage and Cultural Heritage Landscapes. The CHARs identify potential built heritage resources and cultural heritage landscapes within the study areas for consideration during the development and evaluation of alternatives.
	Action Taken: As part of the preliminary design development, properties identified as having cultural heritage or interest were avoided, with the exception of one existing residence. As such, a Cultural Heritage Evaluation Report was undertaken for this property, the findings of which indicated that the property did not retain cultural heritage value and/or interest and no further investigation and/or avoidance measures were required.
Environmental Impacts	
Concerns with impacts on natural heritage within the study area (i.e., wildlife, ecopassages, aquatic habitat/species, trees, etc.)	The proposed design is a balance between the criteria of minimizing socio-economic & environmental impacts and maximizing the highway safety by applying provincial highway standards. Stantec is completing a series of environmental investigations including terrestrial, aquatic, migratory birds, SAR, archaeology, built and cultural heritage, contamination, groundwater, air quality, and noise. Existing conditions will be documented in specialty-specific reports, along with an impact assessment for the Recommended Plans.

Comment	Response Provided and/or Action Taken
	Action Taken: In consultation with the MNRF and MECP, wildlife ecopassage opportunities were explored as part of this study.
Concerned regarding impacts to watercourses and the water table	As part of the study, Stantec is completing a series of environmental investigations including groundwater, archaeology, fish and fish habitat, and the results of the studies and investigations will be incorporated into the evaluation of alternatives and will be presented at the second Public Information Centre. A detailed noise assessment will be conducted to determine existing conditions and potential impacts caused by the proposed improvements. Mitigation measures to reduce noise impacts will be recommended, if warranted by the identified potential impacts.
Concerned with increased Greenhouse Gas emissions and climate change	An Air Quality and Greenhouse Gas Assessment was also completed as part of this study in accordance with provincial guidelines. The purpose of this study was to characterize existing air pollutant emissions, predict air quality effects within the study area after the implementation of the project, and provide recommendations for mitigation, if warranted.
Concerned with impacts to wildlife and road crossings	In consultation with the Ministry of Natural Resources and Forestry (MNRF) and the Ministry of Environment, Conservation and Parks (MECP), wildlife ecopassage opportunities were explored as part of this study. The findings of this preliminary review confirmed the presence of significant natural corridors across Highway 401, and identified two excellent opportunities for future ecopassages, including Shelter Valley Creek and Road, where the existing large culvert structure will be replaced by a bridge. In addition, the culvert at Grafton Creek will also be replaced by a bridge as part of the ultimate plan, providing an opportunity for a potential future wildlife crossing. While a crossing at Northumberland Heights Road is not currently being explored, the proposed crossing at Grafton Creek is in close proximity to Northumberland Heights Road, as illustrated within the below figure. Opportunities to improve the function of wildlife ecopassages, such as the installation of fencing to direct wildlife toward culvert openings, will be further explored during detail design. However, the timing of the detail design is currently unknown.

8.3.5 Property Owner Consultation

Approximately 41 potentially impacted property owners were provided with tailored notification letters that offered a brief overview about the study, information about PIC 1, and, given the location of their property in relation to the study area, the potential for their property to be impacted by the undertaking. The property owner letters and appending Notice of PIC were delivered via Canada Post standard mail on Tuesday, September 4, 2019.

As part of Online PIC 2 notification, a tailored letter package was prepared and issued to property owners that were expected to be directly impacted by the preliminary preferred plan on August 13, 2020. The letter package included a cover letter that provided a summary of the project, the purpose of PIC 2, and reference to an appending property impact plan that outlined the approximate area of their property that may be impacted by the future footprint of Highway 401.

Significantly impacted property owners were invited to contact the project team to arrange a virtual meeting to discuss potential impacts to their property and possible mitigation measures. In addition, a letter notice was also directly mailed to property owners with properties bounding the limits of the Recommended Plan. In total, approximately 93 potentially impacted property owner notifications were issued via Canada Post standard mail delivery on Thursday, August 13, 2020.

In response to the impacted property owner letter package, the project team received a response from approximately 31 property owners, 6 of which requested virtual meetings with members of the project team. Based on the correspondence with potentially impacted property owners, a summary of the concerns raised by property owners and associated response from and/or commitment made by the project team was prepared. For privacy reasons, this correspondence has not been included in this report; however, is summarized within Table 8-2.

Table 8-2: Property Owner Consultation

Comment/Concern	Response Provided and/or Action Taken
Timing of construction and property acquisition	Timing of construction is unknown and is dependent on funding and approvals. The property acquisition process may begin once Environmental Clearance is achieved, which is completed at the end of the Class EA Study process. The MTO contacts the property owner once Environmental Clearance is issued, to discuss property impacts and begin negotiations.
Concerns with increased noise impacts	As part of the study, noise impacts are being assessed based on the anticipated change in traffic noise levels associated with implementation of the project. According to provincial guidelines, if the projected traffic noise levels associated with the proposed improvements result in a change in noise levels above 5dBA, or the projected noise level is equal to or greater than 65 dBA, then the feasibility of noise mitigation measures will be investigated. The noise barriers also have to meet economic feasibility criteria to be implemented. As determined from the noise impact assessment completed for this project, the Recommended Plan will likely result in an increase in sound levels of 0-2db. As such, no noise mitigation is required as part of this undertaking.
Impacts to private property and/or residential dwellings	Opportunities to reduce property impacts are being reviewed as part of this study. MTO is committed to working with property owners to help ensure they understand the property acquisition process and entitlements.
	Action Taken: Where possible, impacts to property were minimized to the extent possible. As described in Section 5.5, impacts to two properties were minimized and/or avoided via a retaining wall or other treatment. Additional intrusive investigation was carried out to review alternative approaches, and a comprehensive evaluation was completed to select a preferred approach.
Interest in “Highway of Hero’s” tree planting project, future highway footprint may impact ability to participate.	MTO advised that if the resident chooses to participate in the “Highway of Hero’s” tree planting project, they should avoid tree planting within the required property illustrated on the property impact plan to avoid harm to the trees in the future. It was noted that vegetation and some mature trees will also need to be removed as part of the preliminary plan, but impacts will be mitigated where possible. A landscape plan was completed as part of this study and considered opportunities for Highway of Heroes tree plantings. However, the landscape restoration plan will be further developed and confirmed during detail design.
Impacts to business operations	Additional studies, including Stage 2 AA, geotechnical drilling, topographical survey, etc. were carried out to investigate the feasibility of installing a retaining wall and significantly reducing and/or avoiding property and business operations impacts. A retaining wall will be built to reduce the impacts of the expansion on the property. Details regarding the retaining wall design are discussed in Section 6.4.

8.4 Agency Consultation

The following external agencies and stakeholders also received an agency comment sheet, requesting input by June 8, 2018:

Provincial Agencies

- Ministry of Natural Resources and Forestry, Peterborough District
- Infrastructure Ontario
- Ministry of Indigenous Relations and Reconciliation
- MPP Northumberland – Quinte West
- Ministry of the Environment, Conservation and Parks – Peterborough District
- Ministry of Heritage, Sport, Tourism and Culture Industries Program Unit
- Ontario Provincial Police – Northumberland Detachment (Cobourg, Brighton)

Municipalities

- Town of Cobourg
- Township of Hamilton
- Northumberland County
- Township of Cramahe
- Alnwick/Haldimand Township

Stakeholders and Utilities

- Great Pine Ridge Snowmobile Association
- Sustainable Cobourg
- Ganaraska Freewheelers Cycling Club
- Northumberland Federation of Agriculture
- Coach Canada
- Ontario Trucking Association
- Highway of Heroes Living Tribute
- Northumberland Chamber of Commerce
- Conseil Scolaire Viamonde
- Peterborough Victoria Northumberland Clarington Catholic School Board
- Ganaraska Conservation Authority
- Willow Beach Field Naturalists
- Pine Ridge Hiking Club
- Cobourg Historical Society
- Ontario Federation of Agriculture
- Greyhound Canada Transportation Corp.
- Northumberland County Economic Development
- Student Transportation Services of Central Ontario
- Conseil Scolaire Catholique MonAvenir
- Kawartha Pine District School Board
- Lower Trent Conservation Authority
- Ontario Provincial Police, Northumberland Detachment
- Cobourg Fire Department
- Alnwick/Haldimand Fire Rescue
- Cobourg Police Service
- Township of Hamilton Fire Department
- Northumberland Paramedics

A copy of the agency contact list is provided in Appendix Q.6.

8.4.2 Municipal Advisory Committee

As part of the study, a Municipal Advisory Committee (MAC) was established at the onset of this study to provide project updates to key municipal staff members, obtain input on the study, design alternatives and the evaluation and selection of the preferred plans. In addition to municipalities, the MAC also included emergency service providers (i.e., police, fire rescue, paramedics), school boards and student transportation services, and local conservation authorities. Two MAC meetings were held as part of this project, as described herein.

MAC Meeting 1

The first MAC meeting was held on May 16, 2019. The purpose of the meeting was to provide an overview of the study, opportunity for discussion/municipal input, the consultation plan, and next steps in the project.

MAC Meeting 2

A second MAC meeting was held on April 1, 2020, to review the study background, present and obtain input on the preferred alternative, and to discuss any comments, question and/or concerns.

A copy of the notes recording during the MAC meetings are included in Appendix Q.7.

8.4.3 Council Presentations

Presentations to the Councils representing Northumberland County, Town of Cobourg, Township of Alnwick/Haldimand, Township of Cramahe, and the Township of Hamilton were scheduled in advance of key public consultation events (i.e., PIC 1 and PIC 2) to provide Council with an update on study progress, to share the information being presented at each PIC event, and to gather feedback from council members. Due to COVID-19 and associated physical distancing requirements, Council presentations related to PIC 2 were shared virtually.

Council Presentations (Round 1)

Presentations to Councils related to PIC 1 were held as follows:

- Town of Cobourg, September 9, 2019
- Township of Hamilton, September 10, 2019
- Township of Cramahe, September 17, 2019
- Northumberland County, September 18, 2019
- Township of Alnwick/Haldimand, September 19, 2019

Council Presentations (Round 2)

Presentations to Councils related to PIC 1 were held as follows:

- Township of Hamilton, August 17, 2020
- Township of Cramahe, August 20, 2020
- Northumberland County, August 26, 2020
- Township of Alnwick/Haldimand, August 17, 2020

It should be noted that a presentation to Town of Cobourg Council was not held in relation to PIC 2.

A copy of the Council presentations is included in Appendix Q.8.

8.4.4 Agency Meetings

MECP and MNRF Meeting 1

The project team held two combined meetings with MNRF and MECP to discuss the project.

The first meeting was held November 12, 2019, to present an overview of the study purpose, existing environmental features and scope of environmental investigations completed as part of the study. Stantec shared data regarding the wildlife collision history within the study area, and MNRF noted there were opportunities to accommodate wildlife ecopassages as part of the culvert rehabilitation and replacement for this project.

Following this meeting, a copy of the Terrestrial Ecosystems and Fish and Fish Habitat Existing Conditions reports were provided to MECP and MNRF for review and comment.

MECP and MNRF Meeting 2

A second meeting was held on June 17, 2020, to discuss potential wildlife eco-passage opportunities and constraints in the study area. As discussed in Section 7.1.7, Wildlife Movement Corridors, two excellent ecopassage opportunities and one good eco-passage opportunity were presented to MNRF and MECP. It was agreed that these recommendations for eco-passages will be further reviewed during detail design, and MNRF and MECP will be included in the design process.

A copy of the notes recorded at the meetings with MNRF and MECP are included in Appendix Q.9.

8.4.5 Agency Correspondence

Correspondence with federal, provincial and local agencies was carried out throughout the duration of the study to provide notification of public consultation events, provide updates on study progress, and to gather feedback. A copy of correspondence carried out between the project team and agency representatives is provided within Appendix Q.10.

8.5 Indigenous Community Consultation and Engagement

Consultation and engagement with Indigenous Communities included written communications with Alderville First Nation, Curve Lake First Nation, Hiawatha First Nation, Scugog Island First Nation, the Coordinator for the Williams Treaties First Nations, Mohawks of the Bay of Quinte, Mississaugas of the New Credit First Nation, Six Nations of the Grand River, and Métis Nation of Ontario at key points in the study process (i.e., Notices of Study Commencement, PIC 1, PIC 2 and TESR). As indicated above, a cover letter was provided as part of each study notification. A summary of additional correspondence with Indigenous Communities is provided herein.

Curve Lake First Nation requested to be kept updated throughout all phases of the project. They advised MTO of Curve Lake First Nation’s Archaeological Protocol, stating the Curve Lake First Nation must participate in all stages of the archaeological assessments conducted on their lands, including the Stage 1 assessment. If a Stage 2 archaeological assessment is required, a trained archaeological liaison is to be present on-site. A copy of the Stage 1 archaeological assessment report was subsequently provided to Curve Lake First Nation for review on May 14, 2020. Curve Lake First Nation noted concerns with the Stage 1 archaeological assessment report and requested that a Williams Treaty Cultural Heritage Liaison be present during potential future Stage 2-4 archaeological assessment field work.

The Mississaugas of Scugog Island First Nation informed the Project Team this area is a treaty territory of the Mississauga Nation, also known as Williams Treaties – Clause 2 Lands. They requested to be kept on the mailing list and apprised of the archaeological assessment results. A copy of the Stage 1 archaeological assessment report was provided to Mississaugas of Scugog Island on May 14, 2020.

Additionally, the Mohawks of the Bay of Quinte requested to be kept informed of the archaeological assessment results. A copy of the Stage 1 archaeological assessment was provided to Mohawks of the Bay of Quinte on May 14, 2020.

In addition to Indigenous Communities correspondence, the Stage 1 Archaeological Assessment report was sent to the coordinator representing the Williams Treaties First Nations, Chippewas of Georgina Island, Beausoleil First Nation and Chippewas of Rama First Nation on May 14, 2020.

A copy of correspondence carried out between the project team and Indigenous Communities, beyond the correspondence undertaken during key consultation events is provided within Appendix Q.11.

9.0 Notice of Study Completion

The Notice of Study Completion was published within the Northumberland News online news platform on July 29, 2025, to notify the public that the Transportation Environmental Study Report (TESR) was available for a 30-day public comment period. The Notice was also made available on the project website and distributed to the MPP, property owners, agencies, stakeholders, Indigenous Communities, and members of the public that expressed an interest in this project during the course of this study.

9.1 Future Consultation

During the detail design stage of this undertaking, the external agencies, Indigenous Communities, and property owners will continue to be contacted and consulted regarding design/construction details and commitments to future work as outlined in this document, where appropriate and/or necessary.

9.2 Future Commitments

Future consultation will be required during the next phase of planning and design to address all outstanding issues, including permits and approvals from external agencies, consultation with Indigenous Communities and detailed environmental investigations regarding impacts and mitigation, and engineering investigations to confirm the final design.

Future consultation is expected to include notification of the start of next phase of design. A summary of proposed future consultation is in Table 9-1.

Table 9-1: Future Consultation with External Agencies

External Agency	Subject of Consultation
Fisheries and Oceans Canada	• Request for Review Form
Ministry of Citizenship and Multiculturalism	• Archaeological Assessment activities
Ministry of Natural Resources and Forestry	• Terrestrial Species and Habitat • Wetland Compensation • Construction timing windows/restrictions • Specific fisheries management objectives • Wildlife ecopassage opportunities and design
Ministry of the Environment, Conservation and Parks	• Terrestrial and/or aquatic Species at Risk species and/or habitat • Endangered Species Act authorization/permit • Wildlife ecopassage opportunities and design
Indigenous Communities	• Participation in archaeological field surveys • Decisions or actions that may adversely impact asserted or established Aboriginal or treaty rights.
Ganaraska Conservation Authority, Lower Trent Conservation Authority	• Wetlands • Source Water Protection
Town of Cobourg, Township of Hamilton, Township of Cramahe, Township of Alnwick/Haldimand, Northumberland County	• Traffic Management Plan • Construction timing • Public concerns, as required
Emergency service providers (i.e., OPP, local police, fire, ambulance, etc.)	• Traffic Management Plan • Construction timing

10.0 Summary of Environmental Effects, Proposed Mitigation and Commitments to Future Work

A summary of environmental effects, proposed mitigation, and commitments to future work, as identified during the course of this study, is provided in Table 10-1, and forms a comprehensive ‘checklist’ of issues identified at the end of Class EA and Preliminary Design and will serve as a starting point for the subsequent detail design phase of the project. Additional site-specific mitigation measures may be required pending final design details for the project.

Table 10-1: Summary of Environmental Effects, Proposed Mitigation and Commitments for Future Work

Legend

DFO: Department of Fisheries and Oceans
MTO: Ministry of Transportation
MNRF: Ministry of Natural Resources and Forestry
MUN: Local Municipalities
GRCA: Ganaraska Region Conservation Authority
LTCA: Lower Trent Conservation Authority
PUB: General Public
EMS: Emergency Medical Services
RES/BUS: Local Residents/Business Owners
MECP: Ministry of Environment, Conservation and Parks
MTCS: Ministry of Tourism, Culture and Sport
STS: Student Transportation Services
UTL: Utilities

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
Natural Environment				
1.0	Surface Water • Potential impacts to surface water and groundwater from disturbance of contaminated soils, leaks, and accidental spills • Potential to introduce drinking water threats	MTO MECP GRCA LTCA Indigenous Communities	1.1	A drainage design plan shall be completed to provide appropriate drainage capacity
			1.2	Runoff and overland flow shall be directed away from working areas and areas of exposed soils
			1.3	All oils, lubricants and other chemicals shall be stored in suitable containers and handled in accordance with applicable regulations
			1.4	Refuelling will not be permitted within 30 m of a watercourse
			1.5	At minimum, best management practices (BMPs) shall be applied for fuel management, including secondary containment of temporary fuel storage
			1.6	A spill response plan shall be prepared during detail design. All spills will be cleaned up immediately, and contaminated materials will be disposed of in an approved manner. The MECP will be informed immediately of all reportable spills
			1.7	Run-off from construction and stockpiles will be contained and discharged to prevent entry of sediment to water
			1.8	The handling and storage of DNAPL will be avoided to the extent possible
			1.9	The need for a private well monitoring program will be reviewed during detail design
			1.90	Additional monitoring will be undertaken during construction to minimize risk of water quality and/or surface water and groundwater interaction impacts
			1.91	Detailed dewatering calculations and assessment of site-specific conditions will be undertaken to further evaluate need for EASR or a PTTW
			1.92	Obtain draft Permit to Take Water (PTTW), if required
2.0	Fish and Fish Habitat • Design-related impacts: • Potential for habitat loss or alteration, potential for changes to fish passage, potential changes to water quality • Construction-related impacts: • Potential for sedimentation due to erosion, potential changes to water quality, potential fish mortalities, potential reduction in access to habitats during critical life stages.	MTO MECP MNRF DFO Indigenous Communities	2.1	Aquatic effects assessments will be completed during detail design to assess risk of the project to result in death of fish or HADD of fish habitat
			2.2	The presence/absence of aquatic SAR (American Eel) and/or potential SAR habitat within Shelter Valley will be determined in consultation with MECP during detail design. If the presence of American Eel is confirmed, design and construction shall consider American Eel and its habitat at this location. MECP shall be consulted to determine the need for a permit under the ESA.
			2.3	Additional field data collection will be completed to support impact assessments, as applicable. Fisheries assessments will be completed at Sites 21X-0468/C0 and 21X-0469/C0 and Culvert 000904010086.
			2.4	In-water work restrictions will be applied. In-water construction activities are permitted from July 1 to September 30, inclusive (i.e., no work from October 1 to June 30)
			2.5	The maintenance of fish passage must be considered during detail design
			2.6	The final design and contract should consider reducing impacts to potential Brook Trout spawning areas
			2.7	Groundwater upwelling areas shall be protected
			2.8	Stormwater runoff shall be directed to ditches or other treatment facilities, and not to centreline culverts identified as fish habitat
			2.9	A Request for Review Form shall be submitted to DFO (per Step 6 of the Protocol) for review under the Fisheries Act with respect to the relocation and realignment of Shelter Valley Creek. DFO review may also be required at additional locations, as determined by the aquatic effects assessments.
			2.10	Vehicle and equipment refueling shall be carried out at least 30 m away from any adjacent waterway

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
			2.11	A spill containment plan shall be established prior to construction and remain on-site during construction
			2.12	Opportunities to improve fish habitat shall be reviewed and confirmed during detail design. Maintenance of fish passage shall be considered during detail design. Where culverts are being replaced, perched conditions and/or other barriers to fish passage shall be removed
			2.13	If fish habitat is identified at Site 21X-0468/C0, Site 21X-0469/C0, design must consider fish passage, opportunities and constraints, as applicable. If fish habitat is identified at Culvert 000904010086 and in-water work is required, Design must consider fish passage, opportunities and constraints, as applicable
			2.14	Drainage systems shall be designed to reduce changes in drainage to watercourses that provide fish habitat. SWM measures shall be designed to reduce effects on watercourses that provide fish habitat to the extent possible
			2.15	A rehabilitation/re-vegetation plan for the long-term stability of areas disturbed during construction shall be prepared during detail design
			2.16	The need for rock protection in creek beds within locations identified as Significant Habitat shall be reduced to the extent possible. Where required below the normal high-water level, appropriately sized material shall be used and a similar slope to the existing shall be installed. A uniform and natural bank/shoreline alignment, such that it does not interfere with fish passage or alter the bankfull channel profile, shall be maintained
			2.17	The following OPSSs shall be implemented during detail design: • Equipment Use – Use of equipment shall be in accordance with OPSS 182 • Fish Salvage – Fish salvage operations shall be conducted in accordance with OPSS.PROV 182. • Dewatering and the Use of Pumps – Dewatering activities and the use of pumps shall be conducted in accordance with OPSS.PROV 517 and OPSS.PROV 182 • Preservation of Riparian Vegetation – Removal of riparian vegetation shall be in accordance with OPSS.PROV 182 • Erosion and Sediment Control – The installation, monitoring, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS.PROV 182, OPSS.PROV 804, and OPSS.PROV 805 • Placement of Aggregates in Waterbodies – Use of aggregate in waterbodies shall be according to OPSS.PROV 825 and OPSS.PROV 1005 • Restoration of Disturbed Areas – Vegetation protection and rehabilitation shall be in accordance with OPSS.PROV 182, OPSS.PROV 803, and OPSS.PROV 804
3.0	Vegetation • Potential for localized impacts to vegetation due to construction disturbance • Vegetation removal and earth grading will result in loss of natural vegetation communities, including forest and significant woodland	MTO MECP MNRF Indigenous Communities	3.1	Precise limits of vegetation removal will be confirmed during detail design
			3.2	A landscape restoration plan shall be developed during detail design for all disturbed and compensation areas. The plan shall include recommendations for use of native species in restoration planting as well as methods for management of invasive species
			3.3	Consultation with MECP shall be carried out prior to any tree removals in order to receive up-to-date guidance on appropriate surveys and mitigation measures to remain compliant under the ESA
			3.4	Vegetation removal will be minimized to the extent possible. All clearing and grubbing activities will take place outside of the breeding bird window (April 1 to August 31 of any year), and comply with the Migratory Birds Convention Act (1994)
			3.5	Environmentally Sensitive Areas will be established to restrict access to sensitive areas during construction
			3.6	The Sediment and Erosion Control measures listed in I.D. #10.0 shall be applied
			3.7	Sediment fencing shall be used to clearly mark and separate work areas from sensitive natural features and minimize the release of sediments and other deleterious substances into adjacent areas of natural vegetation
			3.8	Sediment fencing shall remain in place until vegetation cover is re-established. Seeded areas shall receive water either through precipitation or irrigation after every seven successive days without rainfall for the first two months after seeding
			3.9	Topsoil and organic matter shall be salvaged and reused in areas disturbed during construction, as appropriate
			3.10	Exposed soil areas shall be stabilized with native seed mix and re-vegetated through placement of seed and mulching or seed and an erosion control blanket, immediately following construction activities. All disturbed substrates are recommended to be re-vegetated using seed mixes of species that are native to the site and suitable for site conditions
			3.11	Stockpiling of materials will be kept away from adjacent natural areas

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
			3.12	Topsoil, seed banks and organic matter will be salvaged and reintroduced to any areas disturbed during construction. New seed will be introduced to disturbed substrates as soon as feasible following construction (within 15 days for areas less than 200 m from a waterbody or watercourse, and 45 days for other areas) and sediment fencing or other barrier will remain in place until vegetation cover is re-established
			3.13	Replaced soils will contain native seed bank, which will help facilitate successful revegetation
			3.14	Post-construction seeding of the disturbed ROW shall be done with a suitable native seed mix and in consideration of Monarch habitat. Seed mixes shall include fast-growing, short-lived perennial cover crop to stabilize soil and reduce competition from weedy exotics. Native cover crops are preferred. New seed shall be introduced to disturbed substrates as soon as feasible following construction (within 15 days for areas less than 200 m from a watercourse, and 45 days for other areas)
4.0	Terrestrial Species at Risk (SAR) or Species of Conservation Concern (SOCC) • Potential to impact SAR and associated habitat during construction	MTO MNRF MECP Indigenous Communities	4.1	Further field investigations, including targeted surveys, shall be undertaken during detail design to confirm the presence of SAR or SOCC and their habitat
			4.2	An assessment of sensitive features shall be carried out during detail design to confirm the presence or absence of habitat for SAR or SOCC, including: • An assessment of wetland features and functions where wetlands will experience direct impacts • Daytime breeding bird surveys (grassland, woodland and wetland habitats) • Crepuscular breeding bird (e.g., Whip-poor-will) surveys within 500 m of the ROW • Habitat assessments for turtle overwintering, turtle nesting, amphibian breeding and snake hibernacula • Habitat mapping (Category 1, 2 and 3) for Blanding's Turtle
			4.3	Site-specific avoidance and mitigation measures shall be recommended for each species and/or its habitat, in consultation with MECP
			4.4	Authorization requirements, if any, shall be determined during detail design
			4.5	On-site personnel shall be informed of the potential presence of the SAR and/or SOCC in the project area, obligations under the ESA (2007), and recommended actions in the event of an encounter
			4.6	Species listed as endangered or threatened on the SARO List that are present in the study area shall be protected from harm and harassment
			4.7	Any SAR individual that is incidentally encountered shall be allowed to leave of its own accord. Activities within 20 m shall cease until the individual disperses. Construction machinery/equipment must maintain a minimum operating distance of 20 m from the individual until it disperses from the work zone of its own accord
			4.8	Should on-site personnel be unable to allow an incidentally encountered SAR individuals to disperse from the active construction area under its own ability, MECP shall be contacted immediately for additional guidance
			4.9	Any SAR individual that is encountered in the work zone shall be reported to the MECP staff within 48 hours of the observation or the next working day, whichever comes first. Handling of SAR is not permitted without ESA authorization
			4.10	If an injured or deceased SAR is found, the specimen shall be placed in a non-airtight container that is maintained at an appropriate temperature and MECP must be contacted immediately for additional guidance
			4.11	Temporary alterations to SAR habitat must be limited to the duration and spatial extent possible and be remediated upon completion of activity and monitored as necessary
	• Potential for Bank Swallow colonization of the work zone during construction		4.12	Work that involves the modification of natural exposed earthen banks or stockpiling of silt or sandy materials (e.g., soil stockpiles, excavations, trenches, aggregate areas) shall not be left with vertical faces during the Bank Swallow breeding season
			4.13	Slope faces shall be reduced to 70 degrees or less (MNRF 2017) by sloping off stockpiles, using an excavator to create the desired slopes or contouring faces or piling material on the face. Slope management will be completed by mid-April and slopes will be maintained daily throughout the nesting season (i.e., until the end of August) to meet the 70 degrees or less target
	• Potential to impact Barn Swallow nests on structures or breeding activity during construction activities		4.14	For an activity that has the potential to damage nests or interfere with breeding activity that is required to take place within the Barn Swallow nesting period (May 1 to August 31), exclusionary measures (i.e., pre-tarping) will be installed on the structure before April 1 to dissuade Barn Swallow from nesting on it
			4.15	For construction activities that are timed to take place outside of the Barn Swallow nesting period (May 1 to August 31), inactive nests that have the potential to be damaged or destroyed on the structure must be removed prior to commencement of construction and prior to April 1
	• Potential to harm bat maternity roost habitat		4.16	Habitat characterization and acoustic monitoring of suitable bat habitat, including candidate maternity roosting sites in trees and structures, and rocky areas suitable for Eastern Small-footed Myotis
			4.17	Removal of trees > 10 cm DBH or structures/rocky habitat providing suitable roosting habitat shall occur outside the period when bats occupy maternity roosts (May 1 to August 31)

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			4.18	If removal of, or work on, potential maternity roost habitat is required between May 1 and August 31, maternity exit surveys shall be conducted prior to construction to confirm the presence/absence of bats. Maternity exit surveys are conducted during the evening and should include visual and acoustic surveys using accepted protocols
			4.19	Consultation with MECP shall be carried out during detail design to discuss potential impacts to SAR that may result from the project after mitigation, and to determine potential authorizations/permits
	• Potential to harm Monarch eggs, caterpillar or pupae during construction		4.20	Vegetation clearing in meadow areas shall not be undertaken during the Monarch larval period (i.e., approximately May 1 to September 30)
			4.21	If vegetation clearing will proceed when Monarch larvae may be present, inspection of milkweed plants is recommended to locate larvae. If larvae are present, they may be moved to a location that is suitable and safe under the direction of a qualified professional. Monarch caterpillars may be moved to other milkweed plants; for other larval stages (i.e., eggs and chrysalis), entire milkweed plants should be transplanted
			4.22	Milkweed and nectar producing plants shall be included in seed mixes for areas restored to meadow to provide habitat for Monarch
	• Potential to harm Eastern Meadowlark and/or its habitat		4.23	Avoid vegetation clearing between April 1 and August 31
			4.24	Should impacts to the species' habitat be unavoidable, habitat removal is possible by following the rules set out in O. Reg. 242/08
	• Potential to harm Pileated Woodpecker		4.25	Pileated Woodpecker nests are protected year-round under the Migratory Bird Regulations. A search for Pileated Woodpecker nests shall be undertaken prior to construction.
5.0	Reptiles and Amphibians • Potential to impact reptile and/or amphibian species during construction • Peak active season for reptiles and amphibians (approx. April 1 to October 31) cannot be avoided during construction	MTO GRCA LTCA Indigenous Communities	5.1	Wildlife exclusion fencing shall be implemented before May 15 or after September 15 (i.e., outside of key breeding period) to define Work Zones and restrict the movement of reptiles and amphibians into the working area
			5.2	A qualified biologist shall visually inspect the site for evidence of nesting or individual reptiles and direct installation of construction barrier fencing to avoid nests If construction must be initiated during the turtle nesting or snake gestation season (approximately June 1 to September 1). If it is not possible to isolate a nest from construction, work shall be delayed until it is determined that the nest no longer includes viable eggs (hatchlings have emerged, or eggs were predated)
			5.3	Potential snake hibernation sites (rock outcroppings or stumps extending below-grade, or animal burrows) shall not be disturbed during the hibernation period (November 1 to March 31). If removal of above-ground habitat features (rock slabs or piles, brush) is needed, these features shall be retained outside the active work zone during construction and returned post-construction to the same or a nearby location
			5.4	During ditching and grading activities undertaken between April 1 and October 31, disturbance will be limited to the greatest extent possible to protect reptiles or amphibians that may be present. A spotter could be used to identify individuals present in the work area
6.0	Wildlife • Potential to impact wildlife/wildlife habitat during construction • Potential to accommodate wildlife crossings/ecopassages	MTO MECP MNRF GRCA LTCA Indigenous Communities	6.1	Construction equipment and vehicles are to yield to wildlife
			6.2	Inform construction personnel to not threaten, harass or injure wildlife
			6.3	If wildlife are encountered during construction, personnel are required to move away from the animal and wait for the animal to move off the construction site. If slow-moving wildlife (e.g., turtles, snakes) are observed on the road and in danger, and if safe to do so, they should be moved off the road by gently guiding the individual in the direction it was travelling
			6.4	Opportunities to accommodate new ecopassages will be further examined during detail design
7.0	Woodlands • New woodland edges increase potential for sunlight penetration, susceptibility to windthrow, desiccation and spread of invasive species	MTO GRCA LTCA Indigenous Communities	7.1	Restoration plans shall use native species that are tolerant of the site conditions, including roadside stresses such as salt, pollution and soil compaction, and shall include broadcast seeding to replace seed banks that are lost, as well as planting of woody shrubs and trees to create vertical structure
			7.2	Monitoring plans shall track survivorship and effectiveness of restoration plans and include recommendations to adapt management as appropriate
8.0	Wetlands • Potential for construction to directly impact wetland areas • Potential to disturb invasive phragmites • Potential for construction activities to displace native wetland vegetation with invasive phragmites	MTO MNRF GRCA LTCA Indigenous Communities	8.1	Compensation for wetland area loss shall be determined during detail design, in consultation with MNRF, LTCA and GRCA
			8.2	If Phragmites control is required, further field studies and site-specific mapping shall be undertaken during detail design. A clean equipment protocol may be required for machinery entering riparian areas to prevent the spread of invasive common reed (Phragmites) species
			8.3	Apply sedimentation and erosion control measures outlined in I.D. #10.0

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
9.0	Nesting Birds • Potential to disturb nesting behavior or damage/destroy nests • Potential to disrupt nests/nesting birds on bridges during the Primary Nesting Period (PNP)	MTO MNRF GRCA LTCA Indigenous Communities	9.1	Active nests (nests with eggs or young birds), and birds shall be protected under the *Migratory Birds Convention Act* (MBCA).
			9.2	Vegetation clearing shall not be undertaken within the restricted period (i.e., between April 1 to August 31)
			9.3	If a nest is located, a designated buffer shall be determined by a qualified professional and delineated. No activity shall be permitted within the buffer radius while the next is active.
			9.4	If construction activities may disturb nesting bird on bridges during the PNP, exclusionary measures such as pre-tarping structure before April 1 shall be employed to deter birds from nesting on the bridges, following the MNRF *Best Management Practices for Excluding Barn Swallows and Chimney Swifts from Buildings and Structures* (MNRF 2017).
10.0	Erosion and Sedimentation • Construction activities have potential to increase erosion, sedimentation and dust in wetlands, watercourses, and other natural areas	MTO	10.1	Complete a comprehensive Erosion and Sediment Control Plan (Approach 3: Two Part ESCP – Main and Supplemental) in accordance with the *Environmental Guide for Erosion and Sediment Control During Construction of Highway Project,* prior to construction.
			10.2	At minimum, the Best Management Practices set forth in the *Environmental Guide for Erosion and Sediment Control During Construction of Highway Project* will be followed
			10.3	The limits of construction (site boundaries) adjacent to all natural areas will be flagged and/or fenced prior to construction, and monitored during construction (along with erosion and sediment control measures)
			10.4	Impacts at approaches to watercourses, including installation of sediment control fencing or construction barrier, slope restoration and stabilization during construction, will be minimized to the extent possible
			10.5	Silt barriers shall be installed along work zones where there is potential for sedimentation of watercourses or wetlands, or inadvertent encroachment of construction vehicles into trees or natural areas.
			10.6	Sloped areas will be inspected regularly during construction to identify erosion problems and seepage areas and plan for appropriate temporary stabilization and drainage measures
			10.7	Depending on the proposed grading determined during design, rip rap may be required to protect the embankments
			10.8	No equipment will be permitted to enter any natural areas beyond the sediment fencing (site boundaries) during construction. Equipment arriving on-site will be inspected inside and out prior to entering the site for debris such as mud or accumulation of dirt, plant material or snow/ice. Special Provision No. ENR 0011 requires that equipment and vehicles be inspected as close to the site entrance as possible. Equipment will be cleaned in an area where risk of contamination is low, ideally on a mud free hard surface, at least 30 m away from drainage features, waterbodies, wetlands, or other natural areas. Where risk of runoff is high, cleaning stations will be contained by sediment fence as per standard erosion and sediment control specifications
			10.9	All materials requiring stockpiling (fill, topsoil, etc.) will be stabilized and kept a safe distance from any sensitive natural features
			10.10	All sediment and erosion controls shall be monitored daily, and properly maintain as required. Controls will be removed only after the soils of the construction area have been stabilized and adequately protected or until cover is re-established.
			10.11	All exposed soil areas will be stabilized and re-vegetated. Native seed and mulching, or seed and an erosion control blanket will be applied to disturbed sites promptly upon completion of construction activities
			10.12	In addition to any specified requirements, additional sediment fence will be available on site, prior to grading operations, to provide a contingency supply in the event of an emergency
			10.13	All sediment and erosion controls will be monitored regularly and properly maintained, as required. Controls will be removed only after the soils of the construction area have been stabilized and vegetation cover is re-established
			10.14	Any natural areas that are temporarily disturbed for access or construction will be restored to natural self-sustaining conditions
			10.15	Environmental controls will be monitored by an environmental inspector
			10.16	In addition to any specified requirements, additional silt fence shall be available on site, prior to grading operations, to provide a contingency supply in the event of an emergency.

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
			10.17	Limits of construction adjacent to natural features shall be monitored during construction (along with sediment and erosion control measures) to maintain limits with respect to vehicular traffic and soil or equipment stockpiling.
			10.18	Restore any disturbed natural areas to pre-construction conditions.
Social and Economic Environment				
11.0	Land Use and Property • Potential direct and indirect impacts to adjacent properties, including disruption during construction.	MTO RES/BUS PUB UTL MUN	11.1	Establish and confirm construction staging and laydown areas
			11.2	Engage with impacted property owners to review, discuss and confirm impacts to property and associated mitigation measures
			11.3	Maintain access to private entrances and sideroads during construction
			11.4	Prepare detailed construction staging and traffic management plans. Maintain liaison/coordinate construction staging and traffic management plan with affected stakeholders (e.g., school boards/transportation providers, emergency service providers, local residents and business operators)
			11.5	Notify stakeholders of start of the next stage of design, construction staging, start of construction, etc. to minimize delay in emergency response times during and after construction
			11.6	Consult general public through newspaper notices and directly affected/adjacent property owners through correspondence at the start of the subsequent design process
			11.7	Hold public consultation event(s) during detail design to share and seek input on design, construction staging and traffic management plans
12.0	Management of Excess Materials • Excess materials may be encountered during construction at the sites and require proper management/disposal.	MTO MECP	12.1	Excess materials generated during construction will be managed in accordance with OPSS.PROV 180 and O. Reg. 406/19. All materials and debris will be removed upon completion of the work, in accordance with O. Reg. 406/19.
13.0	Management of Potentially Contaminated Property and Hazardous Materials • Contaminated soils and/or surface water may be encountered during construction • Buildings and/or structures may have the potential to contain hazardous substances	MTO	13.1	Excess soils will be managed in accordance with O. Reg. 406/19 (On-Site and Excess Soil Management) made under the Environmental Protection Act, R.S.O. 1990, c. E.19, as well as the MECP's Rules for Soil Management and Excess Soil Quality Standard, dated 2020
			13.2	A Designated Substances Survey shall be completed for buildings and/or structures, prior to demolition
			13.3	Further assessment, including Phase 1 and/or Phase 2 Environmental Site Assessment activities, are required to investigate the potential for contamination for those properties identified as having potential for environmental concern
			13.4	The selection of soil for analysis should include consideration and observations of unusual odours, staining, or debris/waste in the recovered material
			13.5	Should excess water be generated during construction, water quality analysis should be conducted to determine appropriate management methods. This work should be done by a Qualified Person
			13.6	Should evidence of soil or water impacts be identified during construction, samples should be collected for laboratory analysis to confirm concentrations of potential contaminants to develop appropriate handing and health and safety guidelines
14.0	Construction Noise • Potential noise increase during construction associated with equipment (e.g., boom trucks, pile drivers, dump trucks and paving machines).	MTO RES/BUS PUB	14.1	Once equipment and construction schedules are finalized, construction equipment sound levels will be reviewed to confirm that nose emissions are within the permissible limits. If higher than permissible limits, noise control options will be explored
			14.2	All equipment will be properly maintained to limit noise emissions. As such, all construction equipment will be operated with effective muffling devices that are in good working order
			14.3	The contractor will be required to adhere to standard noise restrictions (i.e., proper maintenance of equipment, no unnecessary idling)
			14.4	The Contract Documents will contain a provision that any initial noise complaint will trigger verification that the general noise control measures agreed to are in effect
			14.5	In the presence of persistent noise complaints, all construction equipment will be verified to comply with MECP NPC-115 guideline
			14.6	In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measured may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration will be given to the technical, administrative and economic feasibility of the various alternatives

I.D. #	Environmental Issues/Concerns and Potential Effects	Concerned Parties	I.D. #	Mitigation/Protection/Monitoring/Commitments to Further Work
15.0	Air Quality • Potential for dust from construction activities to adversely affect nearby land uses and watercourses	MTO MECP RES/BUS PUB	15.1	The Environment and Climate Change Canada's Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities will be followed. At minimum, best practices during construction will include material wetting or use of chemical suppressants to reduce dust, use of wind barriers and limiting exposed areas which may be a source of dust, and equipment washing.
Cultural Heritage				
16.0	Archaeological Resources • Previously unknown/deeply buried artifacts/human remains could be uncovered during construction.	MTO MCM Indigenous Communities	16.1	A Stage 2 Archaeological Assessment shall be completed during detail design for all areas potentially impacted by the Recommended Plan, including construction grading and laydown areas.
			16.2	Indigenous Communities with potential archaeological interests in this area will be notified of any subsequent archaeological assessment activities and invited to participate in archaeological field surveys, and to review any related reporting, prior to submission of the final reports to MCM.
			16.3	Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48(1) of the Ontario Heritage Act (Government of Ontario 1990b). The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48(1) of the Ontario Heritage Act (Government of Ontario 1990b). The Williams Treaties First Nations and Mohawks of the Bay of Quinte shall also be engaged
			16.4	Any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Government and Consumer Services under the Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33
17.0	Cultural Heritage Resources • Potential impacts to identified Cultural Heritage Landscapes	MTO MCM PUB	17.1	Cultural Heritage Landscapes identified within 50 m of the ultimate footprint of Highway 401 (i.e., 305 Gully Road, Cherry Hill Road and Union Cemetery) shall be avoided during construction, in accordance with MTO Environmental Guidelines including no removal, alteration or demolition of built heritage resources should occur; no destructive investigation procedures should be carried out in or near built heritage resources; no removal or changing of cultural heritage landscape resources should occur; and, no land-disturbing or vegetation-disturbing activities should be carried out in or near cultural heritage landscapes.
	Viewscapes • Impacts to existing views	MTO PUB	17.2	The Landscape Compositions Plan will be confirmed during detail design. Visual screening plantings shall be carried out in coordination with the affected residents, and positive landscape viewsheds shall be maintained, where possible. A cultural heritage expert will be consulted on the appropriate design of screenings and naturalization plantings on or adjacent to the Union Cemetery, Barnum House National Heritage Site, and Barnum House Creek Conservation Area. The need for visual screening for the Lyle Street interchange will be reviewed during detail design.
	Commemorative Tree Plantings	MTO Highway of Heroes	17.3	The location of commemorative tree plantings will be confirmed during detail design. MTO will collaborate with the Highway of Heroes Tree Campaign with respect to trees being planted for visual screening or naturalization. The design of commemoration sites will consider the use of native species, wildlife habitat, and pollinator populations.
Technical				
18.0	Utilities • Impacts to existing utilities during construction	MTO UTL	18.1	Utilities will be contacted during next stage of planning and design to confirm the location of existing utilities, potential conflicts and relocation requirements
	Traffic Operations • Impacts to traffic operations during construction • Temporary delay or disruption to EMS providers during construction.	MUN EMS STS	18.2	A detailed Traffic Management Plan will be developed and Detour Routes will be confirmed in consultation with local municipalities, school transportation services, and emergency service providers

11.0 Monitoring

The planning and preliminary design phase of the project is now complete. Specific mitigation measures identified in this report will require confirmation during the next design phase and monitoring during construction.

Monitoring will be conducted by on-site construction supervisory staff to make sure that environmental protection measures, as outlined in this report and confirmed during subsequent design phases, and included in the contract package, are implemented. This includes making sure that the implementation of mitigating measures and key design features is consistent with commitments made to external agencies prior to construction.

For certain activities, monitoring by a qualified environmental specialist will be required.

In the event that protective measures do not address concerns identified or if major problems develop, the appropriate agency will be contacted to provide additional input.

In the event that the impacts of construction are different than anticipated, or that the method of construction is such that there are greater than anticipated impacts, the Contractor’s method of operation will be modified to reduce those impacts.