Appendix N – Cultural Heritage Report (ASI)

September 2023

Cultural Heritage Report:
Existing Conditions and Preliminary Impact Assessment

Maple Grove Road Improvements
Municipal Class Environmental Assessment

City of Cambridge
Regional Municipality of Waterloo, Ontario

Final Report

Prepared for:

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January 2019 (Revised October 2019 and August, September, and December 2021)



Executive Summary

Archaeological Services Inc. was contracted by IBI Group, on behalf of The Regional Municipality of Waterloo, to conduct a Cultural Heritage Report as part of the Maple Grove Road Improvements Municipal Class Environmental Assessment. The Environmental Assessment involves road improvements to a section of Maple Grove Road approximately 4.3 kilometers in length from Fountain Street to Hespeler Road, a 500 metre section of Old Maple Grove Road, and an additional 500 metre segment from the eastern limit of Old Maple Grove Road to Hespeler Road. An additional segment of Beaverdale Road between Old Maple Grove Road to approximately 250 m north of Maple Grover Road was also added to the preferred alternative in 2021. The project study area is generally in a rural agricultural and industrial context north of the City of Cambridge.

The purpose of this report is to present an inventory of known and potential built heritage resources (B.H.R.s) and cultural heritage landscapes (C.H.L.s), identify existing conditions of the project study area, provide a preliminary impact assessment, and propose appropriate mitigation measures. This submission includes the Existing Conditions component of the assessment and the Preliminary Impact Assessment based on the preferred alternative.

The results of background historical research and a review of secondary source material, including historical mapping, indicate a study area with a rural history dating back to the early nineteenth century. A review of federal, provincial, and municipal registers, inventories, and databases revealed that there are nine known B.H.R.s within the study area. An additional three potential B.H.R.s and two potential C.H.L.s were identified during background research and field review.

Based on the results of the assessment, the following recommendations have been developed:

1. Construction activities and staging should be suitably planned and undertaken to avoid unintended negative impacts to identified built heritage resources (B.H.R.s) and cultural heritage landscapes (C.H.L.s). Avoidance measures may include, but are not limited to: erecting

temporary fencing, establishing buffer zones, issuing instructions to construction crews to avoid identified cultural heritage resources, etc.

2. Indirect impacts including encroachment of the right-of-way, grading impacts, and potential tree removals are anticipated to nine known and potential cultural heritage resources including: 1705-1725 Beaverdale Road (B.H.R. 1); 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2); 1370 Maple Grove Road (B.H.R. 4); 4045 Maple Grove Road (B.H.R. 5); 1900 Beaverdale Road (B.H.R. 7); 1965 Beaverdale Road (B.H.R. 8); 1130 Maple Grove Road (B.H.R. 11); and 2320 Maple Grove Road (C.H.L. 1). Where feasible, the preferred alternative should be designed to avoid indirect impacts to these potential cultural heritage resources. Where avoiding property encroachment is determined to be infeasible, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to six of these cultural heritage resources (B.H.R. 1, 3, 4, 5, 8, 11), it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for H.I.A.s in these cases in favour of suitable mitigation measures including post-construction rehabilitation. Due to the potential for impacts to landscape features within C.H.L. 1 and 2 and the significant encroachment of the R.O.W. on B.H.R. 7, H.I.A.s should be completed for these properties.

3. Where feasible, the preferred alternative should be designed in a manner that avoids grading and removal of trees and landscape elements in all identified cultural heritage resources. Should avoidance of tree removals and grading within B.H.R. 1, 3, 4, 5, 7, 8, 11 and C.H.L. 1 and 2 be determined to be infeasible, post-construction landscaping with historically-sympathetic native tree species should be employed to mitigate impacts to the heritage value of the resource. A qualified arborist or landscape architect should be consulted in this respect.

4. Indirect impacts to structures in B.H.R. 1, B.H.R. 2, B.H.R. 3, B.H.R. 7, B.H.R. 8, and C.H.L. 2 due to vibrations during construction activities may occur as a result of their location in close proximity to the proposed alignment. To ensure the structures on the properties at 1705-1725 Beaverdale Road (B.H.R. 1), 1725 Beaverdale Road (B.H.R. 2), 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2), 1900 Beaverdale Road (B.H.R. 7), and 1965 Beaverdale Road (B.H.R. 8) are not adversely impacted during construction, a baseline vibration assessment should be undertaken during detailed design. Should this advance assessment conclude that the any structures will be subject to vibrations, a vibration monitoring plan should be prepared and implemented as part of the detailed design phase of the project to lessen vibration impacts related to construction.

5. Should future work require an expansion of the study area then a qualified heritage consultant should be contacted in order to confirm the impacts of the proposed work on potential heritage resources.

6. This report should be submitted to heritage planning staff at both the City of Cambridge the Region of Waterloo, the Ministry of Heritage, Sport, Tourism and Culture Industries (M.H.S.T.C.I.), and any other relevant stakeholders that may have an interest in this project for review. The final report should be submitted to the City of Cambridge and Region of Waterloo for their records.

Report Accessibility Features

This report has been formatted to meet the Information and Communications Standards under the *Accessibility for Ontarians with Disabilities Act*, 2005 (A.O.D.A.). Features of this report which enhance accessibility include: headings, font size and colour, alternative text provided for images, and the use of periods within acronyms. Given this is a technical report, there may be instances where additional accommodation is required in order for readers to access the report's information. If additional accommodation is required, please contact Annie Veilleux, Manager of the Cultural Heritage Division at Archaeological Services Inc., by email at aveilleux@asiheritage.ca or by phone 416-966-1069 ext. 255.

Project Personnel

- **Senior Project Manager**: Lindsay Graves, M.A., C.A.H.P., Senior Cultural Heritage Specialist, Senior Project Manager - Cultural Heritage Division
- **Project Coordinator:** Katrina Thach, B.A. (Hon), Associate Archaeologist, Project Coordinator - Environmental Assessment Division
- **Project Manager**: John Sleath, M.A., Cultural Heritage Specialist, Project Manager - Cultural Heritage Division
- **Field Review**: Peter Carruthers, M.A., Senior Associate
- **Report Production**: Kirstyn Allam, B.A. (Hon), Advanced Dipl. Applied Museum Studies, Cultural Heritage Technician, Technical Writer and Researcher - Cultural Heritage Division, and John Sleath
- **Graphics Production**: Jonas Fernandez, M.S.c., Manager, Geomatics - Operations Division
- **Report Reviewer(s)**: Lindsay Graves and Katie Hull, P.h.D., Partner, Director – Business Affairs Division

Qualified Persons Involved in the Project

Lindsay Graves, M.A., C.A.H.P.
Senior Cultural Heritage Specialist, Senior Project Manager - Cultural Heritage Division

The Senior Project Manager for this Cultural Heritage Report is **Lindsay Graves** (M.A., Heritage Conservation), Senior Cultural Heritage Specialist and the Environmental Assessment Coordinator for the Cultural Heritage Division. She was responsible for: overall project scoping and approach; development and confirmation of technical findings and study recommendations; application of relevant standards, guidelines and regulations; and implementation of quality control procedures. Lindsay is academically trained in the fields of heritage conservation, cultural anthropology, archaeology, and collections management and has over 15 years of experience in the field of cultural heritage resource management. This work has focused on the assessment, evaluation, and protection of above ground cultural heritage resources. Lindsay has extensive experience undertaking archival research, heritage survey work, heritage evaluation and heritage impact assessment. She has also contributed to cultural heritage landscape studies and heritage conservation plans, led heritage commemoration and interpretive programs, and worked collaboratively with multidisciplinary teams to sensitively plan interventions at historic sites/places. In addition, she is a leader in the completion of heritage studies required to fulfill Class Environmental Assessment processes and has served as Project Manager for over 100 heritage assessments during her time at A.S.I. Lindsay is a member of the Canadian Association of Heritage Professionals.

John Sleath, M.A.
Cultural Heritage Specialist, Project Manager - Cultural Heritage Division

The Project Manager for this Cultural Heritage Report is **John Sleath** (MA), who is a Cultural Heritage Specialist and Project Manager within the Cultural Heritage Division with ASI. He was responsible for the day-to-day management activities, including scoping of research activities and site surveys and drafting of study findings and recommendations. John has worked in a variety of contexts within

the field of cultural heritage resource management for the past 13 years, as an archaeologist and as a cultural heritage professional. In 2015 John began working in the Cultural Heritage Division researching and preparing a multitude of cultural heritage assessment reports and for which he was responsible for a variety of tasks including: completing archival research, investigating built heritage and cultural heritage landscapes, report preparation, historical map regression, and municipal consultation. Since 2018 John has been a project manager responsible for a variety of tasks required for successful project completion. This work has allowed John to engage with stakeholders from the public and private sector, as well as representatives from local municipal planning departments and museums. John has conducted heritage assessments across Ontario, with a focus on transit and rail corridor infrastructure including bridges and culverts.

Kirstyn Allam, B.A. (Hon), Advanced Dipl. in Applied Museum Studies
Cultural Heritage Technician, Technical Writer and Researcher - Cultural Heritage Division

The Cultural Heritage Technician for this project is **Kirstyn Allam** (B.A. (Hon.), Advanced Diploma in Applied Museum Studies), who is a Cultural Heritage Technician and Technical Writer and Researcher within the Cultural Heritage Division. She was responsible for preparing and contributing to research and technical reporting. Kirstyn Allam's education and experience in cultural heritage, historical research, archaeology, and collections management has provided her with a deep knowledge and strong understanding of the issues facing the cultural heritage industry and best practices in the field. Kirstyn has experience in heritage conservation principles and practices in cultural resource management. Kirstyn also has experience being involved with Stage 1-4 archaeological excavations in the Province of Ontario.

Glossary

Adjacent
Definition: "contiguous properties as well as properties that are separated from a heritage property by narrow strip of land used as a public or private road, highway, street, lane, trail, right-of-way, walkway, green space, park, and/or easement or as otherwise defined in the municipal official plan." (Ministry of Tourism, Culture and Sport, 2010)

Built Heritage Resource (B.H.R.)
Definition: "…a building, structure, monument, installation or any manufactured remnant that contributes to a property's cultural heritage value or interest as identified by a community, including an Indigenous community. built heritage resources are located on property that may be designated under Parts IV or V of the *Ontario Heritage Act*, or that may be included on local, provincial, federal and/or international registers" (Government of Ontario, 2020, p. 41).

Cultural Heritage Landscape (C.H.L.)
Definition: "…a defined geographical area that may have been modified by human activity and is identified as having cultural heritage value or interest by a community, including an Indigenous community. The area may include features such as buildings, structures, spaces, views, archaeological sites or natural elements that are valued together for their interrelationship, meaning or association. Cultural heritage landscapes may be properties that have been determined to have cultural heritage value or interest under the *Ontario Heritage Act*, or have been included on federal and/or international registers, and/or protected through official plan, zoning by-law, or other land use planning mechanisms" (Government of Ontario, 2020, p. 42).

Cultural Heritage Resource
Definition: Includes above-ground resources such as built heritage resources and cultural heritage landscapes, and built or natural features below-ground including archaeological resources.

Known Cultural Heritage Resource

Definition: A known cultural heritage resource is a property that has recognized cultural heritage value or interest. This can include a property listed on a Municipal Heritage Register, designated under Part IV or V of the *Ontario Heritage Act*, or protected by a heritage agreement, covenant or easement, protected by the *Heritage Railway Stations Protection Act or the Heritage Lighthouse Protection Act*, identified as a Federal Heritage Building, or located within a U.N.E.S.C.O. World Heritage Site (Ministry of Tourism, Culture and Sport, 2016).

Impact

Definition: Includes negative and positive, direct and indirect effects to an identified cultural heritage resource. Direct impacts include destruction of any, or part of any, significant heritage attributes or features and/or unsympathetic or incompatible alterations to an identified resource. Indirect impacts include, but are not limited to, creation of shadows, isolation of heritage attributes, direct or indirect obstruction of significant views, change in land use, land disturbances (Ministry of Tourism and Culture, 2006). Indirect impacts also include potential vibration impacts (See Section 2.5 for complete definition and discussion of potential impacts).

Mitigation

Definition: Mitigation is the process of lessening or negating anticipated adverse impacts to cultural heritage resources and may include, but are not limited to, such actions as avoidance, monitoring, protection, relocation, remedial landscaping, and documentation of the cultural heritage landscape and/or built heritage resource if to be demolished or relocated.

Potential Cultural Heritage Resource

Definition: A potential cultural heritage resource is a property that has the potential for cultural heritage value or interest. This can include properties/project area that contain a parcel of land that is the subject of a commemorative or interpretive plaque, is adjacent to a known burial site and/or cemetery, is in a Canadian Heritage River Watershed, or contains buildings or structures that are 40 or more years old (Ministry of Tourism, Culture and Sport, 2016).

Significant

Definition: With regard to cultural heritage and archaeology resources, significant means "resources that have been determined to have cultural heritage value or interest. Processes and criteria for determining cultural heritage value or interest are established by the Province under the authority of the *Ontario Heritage Act.* While some significant resources may already be identified and inventoried by official sources, the significance of others can only be determined after evaluation" (Government of Ontario, 2020, p. 51).

Vibration Zone of Influence

Definition: Area within a 50 metre buffer of construction-related activities in which there is potential to affect an identified cultural heritage resource. A 50 metre buffer is applied in the absence of a project-specific defined vibration zone of influence based on existing secondary source literature and direction provided from the Ministry of Heritage, Sport, Tourism and Culture Industries (Carman et al., 2012; Crispino & D'Apuzzo, 2001; P. Ellis, 1987; Rainer, 1982; Wiss, 1981). This buffer accommodates the additional threat from collisions with heavy machinery or subsidence (Randl, 2001).

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1.0 Introduction

Archaeological Services Inc. was contracted by IBI Group, on behalf of the Regional Municipality of Waterloo, to conduct a Cultural Heritage Report as part of the Maple Grove Road Improvements Municipal Class Environmental Assessment. The purpose of this report is to present an inventory of known and potential built heritage resources and cultural heritage landscapes, identify existing conditions of the project study area, provide a preliminary impact assessment, and propose appropriate mitigation measures. This submission includes the Existing Conditions component of the assessment and the Preliminary Impact Assessment based on the preferred alternative.

1.1 Project Overview

The Maple Grove Road Improvements Municipal Class Environmental Assessment involves road improvements to a section of Maple Grove Road approximately 4.3 kilometers in length from Fountain Street to Hespeler Road, a 500 metre section of Old Maple Grove Road, and an additional 500 metre segment from the eastern limit of Old Maple Grove Road to Hespeler Road. An additional segment of Beaverdale Road between Old Maple Grove Road to approximately 250 m north of Maple Grover Road was also added to the preferred alternative in 2021. The project study area consists of is generally in a rural agricultural and industrial context north of the City of Cambridge.

1.2 Description of Study Area

This Cultural Heritage Report will focus on the project study area with an additional 50 metre buffer (Figure 1). This project study area has been defined as inclusive of those lands that may contain built heritage resources or cultural heritage landscapes that may be subject to direct or indirect impacts as a result of the proposed undertaking. Properties within the study area are located in the City of Cambridge, Regional Municipality of Waterloo.

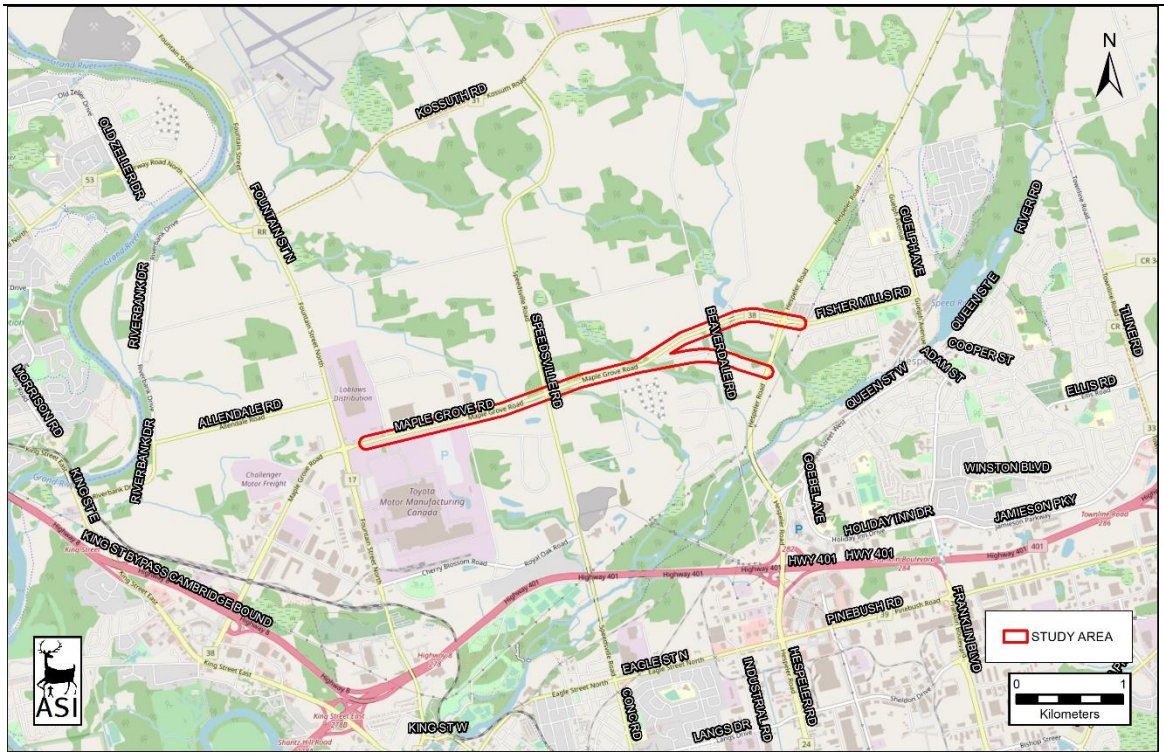


Figure 1: Location of the study area (Base Map: ©OpenStreetMap and contributors, Creative Commons-Share Alike License (CC-BY-SA))

2.0 Methodology

The following sections provide a summary of regulatory requirements and municipal and regional heritage policies that guide this cultural heritage assessment. In addition, an overview of the process undertaken to identify known and potential built heritage resources and cultural heritage landscapes is provided, along with a description of how the preliminary impact assessment will be undertaken.

2.1 Regulatory Requirements

The *Ontario Heritage Act* (Ontario Heritage Act, R.S.O. c. O.18, 1990 [as Amended in 2021], 1990) is the primary piece of legislation that determines policies, priorities and programs for the conservation of Ontario's heritage. There are many other provincial acts, regulations and policies governing land use planning and resource development that support heritage conservation, including:

- The *Planning Act* (Planning Act, R.S.O. 1990, c. P.13, 1990), which states that "conservation of features of significant architectural, cultural, historical, archaeological or scientific interest" (cultural heritage resources) is a "matter of provincial interest". The *Provincial Policy Statement* (Government of Ontario, 2020), issued under the *Planning Act*, links heritage conservation to long-term economic prosperity and requires municipalities and the Crown to conserve significant cultural heritage resources.

- The *Environmental Assessment Act* (Environmental Assessment Act, R.S.O., 1990), which defines "environment" to include cultural conditions that influence the life of humans or a community. Cultural heritage resources, which includes archaeological resources, built heritage resources and cultural heritage landscapes, are important components of those cultural conditions.

The Ministry of Heritage, Sport, Tourism and Culture Industries (herein after "The Ministry") is charged under Section 2.0 of the O.H.A. with the responsibility to determine policies, priorities, and programs for the conservation, protection, and preservation of the heritage of Ontario. The Ministry of Tourism, Culture and Sport (now administered by M.H.S.T.C.I.) published *Standards and Guidelines for Conservation of Provincial Heritage Properties* (Ministry of Tourism, Culture and Sport, 2010) (hereinafter "*Standards and Guidelines*"). These *Standards and Guidelines* apply to properties the Government of Ontario owns or controls that have "cultural heritage value or interest" (C.H.V.I.). The *Standards and Guidelines* provide a series of guidelines that apply to provincial heritage properties in the areas of identification and evaluation; protection; maintenance; use; and disposal. For the purpose of this report, the *Standards and Guidelines* provide points of reference to aid in determining potential heritage significance in identification of built heritage resources and cultural heritage landscapes. While not directly applicable for use in properties not under provincial ownership, the *Standards and Guidelines* are regarded as best practice for guiding heritage assessments and ensure that additional identification and mitigation measures are considered.

Similarly, the *Ontario Heritage Tool Kit* (Ministry of Culture, 2006) provides a guide to evaluate heritage properties. To conserve a built heritage resource or cultural heritage landscape, the *Ontario Heritage Tool Kit* states that a municipality or approval authority may require a heritage impact assessment and/or a conservation plan to guide the approval, modification, or denial of a proposed development.

2.2 Municipal/Regional Heritage Policies

The study area is located within the City of Cambridge, in the Regional Municipality of Waterloo. Policies relating to cultural heritage resources were reviewed from the following sources:

- *Cambridge Official Plan* (City of Cambridge, 2018b)
- Regional Municipality of Waterloo's *Regional Official Plan* (Region of Waterloo, 2015)

2.3 Identification of Built Heritage Resources and Cultural Heritage Landscapes

This Cultural Heritage Report follows guidelines presented in the *Ontario Heritage Tool Kit* (Ministry of Culture, 2006) and *Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes* (Ministry of Tourism, Culture and Sport, 2016). The objective of this report is to present an inventory of known and potential built heritage resources and cultural heritage landscapes, and to provide a preliminary understanding of known and potential built heritage resources and cultural heritage landscapes located within areas anticipated to be directly or indirectly impacted by the proposed project.

In the course of the cultural heritage assessment process, all potentially affected built heritage resources and cultural heritage landscapes are subject to identification and inventory. Generally, when conducting an identification of built heritage resources and cultural heritage landscapes within a study area, three stages of research and data collection are undertaken to appropriately establish the potential for and existence of built heritage resources and cultural heritage

landscapes in a geographic area: background research and desktop data collection; field review; and identification.

Background historical research, which includes consultation of primary and secondary source research and historical mapping, is undertaken to identify early settlement patterns and broad agents or themes of change in a study area. This stage in the data collection process enables the researcher to determine the presence of sensitive heritage areas that correspond to nineteenth- and twentieth-century settlement and development patterns. To augment data collected during this stage of the research process, federal, provincial, and municipal databases and/or agencies are consulted to obtain information about specific properties that have been previously identified and/or designated as having cultural heritage value. Typically, resources identified during these stages of the research process are reflective of particular architectural styles or construction methods, associated with an important person, place, or event, and contribute to the contextual facets of a particular place, neighbourhood, or intersection.

A field review is then undertaken to confirm the location and condition of previously identified built heritage resources and cultural heritage landscapes. The field review is also used to identify potential built heritage resources and cultural heritage landscapes that have not been previously identified on federal, provincial, or municipal databases or through other appropriate agency data sources.

During the cultural heritage assessment process, a property is identified as a potential built heritage resources or cultural heritage landscape based on research, the Ministry screening tool, and professional expertise and best practice. In addition, use of a 40-year-old benchmark is a guiding principle when conducting a preliminary identification of built heritage resources and cultural heritage landscapes. While identification of a resource that is 40 years old or older does not confer outright heritage significance, this benchmark provides a means to collect information about resources that may retain heritage value.

Similarly, if a resource is slightly younger than 40 years old, this does not preclude the resource from having cultural heritage value or interest.

2.4 Background Information Review

To make an identification of previously identified known or potential built heritage resources and cultural heritage landscapes within the study area, the following sections present the resources were consulted as part of this Cultural Heritage Report.

2.4.1 Review of Existing Heritage Inventories

A number of resources were consulted in order to identify previously identified built heritage resources and cultural heritage landscapes within the study area. These resources, reviewed on 11 December 2018, include:

- The *City of Cambridge Heritage Properties Register* (City of Cambridge, 2020), which provides a list of cultural heritage resources that are designated under Part IV of the *Ontario Heritage Act*. It also includes non-designated properties that are of cultural heritage value or interest;
- City of Cambridge Interactive Map, Cambridge Map (https://maps.cambridge.ca/Maps/WebPages/Map/FundyViewer.aspx);
- *Region of Waterloo's Public Building Inventory*, which provides a list of purpose-built public buildings in the Regional Municipality of Waterloo (Region of Waterloo, 2018);
- Historical maps (including historical atlases, topographic maps, and aerial photography);
- The *Ontario Heritage Act Register* (Ontario Heritage Trust, n.d.b);
- The *Places of Worship Inventory* (Ontario Heritage Trust, n.d.c);
- The inventory of Ontario Heritage Trust easements (Ontario Heritage Trust, n.d.a);
- The Ontario Heritage Trust's *An Inventory of Provincial Plaques Across Ontario*: a PDF of Ontario Heritage Trust Plaques and their locations (Ontario Heritage Trust, 2018);

- Inventory of known cemeteries/burial sites in the Ontario Genealogical Society's online databases (Ontario Genealogical Society, n.d.);
- Canada's Historic Places website: available online, the searchable register provides information on historic places recognized for their heritage value at the local, provincial, territorial, and national levels (Parks Canada, n.d.a);
- Directory of Federal Heritage Designations: a searchable on-line database that identifies National Historic Sites, National Historic Events, National Historic People, Heritage Railway Stations, Federal Heritage Buildings, and Heritage Lighthouses (Parks Canada, n.d.b);
- Canadian Heritage River System: a national river conservation program that promotes, protects and enhances the best examples of Canada's river heritage (Canadian Heritage Rivers Board and Technical Planning Committee, n.d.); and,
- United Nations Educational, Scientific and Cultural Organization (U.N.E.S.C.O.) World Heritage Sites (UNESCO World Heritage Centre, n.d.).

2.4.2 Review of Previous Heritage Reporting

No additional cultural heritage studies undertaken within parts of the study area were also available for review as part of this assessment.

2.4.3 Stakeholder Data Collection

The following individuals, groups, and/or organizations were contacted to gather information on known and potential built heritage resources and cultural heritage landscapes, active and inactive cemeteries, and areas of identified Indigenous interest within the study area:

- Laura Waldie, Senior Planner – Heritage, Community Development Department, City of Cambridge was contacted to gather any information on potential cultural heritage resources or concerns within and/or adjacent to the study area (email communication 13 December 2018). A response confirmed the presence of several properties within the study area and that one property (4045 Maple Grove Road) has been approved for demolition and that there are plans to re-develop the property soon.

- Bridget Coady, Planner in Regional Cultural Heritage, Region of Waterloo was contacted to gather any information on potential cultural heritage resources or concerns within and/or adjacent to the study area (email communication 17 December 2018 and 8 January 2019). A response confirmed the presence of several properties within and adjacent to the study area including a bridge and two cultural heritage landscapes. These properties were from a variety of Regional inventories, internal Regional documents, and some identified as 'unofficially listed' by the Region of Waterloo[1].
- Shawn Buckley, Region of Waterloo was contacted to gather any information on potential heritage bridges within and/or adjacent to the study area (email communication 9 January 2019). A response was still outstanding at the time of this report.
- Karla Barboza, (A) Team Lead, Heritage, Ministry of Tourism, Culture and Sport, was also contacted to gather any information on potential cultural heritage resources or concerns within and/or adjacent to the study area (email communication 11 December 2018). A response confirmed that there are no identified Provincial Heritage Properties within or adjacent to the study area.

2.5 Preliminary Impact Assessment Methodology

To assess the potential impacts of the undertaking, identified built heritage resources and cultural heritage landscapes are considered against a range of possible negative impacts, based on the *Ontario Heritage Tool Kit InfoSheet #5: Heritage Impact Assessments and Conservation Plans* (Ministry of Tourism and Culture, 2006). These include:

[1] List of properties identified in documents including *Spanning the Generations: A Study of Old Bridges in Waterloo Region* (Region of Waterloo 2004), the *Heritage Barn Inventory* (Region of Waterloo 2017), and those properties identified as 'unofficially listed' were provided.

Direct impacts:

- Destruction of any, or part of any, significant heritage attributes or features; and
- Alteration that is not sympathetic, or is incompatible, with the historic fabric and appearance.

Indirect impacts:

- Shadows created that alter the appearance of a heritage attribute or change the viability of a natural feature or plantings, such as a garden;
- Isolation of a heritage attribute from its surrounding environment, context or a significant relationship;
- Direct or indirect obstruction of significant views or vistas within, from, or of built and natural features;
- A change in land use such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces; and
- Land disturbances such as a change in grade that alters soils, and drainage patterns that adversely affect an archaeological resource.

Indirect impacts from construction-related vibration have the potential to negatively affect built heritage resources and cultural heritage landscapes depending on the type of construction methods and machinery selected for the project and proximity and composition of the identified resources. Potential vibration impacts are defined as having potential to affect an identified built heritage resources and cultural heritage landscapes where work is taking place within 50 metre of features on the property. A 50 metre buffer is applied in the absence of a project-specific defined vibration zone of influence based on existing secondary source literature and direction provided from the MHSTCI (Carman et al., 2012; Crispino & D'Apuzzo, 2001; P. Ellis, 1987; Rainer, 1982; Wiss, 1981). This buffer accommodates any additional or potential threat from collisions with heavy machinery or subsidence (Randl, 2001).

Several additional factors are also considered when evaluating potential impacts on identified built heritage resources and cultural heritage landscapes. These are outlined in a document set out by the Ministry of Culture and Communications (now Ministry of Heritage, Sport, Tourism and Culture Industries) and the Ministry of the Environment entitled *Guideline for Preparing the Cultural Heritage Resource Component of Environmental Assessments* (1992). While this document has largely been superseded in some respects by more current policies and legislation, the guidance provided that continues to be of relevance to this specific project includes the following definitions:

- Magnitude: the amount of physical alteration or destruction which can be expected;
- Severity: the irreversibility or reversibility of an impact;
- Duration: the length of time an adverse impact persists;
- Frequency: the number of times an impact can be expected;
- Range: the spatial distribution, widespread or site specific, of an adverse impact; and
- Diversity: the number of different kinds of activities to affect a heritage resource.

The proposed undertaking should endeavor to avoid adversely affecting known and potential built heritage resources and cultural heritage landscapes and interventions should be managed in such a way that identified significant cultural heritage resources are conserved. When the nature of the undertaking is such that adverse impacts are unavoidable, it may be necessary to implement alternative approaches or mitigation strategies that alleviate the negative effects on identified built heritage resources and cultural heritage landscapes. Mitigation is the process of lessening or negating anticipated adverse impacts to cultural heritage resources and may include, but are not limited to, such actions as avoidance, monitoring, protection, relocation, remedial landscaping, and documentation of the built heritage resource or cultural heritage landscape if to be demolished or relocated.

Various works associated with infrastructure improvements have the potential to affect built heritage resources and cultural heritage landscapes in a variety of ways, and as such, appropriate mitigation measures for the undertaking need to be considered.

3.0 Summary of Historical Development Within the Study Area

This section provides a brief summary of historical research. A review of available primary and secondary source material was undertaken to produce a contextual overview of the study area, including a general description of physiography, Indigenous land use, and Euro-Canadian settlement.

3.1 Indigenous Land Use and Settlement

Southern Ontario has been occupied by human populations since the retreat of the Laurentide glacier approximately 13,000 years ago, or 11,000 Before the Common Era (B.C.E.) (Ferris, 2013).[2] During the Paleo period (c. 11,000 B.C.E. to 9,000 B.C.E.), groups tended to be small, nomadic, and non-stratified. The population relied on hunting, fishing, and gathering for sustenance, though their lives went far beyond subsistence strategies to include cultural practices including but not limited to art and astronomy. Fluted points, beaked scrapers, and gravers are among the most important artifacts to have been found at various sites throughout southern Ontario, and particularly along the shorelines of former glacial lakes. Given the low regional population levels at this time, evidence concerning Paleo-Indian period groups is very limited (C. J. Ellis & Deller, 1990).

Moving into the Archaic period (c. 9,000 B.C.E. to 1,000 B.C.E.), many of the same roles and responsibilities continued as they had for millennia, with groups generally remaining small, nomadic, and non-hierarchical. The seasons dictated the size of groups (with a general tendency to congregate in the spring/summer

[2] While many types of information can inform the precontact settlement of Ontario, such as oral traditions and histories, this summary provides information drawn from archaeological research conducted in southern Ontario over the last century.

and disperse in the fall/winter), as well as their various sustenance activities, including fishing, foraging, trapping, and food storage and preparation. There were extensive trade networks which involved the exchange of both raw materials and finished objects such as polished or ground stone tools, beads, and notched or stemmed projectile points. Furthermore, mortuary ceremonialism was evident, meaning that there were burial practices and traditions associated with a group member's death (C. J. Ellis et al., 2009; C. J. Ellis & Deller, 1990).

The Woodland period (c. 1,000 B.C.E. to 1650 C.E.) saw several trends and aspects of life remain consistent with previous generations. Among the more notable changes, however, was the introduction of pottery, the establishment of larger occupations and territorial settlements, incipient horticulture, more stratified societies, and more elaborate burials. Later in this period, settlement patterns, foods, and the socio-political system continued to change. A major shift to agriculture occurred in some regions, and the ability to grow vegetables and legumes such as corn, beans, and squash ensured long-term settlement occupation and less dependence upon hunting and fishing. This development contributed to population growth as well as the emergence of permanent villages and special purpose sites supporting those villages. Furthermore, the socio-political system shifted from one which was strongly kinship based to one that involved tribal differentiation as well as political alliances across and between regions (Birch & Williamson, 2013; Dodd et al., 1990; C. J. Ellis & Deller, 1990; Williamson, 1990).

The arrival of European trade goods in the sixteenth century, Europeans themselves in the seventeenth century, and increasing settlement efforts in the eighteenth century all significantly impacted traditional ways of life in Southern Ontario. Over time, war and disease contributed to death, dispersion, and displacement of many Indigenous peoples across the region. The Euro-Canadian population grew in both numbers and power through the eighteenth and nineteenth centuries and treaties between colonial administrators and First Nations representatives began to be negotiated.

The study area is within Treaty 3, the Between the Lakes Purchase. Following the 1764 Niagara Peace Treaty and the follow-up treaties with Pontiac, the English colonial government considered the Mississaugas to be their allies since they had accepted the Covenant Chain. The English administrators followed the terms of the Royal Proclamation and insured that no settlements were made in the hunting grounds that had been reserved for their use (Johnston 1964; Lytwyn 2005). In 1784, under the terms of the "Between the Lakes Purchase" signed by Sir Frederick Haldimand and the Mississaugas, the Crown acquired over one million acres of land in-part spanning westward from near modern day Niagara-on-the-Lake along the south shore of Lake Ontario to modern day Burlington (Aboriginal Affairs and Northern Development Canada 2016).

3.2 Historical Euro-Canadian Township Survey and Settlement

Historically, the study area is in the Former Township of Waterloo, County of Waterloo in part of Lots 19, 20, 29, 30, Beasley's Broken Front Concession; Lots 11-12, Concessions 1 Beasley Lower Block; and Lots 10-12 Concession 2 Beasley Lower Block.

3.2.1 Township of Waterloo

The historic Township of Waterloo was originally known as Block Two of the Grand River land grant which was deeded to the Six Nations Iroquois by the British in 1784 for their loyalty to the Crown in the American War of Independence. In 1796, Block Two, a 38,045 ha tract, was acquired by Richard Beasley from Joseph Brant on behalf of the Six Nations. He subdivided and sold the land, with an approximately 24,281 ha tract of land going to the German Company of Pennsylvania in November 1803 (Janusas, 1988, p. 2). Company members included Samuel and John Bricker; and Daniel, Jacob, and John Erb. The German Company of Pennsylvania had the lands surveyed by Augustus Jones to subdivide the land into 128 farm lots of approximately 181 ha each and 32 farm lots of approximately 34 ha each (Janusas, 1988, p. 96).

When Block Two was incorporated into the District of Gore (County of Halton) in 1816, it was named Waterloo Township, in honour of the battle that ended the Napoleonic Wars in Europe. It remained part of Halton County in the District of Gore until 1842 and then part of the District of Wellington. The County of Waterloo did not come into being until 1852 (Janusas 1988:2).

The first immigrants to settle in Waterloo Township were almost exclusively German Mennonites from Pennsylvania, who had originally emigrated from Switzerland, Germany and France. Most of these settlers were farmers but many were tradesmen and millers. Later settlers were generally of Scottish, English, Irish, and continental German heritage, many of them farmers, but a majority of them were artisans and tradesmen. When the railway was laid through Waterloo Township in the mid-nineteenth century, it became the leading industrial center of Waterloo County (Janusas 1988:10-12).

Abraham Erb purchased approximately 181 ha of land in 1805 and became the first settler in the City of Waterloo. He transferred a portion of his land and ownership of two mills to Jacob Snider in 1829. Snider's son inherited approximately 129 ha which he sold to John Hoffman and Isaac Weber, who sectioned and sold the lands in 1854, at which point the population of Waterloo began to expand (Janusas 1988:102).

In the mid-1850s, the defining development of Waterloo Township and Waterloo County was the construction of the railway. The first railway line built into the township was a main line of the Grand Trunk Railway from Toronto, laid through in 1856. A number of other railway lines were soon laid across the township including: a Grand Trunk branch between Preston and Berlin in 1857; a Great Western line from Galt, Preston, and Guelph in 1857; a Grand Trunk branch between Berlin (Kitchener) and Galt in 1882; and a Grand Trunk Branch between Waterloo and Elmira in 1891.

3.2.2 Town of Hespeler

In 1798, over 90,000 acres known as Block 2 was sold by the Six Nations from the Haldimand Tract Treaty to settler Richard Beasley and his partners, who shortly

afterwards parcelled it off to Mennonite farmers from Pennsylvania, including Abraham Clemens and Cornelius Pannabecker, said to be the first blacksmith in the area. In 1830 Joseph Oberholtzer purchased a large tract from Clemens and deeded a parcel to his sister Susanna and her husband Michael Bergey – they are considered Hespeler's first residents. The settlement that grew around their farm was first called Bergeytown and later New Hope, until after Jacob Hespeler settled there in 1845, purchasing 145 acres to encourage industrial development on the Speed River. The Village of Hespeler incorporated in 1859. The Great Western Railway was built through the village and encouraged further growth. By 1901 Hespeler was incorporated as a town and was known for its industrial strength, including factories such as Dominion Woollens and Worsteds Ltd., one of the largest textile producers in the country. In 1973 the Town of Hespeler was amalgamated with Galt and Preston into the City of Cambridge (City of Cambridge 2018c).

3.2.3 Wanner Mennonite Church and Cemetery

Early church services were held starting around 1800 in a union meetinghouse on lands donated by Samuel Bechtel. In 1837, the Mennonite community around the junction of Maple Grove Road and Beaverdale Road built a small white brick church on the southwest corner of the intersection, on land donated by Henry Wanner Jr. (Wanner Mennonite Church, 2018). The present brick building was constructed in 1938 replacing the old church and is identified on the municipal heritage register. The 1861 and 1881 historical maps show the cemetery/graveyard on the northwest corner of the intersection (Parsell & Co., 1881; Tremaine, 1861). The first burial in the cemetery was a child of the Wanner family in 1814 (CanadaGenWeb's Cemetery Project, 2018).

3.2.4 Maple Grove Public School

The earliest mention of a school in the area was in 1848 when land was sold by Henry and Hannah Wanner to the Wellington District Council. The land was later sold back to the original owner in 1859 and it was re-sold back to the Council. The schoolhouse was built in 1850 and was expanded in 1875. The expansion was built by senior boys (16-18 years old). The original front entrance was replaced

with a central window before 1889. More recently, in 1989 the school was used as a staff training centre and is now currently a child care centre (Region of Waterloo 2018).

3.3 Review of Historical Mapping

The 1861 *Tremaine's Map of the County of Waterloo* (Tremaine, 1861) and the 1881 *Illustrated Historical Atlas of the County of Waterloo* (Parsell & Co., 1881) were examined to determine the presence of historical features within the study area during the nineteenth century (Figure 2 and Figure 3). Historically, the study area is located in the Former Township of Waterloo, County of Waterloo in part of Lots 19, 20, 29, 30, Beasley's Broken Front Concession; Lots 11-12, Concessions 1 Beasley Lower Block; and Lots 10-12 Concession 2 Beasley Lower Block.

It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases. For instance, they were often financed by subscription limiting the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the atlases. The use of historical map sources to reconstruct or predict the location of former features within the modern landscape generally begins by using common reference points between the various sources. The historical maps are geo-referenced to provide the most accurate determination of the location of any property on a modern map. The results of this exercise can often be imprecise or even contradictory, as there are numerous potential sources of error inherent in such a process, including differences of scale and resolution, and distortions introduced by reproduction of the sources.

The nineteenth-century maps illustrate that Maple Grove Road, Old Maple Grove Road, Fountain Street North, Speedsville Road, Beaverdale Road, Fisher Mills Road, and Chilligo Road were historically surveyed roadways. Middle Creek, East Creek, Ellis (Chilligo) Creek, and a pond north of Fisher Mills Road are illustrated on both maps. The 1861 Tremaine Map (Figure 2) depicts a structure to the north of Maple Grove Road in Lot 11 Concession 1 Beasley Lower Block, a schoolhouse (identified as schoolhouse number 20) near the northeast corner of Maple Grove

Road and Speedsville Road (B.H.R. 4), and a grist mill south of Fisher Mills Road (B.H.R. 3). At the southwest corner of Maple Grove Road and Beaverdale Road is a Menonist [sic] Church is depicted (B.H.R. 1); the associated cemetery is also illustrated on the nineteenth century maps. In addition to these structures, there is also a blacksmith located north of Fisher Mills Road and a structure to the west of Beaverdale Road at Fisher Mills Road on the 1881 Illustrated Historical Atlas (Figure 3). The study area is depicted in a rural agricultural context throughout the nineteenth century, with the town of Hespeler to the east of the study area limits.

In addition to nineteenth-century mapping, historical topographic mapping and aerial photographs from the twentieth century were examined. This report presents maps and aerial photographs from 1916, 1954, 1968, and 1998 (Figure 4 to Figure 7). These do not represent the full range of maps consulted for the purpose of this study but were judged to cover the full range of land uses that occurred in the area during this period.

The twentieth-century mapping reveals that the study area retained a rural agricultural character throughout the twentieth-century. The 1916 topographic map (Figure 4) indicates that Maple Grove Road, Old Maple Grove Road, Speedsville Road, and Chilligo Road were unmetalled roadways. Maple Grove Road is depicted as a single major east-west roadway that generally follows the alignment of Old Maple Grove Road in the eastern potion of the study area. Fountain Street North, Beaverdale Road, and Fisher Mills Road are all depicted as metalled roadways. Fountain Street North, Speedsville Road, and Beaverdale Road are all major north-south roadways. There are minimal structures along the roadways. The schoolhouse to the northeast of Maple Grove Road and Speedsville Road is illustrated as a stone or brick structure. One the north side of Fisher Mills Road are three wooden structures and on the south side is a wooden mill. The aerial photograph (Figure 5) depicts the area with minimal changes and in the same context as earlier mapping. To the east of Beaverdale Road at the intersection with Maple Grove Road is a structure in the vicinity of B.H.R. 2. The 1968 topographic map (Figure 6) demonstrates that there has been a small amount of development near the intersections of Maple Grove Road and Beaverdale Road; and Beaverdale Road and Fisher Mills Road. The 1998

topographic map (Figure 7) further illustrates the development in that area with a small hamlet of Fisher Mills now appearing on the map just to the north of the study area. Maple Grove Road's alignment is now altered to its present alignment heading in a northward direction at Beaverdale Road, and Old Maple Grove Road is not depicted. Ellis Creek is still illustrated on the twentieth century mapping following its present alignment, transecting the study area in the eastern portion. The creek passes under Maple Grove Road east of Beaverdale Road.

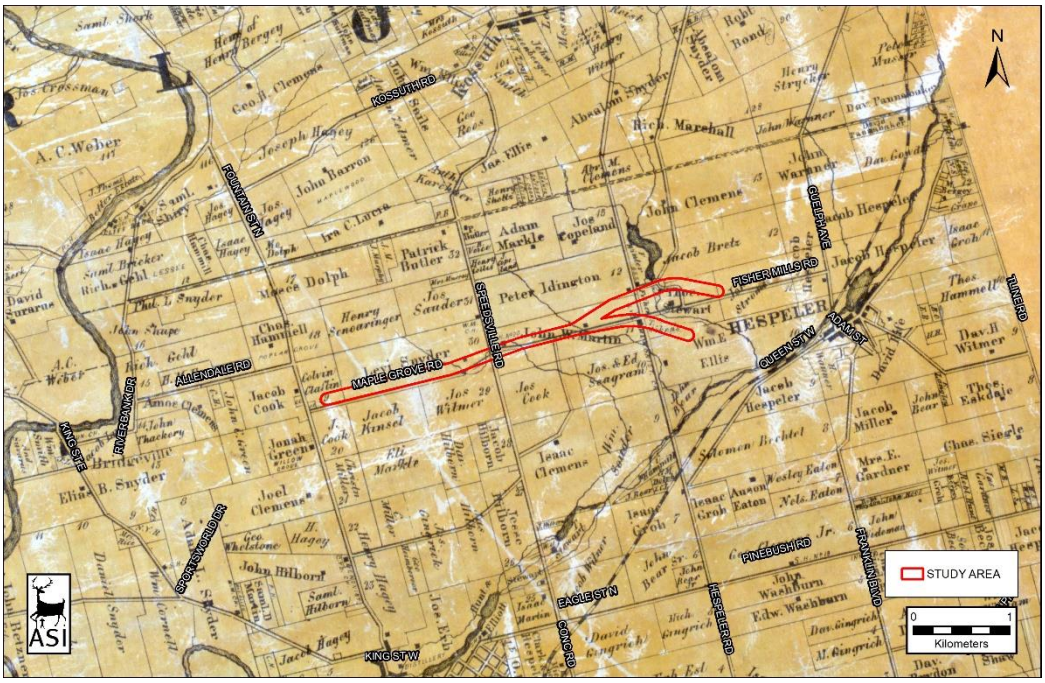


Figure 2: The study area overlaid on the 1861 Tremaine's Map of the County of Waterloo. Base Map: (Tremaine 1861).



Figure 3: The study area overlaid on the 1881 Historical Atlas of the County of Waterloo. Base Map: (Parsell & Co., 1881).

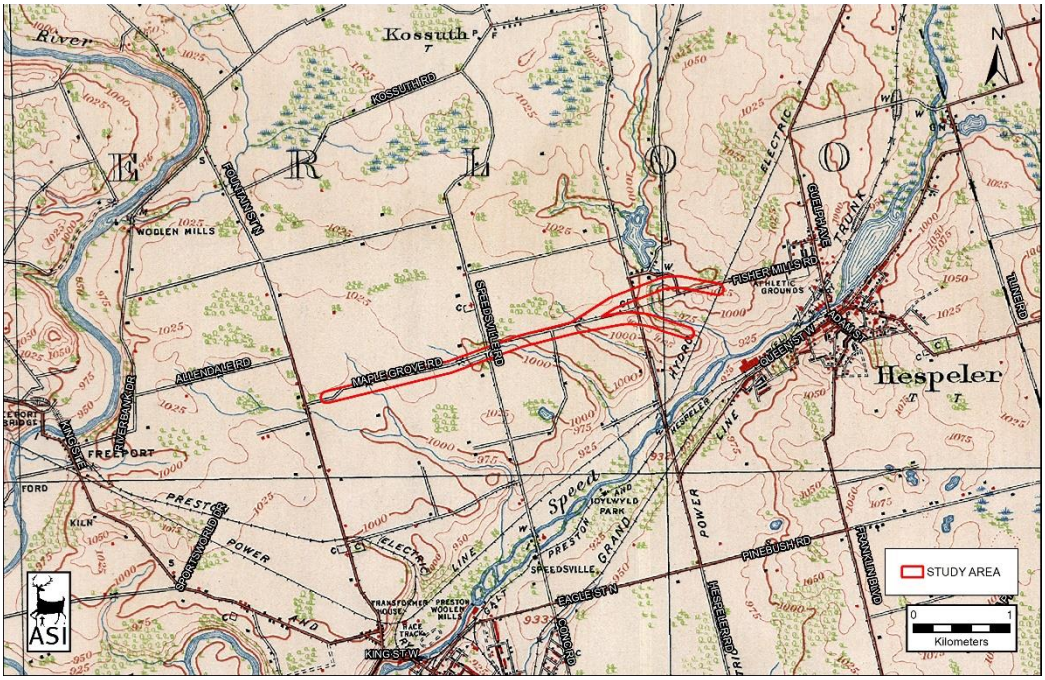


Figure 4: The study area overlaid on the 1916 topographic map of Galt. Base Map:(Department of Militia and Defence, 1916).



Figure 5: The study area overlaid on the 1954 aerial photograph of Southern Ontario. Base Image: (Hunting Survey Corporation Limited, 1954).

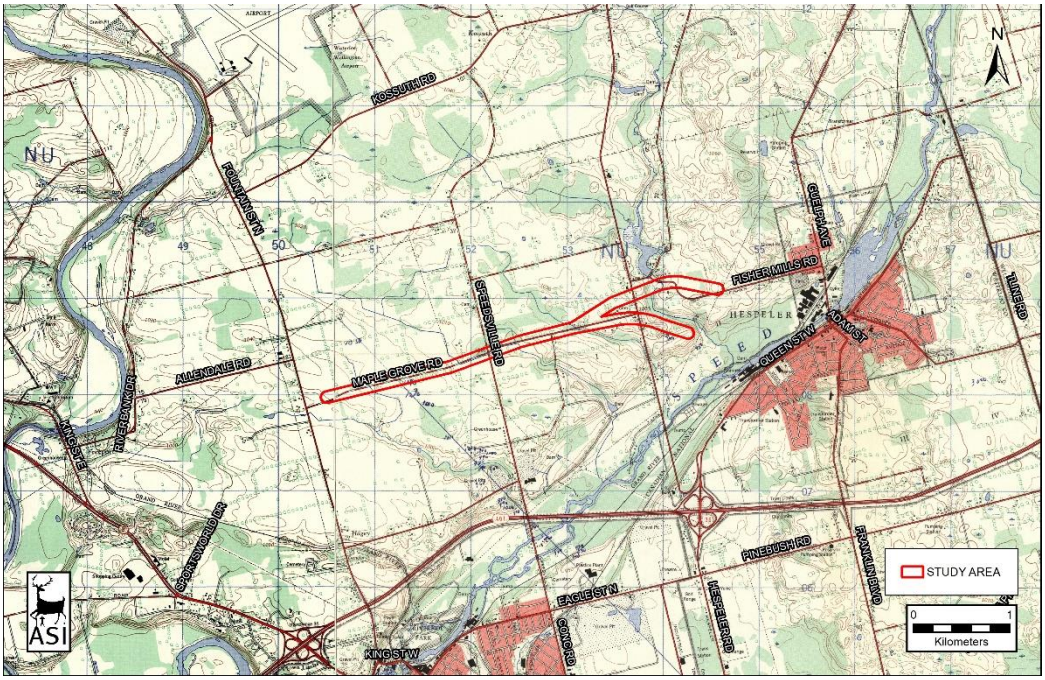


Figure 6: The study area overlaid on the 1968 topographic map of Preston-Hespeler. Base Map:(Energy, Mines and Resources Canada, 1968).

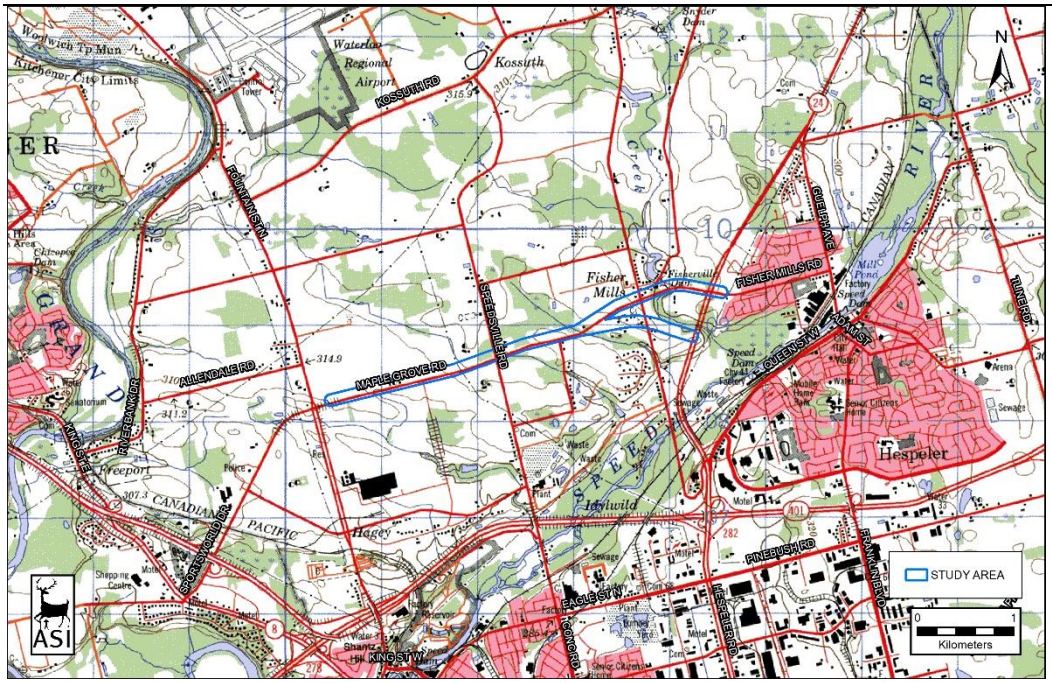


Figure 7: The study area overlaid on the 1998 topographic map of Waterloo .Base Map:(Natural Resources Canada, 1998).

4.0 Existing Conditions

A field review of the study area was undertaken by Peter Carruthers of Archaeological Services Inc., on 28 November 2018 to document the existing conditions of the study area from existing rights-of-way. The existing conditions of the study area are described below and captured in Plate 1 to Plate 18.

4.1 Description of Field Review

The study area includes a 4.3 kilometre section of Maple Grove Road from Fountain Street to Hespeler Road, a 500 metre section of Old Maple Grove Road, and an additional 500 metre segment from the eastern limit of Old Maple Grove Road to Hespeler Road. Maple Grove Road is oriented in a southwest-northeast alignment and features mostly two lanes of southwest and northeast-bound vehicular traffic. The study area is mostly in a rural agricultural context bound by farmland on the north and south of the Maple Grove Road right-of-way. Ellis

Creek transects the study area, east of Beaverdale Road. The western portion of the study area is in an industrial-commercial context between Fountain Street North and Streetsville Road with Loblaw – Maple Grove Distribution Center on the north and Toyota Motor Manufacturing on the south. The roadway lacks curbs and sidewalks and features gravel shoulders and ditches on both sides. There are several residences located adjacent to the study area.

An additional segment of Beaverdale Road between Old Maple Grove Road to approximately 250 m north of Maple Grover Road was also added to the preferred alternative in 2021. This segment generally features residences and farmscapes and a church and cemetery at the intersection of Beaverdale Road and Old Maple Grove Road.



Plate 1: Western portion of the study area, looking southwest.



Plate 2: Western portion of the study area, looking northwest.



Plate 3: View of modern barn along Maple Grove Road, looking northeast.



Plate 4: View of office building on south side of Maple Grove Road, looking southeast.



Plate 5: Ditch along north side of Maple Grove Road, looking northeast.



Plate 6: Active agricultural field along Maple Grove Road, looking northeast.



Plate 7: Gravel shoulder and ditch along Maple Grove Road, looking west-southwest.



Plate 8: Childcare centre (B.H.R. 4) on north side of Maple Grove Road, looking northwest.



Plate 9: Agricultural field on north side of Maple Grove Road, looking northwest.



Plate 10: Looking toward a future development site, in present agricultural field, looking east-southeast.



Plate 11: Old Maple Grove Road, looking west.



Plate 12: Modern residences along Old Maple Grove Road, looking east-northeast.



Plate 13: Looking south along Beaverdale Road.



Plate 14: View of Ellis Creek, looking north-northwest.



Plate 15: Near the eastern portion of the study area, looking west.



Plate 16: Ditch and agricultural field near eastern portion of the study area, looking west-northwest.



Plate 17: Eastern portion of the study area towards the intersection of Maple Grove Road and Hespeler Road, looking east-southeast.



Plate 18: Modern residential development along Fisher Mills Road, looking north-northwest.

4.2 Identification of Known and Potential Built Heritage Resources and Cultural Heritage Landscapes

Based on the results of the background research and field review, a total of fourteen known and potential cultural heritage resources were identified within the study area. Of these, nine are known built heritage resources (B.H.R.s), and an additional three potential B.H.R.s and two potential cultural heritage landscapes (C.H.L.s) were identified during background research and field review. A detailed inventory of known and potential B.H.R.s and C.H.L.s within the study area is presented below in Table 1. See Figure 8 – Figure 12 for mapping showing the location of identified B.H.R.s and C.H.L.s.

Table 1: Inventory of Known and Potential Built Heritage Resources and Cultural Heritage Landscapes within the Study Area

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
B.H.R. 1	Church	1705-1725 Beaverdale Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	The church is depicted on the 1861 *Tremaine's Map* and the 1881 *Illustrated Historical Atlas.* The first church on site was constructed in 1837 with tombstone that date to this early history. The extant Wanner Mennonite Church was constructed in 1938 and is constructed with red brick church on a stone foundation. The church is located on the west side of Beaverdale Road in a rural area to the west of the community of Hespeler, and reflects twentieth century religious and burial practices in the former Township of Waterloo	
B.H.R. 2	Residence	1720 Beaverdale Road	Potential B.H.R./C.H.L. – Identified during field review/desktop research	The residence is located in Lot 11, Concession 2 Beasley Lower Block, and was occupied by T. Aikens in nineteenth century mapping. A house is depicted in the vicinity on the 1954 aerial photograph. The residence is a two-and-a-half storey red brick house with a brick porch and wooden balcony along the front façade. The house has a hipped roof with a central dormer window and chimney and a one storey addition to the rear of the house. Located on the east side of Beaverdale Road in a rural area to the west of the community of Hespeler, the residence reflects twentieth century settlement practices in the former Township of Waterloo.	

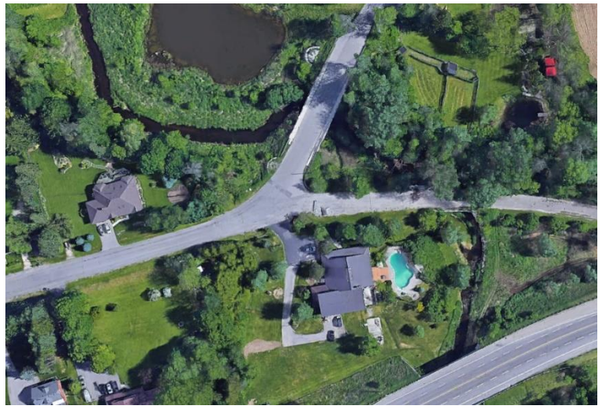
Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
B.H.R. 3	Mill (presently converted into a residence)	566 Fisher Mills Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	Christian Strome operated a sawmill in this location in1835 and sold the property in 1842 to Jacob Fisher who built a four-storey addition to the original sawmill in 1847-1848. The original sawmill was removed from the property in 1890 and a portion of the new one was built. In the 1970s a porch was added to the building, and in 1995 renovations began from a working feed mill into a single-family residence. The residence is a four-storey converted wooden sawmill with gable roof and porch along the front façade. Located on the south side of Fisher Mills Road in a rural area to the west of the community of Hespeler, the property reflects nineteenth century commercial and manufacturing practices in the former Township of Waterloo. Former mill is associated with mill works (C.H.L. 3) located on property.	
B.H.R. 4	School (presently a child care centre)	1370 Maple Grove Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	The property was formerly the site of the Maple Grove Public School, S.S. #20 Waterloo Township. The first mention of a school in the area was in 1848 when the land was purchased by the Wellington District Council, which was later sold back to the original owner, Henry Wanner, in 1859, after which it was again sold back to the Council. The stone school was built in 1850 and was later expanded. in 1989, the school was used as a staff training centre for the school board, and is currently a childcare centre. The structure is a one-storey stone structure with recent addition to the east that reflects	

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
				nineteenth and twentieth-century educational practices in the former Township of Waterloo	
B.H.R. 5	Residence (proposed for demolition)	4045 Maple Grove Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	The residence was constructed circa 1860 on Lot 11, Concession 2 Beasley Lower Block, which was occupied by Thos. Stewart in nineteenth-century mapping. A house is depicted in the vicinity on the 1861 Tremaine map. The residence is a two-storey brick house with a cross hipped roof with a chimney. A porch wraps around two of the elevations, and a three-bay window along one of the façades. The property reflects twentieth-century settlement practices in the former Township of Waterloo. The residence was approved for demolition by the City of Cambridge in 2016.	 Image source: *Cambridge Times* (Vivian 2016)
B.H.R. 6	Farmstead	1380 Beaverdale Road	Known B.H.R./C.H.L. - Identified in the *Heritage Barn Inventory* (Region of Waterloo 2017)	The residence was constructed circa 1840 in Lot 10, Concession 2 Beasley Lower Block. A structure is located in the vicinity of the farmstead on the 1861 *Tremaine's Map* and the 1881 *Illustrated Historical Atlas* on land owned by Wm. E. Ellis and Wm. Ellis. The residence is L-shaped in plan and is largely obscured from view of the R.O.W. A cross gambrel English barn with field stone foundation is also featured on the property. The farmscape reflects nineteenth century settlement practices in the former Township of Waterloo.	 Image source: Google Maps

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
B.H.R. 7	Residence	1900 Beaverdale Road	Potential B.H.R./C.H.L. – Identified during field review/desktop research	The residence was constructed circa 1870 in Lot 12, Concession 2 Beasley Lower Block, and was occupied by F. Winter in nineteenth-century mapping. A blacksmith shop located in the vicinity of the extant residence on the 1861 *Tremaine's Map.* The residence is a two-storey house with vinyl-siding and features a single-storey addition on north elevation and chimney on the south elevation. The residence reflects nineteenth-century settlement practices in the former Township of Waterloo.	
B.H.R. 8	Residence	1965 Beaverdale Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	The residence was constructed circa 1895 in Lot 12, Concession 1 Beasley Lower Block, and was occupied by Peter Idington and John W. Martin in nineteenth-century mapping. A structure was located in the vicinity of the extant residence on the 1861 *Tremaine's Map* and the 1881 *Illustrated Historical Atlas.* The residence is a wood framed, L-shaped one and a half storey vernacular Edwardian farmhouse that features a covered porch over the two front doors on the east façade. The residence reflects nineteenth-century settlement practices in the former Township of Waterloo.	 Image source: Google Streetview

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
B.H.R. 9	Residence	90 Chilligo Road	Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	This location was a former stagecoach stop and site of the Globe Hotel. Former owner Charles Crossin sold the Globe Hotel in 1847 to Octavius Seagram (the father of Joseph Seagram, founder of Joseph E. Seagram and Sons Distillery). Seagram then sold the business after 22 years to Francis Douglas in 1869. The extant structure was constructed circa 1870, was later converted into a grocery store by owner James Stager, and later converted into a single-family residence. Residence is constructed in the Georgian style and features symmetrical windows along the front façade with a small open porch surrounding the front door and a bay window on the side façade. The residence is clad in white stucco. The residence and location as a former hotel reflects nineteenth century settlement practices in the former Township of Waterloo.	 Image source: Google Streetview
B.H.R. 10	Residence	615 Fisher Mills Road	Potential B.H.R./C.H.L. – Identified during field review/desktop research	The residence was constructed 1870 in Lot 12, Concession 2 Beasley Lower Block and was occupied by F. Winter in nineteenth-century mapping. A blacksmith shop is depicted on the 1881 *Illustrated Historical Atlas* in the vicinity of the extant house The one-and-a-half storey residence features a covered front door, symmetrical windows on the first floor and arched window above front door on the second floor. The residence reflects nineteenth century settlement practices in the former Township of Waterloo.	

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
B.H.R. 11	Barn	1130 Maple Grove Road	Known B.H.R./C.H.L. - Identified in the *Heritage Barn Inventory* (Region of Waterloo 2017)	The barn was constructed pre-1881 in Lot 30, Beasley's Broken Front Concession, which was occupied by Levi Snyder in nineteenth century mapping. A structure is depicted on the 1861 *Tremaine's Map* in the vicinity of the extant barn. The extant gambrel barn features a stone foundation, vertical wooden board cladding, and a corrugated metal roof. The extant barn reflects nineteenth-century farming practices in the former Township of Waterloo.	 Image source: Google Streetview
B.H.R. 12	Bridge	Old Fisher Mills Bridge over Ellis Creek	Known B.H.R./C.H.L. - Identified in *Spanning the Generations* (Region of Waterloo 2004)	The subject bridge was constructed in 1965 in Lot 12, Concession 2 Beasley Lower Block on land occupied by Jacob Bretz in nineteenth century mapping. An earlier wooden bridge is illustrated on the 1916 topographic map in the vicinity of the extant bridge. The bridge is a single-span, reinforced concrete bridge that carries Fisher Mills Road over Ellis Creek east of Chilligo Road to the west of the community of Hespeler, and is currently on private property. This bridge reflects twentieth-century transportation practices in the former Township of Waterloo.	

Feature I.D.	Type of Property	Address or Location	Heritage Status and Recognition	Description of Property and Known or Potential C.H.V.I.	Photographs/ Digital Image
C.H.L. 1	Cemetery	2320 Maple Grove Road	Potential B.H.R./C.H.L. – Identified during field review/desktop research	The cemetery is depicted on the 1861 *Tremaine's Map* and the 1881 *Illustrated Historical Atlas,* and the associated church across the street was constructed in 1837. Tombstones that date to this early history are evident in the cemetery. The church is located to the south of Old Maple Grove Road, while the cemetery is located to the north of Old Maple Grove Road with interments in rows running parallel to Beaverdale Road. This cemetery and associated church reflect twentieth-century religious and burial practices in the former Township of Waterloo.	
C.H.L. 2	Associated Mill Works	566 Fisher Mills Road	Potential B.H.R./C.H.L. – Identified during field review/desktop research	Mill works were constructed in this location circa 1924 on Lots 11 and 12, Concession 2 Beasley Lower Block, which was occupied by Thos. Stewart, F. Winter, and Jacob Bretz in nineteenth century mapping. A grist mill is depicted on the 1861 *Tremaine's Map* and the 1881 *Illustrated Historical Atlas* in the vicinity. The landscape features components of a former working mill, including Fisher Mills dam at the south end of Fisher Mills Pond. The mill works reflect twentieth century manufacturing practices in the former Township of Waterloo.	 Image source: Google Earth Pro

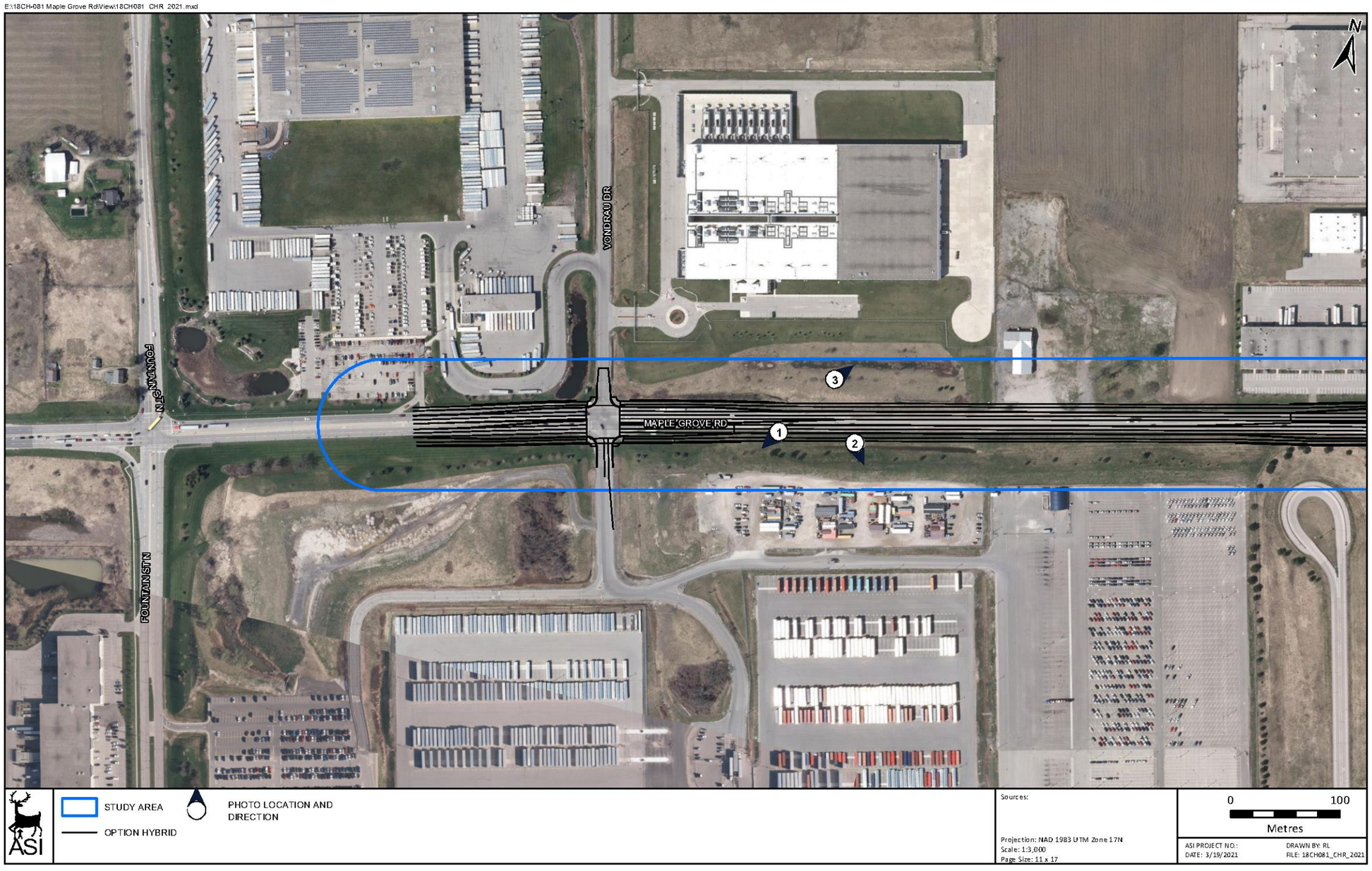


Figure 8: Location of Identified Built Heritage Resources (B.H.R.) and Cultural Heritage Landscapes (C.H.L.) in the Study Area (Sheet 1)

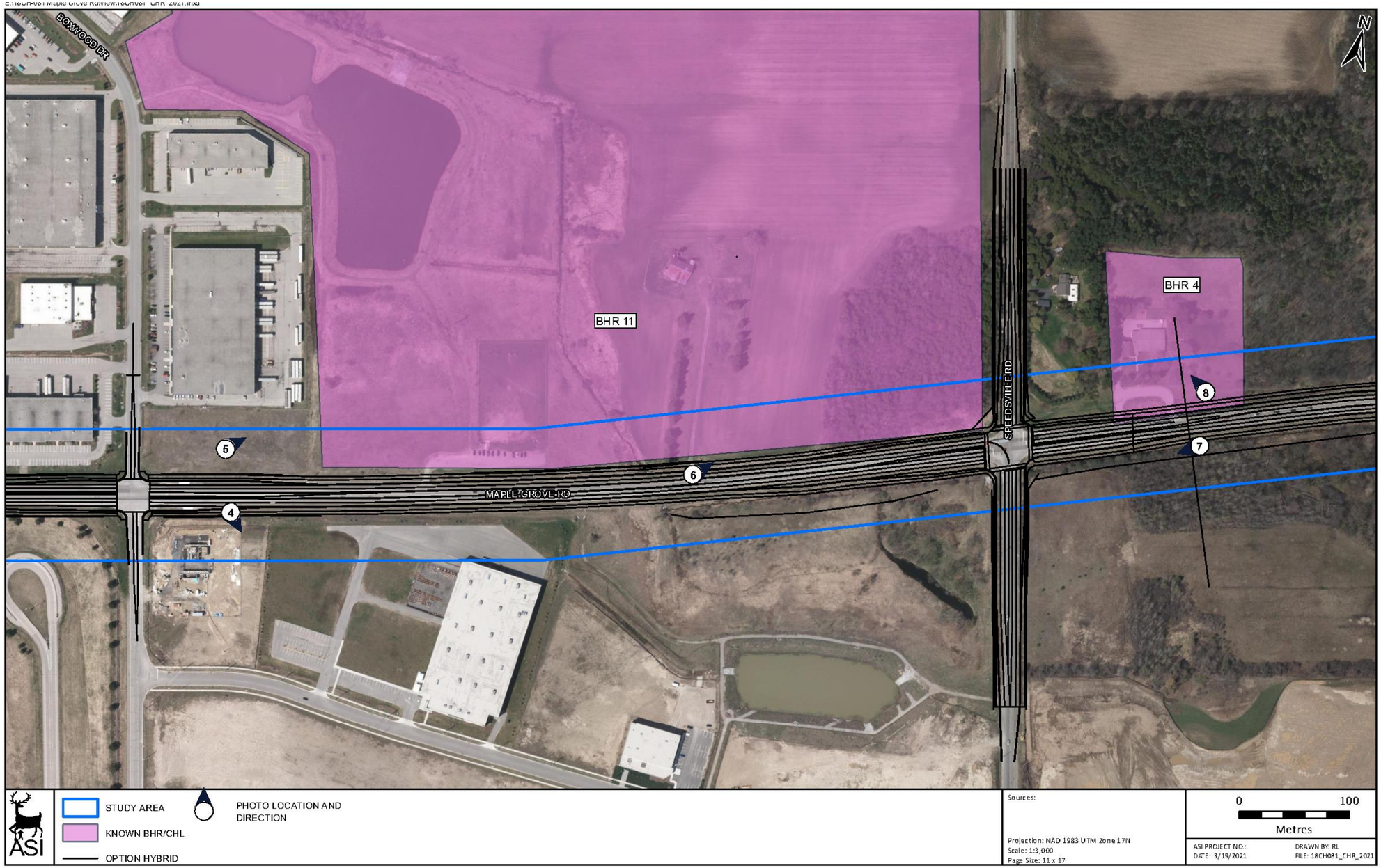


Figure 9: Location of Identified Built Heritage Resources (B.H.R.) and Cultural Heritage Landscapes (C.H.L.) in the Study Area (Sheet 2)

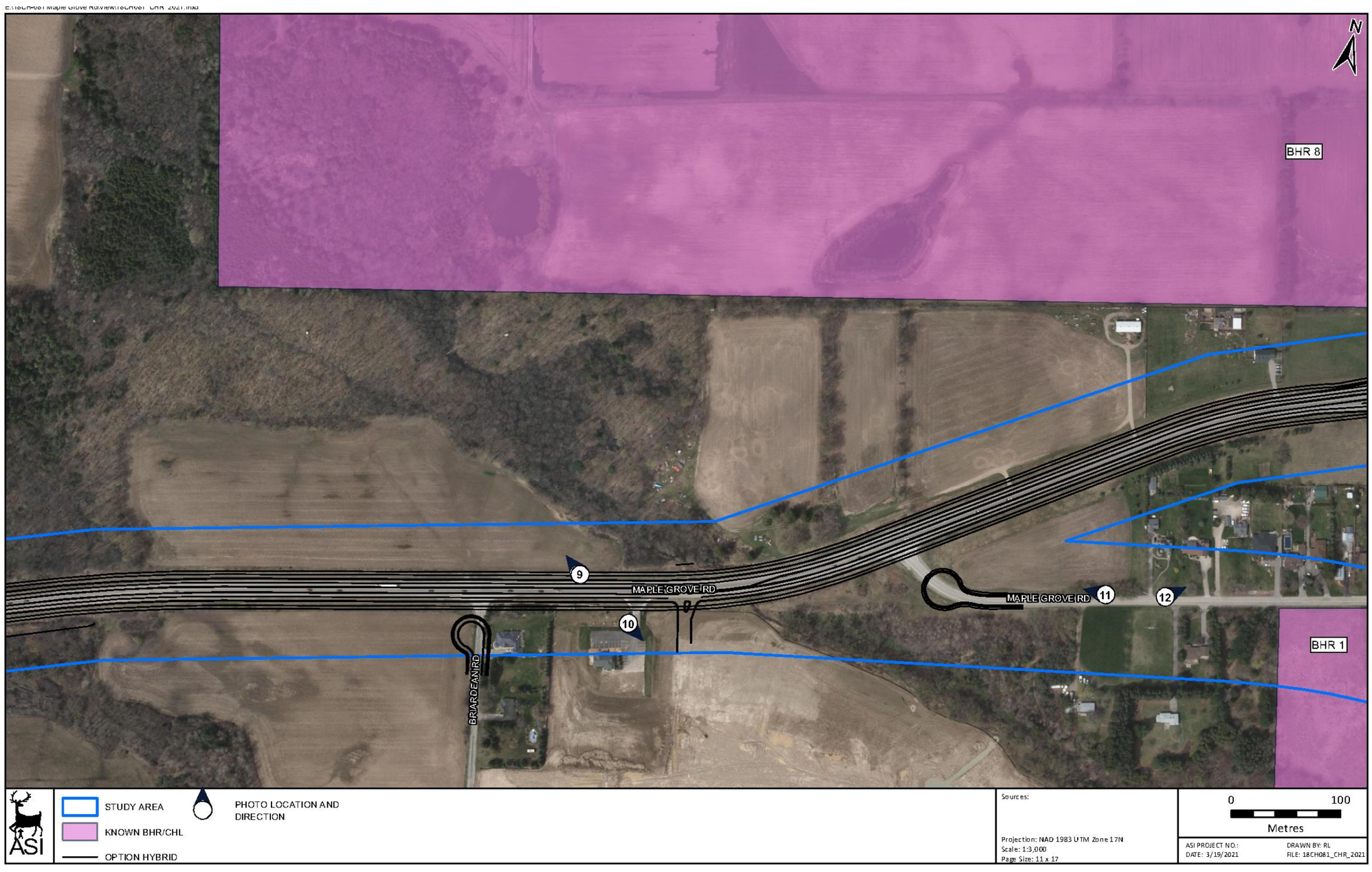


Figure 10: Location of Identified Built Heritage Resources (B.H.R.) and Cultural Heritage Landscapes (C.H.L.) in the Study Area (Sheet 3)

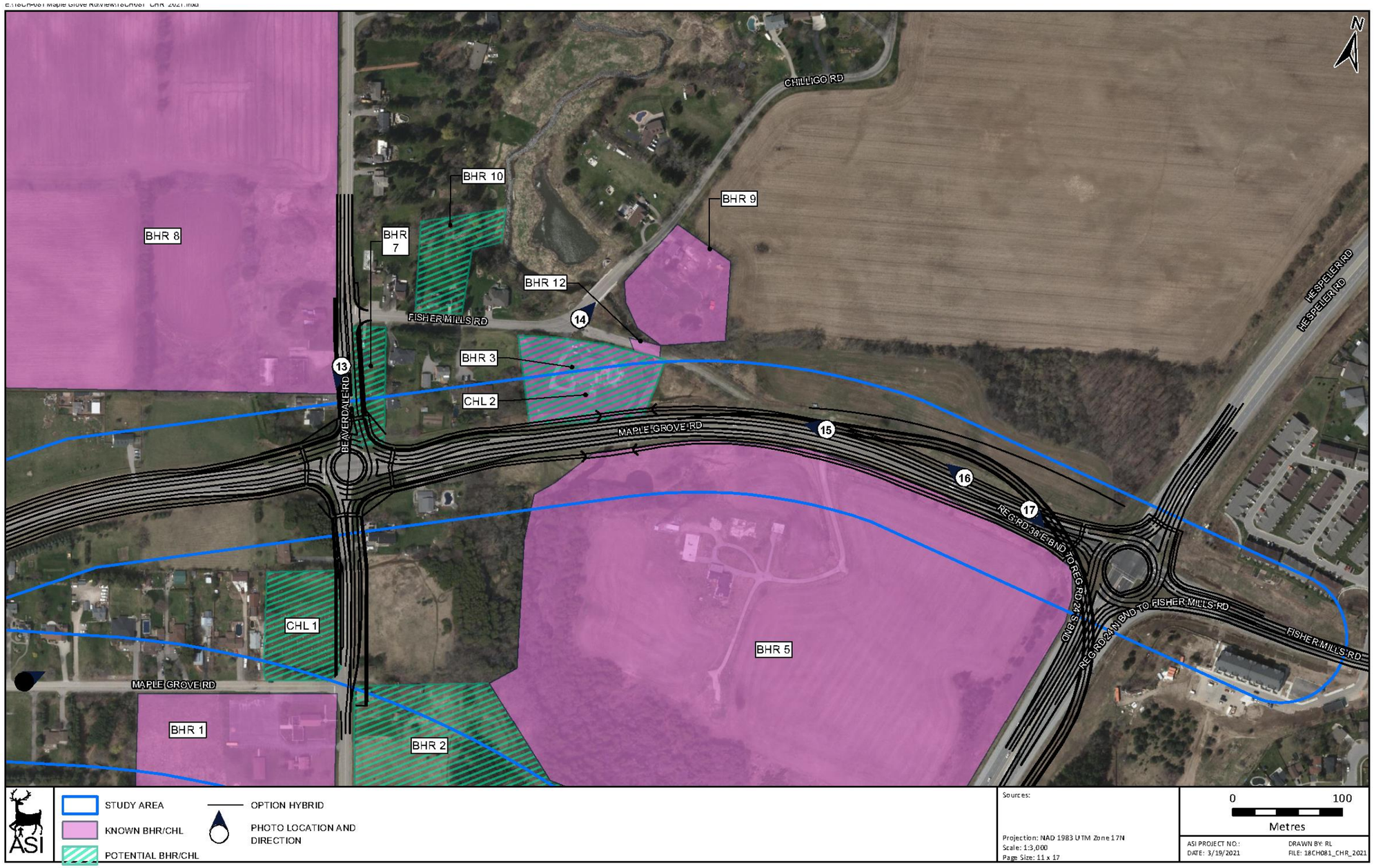


Figure 11: Location of Identified Built Heritage Resources (B.H.R.) and Cultural Heritage Landscapes (C.H.L.) in the Study Area (Sheet 4)

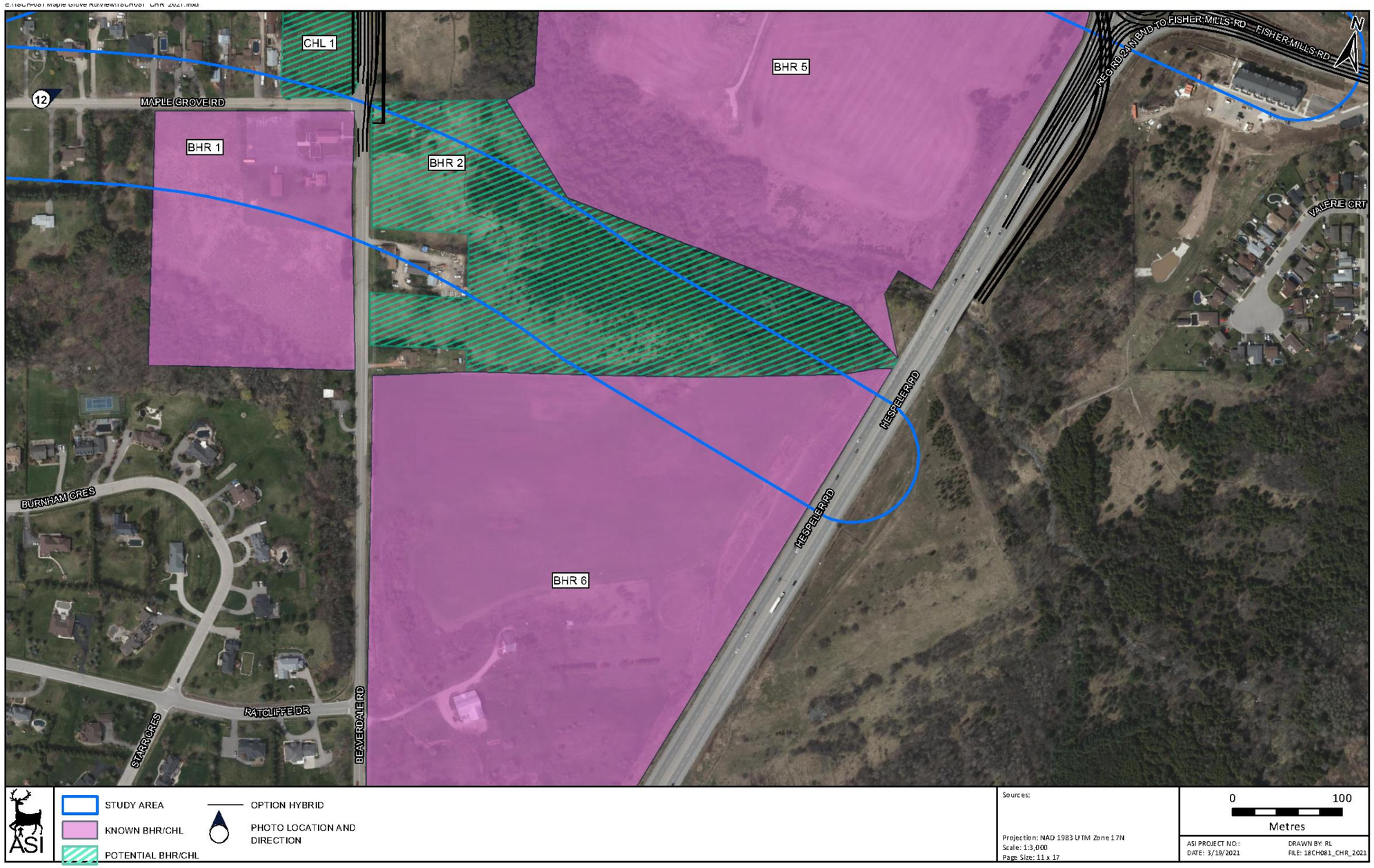


Figure 12: Location of Identified Built Heritage Resources (B.H.R.) and Cultural Heritage Landscapes (C.H.L.) in the Study Area (Sheet 5)

5.0 Preliminary Impact Assessment

The following sections provide more detailed information regarding the proposed project undertaking and analysis of the potential impacts on identified built heritage resources and cultural heritage landscapes.

5.1 Description of Proposed Undertaking

The proposed undertaking for the Maple Grove Road Improvements Municipal Class EA involves road improvements to a section of Maple Grove Road approximately 4.3 kilometers in length from Fountain Street to Hespeler Road, a 500 metre section of Old Maple Grove Road, and an additional 500 metre segment from the eastern limit of Old Maple Grove Road to Hespeler Road. An additional segment of Beaverdale Road between Old Maple Grove Road to approximately 250 m north of Maple Grover Road was also added to the preferred alternative in 2021. The project study area consists of is generally in a rural agricultural and industrial context north of the City of Cambridge.

5.2 Analysis of Potential Impacts

Table 2 outlines the potential impacts on all identified built heritage resources (B.H.R.s) and cultural heritage landscapes (C.H.L.s) within the study area for the preferred alternative.

A draft version of this report with preliminary impact assessment prepared based on the most up-to-date conceptual design drawings was reviewed by IBI Group in August 2021. Following this review, IBI Group confirmed that the conceptual design was preliminary, and that the detailed design for the undertaking would be prepared to ensure that all direct impacts to identified B.H.R.s and C.H.L.s would be avoided (IBI Group email communication, 16 August 2021). As such, the following impact assessment highlights areas where the conceptual design drawings indicate a direct impact, and indicates the required refinement of the project footprint during detailed design in order to avoid these direct impacts. This preliminary impact assessment has been prepared with the understanding that direct impacts will be avoided, as noted by IBI Group.

Table 2: Preliminary Impact Assessment and Recommended Mitigation Measures

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 1	1705-1725 Beaverdale Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	No direct impacts are anticipated as the preferred alternative will be confined to the existing right-of-way (R.O.W.) adjacent to the identified cultural heritage resource. Indirect impacts due to construction-related vibrations are not anticipated as grading limits of the preferred alternative are approximately 40 m from the nearest structure on the property.	Construction should be planned at a distance as far from the cultural heritage resource as possible. If construction is to occur in close proximity to the primary buildings on the property (within 10-15 m), the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.
B.H.R. 2	1720 Beaverdale Road Potential B.H.R./C.H.L. – Identified during field review/desktop research	Direct impacts are anticipated based on a review of the conceptual design drawings. The residence on the subject property would be removed to facilitate sidewalk construction on Beaverdale Road as depicted in Figure 12. Removal of the residence would result in permanent, direct impacts to the identified cultural heritage value of the subject property. IBI Group confirmed that the conceptual design was preliminary, and will be revised during detailed design to prevent direct impacts to the residence at 1720 Beaverdale Road (email communication 16 August 2021). **With suitable revisions to the conceptual design completed during detailed design as noted by IBI Group, no direct impacts are anticipated to B.H.R. 2.** However, as the residence is approximately 5 m from the limits of the existing roadway, impacts from construction-related vibration are possible. As construction is to occur in close proximity to the primary building on the property, the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 2. IBI Group confirmed that the conceptual design will be refined during detailed design with road improvements moved further north and sidewalk construction eliminated in detailed design to avoid all direct impacts to B.H.R. 2. As B.H.R. 2 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific Heritage Impact Assessment (H.I.A.) may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. Heritage planning staff at the City of Cambridge and the Region of Waterloo should be consulted regarding the requirement for a H.I.A. for B.H.R. 2. If the preliminary conceptual design depicted in Figure 12 is revised during detailed design to avoid impacts, as confirmed by IBI Group, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. for B.H.R. 2 in favour of suitable mitigation measures including post-construction rehabilitation. Undertake engineering assessment during detail design to determine potential vibration impacts.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 3	566 Fisher Mills Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	Indirect impacts to B.H.R. 3 are anticipated with significant property encroachment due to grading requirements. No direct impacts to B.H.R. 3 are anticipated as the former mill works and other potential heritage attributes are not anticipated to be directly impacted in the preferred alternatives. However, since the house (former mill) sits approximately 25 m from the limits of the preferred alternative, impacts from construction-related vibration are possible. As construction is to occur in close proximity to the primary buildings on the property, the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 3. Where construction is anticipated to result in grading impacts and tree removal to B.H.R. 3, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. As B.H.R. 3 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the indirect impacts anticipated to B.H.R. 3, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. in this case in favour of suitable mitigation measures including post-construction rehabilitation. Undertake engineering assessment during detail design to determine potential vibration impacts.
B.H.R. 4	1370 Maple Grove Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	Indirect impacts anticipated through property encroachment and grading on the subject property. No direct impacts to B.H.R. 4 are anticipated. The residence is approximately 50 m from the limits of the preferred alternative, and neither it nor other potential heritage attributes are anticipated to be directly or indirectly adversely impacted.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 4. Where construction is anticipated to result in grading impacts to the subject property, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. As B.H.R. 4 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to B.H.R. 4, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. in this case in favour of suitable mitigation measures including post-construction rehabilitation.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 5	4045 Maple Grove Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	Indirect impacts anticipated through property encroachment, grading, and potential tree removal are anticipated. No direct impacts to B.H.R. 5 are anticipated. The residence is approximately 100 m from the limits of the preferred alternative, and neither it nor other potential heritage attributes are anticipated to be directly impacted.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 5. Where construction is anticipated to result in grading impacts and tree removal to B.H.R. 5, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. As B.H.R. 5 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan.However, based on the minor, indirect impacts anticipated to B.H.R. 5, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. in this case in favour of suitable mitigation measures including post-construction rehabilitation.
B.H.R. 6	1380 Beaverdale Road Known B.H.R./C.H.L. - Identified in the *Heritage Barn Inventory* (Region of Waterloo 2017)	No direct or indirect impacts anticipated as the subject property is not adjacent to the preferred alternative.	No further work required.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 7	1900 Beaverdale Road Potential B.H.R./C.H.L. – Identified during field review/desktop research	Direct impacts are anticipated based on a review of the conceptual design drawings. The residence on the subject property would be removed to facilitate sidewalk construction on Beaverdale Road as depicted in Figure 11. Removal of the residence would result in permanent, direct impacts to the identified cultural heritage value of the subject property. IBI Group confirmed that the conceptual design was preliminary, and will be revised during detailed design to prevent direct impacts to the residence at 1900 Beaverdale Road (email communication 16 August 2021). **With suitable revisions to the conceptual design completed during detailed design as noted by IBI Group, no direct impacts are anticipated to B.H.R. 7.** Indirect impacts to B.H.R. 7 are anticipated through property encroachment, grading, and the construction of a roundabout and roadway on the south portion of the property at 1900 Beaverdale Road. As the residence is approximately 6 m from the limits of the existing roadway, impacts from construction-related vibration are possible. As construction is to occur in close proximity to the primary building on the property, the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 7. IBI Group confirmed that the conceptual design will be refined during detailed design with sidewalk construction eliminated in detailed design to avoid all direct impacts to B.H.R. 7. Further, the alignment of Beaverdale Road may be altered in detailed design to reduce indirect impacts to the subject property. As B.H.R. 7 is identified as a potential B.H.R. and there are indirect impacts including significant property encroachment anticipated, a resource-specific H.I.A. is required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. This H.I.A. should be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo. Undertake engineering assessment during detail design to determine potential vibration impacts.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 8	1965 Beaverdale Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	Indirect impacts anticipated through property encroachment, grading, and the construction of a sidewalk. No direct impacts to B.H.R. 8 are anticipated. The residence and other potential heritage attributes are not anticipated to be directly impacted in the preferred alternatives. However, since the house sits very close to the existing road, construction should be planned at a distance as far from the cultural heritage resource as possible. Construction is anticipated to occur in close proximity to the primary buildings on the property (within 10-15m), the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 8. Where construction is anticipated to result in grading impacts B.H.R. 8, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. As B.H.R. 8 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to B.H.R. 8, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. in this case in favour of suitable mitigation measures including post-construction rehabilitation. Undertake engineering assessment during detail design to determine potential vibration impacts.
B.H.R. 9	90 Chilligo Road Known B.H.R./C.H.L. - Identified in the *City of Cambridge Heritage Properties Register*	No direct or indirect impacts anticipated as the subject property is not adjacent to the preferred alternative.	No further work required.
B.H.R. 10	615 Fisher Mills Road Potential B.H.R./C.H.L. – Identified during field review/desktop research	No direct or indirect impacts anticipated as the subject property is not adjacent to the preferred alternative.	No further work required.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
B.H.R. 11	1130 Maple Grove Road Known B.H.R./C.H.L. - Identified in the *Heritage Barn Inventory* (Region of Waterloo 2017)	Indirect impacts anticipated through very minor property encroachment adjacent to R.O.W. and potential tree removal. No direct impacts to B.H.R. 11 are anticipated. The barn is approximately 160 m from the limits of the preferred alternative and is not anticipated to be directly or indirectly impacted.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to B.H.R. 11. Where construction is anticipated to result in grading impacts and tree removal to B.H.R. 11, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. As B.H.R. 11 is identified in the *City of Cambridge Heritage Properties Register*, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to B.H.R. 11, it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for a H.I.A. in this case in favour of suitable mitigation measures including post-construction rehabilitation.
B.H.R. 12	Old Fisher Mills Bridge over Ellis Creek Known B.H.R./C.H.L. - Identified in *Spanning the Generations* (Region of Waterloo 2004)	No direct or indirect impacts anticipated as the subject property is not within or adjacent to the preferred alternative.	No further work required.

Feature I.D.	Location/Name and Recognition	Type and Description of Potential/Anticipated Impact	Mitigation Strategies
C.H.L. 1	2320 Maple Grove Road Potential B.H.R./C.H.L. – Identified during field review/desktop research	Indirect impacts anticipated through-property encroachment and the addition of sidewalk in close proximity to internments. No internments or landscape features are anticipated to be directly impacted in the preferred alternative, however there is potential for unmarked interments or landscape features that are not visible from the R.O.W. to be located within the footprint of the preferred alternative.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to C.H.L. 1. Where construction is anticipated to result in grading impacts to C.H.L. 1, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. Where impacts to C.H.L. 1 are anticipated, a resource-specific H.I.A. should be completed as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. This H.I.A. should be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo.
C.H.L. 2	566 Fisher Mills Road Potential B.H.R./C.H.L. – Identified during field review/desktop research	Indirect impacts to C.H.L. 2 are anticipated with significant property encroachment due to grading requirements. No direct impacts to C.H.L. 2 are anticipated as the former mill works and other potential heritage attributes are not known to be within the footprint of the preferred alternative. However, as visibility of landscape features on the property are obscured from view from the R.O.W. there is potential for unknown landscape features to be located within the footprint of the preferred alternative. However, since the house (former mill) sits approximately 25 m from the limits of the preferred alternative, impacts from construction-related vibration are possible. As construction is to occur in close proximity to the primary buildings on the property, the impacts of the vibrations should be investigated through an engineering assessment and any necessary mitigation measures should be implemented prior to construction.	Where feasible, the preferred alternative should be designed in a manner that avoids all impacts to C.H.L. 2. Where construction is anticipated to result in grading impacts to C.H.L. 2, post-construction landscaping with native species should be employed to mitigate impacts to the heritage value of the resource. Where impacts to C.H.L. 2 are anticipated, a resource-specific H.I.A. should be completed as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. This H.I.A. should be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo. Undertake engineering assessment during detail design to determine potential vibration impacts.

IBI Group confirmed that the conceptual design was preliminary, and will be revised during detailed design to prevent direct impacts to the residences at 1720 Beaverdale Road (B.H.R. 2) and 1900 Beaverdale Road (B.H.R. 7) (email communication 16 August 2021). With suitable revisions to the conceptual design anticipated to be completed during detailed design, no direct impacts are anticipated to B.H.R. 2 or B.H.R. 7[3].

Following these anticipated revisions to the conceptual design, the preferred alternative is anticipated to result in indirect impacts due to property encroachment to nine cultural heritage resources (B.H.R. 1, 3, 4, 5, 7, 8, 11 and C.H.L. 1 and 2), and no impacts to five resources (B.H.R. 2, 6, 9, 10, and 12).

Indirect impacts including encroachment of the R.O.W., grading impacts, and potential tree removals are anticipated to eight known and potential cultural heritage resources including: 1705-1725 Beaverdale Road (B.H.R. 1); 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2); 1370 Maple Grove Road (B.H.R. 4); 4045 Maple Grove Road (B.H.R. 5); 1900 Beaverdale Road (B.H.R. 7); 1965 Beaverdale Road (B.H.R. 8); 1130 Maple Grove Road (B.H.R. 11); and 2320 Maple Grove Road (C.H.L. 1). Where feasible, the preferred alternative should be designed to avoid indirect impacts to these potential cultural heritage resources. Where avoiding property encroachment is determined to be infeasible, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to six of these cultural heritage resources (B.H.R. 1, 3, 4, 5, 8, 11), it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for H.I.A.s in these cases in favour of suitable mitigation measures including post-construction rehabilitation.

[3] If impacts to these properties can not be avoided by revising the project footprint during detailed design, a resource-specific H.I.A. should be completed by a qualified cultural heritage specialist as early as possible in detailed design and submitted to the City of Cambridge and the Region of Waterloo, as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan.

Due to the potential for impacts to landscape features within C.H.L. 1 and 2 and the significant encroachment of the R.O.W. on B.H.R. 7, H.I.A.s should be completed for these properties. These H.I.A.s should be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo.

Where feasible, the preferred alternative should be designed in a manner that avoids grading and removal of trees and landscape elements in all identified cultural heritage resources. Should avoidance of tree removals and grading within B.H.R. 1, 3, 4, 5, 7, 8, 11 and C.H.L. 1 and 2 be determined to be infeasible, post-construction landscaping with historically-sympathetic native tree species should be employed to mitigate impacts to the heritage value of the resource. A qualified arborist or landscape architect should be consulted in this respect

Indirect impact to structures due to vibrations during construction activities may impact B.H.R. 1, B.H.R. 2, B.H.R. 3, B.H.R. 7, B.H.R. 8, and C.H.L. 2 as a result of their location in close proximity to the proposed alignment. To ensure the structures on the properties at 1705-1725 Beaverdale Road (B.H.R. 1), 1725 Beaverdale Road (B.H.R. 2), 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2), 1900 Beaverdale Road (B.H.R. 7), and 1965 Beaverdale Road (B.H.R. 8) are not adversely impacted during construction, a baseline vibration assessment should be undertaken during detailed design. Should this advance assessment conclude that the any structures will be subject to vibrations, a vibration monitoring plan should be prepared and implemented as part of the detailed design phase of the project to lessen vibration impacts related to construction.

6.0 Summary of Community Data Collection

Community consultation will be undertaken as part of the EA project led by IBI Group through Public Information Centres. Additional consultation will be conducted by ASI with municipal heritage staff, the MHSTCI, and any other relevant stakeholder with an interest in the project. This consultation will be conducted by the submission of the Cultural Heritage Report: Existing

Conditions and Preliminary Impact Assessment for review and comment by these groups. At that time, a summary of community data collected will be provided here.

7.0 Results and Mitigation Recommendations

The results of background historical research and a review of secondary source material, including historical mapping, indicate a study area with a rural history dating back to the early nineteenth century. A review of federal, provincial, and municipal registers, inventories, and databases revealed that there are nine known built heritage resources (B.H.R.) within the study area. An additional three potential B.H.R.s and two potential cultural heritage landscapes (C.H.L.) were identified during background research and field review.

7.1 Key Findings

- A total of 12 B.H.R.s and two C.H.L.s were identified within the study area. Of these, nine are known B.H.R.s, and an additional three potential B.H.R.s and two potential C.H.L.s were identified during background research and field review.
- Of the 14 identified built heritage resources and cultural heritage landscapes, six are identified in the *City of Cambridge Heritage Properties Register* (B.H.R.s 1, 3, 4, 5, 8, and 9), two are identified in the *Heritage Barn Inventory* (Region of Waterloo 2017) (B.H.R.s 6 and 11), one is identified in *Spanning the Generations* (Region of Waterloo 2004) (B.H.R. 12), and five were identified during background research and field review (B.H.R.s 2, 7, 10, and C.H.L.s 1 and 2).
- Identified cultural heritage resources are historically, architecturally, and contextually associated with land use patterns in the City of Cambridge and more specifically representative of the rural agricultural settlement of the Town of Hespeler along Maple Grove Road, a nineteenth century rural roadway.

Results of Preliminary Impact Assessment

- The conceptual design presented in this report is anticipated to be revised during detailed design to prevent direct impacts to B.H.R. 2 and B.H.R. 7 (IBI Group email communication, 16 August 2021). No direct impacts to any B.H.R.s or C.H.Ls are anticipated if detailed design is suitably revised.
- The preferred alternative is anticipated to result indirect impacts due to property encroachment to nine cultural heritage resources (B.H.R. 1, 3, 4, 5, 7, 8, 11 and C.H.L. 1 and 2), and no impacts to four resources (B.H.R. 6, 9, 10, and 12).
- Indirect impacts including encroachment of the R.O.W., grading impacts, and potential tree removals are anticipated to nine known and potential cultural heritage resources including: 1705-1725 Beaverdale Road (B.H.R. 1); 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2); 1370 Maple Grove Road (B.H.R. 4); 4045 Maple Grove Road (B.H.R. 5); 1900 Beaverdale Road (B.H.R. 7); 1965 Beaverdale Road (B.H.R. 8); 1130 Maple Grove Road (B.H.R. 11); and 2320 Maple Grove Road (C.H.L. 1).
- Where feasible, the preferred alternative should be designed to avoid direct and indirect impacts to all known and potential cultural heritage resources.
- Where avoiding direct or indirect impacts to known or potential cultural heritage resources is determined to be infeasible, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan.
- Where required, H.I.A.s should be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo.

7.2 Recommendations

Based on the results of the assessment, the following recommendations have been developed:

1. Construction activities and staging should be suitably planned and undertaken to avoid unintended negative impacts to identified built heritage resources (B.H.R.s) and cultural heritage landscapes (C.H.L.s). Avoidance measures may include, but are not limited to: erecting temporary fencing, establishing buffer zones, issuing instructions to construction crews to avoid identified cultural heritage resources, etc.

2. Indirect impacts including encroachment of the right-of-way, grading impacts, and potential tree removals are anticipated to nine known and potential cultural heritage resources including: 1705-1725 Beaverdale Road (B.H.R. 1); 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2); 1370 Maple Grove Road (B.H.R. 4); 4045 Maple Grove Road (B.H.R. 5); 1900 Beaverdale Road (B.H.R. 7); 1965 Beaverdale Road (B.H.R. 8); 1130 Maple Grove Road (B.H.R. 11); and 2320 Maple Grove Road (C.H.L. 1). Where feasible, the preferred alternative should be designed to avoid indirect impacts to these potential cultural heritage resources. Where avoiding property encroachment is determined to be infeasible, a resource-specific H.I.A. may be required as per Section 4.10.1 and 4.10.9 of the City of Cambridge Official Plan and Sections 3.G.13 and 3.G.15 of the Region of Waterloo Official Plan. However, based on the minor, indirect impacts anticipated to six of these cultural heritage resources (B.H.R. 1, 3, 4, 5, 8, 11), it is recommended that the City of Cambridge and Regional Municipality of Waterloo consider waiving the requirement for H.I.A.s in these cases in favour of suitable mitigation measures including post-construction rehabilitation.

3. Due to the potential for impacts to landscape features within C.H.L. 1 and 2 and the significant encroachment of the R.O.W. on B.H.R. 7, H.I.A.s should be completed for these properties. These H.I.A.s should

be completed by a qualified cultural heritage profession as early as possible during detailed design and be developed in consultation with, and submitted to, the M.H.S.T.C.I and heritage planning staff at the City of Cambridge and the Region of Waterloo.

4. Where feasible, the preferred alternative should be designed in a manner that avoids grading and removal of trees and landscape elements in all identified cultural heritage resources. Should avoidance of tree removals and grading within B.H.R. 1, 3, 4, 5, 7, 8, 11 and C.H.L. 1 and 2 be determined to be infeasible, post-construction landscaping with historically-sympathetic native tree species should be employed to mitigate impacts to the heritage value of the resource. A qualified arborist or landscape architect should be consulted in this respect.

5. Indirect impacts to structures in B.H.R. 1, B.H.R. 2, B.H.R. 3, B.H.R. 7, B.H.R. 8, and C.H.L. 2 due to vibrations during construction activities may occur as a result of their location in close proximity to the proposed alignment. To ensure the structures on the properties at 1705-1725 Beaverdale Road (B.H.R. 1), 1725 Beaverdale Road (B.H.R. 2), 566 Fisher Mills Road (B.H.R. 3/ C.H.L. 2), 1900 Beaverdale Road (B.H.R. 7), and 1965 Beaverdale Road (B.H.R. 8) are not adversely impacted during construction, a baseline vibration assessment should be undertaken during detailed design. Should this advance assessment conclude that the any structures will be subject to vibrations, a vibration monitoring plan should be prepared and implemented as part of the detailed design phase of the project to lessen vibration impacts related to construction.

6. Should future work require an expansion of the study area then a qualified heritage consultant should be contacted in order to confirm the impacts of the proposed work on potential heritage resources.

7. This report should be submitted to heritage planning staff at both the City of Cambridge the Region of Waterloo, the Ministry of Heritage,

Sport, Tourism and Culture Industries (M.H.S.T.C.I.); and any other relevant stakeholders that may have an interest in this project for review. The final report should be submitted to the City of Cambridge and Region of Waterloo for their records.

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Appendix O – Stage 1 Archaeological Assessment (ASI)

September 2023

STAGE 1 ARCHAEOLOGICAL ASSESSMENT
MAPLE GROVE ROAD IMPROVEMENTS
FROM FOUNTAIN STREET NORTH TO HESPELER ROAD
PART OF LOTS 19, 20, 29, 30, BEASLEY'S BROKEN FRONT CONCESSION, LOT 11, CONCESSION 1 BEASLEY LOWER BLOCK LOTS 10-12, CONCESSIONS 1-2 BEASLEY LOWER BLOCK (FORMER TOWNSHIP OF WATERLOO, COUNTY OF WATERLOO) CITY OF CAMBRIDGE REGIONAL MUNICIPALITY OF WATERLOO, ONTARIO

ORIGINAL REPORT

Prepared for:

IBI Group
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Archaeological Licence #P450 (Parks)
Ministry of Heritage, Sport, Tourism and Culture Industries PIF# P450-0056-2018
ASI File: 18EA-088

15 February 2022

ASI Providing Archaeological & Cultural Heritage Services
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Stage 1 Archaeological Assessment
Maple Grove Road Improvements
From Fountain Street North to Hespeler Road
Part of Lots 19, 20, 29, 30, Beasley's Broken Front Concession,
Lot 11, Concession 1 Beasley Lower Block
Lots 10-12, Concessions 1-2 Beasley Lower Block
(Former Township of Waterloo, County of Waterloo)
City of Cambridge
Regional Municipality of Waterloo, Ontario

EXECUTIVE SUMMARY

ASI was contracted by IBI Group to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the Maple Grove Road Improvements Project in the City of Cambridge. This project involves the proposed improvements to Maple Grove Road, from Fountain Street to Hespeler Road.

The Stage 1 background study determined that 31 previously registered archaeological sites are located within one kilometre of the Study Area, including the Wanner House site (AiHc-193) which is within the Study Area and has further CHVI. The property inspection determined that parts of the Study Area exhibit archaeological potential and will require Stage 2 assessment, if impacted, prior to any land disturbing activities.

In light of these results, the following recommendations are made:

1. The Study Area exhibits archaeological potential. These lands require Stage 2 archaeological assessment by test pit/pedestrian survey at five metre intervals, where appropriate, if impacted, prior to any land disturbing activities;

2. The Wanner House site (AiHc-193) is within the Study Area and retains CHVI. If impacted by the Maple Grove Road project, the site will require Stage 3 site-specific assessment, in order to more fully identify the character, extent and significance of the archaeological deposits, prior to any proposed development;

    - The Stage 3 assessment should commence with the creation of a recording grid on a fixed datum, the position of which has been recorded using a GPS. A series of one-metre by one-metre units will then be excavated across the entire site area at five metre intervals within an established grid in order to determine the nature and extent of the cultural deposits. An additional 20% of the total number of units excavated on the grid will be strategically excavated at five metre intervals throughout the site, around units of high artifact counts, or in other significant areas of the site. The test units should be excavated five cm into the sterile subsoil and soil fills screened through six mm wire mesh to facilitate artifact recovery. The sterile subsoil should be troweled and all soil profiles examined for undisturbed cultural deposits.

3. The Study Area includes parts of the Wanner Cemetery. There is potential for unmarked burials in the ROW lands directly adjacent to the cemetery boundary due to the lack of clarity about its historical limits. A Stage 3 Cemetery Investigation is required around the present cemetery property boundaries, prior to any proposed impacts, to confirm the presence of absence of unmarked graves in this area:

    a. All cemetery lands must be avoided by the project designs;

    b. If available, mapping depicting the legal boundaries of the cemetery should be obtained from the licensed operator for the Wanner Cemetery prior to any proposed project impacts adjacent to the cemetery to help further determine to what extent, if any, this work might impact the legal boundaries of the cemetery;

    c. If the determination is made that the legal boundaries of the cemetery may be impacted or if the determination is made that there is potential for burials to be located outside the known limits of the cemetery, a Cemetery Investigation Authorization will be required from the Bereavement Authority of Ontario. Prior to the Stage 2 and 3 Archaeological Assessments, consultation with the Bereavement Authority of Ontario is required;

    d. Prior to conducting any Stage 3 investigations in the vicinity of Wanner Cemetery, a Stage 2 test pit survey at five metre intervals should be conducted within the areas of impact to locate any near surface finds;

    e. The Stage 3 cemetery investigation entails the mechanical removal of topsoil where possible within a minimum of 10 metres of the cemetery, under the supervision of a licensed archaeologist. Mechanical topsoil removal (MTR) will begin away from the cemetery boundaries, moving towards the cemetery fence line to confirm the outer limits and reduce impacts to unmarked burials. The exposed subsoil will then be shovel-shined and thoroughly examined for the presence of burial shafts;

    f. If any burials are documented during the course of the Stage 2 or Stage 3 Investigation, the police or coroner and the Registrar of Burial Sites at the Ministry of Government and Consumer Services must be contacted as per the *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act,* 2002.

4. The remainder of the Study Area does not retain archaeological potential on account of deep and extensive land disturbance, low and wet conditions, slopes in excess of 20 degrees or being subject to previous archaeological assessment. These lands do not require further archaeological assessment; and,

5. Should the proposed work extend beyond the current Study Area, further archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

PROJECT PERSONNEL

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1.0 PROJECT CONTEXT

Archaeological Services Inc. (ASI) was contracted by IBI Group to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the Maple Grove Road Improvements in the City of Cambridge (Figure 1). This project involves the proposed improvements to Maple Grove Road, from Fountain Street to Hespeler Road.

All activities carried out during this assessment were completed in accordance with the *Ontario Heritage Act* (1990, as amended in 2018) and the 2011 *Standards and Guidelines for Consultant Archaeologists* (S & G), administered by the Ministry of Heritage, Sport, Tourism and Culture Industries (MHSTCI 2011).

1.1 Development Context

All work has been undertaken as required by the *Environmental Assessment Act*, RSO (Ministry of the Environment 1990 as amended 2010) and regulations made under the Act, and are therefore subject to all associated legislation. This project is being conducted in accordance with the Municipal Engineers' Association document *Municipal Class Environmental Assessment* (2000 as amended in 2007, 2011 and 2015).

Authorization to carry out the activities necessary for the completion of the Stage 1 archaeological assessment was granted by IBI Group on October 18, 2018.

1.2 Historical Context

The purpose of this section, according to the S & G, Section 7.5.7, Standard 1, is to describe the past and present land use and the settlement history and any other relevant historical information pertaining to the Study Area. A summary is first presented of the current understanding of the Indigenous land use of the Study Area. This is then followed by a review of the historical Euro-Canadian settlement history.

1.2.1 Indigenous Land Use and Settlement

Southern Ontario has been occupied by human populations since the retreat of the Laurentide glacier approximately 13,000 years before present (BP) (Ferris 2013). Populations at this time would have been highly mobile, inhabiting a boreal-parkland similar to the modern sub-arctic. By approximately 10,000 BP, the environment had progressively warmed (Edwards and Fritz 1988) and populations now occupied less extensive territories (Ellis and Deller 1990).

Between approximately 10,000-5,500 BP, the Great Lakes basins experienced low-water levels, and many sites which would have been located on those former shorelines are now submerged. This period produces the earliest evidence of heavy wood working tools, an indication of greater investment of labour in felling trees for fuel, to build shelter, and watercraft production. These activities suggest prolonged seasonal residency at occupation sites. Polished stone and native copper implements were being produced by approximately 8,000 BP; the latter was acquired from the north shore of Lake Superior, evidence of extensive exchange networks throughout the Great Lakes region. The earliest evidence for cemeteries dates to approximately 4,500-3,000 BP and is indicative of increased social organization, investment of

labour into social infrastructure, and the establishment of socially prescribed territories (Ellis et al. 1990; Ellis et al. 2009; Brown 1995:13).

Between 3,000-2,500 BP, populations continued to practice residential mobility and to harvest seasonally available resources, including spawning fish. The Woodland period begins around 2500 BP and exchange and interaction networks broaden at this time (Spence et al. 1990:136, 138) and by approximately 2,000 BP, evidence exists for macro-band camps, focusing on the seasonal harvesting of resources (Spence et al. 1990:155, 164). By 1500 BP there is macro botanical evidence for maize in southern Ontario, and it is thought that maize only supplemented people's diet. There is earlier phytolithic evidence for maize in central New York State by 2300 BP - it is likely that once similar analyses are conducted on Ontario ceramic vessels of the same period, the same evidence will be found (Birch and Williamson 2013:13–15). Bands likely retreated to interior camps during the winter. It is generally understood that these populations were Algonquian-speakers during these millennia of settlement and land use.

From the beginning of the Late Woodland period at approximately 1,000 BP, lifeways became more similar to that described in early historical documents. Between approximately 1000-1300 Common Era (CE), the communal site is replaced by the village focused on horticulture. Seasonal disintegration of the community for the exploitation of a wider territory and more varied resource base was still practised (Williamson 1990:317). By 1300-1450 CE, this episodic community disintegration was no longer practised and populations now communally occupied sites throughout the year (Dodd et al. 1990:343). From 1450-1649 CE this process continued with the coalescence of these small villages into larger communities (Birch and Williamson 2013). Through this process, the socio-political organization of the First Nations, as described historically by the French and English explorers who first visited southern Ontario, was developed. By 1600 CE, the communities within Simcoe County had formed the Confederation of Nations encountered by the first European explorers and missionaries. In the 1640s, the traditional enmity between the Haudenosaunee[1] and the Huron-Wendat (and their Algonkian allies such as the Nippissing and Odawa) led to the dispersal of the Huron-Wendat.

Samuel de Champlain in 1615 reported that a group of Iroquoian-speaking people situated between the Haudenosaunee and the Huron-Wendat were at peace and remained "la nation neutre". In subsequent years, the French visited and traded among the Neutral, but the first documented visit was not until 1626, when the Recollet missionary Joseph de la Roche Daillon recorded his visit to the villages of the Attiwandaron, whose name in the Huron-Wendat language meant "those who speak a slightly different tongue" (the Neutral apparently referred to the Huron-Wendat by the same term). Like the Huron-Wendat, Petun, and Haudenosaunee, the Neutral people were settled village agriculturalists. Several discrete settlement clusters have been identified in the lower Grand River, Fairchild-Big Creek, Upper Twenty Mile Creek, Spencer-Bronte Creek drainages, Milton, Grimsby, Eastern Niagara Escarpment and Onondaga Escarpment areas, which are attributed to Iroquoian populations. These settlement clusters are believed by some scholars to have been inhabited by populations of the Neutral Nation or pre- (or ancestral) Neutral Nation (Lennox and Fitzgerald 1990).

Between 1647 and 1651, the Neutral were decimated by epidemics and ultimately dispersed by the Haudenosaunee, who subsequently settled along strategic trade routes on the north shore of Lake Ontario for a brief period during the mid seventeenth-century. Compared to settlements of the Haudenosaunee, the

[1] The Haudenosaunee are also known as the New York Iroquois or Five Nations Iroquois and after 1722 Six Nations Iroquois. They were a confederation of five distinct but related Iroquoian–speaking groups – the Seneca, Onondaga, Cayuga, Oneida, and Mohawk. Each lived in individual territories in what is now known as the Finger Lakes district of Upper New York. In 1722 the Tuscarora joined the confederacy.

"Iroquois du Nord" occupation of the landscape was less intensive. Only seven villages are identified by the early historic cartographers on the north shore, and they are documented as considerably smaller than those in New York State. The populations were agriculturalists, growing maize, pumpkins, and squash. These settlements also played the important alternate role of serving as stopovers and bases for Haudenosaunee travelling to the north shore for the annual beaver hunt (Konrad 1974).

Shortly after dispersal of the Wendat and their Algonquian allies, Ojibwa began to expand into southern Ontario and Michigan from a "homeland" along the east shore of Georgian Bay, west along the north shore of Lake Huron, and along the northeast shore of Lake Superior and onto the Upper Peninsula of Michigan (Rogers 1978:760–762). This history was constructed by Rogers using both Anishinaabek oral tradition and the European documentary record, and notes that it included Chippewa, Ojibwa, Mississauga, and Saulteaux or "Southeastern Ojibwa" groups. Ojibwa, likely Odawa, were first encountered by Samuel de Champlain in 1615 along the eastern shores of Georgian Bay. Etienne Brule later encountered other groups and by 1641, Jesuits had journeyed to Sault Sainte Marie (Thwaites 1896:11:279) and opened the Mission of Saint Peter in 1648 for the occupants of Manitoulin Island and the northeast shore of Lake Huron. The Jesuits reported that these Algonquian peoples lived "solely by hunting and fishing and roam as far as the "Northern sea" to trade for " Furs and Beavers, which are found there in abundance" (Thwaites 1896-1901, 33:67), and "all of these Tribes are nomads, and have no fixed residence, except at certain seasons of the year, when fish are plentiful, and this compels them to remain on the spot" (Thwaites 1896-1901, 33:153). Algonquian-speaking groups were historically documented wintering with the Huron-Wendat, some who abandoned their country on the shores of the St. Lawrence because of attacks from the Haudenosaunee (Thwaites 1896-1901, 27:37).

Other Algonquian groups were recorded along the northern and eastern shores and islands of Lake Huron and Georgian Bay - the "Ouasouarini" [Chippewa], the "Outchougai" [Outchougai], the "Atchiligouan" [Achiligouan] near the mouth of the French River and north of Manitoulin Island the "Amikouai, or the nation of the Beaver" [Amikwa; Algonquian] and the "Oumisagai" [Missisauga; Chippewa] (Thwaites 1896-1901, 18:229, 231). At the end of the summer 1670, Father Louys André began his mission work among the Mississagué, who were located on the banks of a river that empties into Lake Huron approximately 30 leagues from the Sault (Thwaites 1896-1901, 55:133-155).

After the Huron had been dispersed, the Haudenosaunee began to exert pressure on Ojibwa within their homeland to the north. While their numbers had been reduced through warfare, starvation, and European diseases, the coalescence of various Anishinaabek groups led to enhanced social and political strength (Thwaites 1896-1901, 52:133) and Sault Sainte Marie was a focal point for people who inhabited adjacent areas both to the east and to the northwest as well as for the Saulteaux, who considered it their home (Thwaites 1896-1901, 54:129-131). The Haudenosaunee established a series of settlements at strategic locations along the trade routes inland from the north shore of Lake Ontario. From east to west, these villages consisted of Ganneious, on Napanee Bay, an arm of the Bay of Quinte; Quinte, near the isthmus of the Quinte Peninsula; Ganaraske, at the mouth of the Ganaraska River; Quintio, at the mouth of the Trent River on the north shore of Rice Lake; Ganatsekwyagon (or Ganestiquiagon), near the mouth of the Rouge River; Teyaiagon, near the mouth of the Humber River; and Quinaouatoua, on the portage between the western end of Lake Ontario and the Grand River (Konrad 1981:135). Their locations near the mouths of the Humber and Rouge Rivers, two branches of the Toronto Carrying Place, strategically linked these settlements with the upper Great Lakes through Lake Simcoe. The inhabitants of these villages were agriculturalists, growing maize, pumpkins and squash, but their central roles were that of portage starting points and trading centres for Iroquois travel to the upper Great Lakes for the annual beaver hunt (Konrad 1974; Williamson et al. 2008:50–52). Ganatsekwyagon, Teyaiagon, and Quinaouatoua were primarily Seneca; Ganaraske, Quinte and Quintio were likely Cayuga, and Ganneious was Oneida, but judging from

accounts of Teyaiagon, all of the villages might have contained peoples from a number of the Iroquois constituencies (ASI 2013).

During the 1690s, some Ojibwa began moving south into extreme southern Ontario and soon replaced, the Haudenosaunee by force. By the first decade of the eighteenth century, the Michi Saagiig Nishnaabeg (Mississauga Nishnaabeg) had settled at the mouth of the Humber, near Fort Frontenac at the east end of Lake Ontario and the Niagara region and within decades were well established throughout southern Ontario. In 1736, the French estimated there were 60 men at Lake Saint Clair and 150 among small settlements at Quinte, the head of Lake Ontario, the Humber River, and Matchedash (Rogers 1978:761). This history is based almost entirely on oral tradition provided by Anishinaabek elders such as George Copway (Kahgegagahbowh), a Mississauga born in 1818 near Rice Lake who followed a traditional lifestyle until his family converted to Christianity (MacLeod 1992:197; Smith 2000). According to Copway, the objectives of campaigns against the Haudenosaunee were to create a safe trade route between the French and the Ojibwa, to regain the land abandoned by the Huron-Wendat. While various editions of Copway's book have these battles occurring in the mid-seventeenth century, common to all is a statement that the battles occurred around 40 years after the dispersal of the Huron-Wendat (Copway 1850:88; Copway 1851:91; Copway 1858:91). Various scholars agree with this timeline ranging from 1687, in conjunction with Denonville's attack on Seneca villages (Johnson 1986:48; Schmalz 1991:21–22) to around the mid- to late-1690s leading up to the Great Peace of 1701 (Schmalz 1977:7; Bowman 1975:20; Smith 1975:215; Tanner 1987:33; Von Gernet 2002:7–8).

Robert Paudash's 1904 account of Mississauga origins also relies on oral history, in this case from his father, who died at the age of 75 in 1893 and was the last hereditary chief of the Mississauga at Rice Lake. His account in turn came from his father Cheneebeesh, who died in 1869 at the age of 104 and was the last sachem or Head Chief of all the Mississaugas. He also relates a story of origin on the north shore of Lake Huron (Paudash 1905:7-8) and later, after the dispersal of the Huron-Wendat, carrying out coordinated attacks against the Haudenosaunee. Francis Assikinack, an Ojibwa of Manitoulin Island born in 1824, provides similar details on battles with the Haudenosaunee (Assikinack 1858:308–309).

Peace was achieved between the Haudenosaunee and the Anishinaabek Nations in August of 1701 when representatives of more than twenty Anishinaabek Nations assembled in Montreal to participate in peace negotiations (Johnston 2004:10). During these negotiations captives were exchanged and the Iroquois and Anishinaabek agreed to live together in peace. Peace between these nations was confirmed again at council held at Lake Superior when the Iroquois delivered a wampum belt to the Anishinaabek Nations.

From the beginning of the eighteenth century to the assertion of British sovereignty in 1763, there is no interruption to Anishinaabek control and use of southern Ontario. While hunting in the territory was shared, and subject to the permission of the various nations for access to their lands, its occupation was by Anishinaabek until the assertion of British sovereignty, the British thereafter negotiating treaties with them. Eventually, with British sovereignty, tribal designations changed (Smith 1975:221–222; Surtees 1985:20–21). According to Rogers (1978), by the twentieth century, the Department of Indian Affairs had divided the "Anishinaubag" into three different tribes, despite the fact that by the early eighteenth century, this large Algonquian-speaking group, who shared the same cultural background, "stretched over a thousand miles from the St. Lawrence River to the Lake of the Woods." With British land purchases and treaties, the bands at Beausoleil Island, Cape Croker, Christian Island, Georgina and Snake Islands, Rama, Sarnia, Saugeen, the Thames, and Walpole, became known as "Chippewa" while the bands at Alderville, New Credit, Mud Lake, Rice Lake, and Scugog, became known as "Mississauga." The northern groups on Lakes Huron and Superior, who signed the Robinson Treaty in 1850, appeared and remained as "Ojibbewas" in historical documents.

In 1763, following the fall of Quebec, New France was transferred to British control at the Treaty of Paris. The British government began to pursue major land purchases throughout Ontario in the early nineteenth century, and entered into negotiations with various Nations for additional tracts of land as the need arose to facilitate European settlement.

During the American Revolution, Mississauga warriors supported the English military. Rebel forces destroyed the villages of the Six Nations Iroquois in New York and many people were forced to move to the Niagara area. When Six Nations Iroquois leaders learned that the English planned to make a peace treaty with the Americans and establish a boundary line that would give away their homelands they were angry. The English government offered to protect Six Nations Iroquois peoples and give them land within their boundaries. On August 8, 1783, Lord North instructed Governor Haldimand to set apart land for the Six Nations Iroquois and ensure that they carried on their hunting and fur trading with the British. On May 22, 1784, a tract of land along the Grand River was purchased by the British government from the Mississaugas who lived in the vicinity (Johnston 1964; Lytwyn 2005). The land set apart is called the Haldimand Tract. Joseph Brant led Haudenosaunee loyalists (1600 people) to the Haldimand tract in 1784 and in the fall of 1784, Sir Frederick Haldimand formally awarded the tract to the Mohawks "and others of the Six Nations [Iroquois]." They were authorized to "Settle upon the Banks of the River" and were allotted "for that Purpose six miles [10 km] deep from each Side of [it] beginning at Lake Erie, & extending in the Proportion to [its] Head." The precise boundaries of the grant were unclear as there was no survey; for example, the northern boundary of the original deed from the Mississaugas to the Crown stated that the line extended "from the creek that falls from a small lake into…the bay known by the name of Waghquata [Burlington Bay]…until it strikes the river La Tranche [Thames]." The 1790 survey by Augustus Jones intentionally failed to include the headwaters of the Grand, an action made all the more difficult to address given the unclear description of the extent in the original deeds (Johnston 1964; Lytwyn 2005).

Brant regarded the territory as his own to manage on behalf of the Confederacy and interpreted the proclamation as tantamount to full national recognition of the Mohawks and fellow tribesmen. This interpretation was strongly denied by the British (Johnston 1964; Lytwyn 2005). Appointed as Lieutenant Governor of the new colony of Upper Canada in 1791, Simcoe refused to permit the Six Nations Iroquois to sell/lease any part of their reserve because they were arranged independently of the Crown. Brant, on the other hand, argued for the Six Nations Iroquois' need for an immediate assured income from land sales as they could no longer hope to survive by hunting exclusively. Simcoe thought that if such practices were permitted, it could lead to other Europeans attempting to seize control by any means of the better part of the Six Nations Iroquois' reserve and it was therefore unresolved as to whether Six Nations Iroquois people could dispose of their lands directly to whomever they chose (Johnston 1964; Lytwyn 2005).

In the first few years, Brant, who had been described, by some, as a Europeanized entrepreneur, took the initiative and invited white friends and acquaintances to the tract and provided them with rough land titles. Over the next 25 years (1784-1810), a considerable number of Europeans and Americans obtained similar leases authorizing them (in Brant's opinion) to occupy and improve lots overlooking the river (Johnston 1964; Lytwyn 2005).

The subsequent Peter Russel administration (1797-1798), however, recognized the leases and the sales that Brant arranged with white settlers along the Grand River Valley. Trustees were appointed to act on the behalf of the Six Nations Iroquois with the authority to receive payment of purchases. On the other hand, some Six Nations Iroquois thought that the land sale practices violated the ancient principle that land was not a "commodity which could be conveyed." Two Mohawk sachems even tried to take up arms

to depose Brant because they did not agree with his ways. Their efforts were for naught and they returned to the Bay of Quinte where other Six Nation Iroquois peoples, led by Sachem John Deseronto, had settled after the American Revolution (Johnston 1964; Lytwyn 2005).

A formal investigation of the matter was launched in 1812 although leases were not set aside. Due to problems of white encroachment including squatters without titles, settlers who bought land from individuals or through other transactions with Six Nations Iroquois, many of the leases were confirmed by the Crown in 1834-5. Unauthorized sales and agreements remained rampant (Johnston 1964; Lytwyn 2005).

In 1841, Samuel P. Jarvis (Indian Superintendent) informed the Six Nations Iroquois that the only way to keep white intruders off their land would be for them to surrender it to the Crown, to be administered for their sole benefit. With this plan, the Six Nations Iroquois would retain lands that they actually occupied and a reserve of approximately 8,094 ha. The surrender of land was made by the Confederacy in January, 1841 (Johnston 1964; Lytwyn 2005).

Today, this history and those surrenders are still contested and there are numerous specific land claims that have been filed by the Six Nations Iroquois with the federal government in regard to lands within the Haldimand Tract (Johnston 1964; Lytwyn 2005).

The eighteenth century saw the ethnogenesis in Ontario of the Métis, when Métis people began to identify as a separate group, rather than as extensions of their typically maternal First Nations and paternal European ancestry (Métis National Council n.d.). Métis populations were predominantly located north and west of Lake Superior, however, communities were located throughout Ontario (MNC n.d.; Stone and Chaput 1978:607,608). During the early nineteenth century, many Métis families moved towards locales around southern Lake Huron and Georgian Bay, including Kincardine, Owen Sound, Penetanguishene, and Parry Sound (MNC n.d.). Recent decisions by the Supreme Court of Canada (Supreme Court of Canada 2003; Supreme Court of Canada 2016) have reaffirmed that Métis people have full rights as one of the Indigenous people of Canada under subsection 91(24) of the Constitution Act, 1867.

1.2.2 Euro-Canadian Land Use: Township Survey and Settlement

Historically, the Study Area is located in the Former Township of Waterloo, County of Waterloo in part of Lots 19, 20, 29, 30, Beasley's Broken Front Concession (BBFC); Lot 11, Concession 1 Beasley Lower Block (BLB); and Lots 10-12, Concessions 1-2 BLB.

The S & G stipulates that areas of early Euro-Canadian settlement (pioneer homesteads, isolated cabins, farmstead complexes), early wharf or dock complexes, pioneer churches, and early cemeteries are considered to have archaeological potential. Early historical transportation routes (trails, passes, roads, railways, portage routes), properties listed on a municipal register or designated under the *Ontario Heritage Act* or a federal, provincial, or municipal historic landmark or site are also considered to have archaeological potential.

For the Euro-Canadian period, the majority of early nineteenth century farmsteads (i.e., those that are arguably the most potentially significant resources and whose locations are rarely recorded on nineteenth century maps) are likely to be located in proximity to water. The development of the network of concession roads and railroads through the course of the nineteenth century frequently influenced the

siting of farmsteads and businesses. Accordingly, undisturbed lands within 100 m of an early settlement road are also considered to have potential for the presence of Euro-Canadian archaeological sites.

The first Europeans to arrive in the area were transient merchants and traders from France and England, who followed Indigenous pathways and set up trading posts at strategic locations along the well-traveled river routes. All of these occupations occurred at sites that afforded both natural landfalls and convenient access, by means of the various waterways and overland trails, into the hinterlands. Early transportation routes followed existing Indigenous trails, both along the lakeshore and adjacent to various creeks and rivers (ASI 2006).

Township of Waterloo

The historic Township of Waterloo was originally known as Block Two of the Grand River land grant which was deeded to the Six Nations Iroquois by the British in 1784 for their loyalty to the Crown in the American War of Independence. In 1796, Block Two, a 38,045 ha tract, was acquired by Richard Beasley from Joseph Brant on behalf of the Six Nations. He subdivided and sold the land, with an approximately 24,281 ha tract of land going to the German Company of Pennsylvania, in November 1803 (Janusas 1988:2). Company members included Samuel and John Bricker; and Daniel, Jacob, and John Erb. The German Company of Pennsylvania had the lands surveyed by Augustus Jones to subdivide the land into 128 farm lots of approximately 181 ha each and 32 farm lots of approximately 34 ha each (Janusas 1988:96).

When Block Two was incorporated into the District of Gore (County of Halton) in 1816, it was named Waterloo Township, in honour of the battle that ended the Napoleonic Wars in Europe. It remained part of Halton County in the District of Gore until 1842 and then part of the District of Wellington. The County of Waterloo did not come into being until 1852 (Janusas 1988: 2).

The first immigrants to settle in Waterloo Township were almost exclusively German Mennonites from Pennsylvania, who had originally emigrated from Switzerland, Germany and France. Most of these settlers were farmers but many were tradesmen and millers. Later settlers were generally of Scottish, English, Irish, and continental German heritage, many of them farmers, but a majority of them were artisans and tradesmen. When the railway was laid through Waterloo Township in the mid-nineteenth century, it became the leading industrial center of Waterloo County (Janusas 1988: 10-12).

Abraham Erb purchased approximately 181 ha of land in 1805 and became the first settler in the City of Waterloo. He transferred a portion of his land and ownership of two mills to Jacob Snider in 1829. Snider's son inherited approximately 129 ha which he sold to John Hoffman and Isaac Weber, who sectioned and sold the lands in 1854, at which point the population of Waterloo began to expand (Janusas 1988: 102).

In the mid-1850s, the defining development of Waterloo Township and Waterloo County was the construction of the railway. The first railway line built into the township was a main line of the Grand Trunk Railway from Toronto, laid through in 1856. A number of other railway lines were soon laid across the township including: a Grand Trunk branch between Preston and Berlin in 1857; a Great Western line from Galt, Preston, and Guelph in 1857; a Grand Trunk branch between Berlin (Kitchener) and Galt in 1882; and a Grand Trunk Branch between Waterloo and Elmira in 1891.

Town of Hespeler

In 1798, over 90,000 acres known as Block 2 was sold by the Six Nations from the Haldimand Tract Treaty to settler Richard Beasley and his partners, who shortly afterwards parcelled it off to Mennonite farmers from Pennsylvania, including Abraham Clemens and Cornelius Pannabecker, said to be the first blacksmith in the area. In 1830 Joseph Oberholtzer purchased a large tract from Clemens and deeded a parcel to his sister Susanna and her husband Michael Bergey – they are considered Hespeler's first residents. The settlement that grew around their farm was first called Bergeytown and later New Hope, until after Jacob Hespeler settled there in 1845, purchasing 145 acres to encourage industrial development on the Speed River. The Village of Hespeler incorporated in 1859. The Great Western Railway was built through the village and encouraged further growth. By 1901 Hespeler was incorporated as a town and was known for its industrial strength, including factories such as Dominion Woollens and Worsteds Ltd., one of the largest textile producers in the country. In 1973 the Town of Hespeler was amalgamated with Galt and Preston into the City of Cambridge (City of Cambridge 2018).

Wanner Mennonite Church and Cemetery

The Wanner Cemetery is located at 2320 Maple Grove Road. Early church services were held starting around 1800 in a union meetinghouse on lands donated by Samuel Bechtel. In 1837, the Mennonite community around the junction of Maple Grove Road and Beaverdale Road built a small white brick church on the southwest corner of the intersection, on land donated by Henry Wanner Jr. (Wanner Mennonite Church 2018). The present brick building was constructed in 1938 replacing the old church and is identified on the municipal heritage register. The 1861 and 1881 historical maps show the cemetery/graveyard on the northwest corner of the intersection (Tremaine 1861; Parsell & Co. 1881). The first burial in the cemetery was a child of the Wanner family in 1814 (CanadaGenWeb's Cemetery Project 2018). In 1864 the land was transferred to the Trustees for the Mennonite Society, and the cemetery remains under operation by the Wanner Mennonite Cemetery Board of Trustees as an active cemetery. A map of the legal boundaries is provided in Appendix A, as provided by the Regional Municipality of Waterloo's Property department.

Maple Grove Public School

The earliest mention of the extant school at 1370 Maple Grove Road was in 1848 when land was sold by Henry and Hannah Wanner to the Wellington District Council. The land was later sold back to the original owner in 1859 and it was re-sold back to the Council. The Maple Grove Public School, S.S. #20 Waterloo Township, was built in 1850 as a one storey stone structure and was expanded in 1875. The expansion was built by senior boys (16-18 years old). The original front entrance was replaced with a central window before 1889. More recently, in 1989 the school was used as a staff training centre and is now currently a child care centre (Region of Waterloo 2018; City of Cambridge 2015).

1.2.3 Historical Map Review

The 1861 *Map of the County of Waterloo* and the 1881 *Illustrated Atlas of the County of Waterloo*, Township of Waterloo Page were examined to determine the presence of historic features within the Study Area during the nineteenth century (Figures 2-3).

It should be noted, however, that not all features of interest were mapped systematically in the Ontario series of historical atlases, given that they were financed by subscription, and subscribers were given

preference with regard to the level of detail provided on the maps. Moreover, not every feature of interest would have been within the scope of the atlases.

In addition, the use of historical map sources to reconstruct/predict the location of former features within the modern landscape generally proceeds by using common reference points between the various sources. These sources are then geo-referenced in order to provide the most accurate determination of the location of any property on historic mapping sources. The results of such exercises are often imprecise or even contradictory, as there are numerous potential sources of error inherent in such a process, including the vagaries of map production (both past and present), the need to resolve differences of scale and resolution, and distortions introduced by reproduction of the sources. To a large degree, the significance of such margins of error is dependent on the size of the feature one is attempting to plot, the constancy of reference points, the distances between them, and the consistency with which both they and the target feature are depicted on the period mapping.

Table 1: Nineteenth-century property owner(s) and historical features(s) within or adjacent to the Study Area

		1861 Tremaine Map		*1881 Illustrated Historical Atlas*	
Lot #	**Con #**	**Property Owner(s)**	**Historical Feature(s)**	**Property Owner(s)**	**Historical Feature(s)**
19	BBFC	Calvin Claftin	None	Hugh Turnbull	None
20		J. Cook	None	None Identified	None
29		West ½: Jacob Kinsel East ½: Jos. Witmer	Road	None Identified	Road
30		Levi Snyder	Road	Levi Snyder	Road
11	1 BLB	John W. Martin	Schoolhouse No. 20 Menonist [sic] Church Road	John W. Martin	Schoolhouse Church Road
12		Peter Idington	None	Walter Idington	Structure Road
10	2 BLB	Wm. E. Ellis	Road	Wm. Ellis	Road
11		Northwest 1/3: Fisher Northeast 2/3: Thos. Stewart South ½: T. Aikens	Road Residence Grist Mill Road		Grist Mill Road
12		Jacob Bretz	None		Blacksmith Road

The nineteenth-century maps illustrate that Maple Grove Road, Old Maple Grove Road, Fountain Street North, Speedsville Road, Beaverdale Road, Fisher Mills Road, and Chilligo Road were historically surveyed roadways. Nine structures are shown within or directly adjacent to the Study Area, including the School House No. 20 near the northeast corner of Maple Grove Road and Speedsville Road, a grist mill south of Fisher Mills Road, and the Mennonite church and cemetery at Maple Grove Road and Beaverdale Road. In addition to these structures, there is also a blacksmith shop located north of Fisher Mills Road. The Study Area is depicted in a rural agricultural context throughout the nineteenth century.

Middle Creek, East Creek, Ellis Creek, and a pond north of Fisher Mills Road are illustrated on both maps.

1.2.4 Twentieth-Century Mapping Review

The 1916 National Topographic System *Galt Sheet*, the 1955 aerial photograph of Cambridge, the 1968 National Topographic System *Cambridge-Preston/Kitchener-Breslau Sheets*, and the 1998 National Topographic System *Cambridge Sheet* were examined to determine the extent and nature of development and land uses within the Study Area (Figures 4-7).

The 1916 topographic map (Figure 4) indicates Briardene Road had been constructed. Maple Grove Road is shown to be carried over three creeks as well as the bridge along Fisher Mills Road. The 1955 photograph (Figure 5) shows the Study Area relatively unchanged into the mid-twentieth century surrounded by an agricultural landscape, with a cluster of residences near Maple Rove Road and Beaverdale Road, and along Fisher Mills Road. The 1968 map demonstrates additional residential development around Maple Grove Road, Fisher Mills Road, and Beaverdale Road. The 1998 map illustrates the small hamlet of Fisher Mills with a dam on the north side of the Study Area. Maple Grove Road and Hespeler Road are shown in their present alignments. Old Maple Grove Road is now shown.

1.3 Archaeological Context

This section provides background research pertaining to previous archaeological fieldwork conducted within and in the vicinity of the Study Area, its environmental characteristics (including drainage, soils or surficial geology and topography, etc.), and current land use and field conditions. Three sources of information were consulted to provide information about previous archaeological research: the site record forms for registered sites available online from the MTCS through "Ontario's Past Portal"; published and unpublished documentary sources; and the files of ASI.

1.3.1 Current Land Use and Field Conditions

A review of available Google satellite imagery shows development within the western part of the Study Area between Vondrau Drive and Speedsville Road in 2005-2006. In 2006, the imagery shows topsoil stripping and construction of the residential subdivision at Fisher Mills and Hespeler Roads, as well as the construction of the house at 915 Briardean Road. In 2016, the model home at what is now Compass Trail was constructed, and topsoil stripping and grading is shown.

A Stage 1 property inspection was conducted on November 28, 2018 that noted the Study Area is approximately 4.3 kilometres along Maple Grove Road between just east of Fountain Street North and Hespeler Road, with a southern branch that is approximately half a kilometer in length along Old Maple Grove Road and continues another half a kilometer southeast to Hespeler Road. The Maple Grove Road right-of-way (ROW) lacks curbs and sidewalks and has gravel shoulders and ditches on both sides. Maple Grove Road is oriented in a southwest-northeast alignment and features mostly two lanes of southwest and northeast-bound vehicular traffic. Most of the land beyond the Maple Grove Road ROW is within a rural agricultural context. The western portion of the Study Area between Fountain Street North and Streetsville Road is within an industrial-commercial setting, including the Loblaw – Maple Grove Distribution Center and Toyota Motor Manufacturing on the south. East of Speedsville Road also contains nineteenth-century farmsteads and twentieth century houses with a modern residential

subdivision constructed east of Hespeler Road. The southern edge of the Wanner Cemetery is within the Study Area. The Study Area southern arm passes through the Wanner Mennonite Church, which is surrounded by a heavily landscaped yard and parking lot. Between Beaverdale Road and Hespeler Road the Study Area slopes heavily through a wooded area into a large wetland area and tributary

1.3.2 Geography

In addition to the known archaeological sites, the state of the natural environment is a helpful indicator of archaeological potential. Accordingly, a description of the physiography and soils are briefly discussed for the Study Area.

The S & G stipulates that primary water sources (lakes, rivers, streams, creeks, etc.), secondary water sources (intermittent streams and creeks, springs, marshes, swamps, etc.), ancient water sources (glacial lake shorelines indicated by the presence of raised sand or gravel beach ridges, relic river or stream channels indicated by clear dip or swale in the topography, shorelines of drained lakes or marshes, cobble beaches, etc.), as well as accessible or inaccessible shorelines (high bluffs, swamp or marsh fields by the edge of a lake, sandbars stretching into marsh, etc.) are characteristics that indicate archaeological potential.

Water has been identified as the major determinant of site selection and the presence of potable water is the single most important resource necessary for any extended human occupation or settlement. Since water sources have remained relatively stable in Ontario since 5,000 BP (Karrow and Warner 1990:Figure 2.16), proximity to water can be regarded as a useful index for the evaluation of archaeological site potential. Indeed, distance from water has been one of the most commonly used variables for predictive modeling of site location.

Other geographic characteristics that can indicate archaeological potential include: elevated topography (eskers, drumlins, large knolls, and plateaux), pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground, distinctive land formations that might have been special or spiritual places, such as waterfalls, rock outcrops, caverns, mounds, and promontories and their bases. There may be physical indicators of their use, such as burials, structures, offerings, rock paintings or carvings. Resource areas, including; food or medicinal plants (migratory routes, spawning areas) are also considered characteristics that indicate archaeological potential (S & G, Section 1.3.1).

The Study Area is located on drumlinized till plains and spillways within the Guelph Drumlin Field physiographic region, which occupies roughly 830 square kilometres. Within the Guelph Drumlin Field, there are approximately 300 drumlins of varying sizes. For the most part these hills are of the broad oval type with slopes less steep than those of the Peterborough drumlins and are not as closely grouped as those in some other areas. The till in these drumlins is loamy and calcareous, and was derived mostly from dolostone of the Amabel Formation which can be found exposed below the Niagara Escarpment (Chapman and Putnam 1984:137–139). Spillways are former glacial meltwater channels. They are often found in association with moraines but in opposition are entrenched rather than elevated landforms. They are often, though not always, occupied by stream courses, the fact of which raises the debate of their glacial origin. Spillways are typically broad troughs floored wholly or in part by gravel beds and are typically vegetated by cedar swamps in the lowest beds (Chapman and Putnam 1984:15).

Figure 8 depicts surficial geology for the Study Area. The surficial geology mapping demonstrates that the Study Area is underlain by sandy glaciofluvial river deposits and delta topset facies; stone-poor, sandy

silt to silty sand-textured till on Paleozoic terrain; ice-contact stratified deposits of sand and gravel; and modern alluvial deposits (Ontario Geological Survey 2010). Soils within the Study Area consist of some well-drained soils including Freeport sandy loam, Guelph loam, Lisbon sandy loam; soils with imperfect drainage Tuscola and Floradale loam; poorly drained Hespeler sandy loam; and soils formed on organic deposits such as muck and peat with very poor drainage (Presant and Wicklund 1971). Soil drainage is illustrated in Figure 9.

The Study Area crosses West Creek, Middle Creek, Hunsperger Drain, East Creek, Chilligo (or Ellis) Creek – all tributaries of the Speed River, which flows through old spillway through its entire length and as a watercourse is representative of the late Pleistocene/early Holocene geography of southern Ontario (City of Cambridge 2016). The Speed River is unexpectedly shallow as it is partly floored by bedrock (Chapman and Putnam 1984: 98). It is a major tributary of the Grand River, which drains an area of approximately 673,397 hectares.

The Grand River main stream begins northeast of Dundalk at 526 m above sea level and flows for approximately 290 km to Lake Erie at Port Maitland (Chapman and Putnam 1984:95). The Grand River was an important transportation route and a critical resource extraction area for generations of Indigenous people. Historically, the Grand River has been utilized as a navigable waterway, as a power source (such power sites served as settlement nuclei), and above Brantford as a course for driving logs (Chapman and Putnam 1984:98).

1.3.3 Previous Archaeological Research

In Ontario, information concerning archaeological sites is stored in the Ontario Archaeological Sites Database (OASD) maintained by the MTCS. This database contains archaeological sites registered within the Borden system. Under the Borden system, Canada has been divided into grid blocks based on latitude and longitude. A Borden block is approximately 13 km east to west, and approximately 18.5 km north to south. Each Borden block is referenced by a four-letter designator, and sites within a block are numbered sequentially as they are found. The Study Area under review is located in Borden block *AiHc* and *AiHb*.

According to the OASD, 31 previously registered archaeological sites are located within one kilometre of the Study Area (MHSTCI 2018). A summary of the sites is provided below.

Table 2: List of previously registered sites within one kilometre of the Study Area

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AiHb-10	Ellis Kiln Complex	Euro-Canadian	Kiln	Lennox 1980
AiHb-11	Beaver	Middle Archaic; Late Woodland	Camp	Lennox 1980
AiHb-169	Fisher Mills Rd.	Indigenous Pre-Contact	Unknown	ARA 1986
AiHb-170	*Deadman*	*Indigenous Pre-Contact*	*Camp*	*ARA 1986*
AiHb-330	n/a	Indigenous Pre-Contact	Hunting	Grimes 2016
AiHb-350	Maple Grove 1	Euro-Canadian	Refuse deposit	ARA 2014
AiHc-30	Toyota	Late Archaic	Camp	Fox 1986; MHC
AiHc-73	Bertrand Russell	Late Archaic	Camp	MPP 1988

Borden #	Site Name	Cultural Affiliation	Site Type	Researcher
AiHc-74	Arriscraft Cambridge 2	Indigenous Pre-Contact	Findspot	MPP 1988
AiHc-75	Henry Morgentaler	Indigenous Pre-Contact	Scatter	MPP 1988
AiHc-78	Arriscraft Cambridge 6	Indigenous Pre-Contact	Scatter	MPP 1988
AiHc-133	*Briardean*	*Middle Woodland*	*Findspot*	*ARA 1986*
AiHc-134	*Maple Grove*	*Indigenous Pre-Contact*	*Camp*	*ARA 1986*
AiHc-135	Toyota	Euro-Canadian	House	ARA 1986
AiHc-136	Erle	Euro-Canadian	House	ARA 1986
AiHc-137	Kurucz	Indigenous Pre-Contact	Camp	ARA 1986
AIHc-193	**Wanner House**	**Euro-Canadian**	**House**	**ARA 1986**
AiHc-211	West Briardean 1	Indigenous Pre-Contact	Scatter	ASI 1998
AiHc-212	West Briardean 2	Indigenous Pre-Contact	Findspot	ASI 1998
AiHc-213	*Speedsville Road*	*Indigenous Pre-Contact*	*Findspot*	*ASI 1998*
AiHc-214	East Briardean	Indigenous Pre-Contact	Findspot	ASI 1998
AiHc-220	Riddel	Archaic	Camp	Grimes 1998
AiHc-376	n/a	Indigenous Pre-Contact	Findspot	NDA 2008
AiHc-377	n/a	Indigenous Pre-Contact	Scatter	NDA 2008
AiHc-378	Boxwood I	Indigenous Pre-Contact	Unknown	Stantec 2008
AiHc-379	Boxwood 9	Early Archaic; Indigenous Pre-Contact	Unknown	Stantec 2008
AiHc-380	Boxwood 12	Indigenous Pre-Contact	Unknown	Stantec 2008
AiHc-381	Boxwood 17	Indigenous Pre-Contact	Unknown	Stantec 2008
AiHc-385	Boxwood 23	Paleo-Indian	Unknown	Stantec 2008
AiHc-386	Boxwood 2	Euro-Canadian	Homestead	Stantec 2008
AiHc-449	Location 3	Indigenous Pre-Contact	Scatter	Golder 2011

Sites in **bold** are within the Study Area
Sites in *italics* are within 50m of the Study Area
ARA – Archaeological Research Associates Ltd.
MHC – Mayer Heritage Consultants Inc.
MPP – Mayer, Pihl, Poulton & Assoc. Inc.
NDA – New Directions Archaeology Ltd.

According to the OASD AiHb-170, AiHc-133, AiHc-134, and AiHc-213 are within 50 metres of the Study Area. All represent small lithic scatters or isolated finds with no diagnostic material and were not considered to have sufficient Cultural Heritage Value or Interest (CHVI) to require further assessment, therefore no further work was recommended on these sites.

The Wanner House site (AiHc-193) is within the Study Area. It was identified by ARA (1993) during an archaeological assessment of the Wanner House within an area approximately 20 metres by 60 m in size. The site was found in the location of the former Wanner homestead on Maple Grove Road. It was a one-

and-a-half storey Georgian brick house identified as a heritage resource in 1991 but at the time was not considered structurally significant enough to preserve and was to be demolished due to road realignments. Henry Wanner settled on the lot in 1810, with a grant from Richard Beasley. He then granted the property to his son Henry Junior in 1815 who's family lived there until 1860. After 1874 it was owned by a series of families until the 1960s when it was purchased by the Ontario government and the residences were leased to tenants. There was a farm complex of two barns and several outbuildings until the 1970s when most of the structures were demolished. The earliest structure was the stone outbuilding built circa 1827 where the Wanner family lived until a large wooden house was built circa 1832 (the date was carved on a beam found in the cellar during the 1970 demolition). In 1854 a brick house was attached to the wooden house from the summer kitchen. Approximately 1900 artifacts were recovered during the test excavations. The site was considered to represent an early to mid-nineteenth century, domestic occupation. A portion of the site was impacted by the demolition of the 1860 brick house. The remainder of the 1830s Wanner House site is extant and has been protected. ARA made recommendations for archaeological monitoring during demolition of the brick house. The former locations of the wooden house, stone building, well, and privies were recommended for monitoring and protection during demolition, and if they are to be impacted by future work, that additional archaeological assessment should be conducted.

According to the background research, four previous reports detail fieldwork within 50 m of the Study Area.

ASI (1998) conducted a Stage 2 archaeological assessment associated with an aggregate pit license application which included two parcels of land, one of which overlaps the current Study Area fronting Maple Grove Road at Briardean Road comprising approximately 11.4 hectares. The parcel was subject to pedestrian survey at five metre intervals and visual confirmation of low and wet lands. AiHc-214 was identified, consisting of a fragment of a non-diagnostic broad projectile point blade which was beyond 50 metres from the current Study Area. A 30 metre radius around the find was intensified at two metre intervals and the property was cleared of archaeological concern.

ASI (2008) conducted a Stage 1 archaeological assessment of approximately three hectares located at the southeast corner of the intersection of Hespeler Road and Fisher Mills Road, including parts of the current Study Area. The property inspection determined that the subject lands had been subject to minimal disturbance due to the construction of the adjacent road and subdivision, however, the majority of the subject lands have archaeological potential and were recommended for Stage 2 survey prior to any land-disturbing activities.

ASI (2009) conducted a Stage 1 archaeological assessment as part of the Maple Grove Road Design and Construction from Cherry Blossom Road to Hespeler Road within the current Study Area. Six previously registered sites were identified immediately adjacent to the study corridor, but none required further investigation. Based on the results of the property inspection, it was determined that the Maple Grove Road ROW has been subject to extensive and deep land alterations. Portions of the study corridor can also be characterized as being low and wet or having excessive slope. However, minimal disturbances have occurred beyond the disturbed ROW.

ASI (2015) conducted a Stage 1 archaeological assessment as part of the Fountain Street MCEA, including parts of the current Study Area. The property inspection identified that much of the study corridor was documented to have deep and extensive land disturbance due to recent deeply buried utility installation, modern ROW construction, and grading and property development. Some sections of the Fountain Street study corridor contained areas that exhibit archaeological potential and require Stage 2 survey prior to any land-disturbing activities.

2.0 FIELD METHODS: PROPERTY INSPECTION

A Stage 1 property inspection must adhere to the S & G, Section 1.2, Standards 1-6, which are discussed below. The entire property and its periphery must be inspected. The inspection may be either systematic or random. Coverage must be sufficient to identify the presence or absence of any features of archaeological potential. The inspection must be conducted when weather conditions permit good visibility of land features. Natural landforms and watercourses are to be confirmed if previously identified. Additional features such as elevated topography, relic water channels, glacial shorelines, well-drained soils within heavy soils and slightly elevated areas within low and wet areas should be identified and documented, if present. Features affecting assessment strategies should be identified and documented such as woodlots, bogs or other permanently wet areas, areas of steeper grade than indicated on topographic mapping, areas of overgrown vegetation, areas of heavy soil, and recent land disturbance such as grading, fill deposits and vegetation clearing. The inspection should also identify and document structures and built features that will affect assessment strategies, such as heritage structures or landscapes, cairns, monuments or plaques, and cemeteries.

The Stage 1 archaeological assessment property inspection was conducted under the field direction of Peter Carruthers (P163) of ASI, on November 28, 2018, in order to gain first-hand knowledge of the geography, topography, and current conditions and to evaluate and map archaeological potential of the Study Area. It was a visual inspection only and did not include excavation or collection of archaeological resources. Fieldwork was only conducted when weather conditions were deemed suitable and seasonally appropriate, per S & G Section 1.2., Standard 2. Previously identified features of archaeological potential were examined; additional features of archaeological potential not visible on mapping were identified and documented as well as any features that will affect assessment strategies. Field observations are compiled onto the existing conditions of the Study Area in Section 7.0 (Figures 10-13) and associated photographic plates are presented in Section 8.0 (Plates 1-28).

3.0 ANALYSIS AND CONCLUSIONS

The historical and archaeological contexts have been analyzed to help determine the archaeological potential of the Study Area. These data are presented below in Section 3.1. Results of the analysis of the Study Area property inspection are presented in Section 3.2.

3.1 Analysis of Archaeological Potential

The S & G, Section 1.3.1, lists criteria that are indicative of archaeological potential. The Study Area meets the following criteria indicative of archaeological potential:

- Previously identified archaeological sites (see Table 2);
- Water sources: primary, secondary, or past water source (Speed River tributaries: West Creek, Middle Creek, Hunsperger Drain, East Creek, Chilligo Creek,);
- Early historic transportation routes (Maple Grove Rd, Fountain St, Speedsville Rd, Beaverdale Rd, Chilligo Rd);
- Proximity to early settlements (farmsteads, School House No. 10, church, cemetery); and
- Well-drained soils (Freeport sandy loam, Guelph loam, Lisbon sandy loam)

According to the S & G, Section 1.4 Standard 1e, no areas within a property containing locations listed or designated by a municipality can be recommended for exemption from further assessment unless the area can be documented as disturbed. The Municipal Heritage Register was consulted and eight properties within the Study Area are Listed or Designated under the Ontario Heritage Act:

- 1705 Beaverdale Road: Church c. 1837
- 566 Fisher Mills Road: Chilligo Mill – Feed Store, Landmark Series
- 1370 Maple Grove Road: Maple Grove Public School School Section (S.S.) No.20 c.1850
- 4045 Maple Grove Road: farmhouse, demolished

These criteria are indicative of potential for the identification of Indigenous and Euro-Canadian archaeological resources, depending on soil conditions and the degree to which soils have been subject to deep disturbance.

3.2 Analysis of Property Inspection Results

The property inspection determined that parts of the Study Area exhibit archaeological potential (Figures 11-13: areas highlighted in green and orange). These areas will require Stage 2 archaeological assessment, if impacted, prior to any land disturbing activities. According the S & G Section 2.1.1, pedestrian survey is required in actively or recently cultivated fields (eg. Plates 9, 10, 15, 18, 20, 26). According to the S & G Section 2.1.2, test pit survey is required on terrain where ploughing is not viable, such as wooded areas, properties where existing landscaping or infrastructure would be damaged, overgrown farmland with heavy brush or rocky pasture, and narrow linear corridors up to 10 metres wide (eg. Plates 9, 11-13, 17-20, 23-25).

The Wanner House site (AiHc-193) is within the Study Area and considered to retain further Cultural Heritage Value or Interest. The site will require Stage 3 archaeological assessment following Section 3 of the S & G, if impacted, prior to any land disturbing activities (see *Supplementary Documentation for detailed site location information*). Given the length of time since the original Stage 2 assessment, it is not yet evident that the level of CHVI will be sufficient to lead to a recommendation for Stage 4, thus the excavation should follow the strategy provided for these types of sites in S & G Table 3.1.

Part of the Wanner Cemetery property is within the Study Area. All cemetery lands should be avoided by the project designs (Figure 13: areas outlined in navy blue). If available, mapping illustrating the legal boundaries of the cemetery should be obtained to determine to what extent any proposed work will impact the boundaries of the cemetery. A Stage 3 Cemetery Investigation will be required where possible on any lands impacted by the project designs within 10 metres of the cemetery property to confirm the presence or absence of unmarked graves (Figures 13: areas highlighted in purple). A Stage 2 test-pit survey at five metre intervals should be conducted within the areas of impact to locate any near-surface finds, prior to the Stage 3 cemetery investigation (Figure 13: areas highlighted in purple). The Stage 3 entails the careful mechanical removal of topsoil where possible, within a 10 metre buffer around the cemetery property limits, under the supervision of a licensed archaeologist. Any exposed subsoil will be shovel-shined by hand and thoroughly examined for the presence of burial shafts. In the event that unmarked grave shafts or cultural features are uncovered during the Stage 3 mechanical topsoil removal should continue 10 metres beyond such features.

Parts of the Study Area have been previously assessed (ASI 1998, 2008, 2009, 2015, 2016) and do not require further archaeological assessment (Figures 11-13: areas highlighted in light red). Some of the

lands within the Study Area are sloped in excess of 20 degrees (Grand River Conservation Authority 2018), and according to the S & G Section 2.1 do not retain potential (Figure 13: areas highlighted in pink). Parts of the Study Area are located in low and wet conditions, and according to the S & G Section 2.1 does not retain potential (Plate 14, 16, 25; Figures 11-13: areas highlighted in blue). The remainder of the Study Area has been subjected to deep soil disturbance events and according to the S & G Section 1.3.2 do not retain archaeological potential (Plates 1-8, 11, 12, 18-21, 24, 25, 27, 28; Figures 11-13: areas highlighted in yellow). These areas do not require further survey.

3.3 Conclusions

The Stage 1 background study determined that 31 previously registered archaeological sites are located within one kilometre of the Study Area, including the Wanner House site (AiHc-193) which is within the Study Area and has further CHVI. The property inspection determined that parts of the Study Area exhibit archaeological potential and will require Stage 2 assessment, if impacted, prior to any land disturbing activities.

4.0 RECOMMENDATIONS

In light of these results, the following recommendations are made:

1. The Study Area exhibits archaeological potential. These lands require Stage 2 archaeological assessment by test pit/pedestrian survey at five metre intervals, where appropriate, if impacted, prior to any land disturbing activities;

2. The Wanner House site (AiHc-193) is within the Study Area and is considered to have further CHVI. If impacted by the Maple Grove Road project, the site will require Stage 3 site-specific assessment following Section 3 of the S & Gs for historical sites in order to more fully identify the character, extent and significance of the archaeological deposits, prior to any proposed development;

    - The Stage 3 assessment should commence with the creation of a recording grid on a fixed datum, the position of which has been recorded using a GPS. A series of one-metre by one-metre units will then be excavated across the entire site area at five metre intervals within an established grid in order to determine the nature and extent of the cultural deposits. An additional 20% of the total number of units excavated on the grid will be strategically excavated at five metre intervals throughout the site, around units of high artifact counts, or in other significant areas of the site. The test units should be excavated five cm into the sterile subsoil and soil fills screened through six mm wire mesh to facilitate artifact recovery. The sterile subsoil should be troweled and all soil profiles examined for undisturbed cultural deposits.

1. The Study Area includes parts of the Wanner Cemetery. There is potential for unmarked burials in the ROW lands directly adjacent to the cemetery boundary due to the lack of clarity about its historical limits. A Stage 3 Cemetery Investigation is required around the present cemetery property boundaries, prior to any proposed impacts, to confirm the presence of absence of unmarked graves in this area:

a) All cemetery lands must be avoided by the project designs;

b) If available, mapping depicting the legal boundaries of the cemetery should be obtained from the licensed operator for the Wanner Cemetery prior to any proposed project impacts adjacent to the cemetery to help further determine to what extent, if any, this work might impact the legal boundaries of the cemetery;

c) If the determination is made that the legal boundaries of the cemetery may be impacted or if the determination is made that there is potential for burials to be located outside the known limits of the cemetery, a Cemetery Investigation Authorization will be required from the Bereavement Authority of Ontario. Prior to the Stage 2 and 3 Archaeological Assessments, consultation with the Bereavement Authority of Ontario is required;

d) Prior to conducting any Stage 3 investigations in the vicinity of Wanner Cemetery, a Stage 2 test pit survey at five metre intervals should be conducted within the areas of impact to locate any near surface finds;

e) The Stage 3 cemetery investigation entails the mechanical removal of topsoil where possible within a minimum of 10 metres of the cemetery, under the supervision of a licensed archaeologist. Mechanical topsoil removal (MTR) will begin away from the cemetery boundaries, moving towards the cemetery fence line to confirm the outer limits and reduce impacts to unmarked burials. The exposed subsoil will then be shovel-shined and thoroughly examined for the presence of burial shafts;

f) If any burials are documented during the course of the Stage 2 or Stage 3 Investigation, the police or coroner and the Registrar of Burial Sites at the Ministry of Government and Consumer Services must be contacted as per the *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002.

2. The remainder of the Study Area does not retain archaeological potential on account of deep and extensive land disturbance, low and wet conditions, slopes in excess of 20 degrees or being subject to previous archaeological assessment. These lands do not require further archaeological assessment; and,

3. Should the proposed work extend beyond the current Study Area, further archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

NOTWITHSTANDING the results and recommendations presented in this study, ASI notes that no archaeological assessment, no matter how thorough or carefully completed, can necessarily predict, account for, or identify every form of isolated or deeply buried archaeological deposit. In the event that archaeological remains are found during subsequent construction activities, the consultant archaeologist, approval authority, and the Cultural Programs Unit of the MTCS should be immediately notified.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

ASI also advises compliance with the following legislation:

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

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

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

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

- Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48(1) of the Ontario Heritage Act and may not be altered, nor may artifacts be removed from them, except by a person holding an archaeological license.

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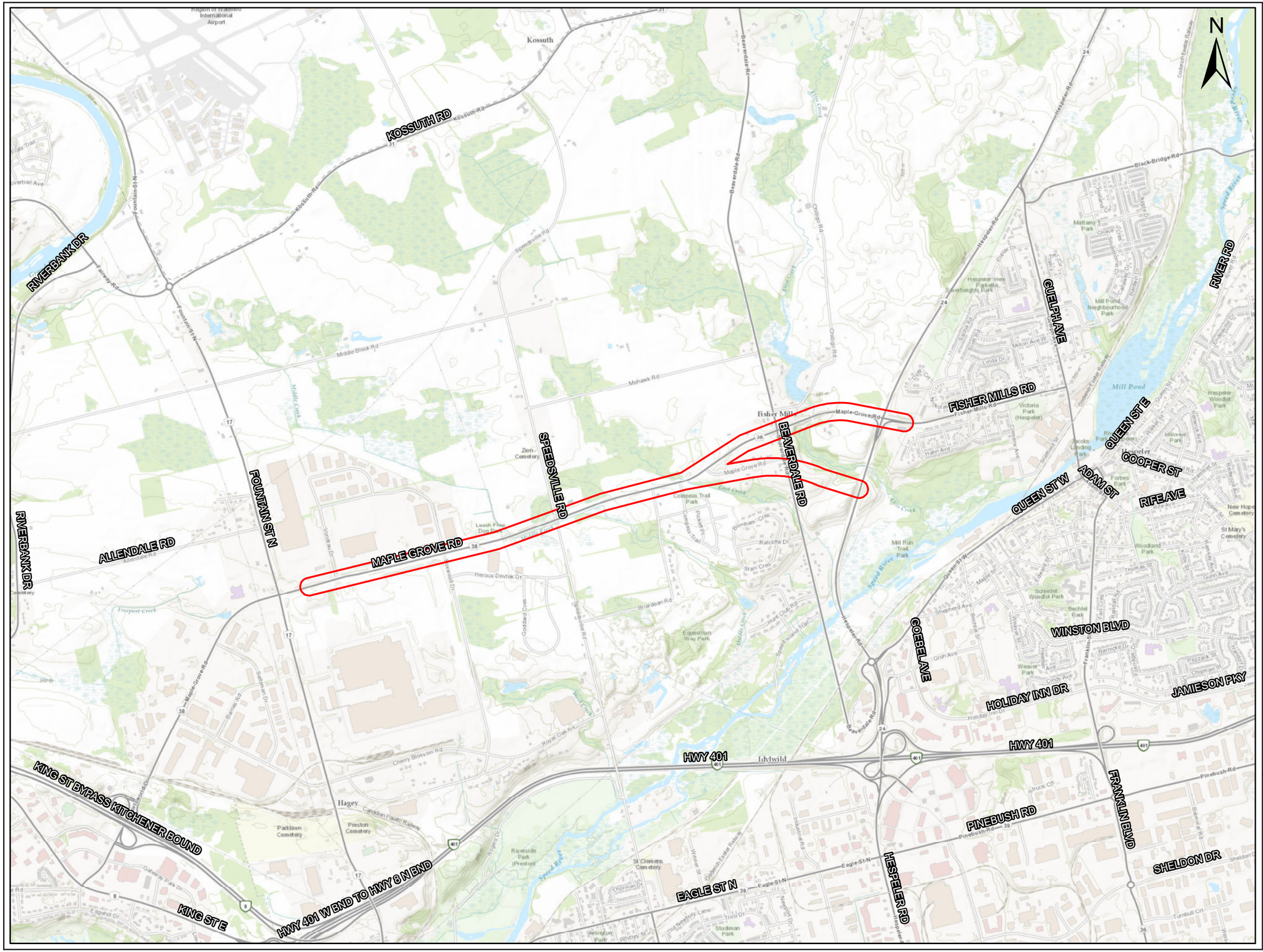
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7.0 MAPS





STUDY AREA

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ASI PROJECT NO.:18EA-088
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Figure 1: Maple Grove Road Improvements - Location of the Study Area

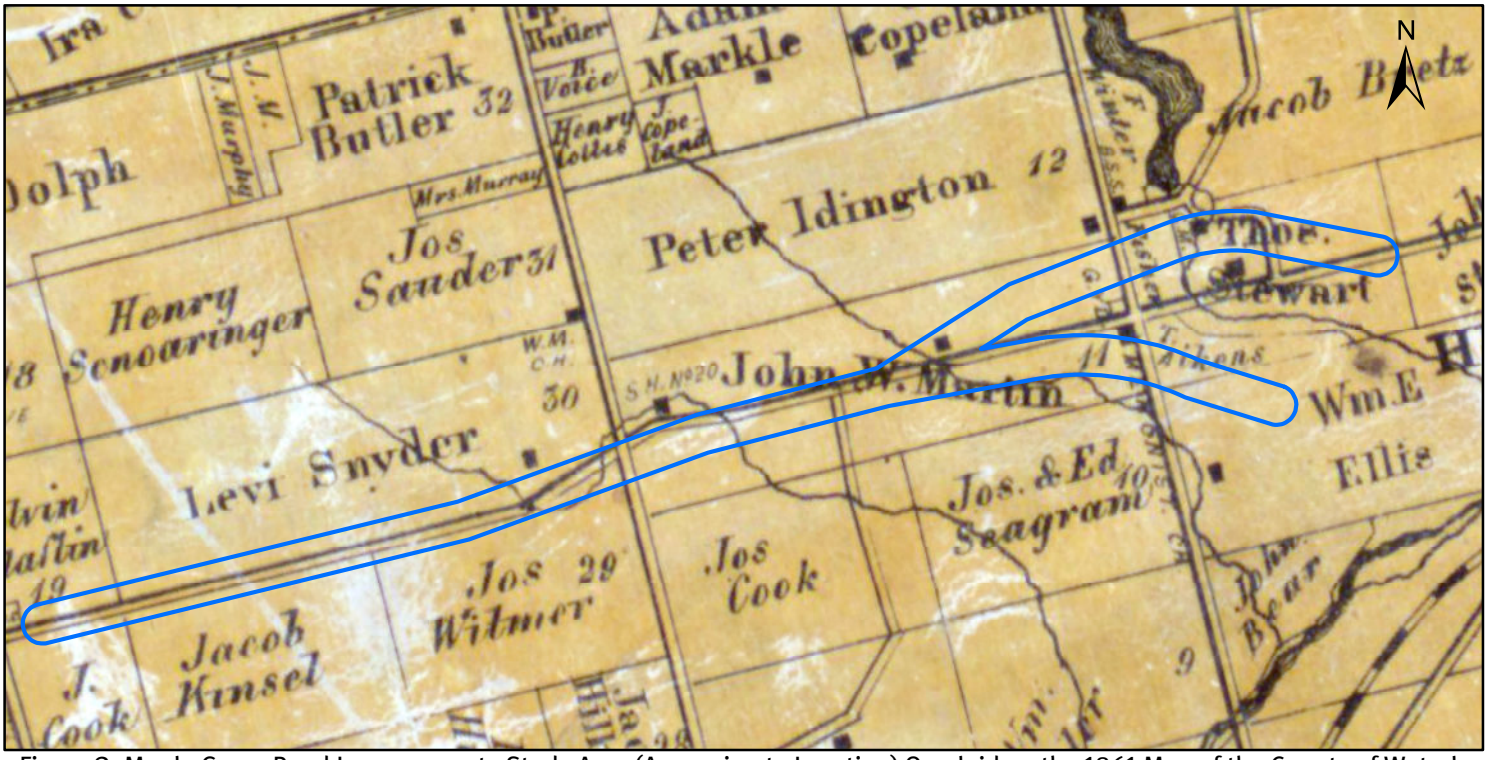


Figure 2: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1861 Map of the County of Waterloo

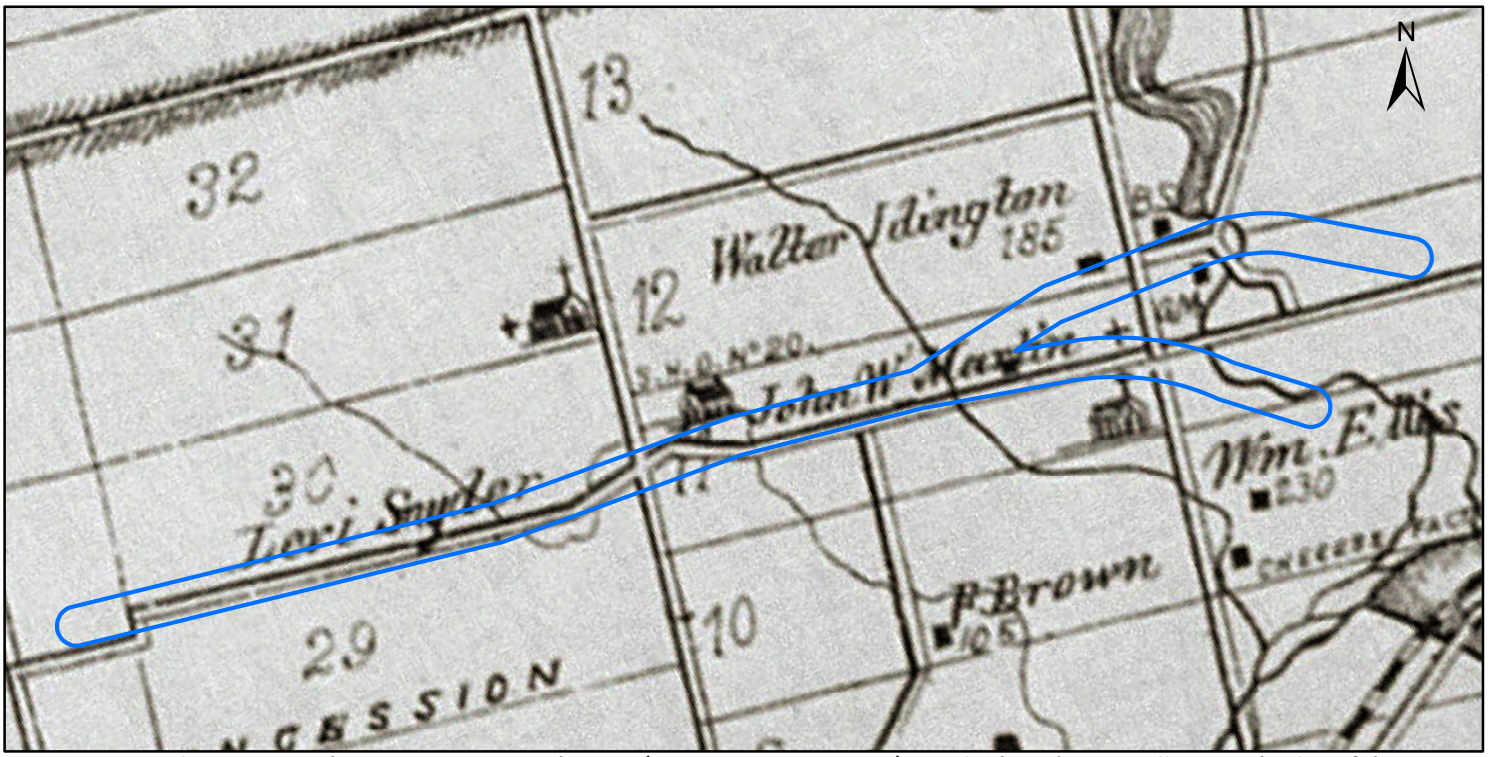


Figure 3: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1881 Illustrated Atlas of the County of Waterloo, Township of Waterloo Page

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STUDY AREA

Base:
1861 Map of the County of Waterloo
1881 Illustrated Atlas of the County of Waterloo, Township of Waterloo Page

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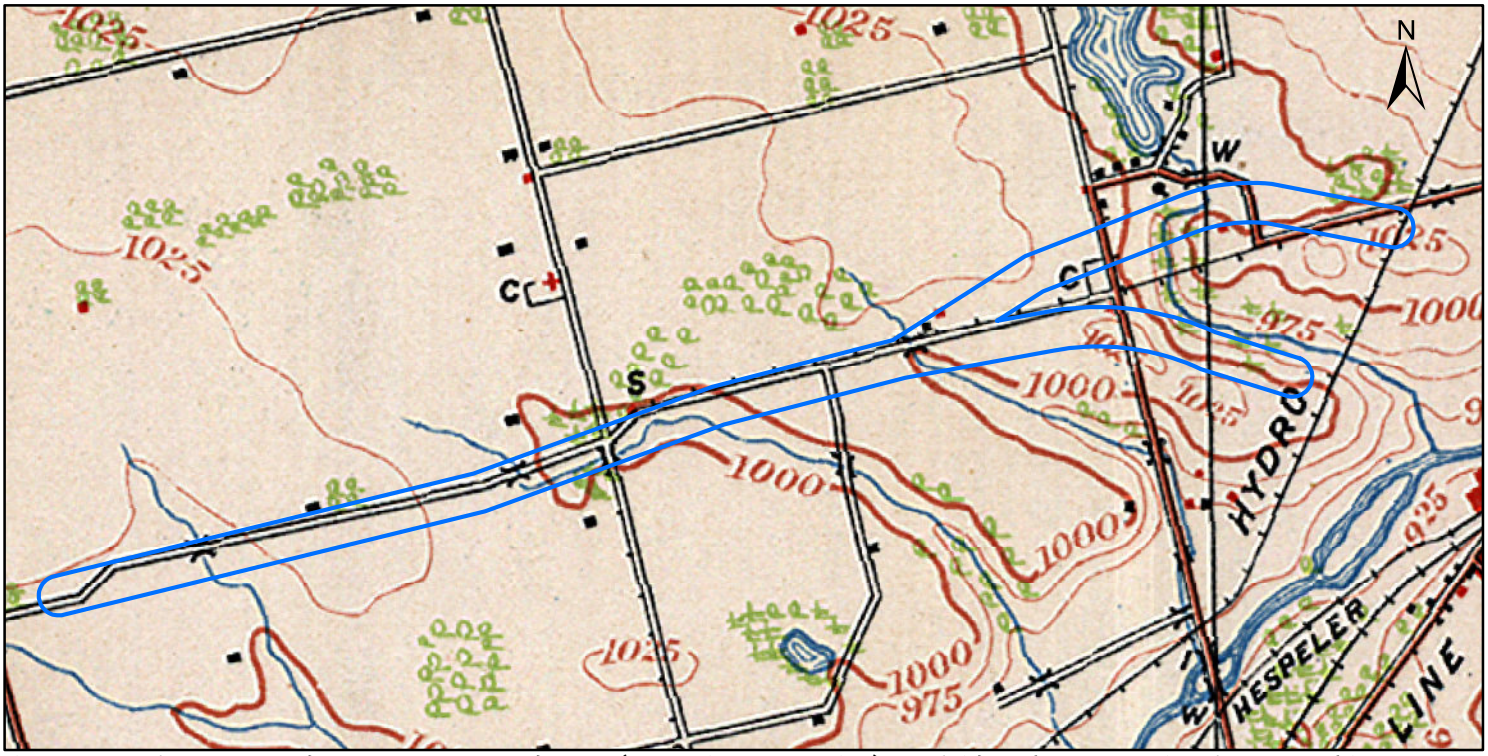


Figure 4: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1916 National Topographic System Galt Sheet



Figure 5: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1955 Aerial Photograph of Cambridge

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STUDY AREA

Base:
1916 NTS Galt Sheet
1955 Aerial Photograph of Cambridge

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Metres

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DATE: 12/11/2018

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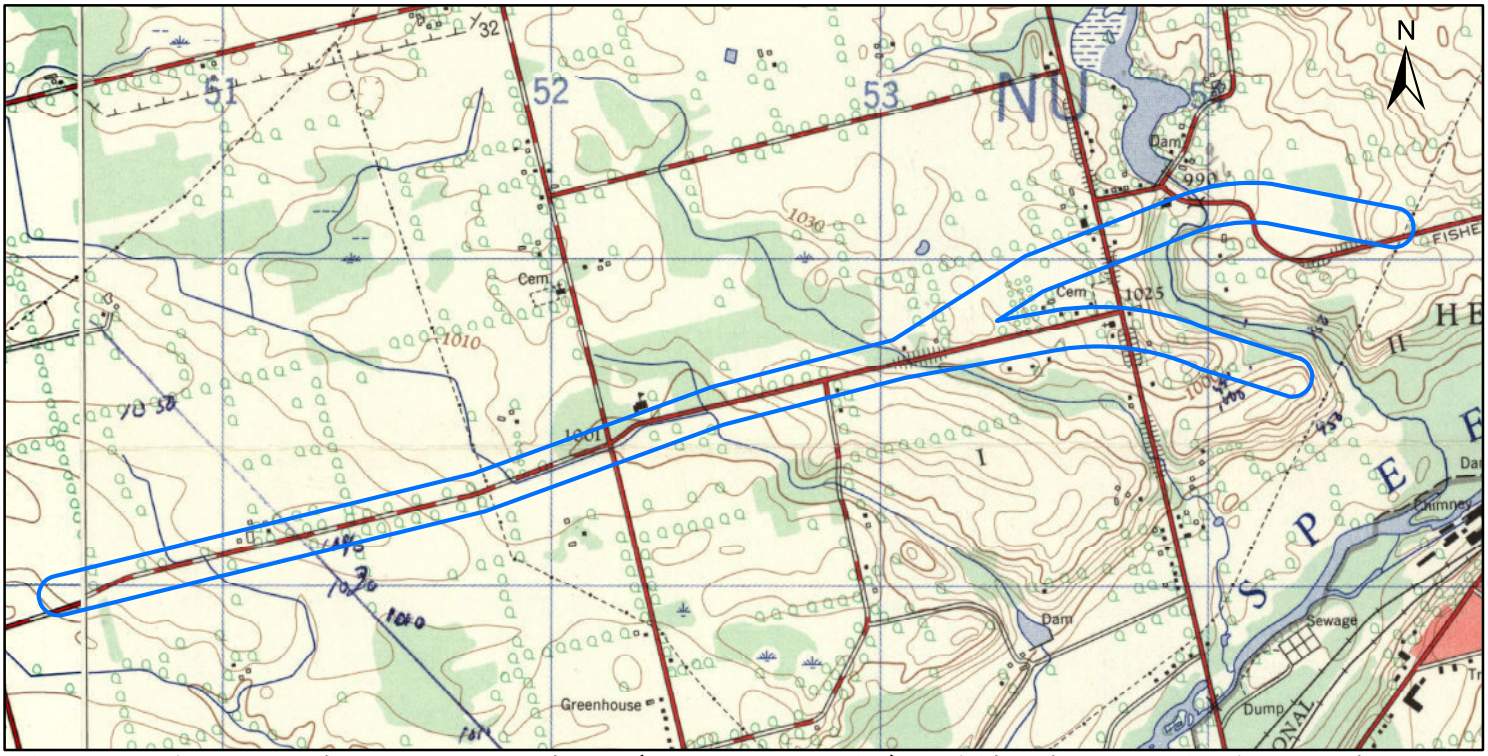


Figure 6: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1968 National Topographic System Cambridge-Preston/Kitchener-Breslau Sheets

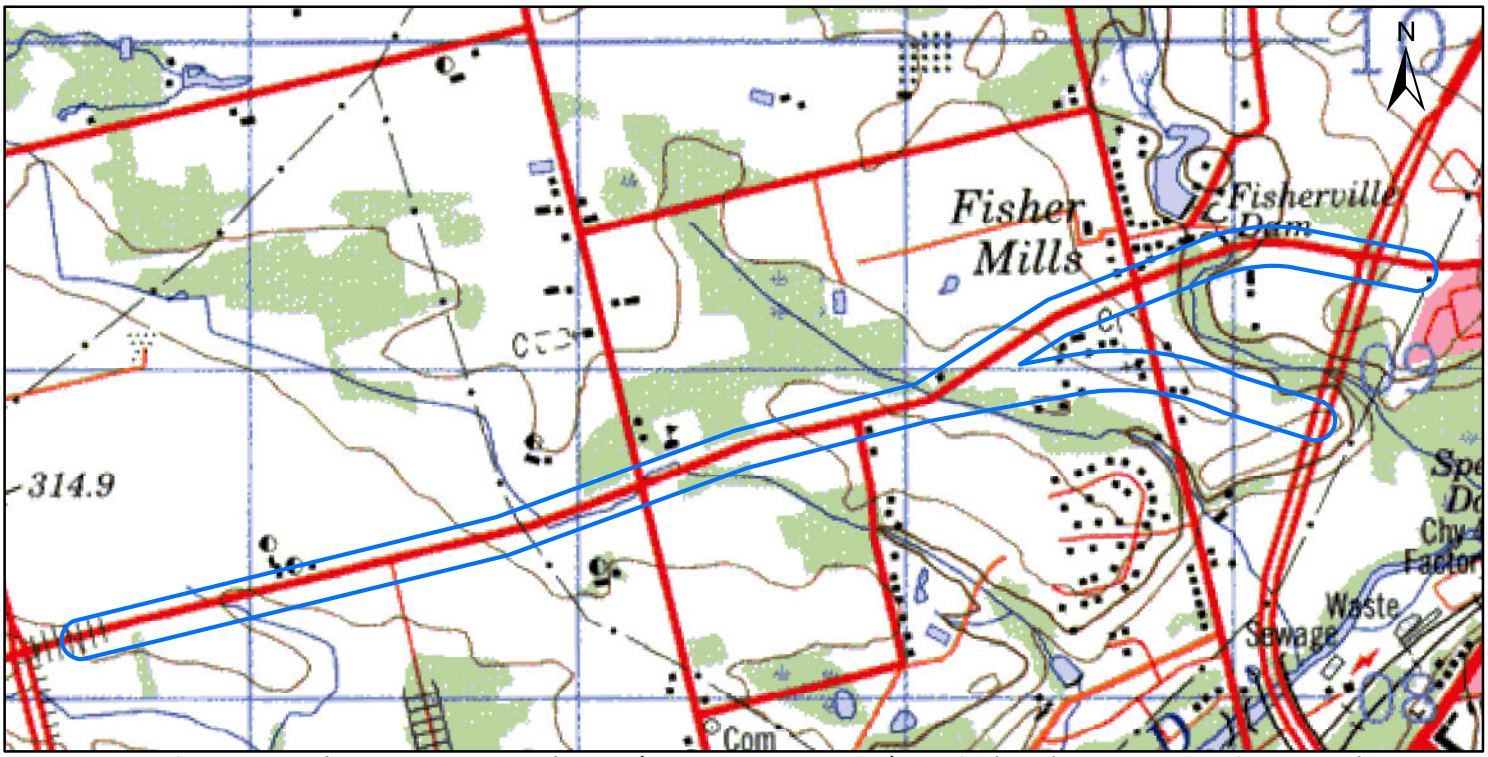


Figure 7: Maple Grove Road Improvements Study Area (Approximate Location) Overlaid on the 1998 National Topographic System Cambridge Sheet

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STUDY AREA

Base:
1968 NTS Galt Sheet
1988 NTS Cambridge Sheet

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Metres

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DATE: 12/11/2018

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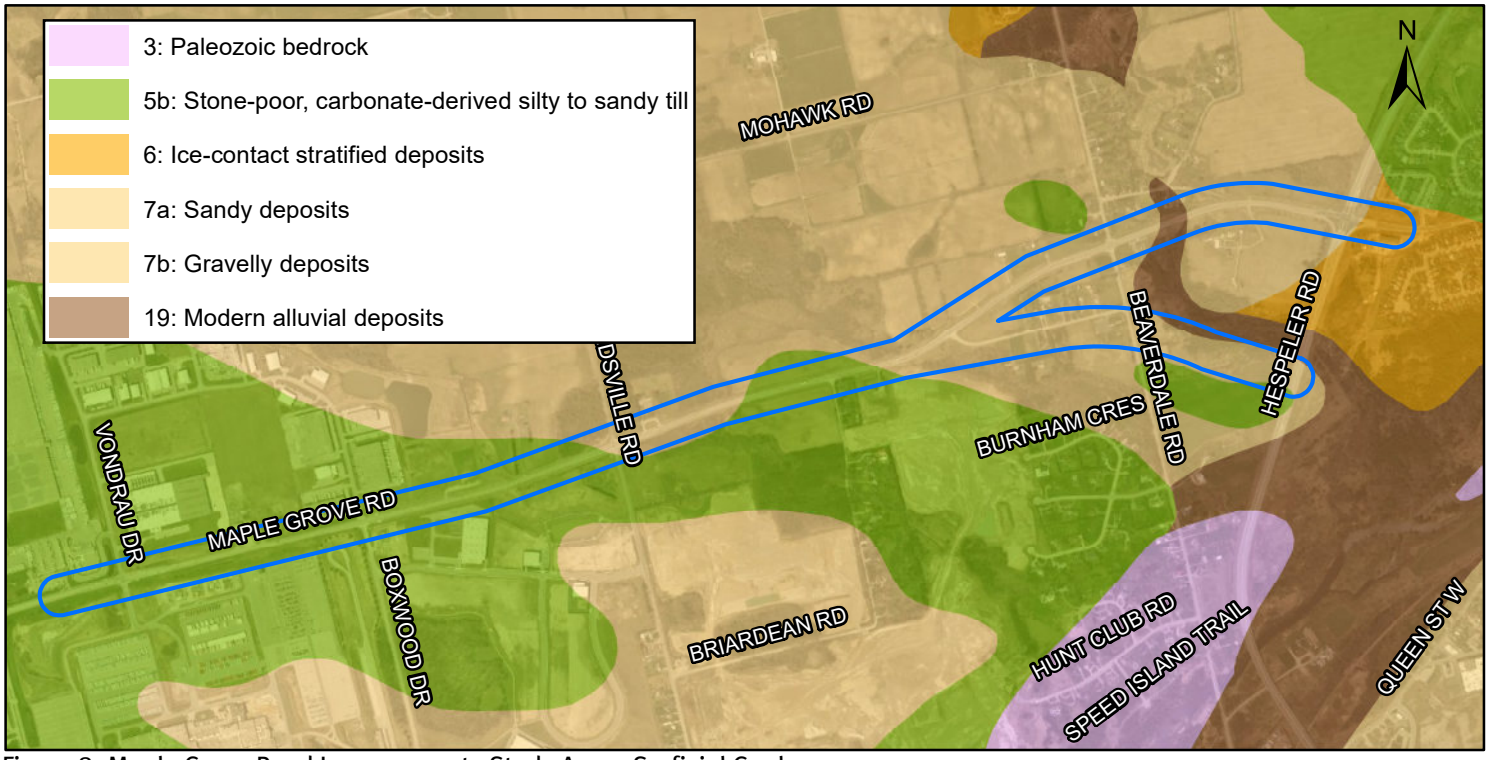


Figure 8: Maple Grove Road Improvements Study Area - Surficial Geology

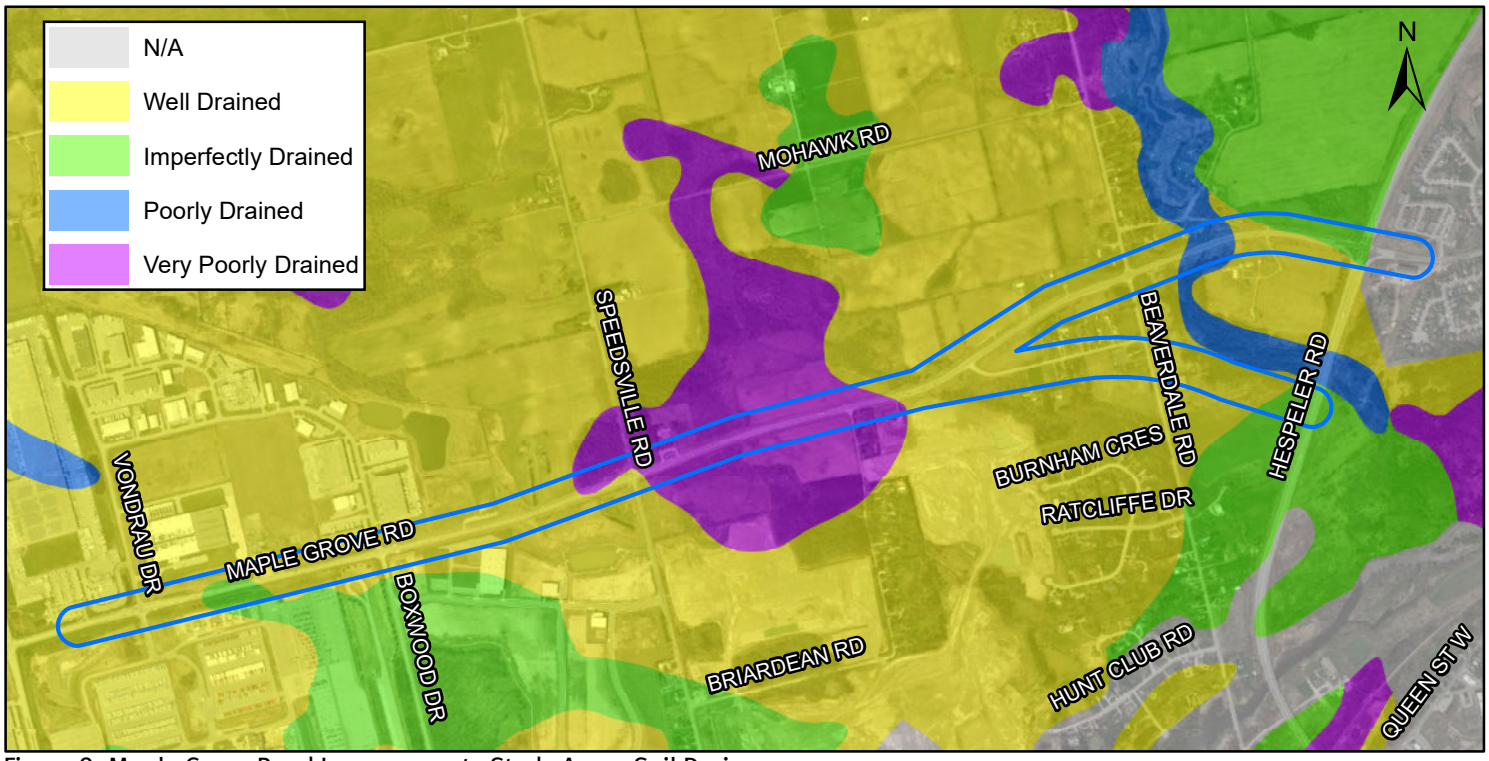


Figure 9: Maple Grove Road Improvements Study Area - Soil Drainage

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STUDY AREA

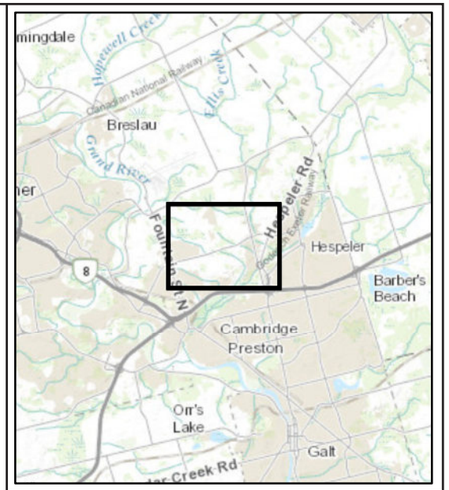
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STUDY AREA
MAP SHEET
PREVIOUSLY ASSESSED
DISTURBED – NO POTENTIAL
PEDESTRIAN SURVEY
SLOPE – NO POTENTIAL
REQUIRES CEMETERY INVESTIGATION & TEST PIT SURVEY
TEST PIT SURVEY
LOW AND WET – NO POTENTIAL

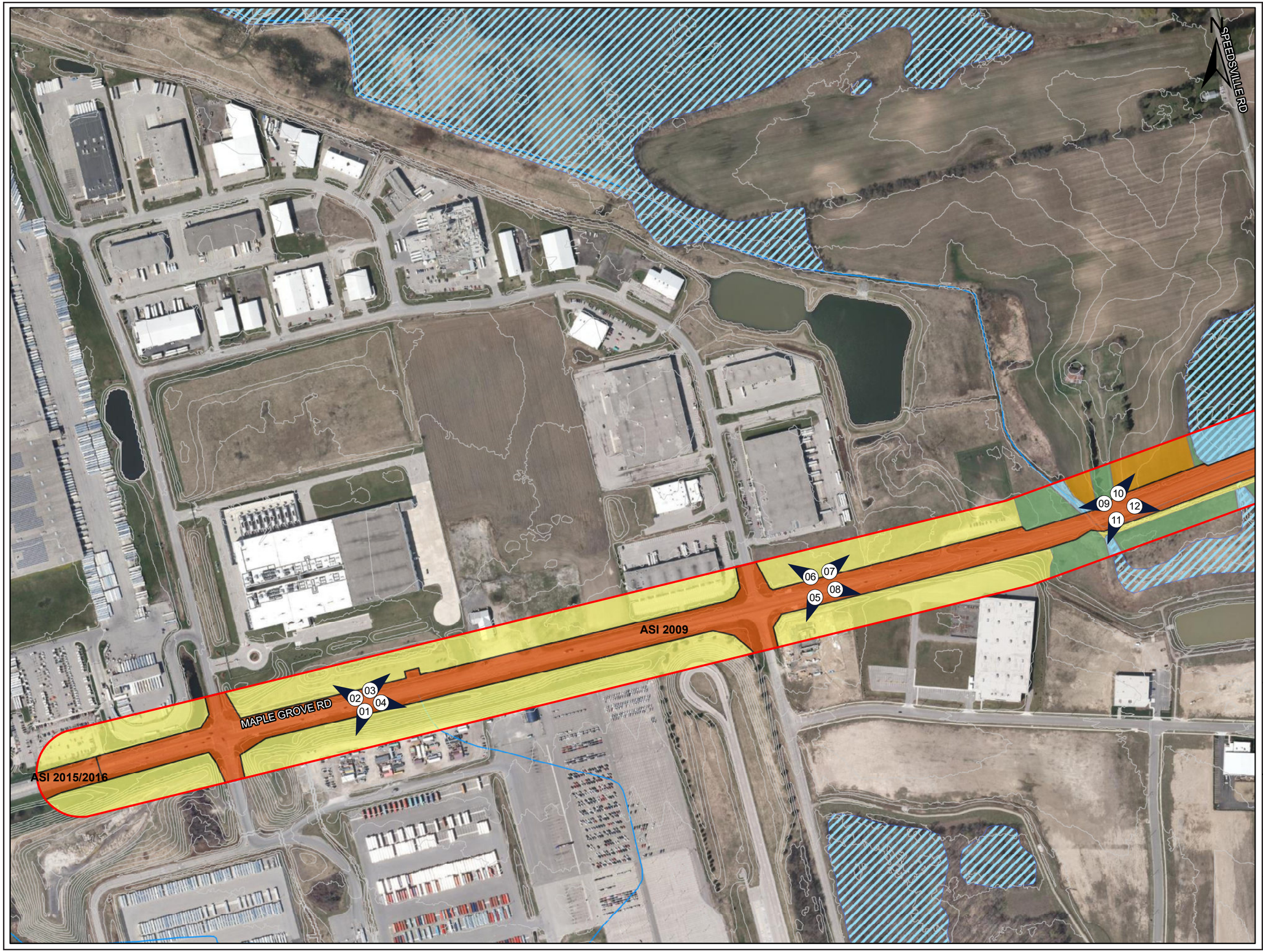
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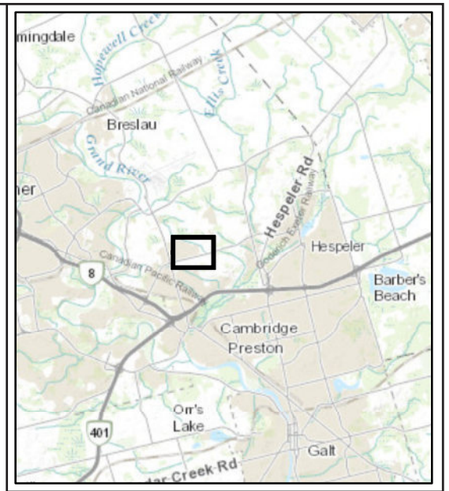
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Figure 10: Maple Grove Road Improvements Study Area - Results of the Property Inspection (Key Map)





STUDY AREA

PHOTO LOCATION AND DIRECTION

PREVIOUSLY ASSESSED

DISTURBED – NO POTENTIAL

PEDESTRIAN SURVEY

TEST PIT SURVEY

LOW AND WET – NO POTENTIAL

ELEVATION CONTOUR

WETLAND

WATERCOURSE

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Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

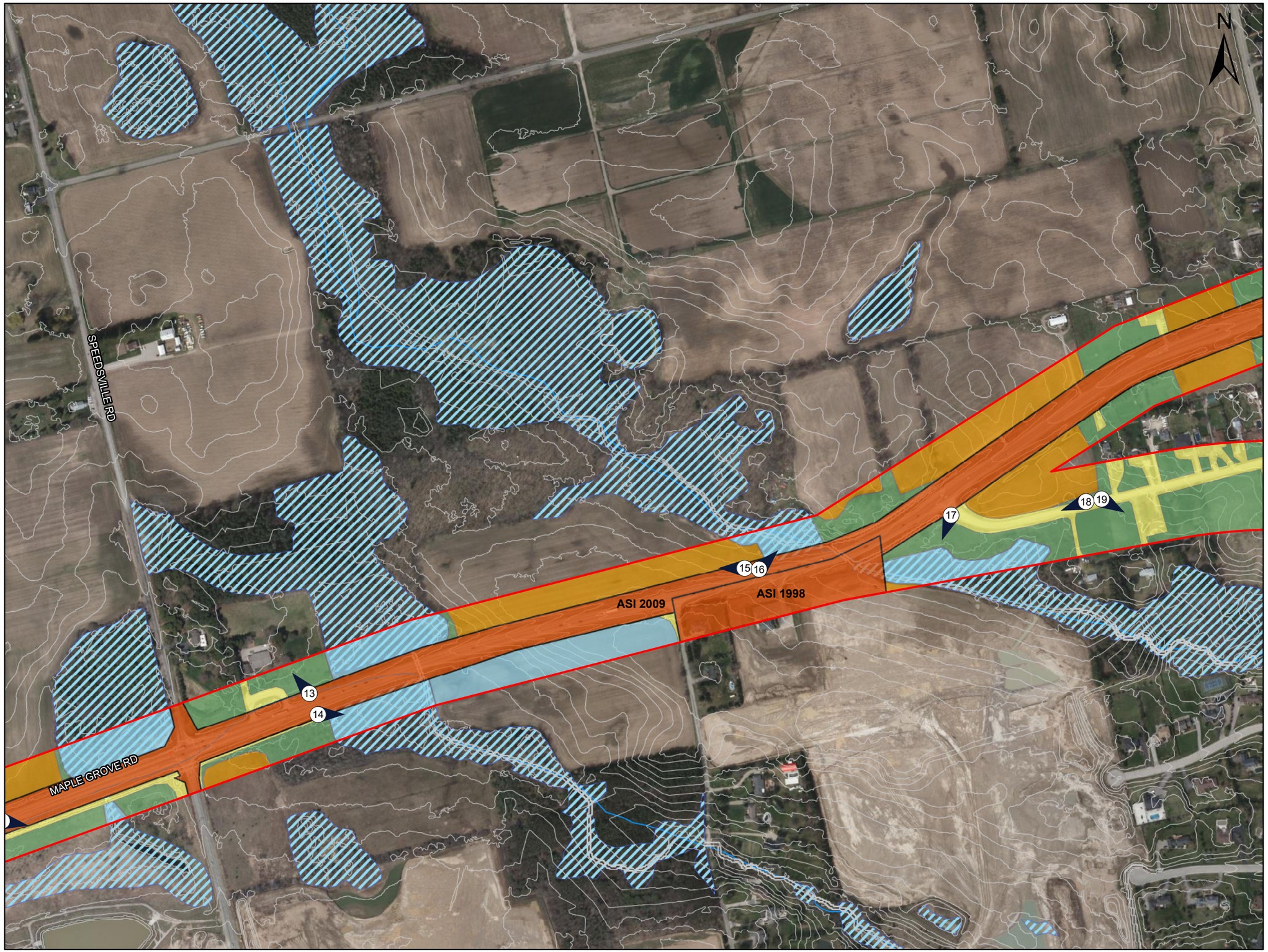
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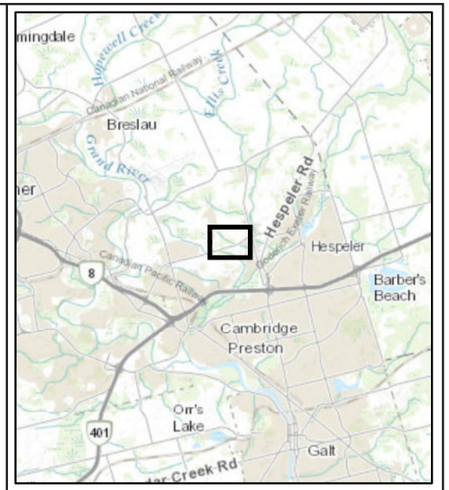
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DATE: 12/14/2018

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FILE: 18EA088_fig11_S1

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Figure 11: Maple Grove Road Improvements Study Area - Results of the Property Inspection (Sheet 1)





STUDY AREA

PHOTO LOCATION AND DIRECTION

PREVIOUSLY ASSESSED

DISTURBED – NO POTENTIAL

PEDESTRIAN SURVEY

TEST PIT SURVEY

LOW AND WET – NO POTENTIAL

ELEVATION CONTOUR

WETLAND

WATERCOURSE

BASE: Ortho
Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

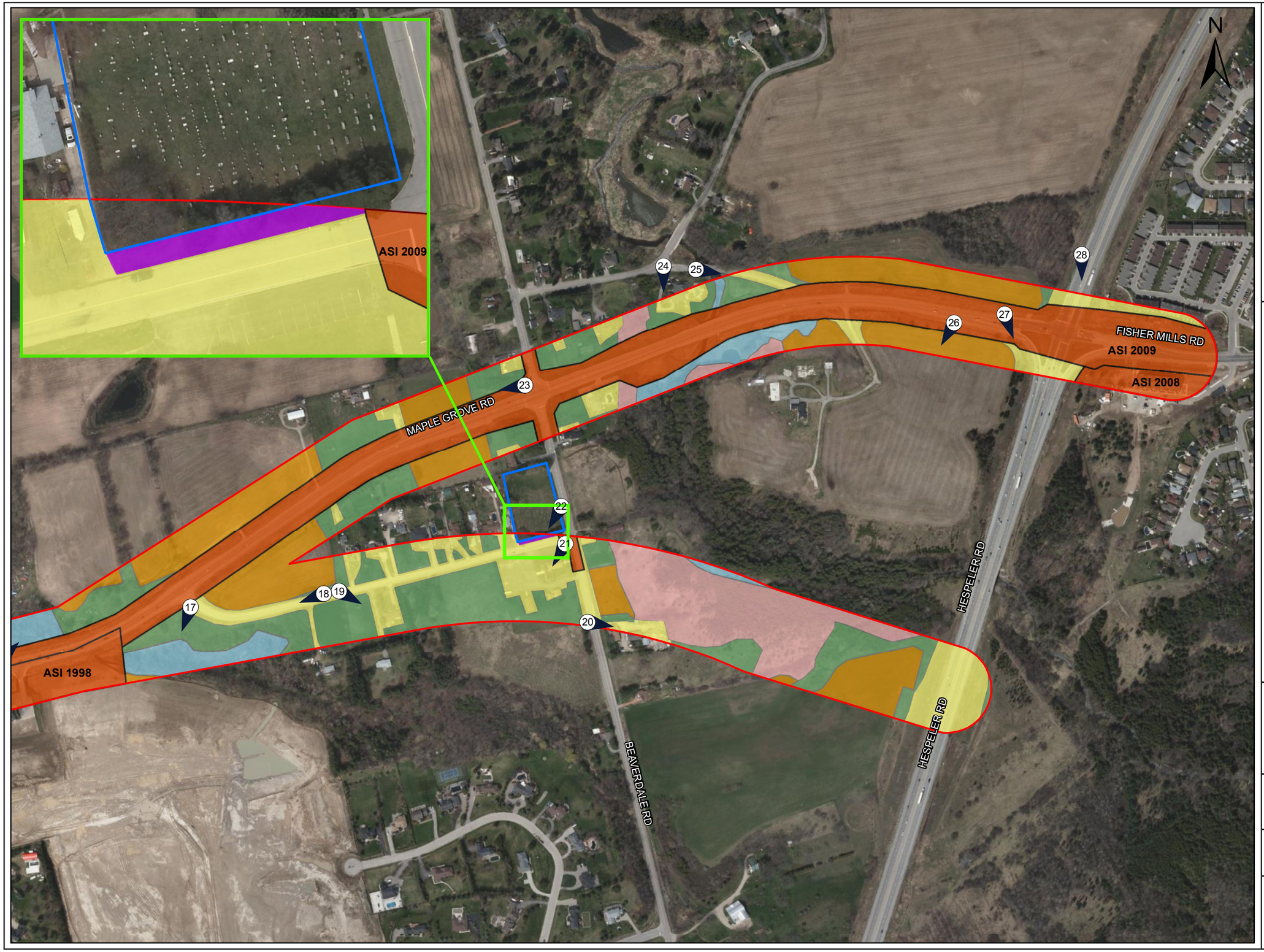
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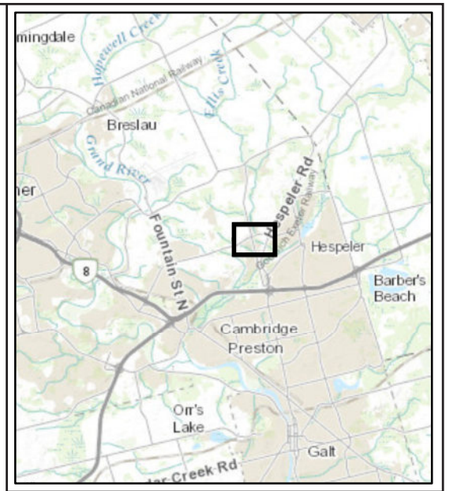
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Figure 12: Maple Grove Road Improvements Study Area - Results of the Property Inspection (Sheet 2)





STUDY AREA

PHOTO LOCATION AND DIRECTION

WANNER CEMETERY

PREVIOUSLY ASSESSED

DISTURBED – NO POTENTIAL

PEDESTRIAN SURVEY

SLOPE – NO POTENTIAL

REQUIRES CEMETERY INVESTIGATION & TEST PIT SURVEY

TEST PIT SURVEY

LOW AND WET – NO POTENTIAL

BASE: Ortho
Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Figure 13: Maple Grove Road Improvements Study Area - Results of the Property Inspection (Sheet 3)

8.0 IMAGES



Plate 1: Southwest view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 2: Northwest view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 3: Northeast view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 4: Southeast view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 5: Southwest view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 6: Northwest view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 7: Northeast view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 8: Southeast view of Maple Grove Rd.; Area beyond previous assessment is disturbed, no potential



Plate 9: West view of Maple Grove Rd.; Area beyond previous assessment and wet area requires Stage 2 survey



Plate 10: Northeast view of Maple Grove Rd.; Area beyond previous assessment requires Stage 2 survey



Plate 11: Southwest view of Maple Grove Rd.; Area beyond previous assessment and wet area requires Stage 2 survey



Plate 12: Southeast view of Maple Grove Rd.; Area beyond previous assessment and disturbed ditch requires Stage 2 survey



Plate 13: Northwest view of 1370 Maple Grove Rd.; Area beyond previous assessment and disturbed driveway requires Stage 2 survey



Plate 14: East view of Maple Grove Rd.; Area beyond previous assessment is low and wet, no potential



Plate 15: West view of Maple Grove Rd.; Area beyond previous assessment requires Stage 2 survey



Plate 16: Northeast view of Maple Grove Rd.; Area beyond previous assessment surrounding the wetland requires Stage 2 survey



Plate 17: Southwest view of Maple Grove Rd.; Area beyond previous assessment requires Stage 2 survey



Plate 18: West view of Old Maple Grove Rd.; Area beyond disturbed road requires Stage 2 survey



Plate 19: Southeast view of Old Maple Grove Rd.; Area beyond disturbed road requires Stage 2 survey



Plate 20: East view of Beaverdale Rd.; Area beyond disturbed road requires Stage 2 survey


Plate 21: Southwest view of Wanner Mennonite Church; Area is disturbed, no potential


Plate 22: Southwest view of Wanner Cemetery on Beaverdale Rd.; Area between Old Maple Grove Rd. and tree line requires Cemetery Investigation if impacted by project.



Plate 23: West view of Maple Grove Rd.; Area beyond previous assessment requires Stage 2 survey



Plate 24: South view of Fisher Mills Rd.; Area beyond disturbed road and residential lawns requires Stage 2 survey



Plate 25: East view of Fisher Mills Rd.; Area beyond disturbed road requires Stage 2 survey



Plate 26: Southwest view of Maple Grove Rd.; Area beyond previous assessment requires Stage 2 survey

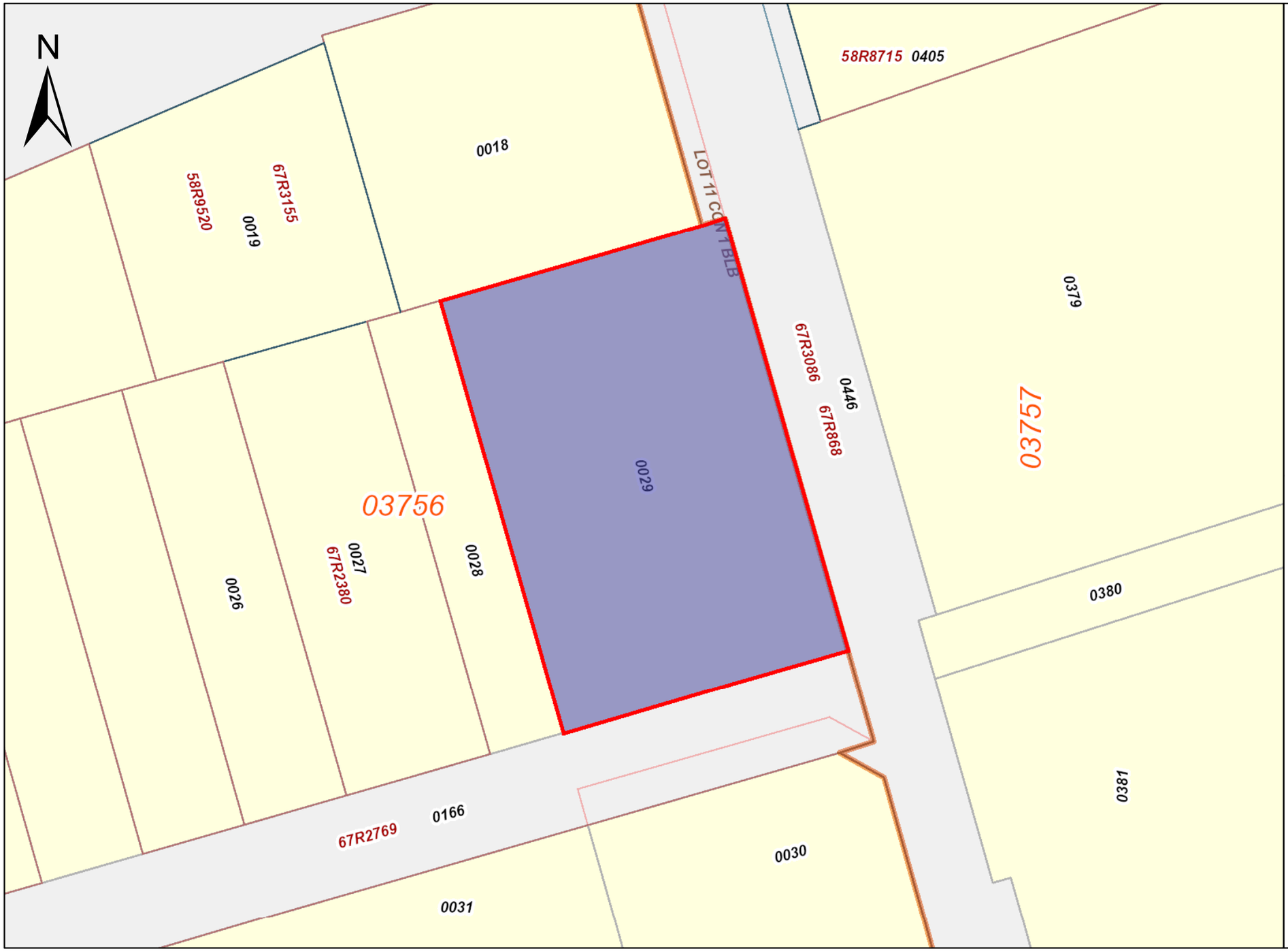


Plate 27: Southeast view of Maple Grove Rd. and Hespeler Rd.; Area beyond previous assessment is disturbed, no potential



Plate 28: South view of Hespeler Rd.; Area beyond previous assessment is disturbed, no potential

9.0 APPENDIX A



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SCALE

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PROPERTY INDEX MAP

WATERLOO(No. 58)

LEGEND

FREEHOLD PROPERTY	
LEASEHOLD PROPERTY	
LIMITED INTEREST PROPERTY	
CONDOMINIUM PROPERTY	
RETIRED PIN (MAP UPDATE PENDING)	
PROPERTY NUMBER	*0449*
BLOCK NUMBER	**08050**
GEOGRAPHIC FABRIC	
EASEMENT	

THIS IS NOT A PLAN OF SURVEY

NOTES

REVIEW THE TITLE RECORDS FOR COMPLETE PROPERTY INFORMATION AS THIS MAP MAY NOT REFLECT RECENT REGISTRATIONS

THIS MAP WAS COMPILED FROM PLANS AND DOCUMENTS RECORDED IN THE LAND REGISTRATION SYSTEM AND HAS BEEN PREPARED FOR PROPERTY INDEXING PURPOSES ONLY

FOR DIMENSIONS OF PROPERTIES BOUNDARIES SEE RECORDED PLANS AND DOCUMENTS

ONLY MAJOR EASEMENTS ARE SHOWN

REFERENCE PLANS UNDERLYING MORE RECENT REFERENCE PLANS ARE NOT ILLUSTRATED

Ontario

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Appendix P – Traffic Study VISSIM Technical Report (IBI Group)

September 2023

Region of Waterloo

Report

Maple Grove Road Improvements and Corridor Study

VISSIM Technical Report

Prepared for Regional Municipality of Waterloo
by IBI Group
April 28, 2022

Document Control Page

CLIENT:	Regional Municipality of Waterloo
PROJECT NAME:	Maple Grove Road Improvements and Corridor Study
REPORT TITLE:	VISSIM Technical Report
IBI REFERENCE:	117540
VERSION:	1.0
DIGITAL MASTER:	
ORIGINATOR:	Josh Wilson, Shubham Bohra
REVIEWER:	Scott Johnston
AUTHORIZATION:	
CIRCULATION LIST:	
HISTORY:	

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1 Background

The Region of Waterloo is undertaking an environmental assessment (EA) to study impacts of the possible widening of Maple Grove Road between Fountain Street and Hespeler Road, as planned in the Region's Transportation Master Plan (2018 TMP).

As part of this EA study, IBI Group has been tasked with developing a microsimulation model to test various corridor widening scenarios and potential intersection configuration options. This microsimulation task will build on prior modelling efforts undertaken by the Region and CIMA+, including refining the recommendations detailed in a prior intersection control study (ICS).

This report details the methodologies used to develop and calibrate an existing conditions microsimulation model using VISSIM (version 10), as well as to develop future model scenarios to test various corridor/intersection configuration options under 2036 and 2041 planning horizons. Recommended interim and ultimate configurations of study corridor intersections are provided.

1.1 Study Area

Maple Grove Road is a major east-west arterial road in Cambridge that is within the jurisdiction of the Region of Waterloo. To the west, the road becomes Sportsworld Drive at Highway 8 and extends to King Street E. To the east, the road becomes Fischer Mills Road at Hespeler Road and extends to Guelph Avenue.

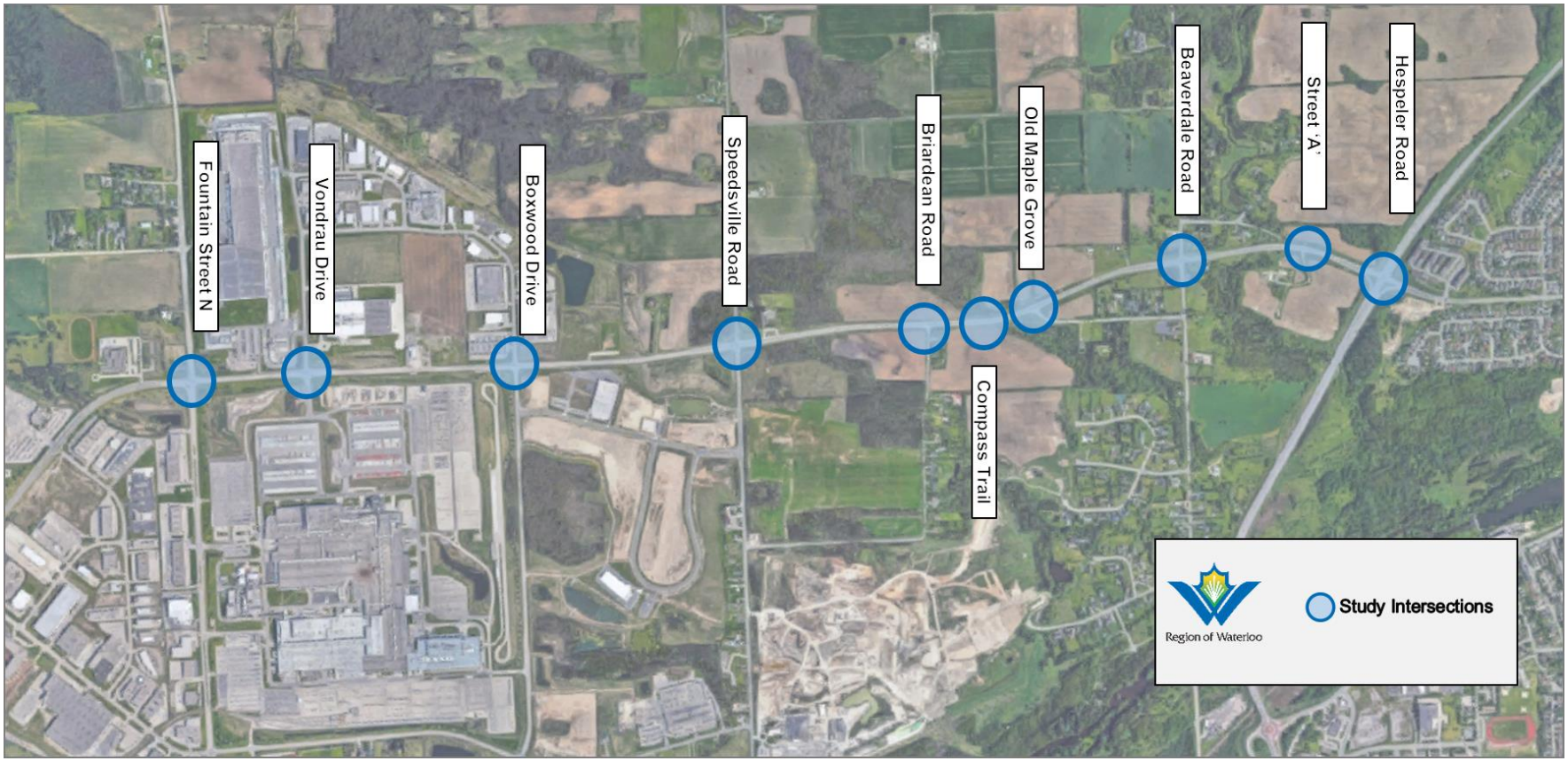
The configuration of Maple Grove Road & Fountain Street has been planned in a prior separate EA study. The current EA study will assess the future widening of the corridor from two to four lanes, as is planned in the Region's Transportation Master Plan (2018 TMP) and matching the four-lane crossing existing near and west of Fountain Street. The current EA will also provide recommended configurations and preliminary design for all major intersections within the study area, which are illustrated in Exhibit 1-2.

The existing traffic control used at the various study area intersections is detailed in Exhibit 1-1.

Exhibit 1-1: Current Traffic Control at Study Intersections

INTERSECTION	EXISTING CONTROL TYPE
Hespeler Road & Maple Grove Road	Signalized
Beaverdale Road & Maple Grove Road	Signalized
Old Maple Grove Road & Maple Grove Road	One-Way Stop Control
Compass Trail & Maple Grove Road	One-Way Stop Control
Speedsville Road & Maple Grove Road	Signalized
Boxwood Drive & Maple Grove Road	Two-Way Stop Control
Vondrau Drive & Maple Grove Road	Signalized

Exhibit 1-2: Study Area Map



1.2 Prior Study Findings

In 2018 and 2019, CIMA+ completed intersection control studies (ICS) for several intersections along Maple Grove Road. These studies provided recommendations on future intersection control according to operational performance findings (using Synchro and ARCADY), construction and life-cycle cost estimates, and several other qualitative criteria. The studies also included design concepts for potential interim and ultimate intersection configurations.

The following intersections along Maple Grove Road were assessed:

- Hespeler Road;
- Boxwood Drive;
- Speedsville Road;
- Old Maple Grove Road; and
- Beaverdale Road.

The Hespeler Road intersection was studied based on future horizons of 2025 and 2035, while the other four intersections were studied based on 2036 and 2041 horizons. The type of traffic control recommended at each of the analyzed intersections is summarized in Exhibit 1-3.

Exhibit 1-3: ICS Recommended Intersection Configurations

INTERSECTION	ICS RECOMMENDED CONTROL	
	Interim	Ultimate
Hespeler Road & Maple Grove Road	2-lane Roundabout	2x3-lane Roundabout
Beaverdale Road & Maple Grove Road	2-lane Roundabout	3x2-lane Roundabout
Old Maple Grove Road & Maple Grove Road	2-lane Roundabout	3x2-lane Roundabout
Speedsville Road & Maple Grove Road	Signalized w/ dual NBL	Signalized w/ dual NBL
Boxwood Drive & Maple Grove Road	Signalized	Signalized

As part of the current study and report, IBI Group will model the ICS recommended intersection configurations using the VISSIM microsimulation software, for 2036 and 2041 horizon years. The VISSIM software is able to predict and account for certain relationships between adjacent intersections, such as long traffic queues affecting an upstream intersection, or improved traffic output at an upstream intersection resulting in higher traffic volumes at downstream intersections. The results of this VISSIM modelling exercise will be used to confirm and/or refine ICS recommended designs, as well as to determine recommended future configurations at the remaining study area intersections.

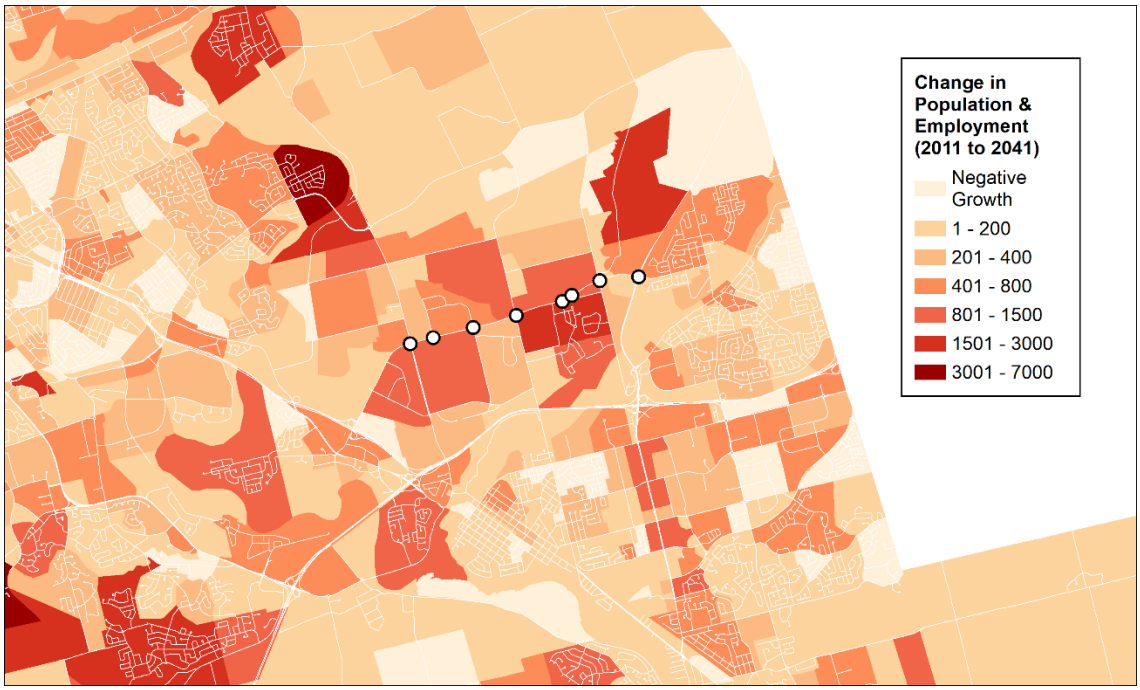
1.3 Future Development Growth

A significant amount of development growth is forecasted within and nearby the study area. This includes development of the East Side Lands, located in the area surrounding the boundaries of East Kitchener, North Cambridge, and Woolwich. The Regional Official Plan (2015) approved plans for development of these East Side Lands, which will occur in stages and is designated primarily for industrial and commercial uses.

The Provincial Growth Plan (2017) also includes fairly aggressive growth forecasts for the Region. Exhibit 1-4 illustrates the forecasted change in population and employment between 2011 and 2041, in the areas surrounding the Maple Grove Road corridor (the study intersections

are shown). A significant portion of this growth has yet to occur and assumedly will be observed in the period between 2020 and 2041.

Exhibit 1-4: Change in Population & Employment, 2011 to 2041



This strong development growth will translate to a significant increase in travel demands, including both an increase in local site traffic generated to and from the study area, as well as an increase in background traffic travelling on the Maple Grove Road corridor and along major intersecting roadways.

In the context of this study, the future traffic volumes provided by the Region were derived from the Region's future travel demand model and accounts for these future growth forecasts. It is therefore important to note that the required timing of recommended road and intersection improvements will ultimately depend on the actual rate of future growth. If growth were to occur at a different rate than that forecasted by the Province/Region, then phasing of improvements would likely need to be advanced or deferred accordingly.

2 Model Development

This section of the report details the methodologies and input parameters used to develop and calibrate the VISSIM models.

First, a base model scenario was modelled in VISSIM for model calibration and validation purposes. This base scenario modelled the majority of intersections given their current configuration, although certain potential intersection closures were modelled including those proposed at Briardean Road & Old Maple Grove Road (with access instead provided via Compass Road). This base scenario was calibrated by modelling operations using traffic volumes representative of a 2019 base year, and comparing results with measured field data.

Once calibrated, the base scenario was modified to test various intersection configuration options, including the ICS recommended designs, for 2036 and 2041 horizon years. This was an iterative process, as further modifications to the corridor and intersection configurations were made based on prior scenario results. This yielded several model runs testing different corridor and intersection designs under the respective planning horizons.

2.1 Road Network

The base road network was modelled in VISSIM as shown in Exhibit 2-2, made up of 'links' and 'connectors'. A 'link' is a basic element in VISSIM used to model a single-lane or multi-lane roadway segment having specified direction of travel. For example, a two-way road is made up of two parallel links. A 'connector' is used to connect two links, such as when modelling turning movements or when transitioning between road segments having a different number of lanes. The intersection of two links is classified in VISSIM as a 'node'.

Road alignments, geometries and lengths were input based on aerial imagery from Google Maps. Field visits were also conducted to confirm current road and intersection configurations, as well as for model calibration and validation purposes (as detailed in Section 2.5).

2.2 Network Parameters

The settings/values for several general network parameters used in all of the VISSIM model scenarios are summarized in Exhibit 2-1.

Exhibit 2-1: Network Parameters

PARAMETER	VALUE USED
Lane Width	3.5m
Link Lane Change Distance	200m (Default)
Link Behaviour	Urban (Motorized)
Desired Speed Distribution	70 km/h (default range)
Left Turn Reduced Speed	20 km/h
Right Turn Reduced Speed	25 km/h
Right Turn Channelized Reduced Speed	30 km/h

VISSIM uses category-range distributions for vehicle operating speeds, which allows the model to simulate a spectrum driver behaviours as opposed to modelling static/uniform vehicle types. For example, in addition to modelling typical interactions between fast cars and slow trucks, the category-range distributions also produce interactions between aggressive trucks versus passive trucks, or fast cars versus slow cars. The default category-range distributions were used.

Exhibit 2-2: Links (blue) and Connectors (pink) in Base Model Scenario



2.2.1 Conflict Zones

Conflicting movements are modelled using vehicle conflict zones, which outline the rules determining which drivers possess the right-of-way and which are required to yield. These vehicle conflict zones, which include merging and crossing movements, must be coded with a certain gap acceptance to define when yielding vehicles may complete the movement.. The following provides examples of how right-of-way was assigned in the model:

- Left-turning vehicles must wait for a suitable gap in the opposing traffic stream, with priority given to through traffic; and
- Right-turning vehicles are given priority over left-turning vehicles when turning into the same receiving lane.

Exhibit 2-3 provides an example of how conflict zones were coded at a typical signalized intersection, with green showing the movements that are given priority in a particular conflict rule, and red showing the movements required to yield in a particular conflict.

2.2.2 Speed Reduction Zones

Speed reduction zones were added in to model realistic turning behaviour, so that vehicles slow down when making a turning movement, thereby preventing turns at excessive and unrealistic speeds Exhibit 2-4 provides an example of how speed reduction zones were coded at a typical signalized intersection.

2.2.3 Routing Decisions

Routing decisions were implemented to model various travel routes through each intersection and therefore through the modelled road network. The distribution of vehicles taking each of the various routes at each at each intersection is user-defined, and these distributions were determined based on current and forecasted turning movement count data. Exhibit 2-5 provides an example of how a typical static routing decision were coded at a typical signalized intersection, in this case defining the possible routes that eastbound traffic approaching the intersection may travel.

When coding roundabouts, lane-change maneuvers were restricted from occurring within the roundabouts by enabling ‘lane blocking’ for all vehicle types. This means that certain turning movements are possible from each entry lane, according to how the roundabout is signed on approach. Exhibit 2-6 provides an example how static routing decisions were coded at a typical intersection, in this case defining the possible routes that eastbound traffic approaching the roundabout may travel. Routing decisions were also calibrated to produce a realistic distribution of traffic amongst the available entry lanes.

Exhibit 2-3: Example of Conflict Zones at a Signalized Intersection

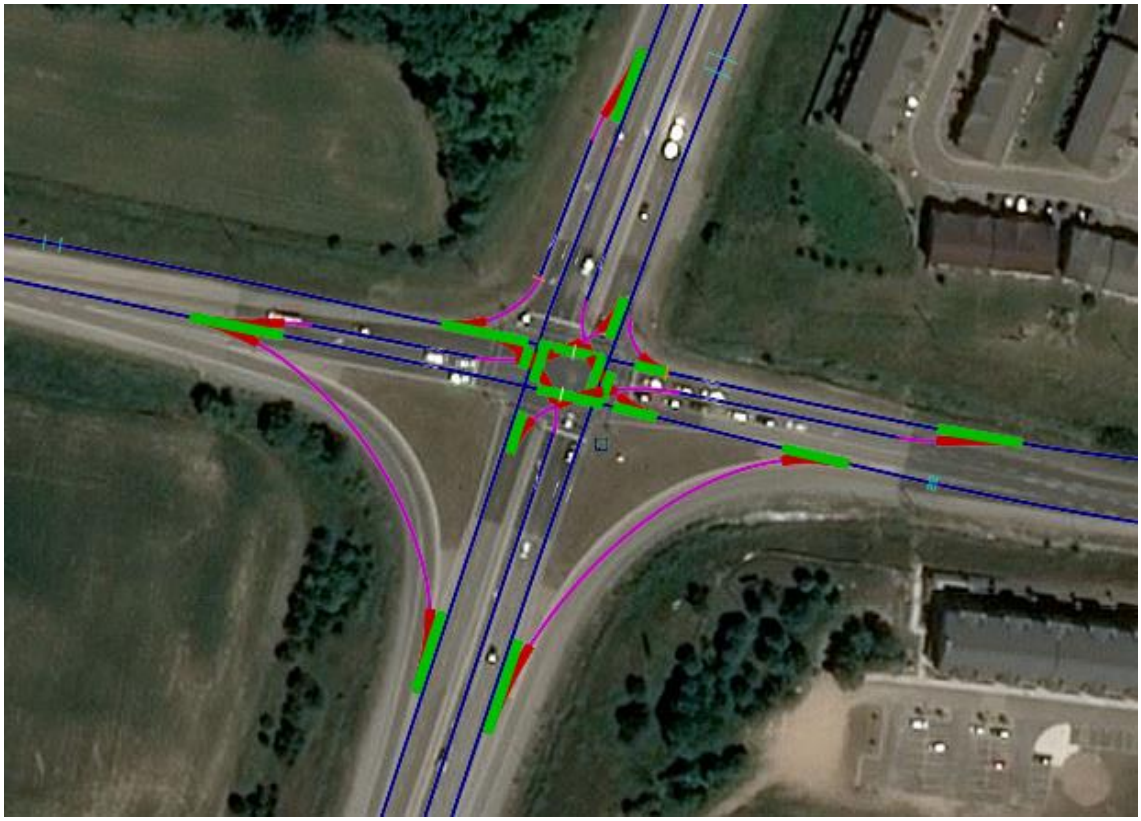


Exhibit 2-4: Example of Speed Reduction Zones at a Signalized Intersection

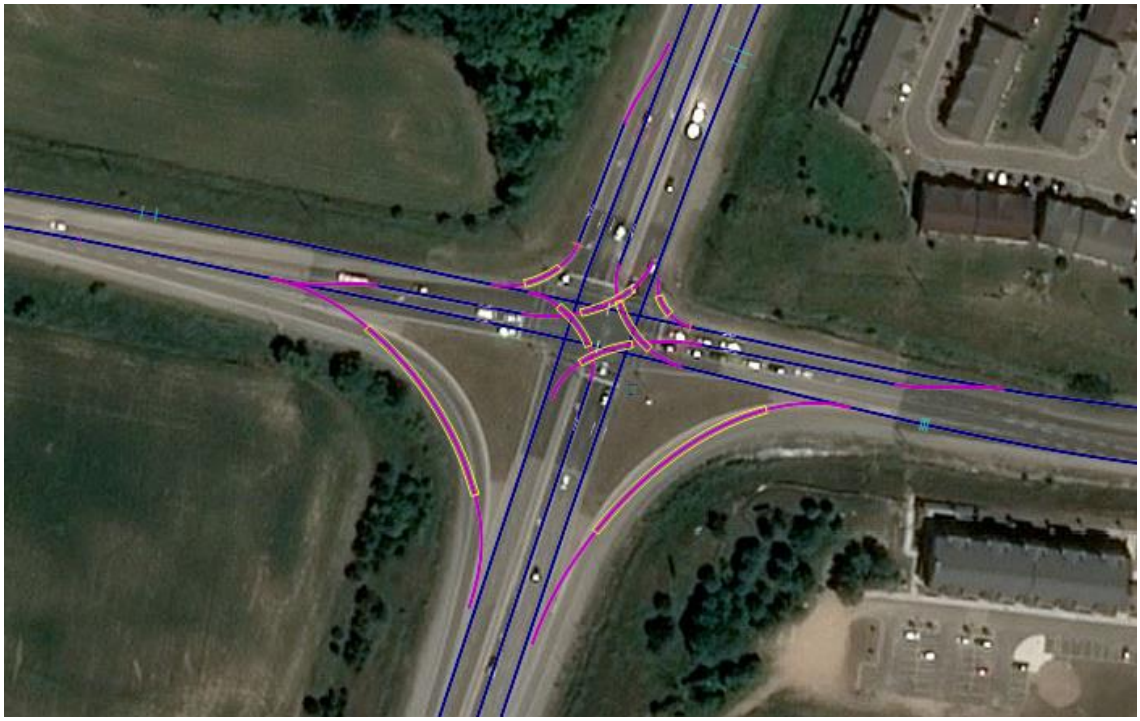


Exhibit 2-5: Example of a Static Routing Decision at a Signalized Intersection



Exhibit 2-6: Example of a Static Routing Decision at a Roundabout



2.3 Volume Balancing

To calibrate the Base Scenario, traffic volumes between adjacent intersections were balanced achieve/preserve consistent entry and exit volumes. The following approach was taken:

- When comparing entry and exit volumes at each intersection, the higher volume was always taken as the 'correct' volume (conservative estimation);
- To balance entry and exit volumes, the source individual movements were adjusted based on several factors including available capacity, contribution percentage, and/or proximity to modelled volume entry and exit points.

The results of this volume balancing exercise are detailed in Exhibit 2-7.

Exhibit 2-7: Volume Balancing Adjustments

INTERSECTING STREET	DIRECTION	IMBALANCE	ADJUSTED MOVEMENT	VOLUME ADJUSTMENT
Hespeler Road	WB	-140	NBL	+72
			SBR	+22
			WBT	+46
	EB	-60	EBT	+60
Beaverdale Road	WB	-140	WBT	+140
	EB	-60	EBT	+60
Old Maple Grove	WB	-135	WBT	+135
	EB	-65	EBT	+65
Compass Trail	WB	-135	WBT	+135
	EB	-60	EBT	+60
Speedsville Road	WB	-130	WBT	+130
	EB	-80	EBT	+80
Boxwood Drive	WB	-130	WBT	+130
	EB	-80	EBT	+80
Vondrau Dr	WB	-130	WBT	+130
	EB	-80	EBT	+80
Fountain Street	WB	-230	WBT	+230
	EB	-50	EBT	+50

2.4 Simulation Parameters

Each model scenario was tested using separate models for the a.m. and p.m. peak hours. Each simulation was defined to run for 4,500 seconds (75 minutes), with the data collection defined to begin at 1,800 seconds (15 minutes). This delayed start time for data collection allows time for vehicles to sufficiently populate the road network, before a data collection period of 3,600 seconds (60 minutes) is measured, representative of the a.m. or p.m. peak hour.

Five repeat simulations were conducted for each scenario, which each repeat simulation using a different 'random seed number'. The random seed number affects many parameters in VISSIM, such as the arrival time of vehicles entering the model, and the assignment of driver behaviours to each vehicle. The same set of five seed numbers (which itself was established at random) was used across all model scenarios to ensure a consistent seeding pattern was used.

2.5 Model Calibration

This section details the various calibration/validation measures used to ensure that the performance of the Base Scenario VISSIM model matched actual site conditions. Methods included performing a visual check of lane configurations, observing typical driving behaviours, and reviewing the operational performance of the model.

As part of this calibration effort, a site visit was conducted to observe real world conditions during peak travel periods, and as a method of quality control through visual checks to confirm lane configurations and typical driver behaviours.

Additionally, outputs from five simulation runs of the Base Scenario model were aggregated and average values were determined for the following metrics:

- Total vehicle count for the simulation hour;
- Average Delay for the simulation hour in seconds; and
- Average Queue for the simulation hour in metres.

These average metrics were reviewed against field data and outputs from alternative traffic tools to ensure that results fell within an acceptable range of variance. This process is detailed further in the following sections.

2.5.1 Volumetric Calibration

Modelled intersection volumes were compared to reference turning movement counts, and calibrated so that the following rules were met:

- Total intersection volume did not exceed a maximum variance of 10%; and
- Individual turning movements did not vary by more than 50 vph.

Exhibit 2-8 shows volume differences at each intersection in the a.m. peak hour following volumetric calibration.

Exhibit 2-8: Volumetric Calibration Results

NODE	INTERSECTING STREET	VISSIM VOLUME	COUNT VOLUME	Δ%
1	Beaverdale Road	2145	2168	1.07%
2	Speedsville Road	2409	2437	1.16%
3	Vondrau Drive	2117	2142	1.17%
4	Fountain Street	3360	3354	0.18%
5	Boxwood Drive	1995	2005	0.50%
6	Compass Trail	1903	1932	1.51%
7	Old Maple Grove	1877	1905	1.48%
8	Hespeler Road	3660	3687	0.73%

2.5.2 Performance Calibration

Performance results output from the Base Scenario modelled in VISSIM were compared to those output for the same scenario modelled in Synchro (and using HCM 2010 methodologies). Exhibit 2-9 provides a summary of this comparison for a.m. peak hour outputs, which are deemed to fall within an acceptable variance.

Exhibit 2-9: Performance Calibration Results

Intersection	Movement	VISSIM		Synchro	
		Intersection LOS	Intersection Delay (s)	LOS	Delay (s)
Hespeler Road & Maple Grove Road	EBL	D	40	D	49
	EBT	D	44	D	50
	EBR	A	7	A	8
	WBL	F	80	E	56
	WBT	E	79	F	121
	NBL	D	44	F	102
	NBT	B	14	B	15
	NBR	A	3	B	12
	SBL	C	29	D	39
	SBT	C	34	E	72
	SBR	B	13	D	43

3 Base Scenario

3.1 Existing Traffic Volumes

Turning movement counts (TMC's) for the study area intersections were provided by the Region, with all counts having been undertaken on October 22, 2018. The scope of this analysis was limited to the morning (a.m.) and afternoon (p.m.) peak hours. Traffic volume diagrams are provided in Appendix A.

3.2 Traffic Operations

Exhibit 3-1 summarizes the lane configurations modelled at intersection approaches in the 2019 Base Scenario. Intersections were modelled based on their current lane configuration, with two exceptions:

- The planned future Compass Trail intersection was included and modelled with one-way stop control; and
- The existing Briardean Road intersection (one-way stop control) was modelled as being closed, as future access is assumed to be provided via Compass Trail.

Exhibit 3-1: Modelled Intersection Configurations, 2019 Base Scenario

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	Signalized	1L,1T,1R	1L,1TR	1L,2T,1R	1L,2T,1R
Beaverdale Road	Signalized	1L,1T,1TR	1L,1T,1TR	1L,1TR	1L,1TR
Old Maple Grove	One-Way Stop Control	1TR	1TL	1LR	-
Compass Trail	One-Way Stop Control	1TR	1TL	1LR	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	Signalized	1L,1TR	1L,1T,1R	1LTR	1LTR
Boxwood Drive	Two-Way Stop Control	1L,1TR	1L,1T,1R	1L,1TR	1LTR
Vondrau Drive	Signalized	1L,1T,1R	1L,1TR	1LTR	1LTR

Exhibit 3-2 provides a summary of traffic operations along the corridor under the 2019 Base Scenario. It also lists all critical movements identified, which are defined as movements operating with level-of-service (LOS) E or F. Detailed VISSIM outputs are also included in Appendix B.

Exhibit 3-2: Summary of Traffic Operations, 2019 Base Scenario

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	D	WBL	29	80	F	E	NBL	447	200	F
		WBT	80	79	E		NBT	11	67	E
		WBR	80	79	E					
Beaverdale Road & Maple Grove Road	A	(no critical movements)				C	(no critical movements)			
Old Maple Grove & Maple Grove Road	A	(no critical movements)				C	(no critical movements)			
Compass Trail & Maple Grove Road	A	(no critical movements)				B	NBL	29	90	F
							NBR	30	58	E
Speedsville Road & Maple Grove Road	C	(no critical movements)				E	NBL	68	73	E
							NBT	68	59	E
							NBR	68	55	E
							EBL	1	77	E
							WBL	4	124	F
							WBT	357	99	F
							WBR	354	82	F
Boxwood Drive & Maple Grove Road	A	(no critical movements)				E	NBL	6	77	E
							SBL	125	198	F
							SBT	63	187	F
							SBR	127	227	F
							WBL	1	58	E
							WBT	157	90	F
Vondrau Drive & Maple Grove Road	B	(no critical movements)				F	NBL	16	190	F
							NBT	16	69	E
							SBL	29	88	F
							SBR	27	250	F
							EBL	18	59	E
							WBL	13	190	F
							WBT	270	274	F
							WBR	0	118	F

The 2019 Base Scenario model operates as follows:

- Hespeler Road & Maple Grove Road, currently a signalized intersection, operates poorly at LOS D and E in the a.m. and p.m. peak hours respectively. In the a.m. peak, moderate delays are observed on the westbound approach, largely due to priority green time being allocated to the heavier northbound and southbound movement. In the p.m. peak, significant delays are observed on the northbound approach and in particular for NBL movement, where average delays exceed three minutes and average queues extend beyond 400 metres.
- Beaverdale Road & Maple Grove Road, currently a signalized intersection, operates well in both peak hours and no critical movements are identified.
- Compass Trail & Maple Grove Road was included in this model as a new unsignalized development access with one-way stop control (northbound approach). The intersection operates well in both peak hours and no critical movements are identified. With its inclusion, the unsignalized intersection at Briardean Road was in turn modelled as being closed.

- Speedsville Road & Maple Grove Road, currently a signalized intersection, operates satisfactorily at LOS C in the a.m. peak hour, however deteriorates to LOS E in the p.m. peak hour. Heavy westbound volumes are not sufficiently accommodated in the in the p.m. peak hour, suggesting a strong need to widen Maple Grove Road. Traffic along the northbound approach also experiences delays and queuing.
- Boxwood Drive & Maple Grove Road, which operates under two-way stop control, performs well in the a.m. peak hour but poorly in the p.m. peak hour at LOS E. The minor northbound and southbound approaches possess only a single shared through/left/right lane while carrying a high percentage of heavy trucks, and experience significant delays as a result. With these approaches also unsignalized, left-turning traffic can be delayed when attempting to turn onto Maple Grove Road.
- Vondrau Drive & Maple Grove Road, currently a signalized intersection, performs well in the a.m. peak hour but poorly in the p.m. peak hour at LOS F. Similar to the intersection at Boxwood Drive, minor northbound and southbound approaches possess only a single shared through/left/right lane while carrying a high percentage of heavy trucks, and experience significant delays as a result.

4 Future Interim Conditions (2036)

4.1 Future Volume Projections and Modelled Road Network

Future volume projections for the 2036 interim horizon were provided by the Region. These projections originated from Region's travel demand model and account for development growth forecasts. Traffic volume diagrams are provided in Appendix A.

Several road network modifications were made in all future-year VISSIM model scenarios, accounting for planned or potential road projects to occur within the study area. These future road network changes are detailed as follows:

- Maple Grove Road was modelled as being widened from 2 to 4 lanes;
- Beaverdale Road and Speedsville Road, which are each candidates to be widened and uploaded to the Region, were both modelled as being widened from 2 to 4 lanes for the purpose of this exercise; and
- The planned Compass Trail intersection was included, while access to both Old Maple Grove Road and Brairdean Road was modelled as being closed (cul-de-sac).

4.2 Traffic Operations

4.2.1 2036 ICS Interim Design

The present microsimulation task will build on prior modelling efforts, thereby confirming and/or refining recommendations of the intersection control studies (ICS) completed by CIMA+.

For the 2036 horizon year, an initial VISSIM model was developed that incorporates the interim ICS designs at Hespeler Road, Beaverdale Road, Speedsville Road, and Boxwood Road. Note that Old Maple Grove Road was modelled as being closed based on preliminary EA findings.

Exhibit 4-1 summarizes the lane configurations modelled at each intersection approach in the 2036 ICS Interim Design model. Future base lane configurations were assumed for intersections not included in the ICS studies.

Exhibit 4-1: Modelled Intersection Configurations, 2036 ICS Interim Design

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2-lane Roundabout	1TL, 1T, 1R	1TL,1TR	1TL,1TR	1TL,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	One-Way Stop Control	1T,1TR	1TL,1T	1LR	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	Signalized w/ dual NBL	1L,3T,1R	1L, 2T, 1TR	2L,2T,1R	1L,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 4-2 provides a summary of future traffic operations along the corridor output from the 2036 ICS Interim Design model, including a list of critical movements operating at LOS E or F. Detailed VISSIM outputs are provided in Appendix B.

Exhibit 4-2: Summary of Traffic Operations, 2036 ICS Interim Design

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	F	NBL	492	264	F	F	NBL	487	208	F
		NBT	492	204	F		NBT	487	163	F
		NBR	492	173	F		NBR	487	139	F
		SBL	498	481	F		SBL	465	221	F
		SBT	498	315	F		SBT	465	193	F
		SBR	498	137	F		SBR	465	130	F
		EBL	178	156	F		EBL	302	213	F
		EBT	178	106	F		EBT	302	149	F
		WBL	501	985	F		EBR	195	55	D
		WBT	501	521	F		WBL	347	444	F
		WBR	501	340	F		WBT	347	166	F
							WBR	348	60	E
Beaverdale Road & Maple Grove Road	A	(no critical movements)				D	NBL	77	167	F
							NBT	77	138	F
							NBR	71	107	F
							SBL	26	63	E
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville Road & Maple Grove Road	C	(no critical movements)				C	NBL	75	145	F
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	B	(no critical movements)				C	(no critical movements)			

The 2036 ICS Interim Design model operates as follows:

- Hespeler Road & Maple Grove Road is modelled as a 2-lane roundabout and operates very poorly at LOS F during both peak hours. Significant delay and queuing is observed at all four approaches, as three circulatory flows within the roundabout are high and there are insufficient gaps for traffic to enter.
- Beaverdale Road & Maple Grove Road is modelled as a 2-lane roundabout and operates at LOS A and D in the a.m. and p.m. peak hours respectively. Steady eastbound and westbound flows make it difficult for northbound traffic to enter, causing some delays and queuing.
- Old Maple Grove & Maple Grove Road (not shown) is modelled as being closed, with Old Maple Grove Road terminating at a cul-de-sac before Maple Grove Road.
- Compass Trail & Maple Grove Road is an unsignalized intersection with one-way stop control (northbound approach), modelled with full-moves access in this scenario. The intersection operates well in both peak hours. However, it is noted that the NBL movement involves crossing multiple east/west traffic lanes carrying heavy volumes at high speeds, and so consideration should be given towards prohibiting this movement to mitigate potential safety concerns.
- Speedsville Road & Maple Grove Road is modelled as a signalized intersection with dual NBL lanes to accommodate heavy volumes at this movement. The intersection operates well given this configuration, at overall LOS C in both peak hours. The

NBL movement experiences delays in the p.m. peak hour even despite the dual turning-lanes, however no other critical movements are identified.

- Both the intersections at Boxwood Drive and at Vondrau Drive are modelled in this scenario as being signalized, with several auxiliary turning lanes added. These new auxiliary turning lanes, in combination with widening of Maple Grove Road, result in vastly improved operations in the p.m. peak hour when compared to the 2019 Base Scenario model results. Both intersections are now shown to operate well in both peak hours, and no critical movements are identified.

4.2.2 2036 Modified Design #1

Intersection configurations were modified based on the results of this prior model run and to test other design options. The first round of design modifications for the 2036 horizon include:

- Testing a 2x3-lane roundabout at Hespeler Road, maintaining two lanes on the east and west approaches but flaring out the north and south approaches to three lanes;
- Restricting access at Compass Trail, prohibiting northbound left-turns; and
- Testing a 2-lane roundabout at Speedsville Road.

Exhibit 4-3 summarizes the lane configurations modelled at each intersection approach in the 2036 Modified Design #1 model.

Exhibit 4-3: Modelled Intersection Configurations, 2036 Modified Design #1

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane Roundabout	1TL,1TR,1R	1TL,1TR	1L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	2-lane Roundabout	1TL,1TR,1R	1TL,1TR	1TL,1TR	1TL,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 4-4 provides a summary of future traffic operations along the corridor output from the 2036 Modified Design #1 model, including a list of critical movements operating at LOS E or F. Detailed VISSIM outputs are provided in Appendix B.

Exhibit 4-4: Summary of Traffic Operations, 2036 Modified Design #1

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	F	NBT	158	55	E	F	NBL	482	246	F
		SBL	483	730	F		NBT	482	195	F
		SBT	483	576	F		NBR	482	101	F
		SBR	483	143	F		SBL	496	678	F
							SBT	496	541	F
							SBR	496	187	F
Beaverdale Road & Maple Grove Road	B	SBL	29	71	E	C*	NBL	85	213	F
							NBT	85	182	F
							NBR	86	68	E
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville Road & Maple Grove Road	F	NBL	9	14	B	F	NBL	171	139	F
		SBL	130	341	F		NBT	171	97	F
		SBT	130	307	F		SBL	410	909	F
		SBR	126	274	F		SBT	410	875	F
		WBT	211	69	E		SBR	408	794	F
		WBR	210	85	F		WBT	345	118	F
							WBR	345	146	F
Boxwood Drive & Maple Grove Road	B	(no critical movements)				C	SBL	123	250	F
							SBT	123	223	F
							SBR	123	254	F
Vondrau Drive & Maple Grove Road	B	(no critical movements)				C	(no critical movements)			

** Reduced demand on the eastbound approach due to limited throughput at Speedsville Road.*

The 2036 Modified Design #1 model operates as follows:

- Hespeler Road & Maple Grove Road still operates very poorly despite the northbound and southbound approaches being flared to three lanes. While average intersection delay is slightly reduced, the intersection still operates at LOS F in both peak hours. Significant left-turning volumes at all four approaches continue to contribute to high circulatory volumes.
- There are no changes at Beaverdale Road & Maple Grove Road, however it is noted that a breakdown of conditions at Speedsville Road result in reduced eastbound volumes at Beaverdale Road.
- Speedsville Road & Maple Grove Road operates very poorly when modelled as a 2-lane intersection, operating at LOS F in both peak hours. This is largely due to the presence of very high NBL volumes, which contribute to very high circulatory volumes and conflict with entering traffic from the westbound and southbound approaches.
- There are no significant changes to operations at the remaining study intersections.

4.2.3 2036 Modified Design #2

Intersection configurations were modified based on the results of this prior model run and to test other design options. The second round of design modifications for the 2036 horizon include:

- Testing the 2x3-lane roundabout with the addition of a north-to-west flyover, a grade separated facility that allows NBL traffic to bypass the roundabout; and
- Reverting Speedsville Road to a signalized intersection with dual NBL lanes, again in accordance with the ICS recommendations.

Exhibit 4-5 summarizes the lane configurations modelled at each intersection approach in the 2036 Modified Design #2 model.

Exhibit 4-5: Modelled Intersection Configurations, 2036 Modified Design #2

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane RB w/ flyover	1TL,1TR,1R	1TL,1TR	2L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	Signalized w/ dual NBL	1L,3T,1R	1L, 2T, 1TR	2L,2T,1R	1L,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 4-6 provides a summary of future traffic operations output for 2036 Modified Design #2. Detailed VISSIM results are included in Appendix B.

Exhibit 4-6: Summary of Traffic Operations, 2036 Modified Design #2

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	C	WBL	59	86	F	C	WBL WBT	55 90	125 64	F E
Beaverdale Road & Maple Grove Road	B	(no critical movements)				D	SBL SBT SBR	185 185 185	385 230 143	F F F
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville & Maple Grove Road	C	(no critical movements)				D	NBL	81	153	F
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	B	(no critical movements)				D	(no critical movements)			

The 2036 Modified Design #2 model operates as follows:

- Hespeler Road & Maple Grove Road operates well with the inclusion of the NBL flyover, at LOS C during both peak hours. With the heavy NBL volume bypassing the roundabout, circulatory volumes are far less and there is reduced delay and queuing at all roundabout approaches.
- With the configuration of Speedsville Road & Maple Grove Road reverted back to a signalized intersection with dual NBL lanes, the intersection operates well once again at overall LOS C in both peak hours.
- There are no significant changes to operations at the remaining study intersections.

5 Future Ultimate Conditions (2041)

5.1 Future Network Changes & Volume Projections

Future volume projections for the 2041 ultimate horizon were provided by the Region. These projections originated from Region's travel demand model and account for development growth forecasts. Traffic volume diagrams are provided in Appendix A.

The same initial network modifications made in the 2036 VISSIM model scenarios were also carried forward to the 2041 scenarios. Again, these include the following road network changes:

- Maple Grove Road was modelled as being widened from 2 to 4 lanes;
- Beaverdale Road and Speedsville Road, which are each candidates to be widened and uploaded to the Region, were both modelled as being widened from 2 to 4 lanes for the purpose of this exercise; and
- The planned Compass Trail intersection was included, while access to both Old Maple Grove Road and Brairdean Road was modelled as being closed (cul-de-sac).

5.2 Traffic Operations

5.2.1 2041 ICS Ultimate Design

Similar to the initial model developed for the 2036 horizon, an initial VISSIM model was also developed for the 2041 horizon that incorporates the ultimate ICS designs at Hespeler Road, Beaverdale Road, Speedsville Road, and Boxwood Road. Note that Old Maple Grove Road was modelled as being closed based on preliminary EA findings.

Exhibit 5-1 summarizes the lane configurations modelled at each intersection approach in the 2041 ICS Ultimate Design model. Future base lane configurations were assumed for intersections not included in the previous ICS studies.

Exhibit 5-1: Modelled Intersection Configurations, 2041 ICS Ultimate Design

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane Roundabout	1TL,1TR,1R	1TL,1TR	1L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	One-Way Stop Control	1T,1TR	1TL,1T	1LR	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	Signalized w/ dual NBL	1L,3T,1R	1L, 2T, 1TR	2L,2T,1R	1L,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 5-2 provides a summary of future traffic operations along the corridor output from the 2041 ICS Ultimate Design model, including a list of critical movements operating at LOS E or F. Detailed VISSIM outputs are provided in Appendix B.

Exhibit 5-2: Summary of Traffic Operations, 2041 ICS Ultimate Design

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	F	NBL	227	117	F	F	NBL	466	212	F
		NBT	227	122	F		NBT	466	226	F
		NBR	227	86	F		NBR	466	162	F
		SBL	222	130	F		SBL	484	291	F
		SBT	222	151	F		SBT	484	327	F
		WBL	421	556	F		SBR	484	119	F
		WBT	421	357	F		EBL	448	73	E
		WBR	421	335	F		EBT	448	111	F
							EBR	445	117	F
							WBL	116	159	F
							WBT	116	79	E
Beaverdale Road & Maple Grove Road	B	(no critical movements)				F*	NBL	113	349	F
							NBT	113	190	F
							NBR	113	199	F
							SBL	49	115	F
							EBL	297	122	F
							EBT	297	136	F
Compass Trail & Maple Grove Road	A	(no critical movements)				D	NBL	16	79	E
							NBR	18	99	F
							EBT	115	63	E
Speedsville Road & Maple Grove Road	C	NBL	52	96	F	D	NBL	91	168	F
							WBL	44	108	F
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	B	(no critical movements)				C	(no critical movements)			

** Impacted by queueing at downstream Hespeler Road intersection.*

The 2041 ICS Ultimate Design model operates as follows:

- Hespeler Road & Maple Grove Road is modelled as a 2x3-lane roundabout and operates very poorly at LOS F during both peak hours. Significant delay and queuing is observed at all four approaches, as three circulatory flows within the roundabout are high and there are insufficient gaps for traffic to enter.
- Beaverdale Road & Maple Grove Road is modelled as a 2-lane roundabout and operates at LOS A and F in the a.m. and p.m. peak hours respectively. However, poor operations in the p.m. peak hour are partly attributable to the intersection occasionally being impacted by eastbound queuing at the downstream Hespeler Road intersection.
- Old Maple Grove & Maple Grove Road (not shown) is modelled as being closed, with Old Maple Grove Road terminating at a cul-de-sac before Maple Grove Road.
- Compass Trail & Maple Grove Road is an unsignalized intersection with one-way stop control (northbound approach), modelled with full-moves access in this scenario. The intersection operates at LOS A and D in the a.m. and p.m. peak hours respectively. Delay at the NBL movement contributes to the deteriorated conditions in the p.m. peak, and it is again noted that this movement involves

crossing multiple east/west traffic, and consideration should be given towards prohibiting this movement to mitigate potential safety concerns.

- Speedsville Road & Maple Grove Road is modelled as a signalized intersection with dual NBL lanes to accommodate heavy volumes at this movement. The intersection operates well given this configuration, at overall LOS C and D in the a.m. and p.m. peak hours respectively. The EBT movement experiences some delays in the p.m. peak, as additional green time is allocated towards the NBL movement.
- Both the intersections at Boxwood Drive and at Vondrau Drive are modelled in this scenario as being signalized, with several auxiliary turning lanes added. These new auxiliary turning lanes, in combination with widening of Maple Grove Road, result in vastly improved operations in the p.m. peak hour when compared to the 2019 Base Scenario model results. Both intersections are now shown to operate well in both peak hours, and no critical movements are identified.

5.2.1 2041 Modified Design #1

Intersection configurations were modified based on the results of this prior model run and to test other design options. The first round of design modifications for the 2041 horizon include:

- Testing the 2x3-lane roundabout with the addition of a north-to-west flyover, a grade separated facility that allows NBL traffic to bypass the roundabout; and
- Restricting access at Compass Trail, prohibiting northbound left-turns; and
- Testing a 2-lane roundabout at Speedsville Road.

Exhibit 5-3 summarizes the lane configurations modelled at each intersection approach in the 2041 Modified Design #1 model.

Exhibit 5-3: Modelled Intersection Configurations, 2041 Modified Design #1

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane RB w/ flyover	1TL,1TR,1R	1TL,1TR	2L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	2-lane Roundabout	1TL,1TR,1R	1TL,1TR	1TL,1TR	1TL,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 5-4 provides a summary of future traffic operations output for 2041 Modified Design #1. Detailed VISSIM results are included in Appendix B.

Exhibit 5-4: Summary of Traffic Operations, 2041 Modified Design #1

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	D	WBT	61	62	E	F	NBL	0	68	E
		WBR	61	60	E		NBT	393	104	F
							NBR	393	117	F
							EBL	433	283	F
							EBT	433	134	F
							EBR	343	66	E
							WBT	48	55	E
							WBR	48	57	E
Beaverdale Road & Maple Grove Road	B	SBL	55	137	F	F*	NBL	192	512	F
		SBT	55	77	E		NBT	192	426	F
							NBR	192	370	F
							SBL	116	242	F
							SBT	116	142	F
							SBR	116	64	E
							EBL	264	113	F
							EBT	264	122	F
							EBR	264	90	F
Compass Trail & Maple Grove Road	B	(no critical movements)				B	(no critical movements)			
Speedsville Road & Maple Grove Road	F	SBL	313	709	F	F	NBL	494	429	F
		SBT	313	677	F		NBT	494	348	F
		SBR	309	623	F		NBR	444	260	F
		WBL	383	175	F		SBL	445	759	F
		WBT	383	124	F		SBT	445	966	F
		WBR	382	89	F		SBR	445	1036	F
							EBL	193	71	E
							EBT	193	68	E
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	NBL	19	64	E
							SBL	47	95	F
							SBT	47	98	F
							SBR	47	98	F
Vondrau Drive & Maple Grove Road	B	(no critical movements)				C	(no critical movements)			

** Impacted by queueing at downstream Hespeler Road intersection.*

The 2041 Modified Design #1 model operates as follows:

- Despite the addition of the NBL flyover, Hespeler Road & Maple Grove Road still operates very poorly in the p.m. peak hour in 2041. In comparing the results of this scenario with those from the 2036 Modified Design #2 scenario, it is noted that additional traffic demands resulted in increased average delays, with increased queuing on the eastbound approach of particular concern.
- There are no changes at Beaverdale Road & Maple Grove Road. The intersection again operates at LOS F in the p.m. peak hour, as it continues to be impacted by eastbound queuing from the downstream Hespeler Road intersection.
- Speedsville Road & Maple Grove Road operates very poorly when modelled as a 2-lane intersection, operating at LOS F in both peak hours. This is largely due to the presence of very high NBL volumes, which contribute to very high circulatory

volumes and limit gaps available to traffic entering the roundabout from the westbound and southbound approaches.

- There are no significant changes to operations at the remaining study intersections.

5.2.2 2041 Modified Design #2

Intersection configurations were modified based on the results of this prior model run and to test other design options. The second round of design modifications for the 2041 horizon include:

- Further to the NBL flyover, adding an EBR bypass lane to the Hespeler Road intersection (in conjunction with the NBL flyover), which includes a long southbound acceleration lane allowing EBR vehicles to merge more easily with southbound traffic exiting the roundabout.
- Reverting Speedsville Road to a signalized intersection with dual NBL lanes, again in accordance with the ICS recommendations.

Exhibit 5-5 summarizes the lane configurations modelled at each intersection approach in the 2041 Modified Design #2 model.

Exhibit 5-5: Modelled Intersection Configurations, 2041 Modified Design #2

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane RB w/ flyover & extended EBR bypass	1TL,1TR,1R	1TL,1TR	2L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	2-lane Roundabout	1TL,1TR	1TL,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	2T	2T	cul-de-sac	-
Speedsville Road	Signalized w/ dual NBL	1L,3T,1R	1L, 2T, 1TR	2L,2T,1R	1L,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 5-6 provides a summary of future traffic operations output for 2041 Modified Design #2. Detailed VISSIM results are included in Appendix B.

Exhibit 5-6: Summary of Traffic Operations, 2041 Modified Design #2

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	D	WBL WBT WBR SBL	89 89 89 24	102 67 56 60	F E E E	E	NBT NBR WBL	305 305 88	101 139 103	F F F
Beaverdale Road & Maple Grove Road	B	NBL	136	355	F	D	NBL SBL SBT	42 82 82	95 152 88	F F F
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville Road & Maple Grove Road	C	NBL	58	105	F	D	NBL	24	64	E
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	B	(no critical movements)				D	EBL	136	134	F

The 2041 Modified Design #2 model operates as follows:

- Now having both a NBL flyover and an EBR bypass with extended acceleration lane, Hespeler Road & Maple Grove Road operates at LOS D and E in the a.m. and p.m. peak hours respectively. Inclusion of the EBR bypass greatly reduces delay and queuing along the eastbound approach, and for the roundabout overall.
- While are no changes at Beaverdale Road & Maple Grove Road, p.m. peak operations are greatly improved as the intersection is no longer impacted by eastbound queuing from the downstream Hespeler Road intersection (given inclusion of the EBR bypass lane).
- With the configuration of Speedsville Road & Maple Grove Road reverted back to a signalized intersection with dual NBL lanes, the intersection operates well once again at overall LOS C and D in the a.m. and p.m. peak hours respectively.
- There are no significant changes to operations at the remaining study intersections.

5.2.3 2041 Modified Design #2B

Intersection configurations were modified based the initial #2 Design, but with minor modifications. This round of design modifications for the 2041 horizon include:

- Beaverdale Road has been upgraded to the ultimate 3x2 lane configuration

Exhibit 5-7 summarizes the lane configurations modelled at each intersection approach in the 2041 Modified Design #2B model.

Exhibit 5-7: Modelled Intersection Configurations, 2041 Modified Design #2B

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane RB w/ flyover & extended EBR bypass	1TL,1TR,1R	1TL,1TR	2L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	3x2-lane Roundabout	1TL,1T,1TR	1TL,1T,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	Signalized w/ dual NBL	1L,3T,1R	1L, 2T, 1TR	2L,2T,1R	1L,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 5-8 provides a summary of future traffic operations output for 2041 Modified Design #2B. Detailed VISSIM results are included in Appendix B.

Exhibit 5-8: Summary of Traffic Operations, 2041 Modified Design #2B

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	D	EBL WBL WBT WBR	57 129 129 129	65 101 160 157	E F F F	D	EBL EBT EBR WBT WBR	177 177 145 102 102	60 98 60 112 115	E F E F F
Beaverdale Road & Maple Grove Road	A	(no critical movements)				D	SBL SBT SBR	173 173 173	390 260 191	F F F
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville Road & Maple Grove Road	D	NBL WBL	99 30	175 65	F E	E	NBL NBT NBR	356 9 12	413 125 102	F F F
Boxwood Drive & Maple Grove Road	B	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	C	(no critical movements)				C	(no critical movements)			

The 2041 Modified Design #2B model operates as follows:

- Hespeler Road & Maple Grove Road operates at LOS D in both a.m. and p.m. peak hours respectively. Inclusion of the EBR bypass greatly reduces delay and queuing along the eastbound approach, and for the roundabout overall.
- Beaverdale Road & Maple Grove Road was upgraded to the 3x2 configuration. Both a.m. and p.m. peak operations deteriorate with the addition of the third eastbound and westbound lane, as southbound operations worsen due to fewer opportunities to use the roundabout.
- With the configuration of Speedsville Road & Maple Grove Road as a signalized intersection with dual NBL lanes, the intersection operates with delays, overall with LOS D and E in the a.m. and p.m. peak hours respectively.
- There are no significant changes to operations at the remaining study intersections.

5.2.1 2041 Modified Design #3

Intersection configurations were modified based on the results of this prior model run and to test other design options. The third round of design modifications for the 2041 horizon include:

- Testing a 3x2-lane roundabout at Beaverdale Road, maintaining two lanes on the north and south approaches but flaring out the east and west approaches to three lanes;
- Testing a 3-lane roundabout at Speedsville Road, with inclusion of EBR and NBR bypass lanes as per the ICS recommendations.

Exhibit 5-9 summarizes the lane configurations modelled at each intersection approach in the 2041 Modified Design #3 model.

Exhibit 5-9: Modelled Intersection Configurations, 2041 Modified Design #3

INTERSECTING STREET	CONTROL TYPE	LANE CONFIGURATION			
		EB	WB	NB	SB
Hespeler Road	2x3-lane RB w/ flyover & extended EBR bypass	1TL,1TR,1R	1TL,1TR	2L,1TL,1TR	1TL,1T,1TR
Beaverdale Road	3x2-lane Roundabout	1TL,1T,1TR	1TL,1T,1TR	1TL,1TR	1TL,1TR
Old Maple Grove	Closed	2T	2T	cul-de-sac	-
Compass Trail	LI/RI/RO	1T,1TR	1TL,1T	1R	-
Briardean Road	Closed	1T	1T	cul-de-sac	-
Speedsville Road	3-lane RB w/ EBR & NBR bypasses	1TL,2T,1R	1TL,1T,1TR	1TL,2T,1R	1TL,1T,1TR
Boxwood Drive	Signalized	1L,2T,1R	1L,1T,1TR	1L,1TR	1TLR
Vondrau Drive	Signalized	1L,2T,1R	1L,2T,1R	1TL,1R	1TLR

Exhibit 5-10 provides a summary of future traffic operations output for 2041 Modified Design #3. Detailed VISSIM results are included in Appendix B.

Exhibit 5-10: Summary of Traffic Operations, 2041 Modified Design #3

INTERSECTION	AM PEAK HOUR					PM PEAK HOUR				
	Overall LOS	Individual Movements				Overall LOS	Individual Movements			
		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS		Mvmt	Avg. Queue (m)	Avg. Delay (s)	LOS
Hespeler Road & Maple Grove Road	D	NBL	15	15	B	E	EBL	182	56	E
		EBT	73	74	E		EBT	182	128	F
		WBL	115	144	F		WBL	99	177	F
		WBT	115	96	F		WBT	99	64	E
		WBR	115	84	F					
Beaverdale Road & Maple Grove Road	B	NBL	18	64	E	E*	NBL	54	176	F
							SBL	117	244	F
							SBT	117	129	F
							WBL	202	94	F
							WBT	202	84	F
							WBR	202	54	D
Compass Trail & Maple Grove Road	A	(no critical movements)				A	(no critical movements)			
Speedsville Road & Maple Grove Road	C	(no critical movements)				F	NBL	420	247	F
							NBT	420	208	F
							SBT	28	56	E
							EBL	134	70	E
Boxwood Drive & Maple Grove Road	A	(no critical movements)				B	(no critical movements)			
Vondrau Drive & Maple Grove Road	B	(no critical movements)				C	(no critical movements)			

** Impacted by upstream 3-lane roundabout at Speedsville Road, as steady eastbound traffic flow results in fewer gaps for southbound traffic to enter the roundabout.*

The 2041 Modified Design #3 model operates as follows:

- While are no changes at Beaverdale Road & Maple Grove Road, p.m. peak operations slightly deteriorate when compared to the previous model run. This is due to presence of a 3-lane roundabout at Speedsville Road, which produces steadier eastbound exit traffic flows as compared to the previous signalized configuration. In turn, the number of gaps available for northbound and southbound traffic to enter the Beaverdale Road roundabout are more limited.
- Speedsville Road & Maple Grove Road, modelled as a 3-lane roundabout with EBR and NBR bypass lanes, operates at LOS C in the a.m. peak hour but LOS F in the p.m. peak hour. Despite the presence of three northbound approach lanes, where the leftmost lane operates as a dedicated left-turn lane while centre lane serves as a shared left-through lane, heavy NBL volumes continue to impact roundabout operations. Delays are observed on the northbound, eastbound, and southbound approaches.
- There are no significant changes to operations at the remaining study intersections.

6 Summary of Findings

This report describes the methodologies and findings of VISSIM microsimulation models developed to test possible future corridor and intersection configuration options along Maple Grove Road. This analysis builds on the findings of intersection control studies (ICS) by the Region and CIMA+.

Two planning horizons, 2036 (interim) and 2041 (ultimate), were analyzed as a way to consider potential phasing of certain intersection improvements. These planning horizons match those considered in the previous ICS studies, with exception of those used for the Hespeler Road intersection (being 2025 and 2035).

A summary of findings for each study intersection is detailed below.

Hespeler Road & Maple Grove Road:

- Noting that different horizon years were considered, the ICS studies recommended a 2-lane roundabout in the interim and a 2x3-lane roundabout in the ultimate.
- Microsimulation results suggest that even a 2x3-lane roundabout will not be sufficient in the 2036 horizon year unless a NBL flyover is also provided. In addition to the NBL flyover, results also indicate that operations are greatly improved if an EBR bypass lane, including an extended acceleration lane in the southbound direction, is also provided by 2041.

Beaverdale Road & Maple Grove Road:

- The ICS studies recommended a 2-lane roundabout in the interim and a 3x2-lane roundabout in the ultimate.
- Microsimulation results suggest that a 2-lane roundabout is sufficient in 2036 and may be sufficient even for 2041. A 3x2-lane roundabout was also tested, but the flaring out of the east and west approaches to three lanes resulted in additional delays on the north and south approaches, and overall LOS actually worsened. It is recommended that right of way be protected for the optional expansion to a 3x2 lane roundabout in 2041.

Old Maple Grove Road & Maple Grove Road:

- The ICS studies recommended a 2-lane roundabout in the interim and a 3x2-lane roundabout in the ultimate.
- Based on preliminary EA findings, this intersection was modelled as being closed. Residents along Old Maple Grove Road have expressed concerns of frequent speeding along this roadway, which is likely being used as a short-cut route between Maple Grove Road and Beaverdale Road. Following this, it is recommended to close the intersection, access to Old Maple Grove Road will be provided solely via Beaverdale Road.

Compass Trail and Briardean Road intersections:

- Compass Trail is a planned future development access off Maple Grove Road. Microsimulation results suggest this intersection will operate well unsignalized under one-way stop control. However the NBL movement involves crossing multiple east/west traffic lanes carrying heavy volumes at high speeds, and so consideration should be given towards prohibiting this movement to mitigate potential safety concerns.
- Briardean Road & Maple Grove Road was modelled as being closed, with access to Briardean Road instead provided via Speedsville Road and the new Compass Trail.

Speedsville Road & Maple Grove Road

- The ICS studies recommended this intersection be signalized, with dual left-turn lanes provided on the northbound approach to accommodate heavy NBL volumes.
- Microsimulation results show that this intersection operates well in 2036 and 2041 when signalized with dual NBL lanes, as per the ICS recommendations.
- Several roundabout configurations were also modelled and tested. Findings suggest that a 2-lane roundabout will operate very poorly in 2036. Furthermore, a 3-lane roundabout with EBR and NBR bypass lanes (per the ICS recommendations) was tested in the 2041 horizon, and was found to operate well in the a.m. peak but poorly in the p.m. peak. Therefore, it is recommended to signalize the intersection.

Boxwood Drive and Vondrau Drive intersections:

- Microsimulation results indicate that both of these intersections will operate well in 2041 either signalized (with several auxiliary turning lanes added) or as 2-lane roundabouts. Given that Boxwood Drive and Vondrau Drive serve industrial land-uses, and these intersections serve high heavy truck volumes, signalized intersections may be preferred as they would likely enable easier truck access.

The Roundabout Coordination Committee (RCC) reviewed the recommendation listed above and approved of the intersection configurations and agreed with the rational for each configuration.

Overall, the recommended design to be carried forward is the Design #2 in 2036 and Design #2B in 2041

Appendix Q – Intersection Control Study (CIMA)

September 2023

The Region of Waterloo

Intersection Control Study

Maple Grove Road at Boxwood Drive, Speedsville Road, Old Maple Grove Road and Beaverdale Road

February 25, 2020

B001016

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The Region of Waterloo

Intersection Control Study

Maple Grove Road at Boxwood Drive, Speedsville Road, Old Maple Grove Road and Beaverdale Road

Project no B001016

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February 25, 2020

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1. Executive Summary

CIMA+ has undertaken an Intersection Control Study (ICS) for four locations along Maple Grove Road in Cambridge: Boxwood Drive, Speedsville Road, Old Maple Grove Road and Beaverdale Road. The ICS is further to the planned widening and reconstruction of Maple Grove Road between Fountain Street and Hespeler Road. A roundabout is currently planned for construction at Fountain Street, and several intersection control alternatives are currently being explored at Hespeler Road.

Signalized intersections and roundabouts were evaluated at each location. The quantitative criteria formally evaluated consisted of peak hour operational performance for motorists, estimated construction costs, and 20-year study period costs (which include motor vehicle collision and intersection maintenance costs). A number of other more qualitative criteria were also discussed.

A summary of the quantitative comparison is provided in Tables i to iv. Note that traffic forecasts are without a Maple Grove Road bypass (Scenario 1) and with a bypass (Scenario 2), and LOS means level of service. Conceptual designs for both alternatives are at the end of this report as Figures 2 through 13.

Table i: Summary Evaluation – Boxwood Dr.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'A' ('B')	'A' ('A')	'A' ('B')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'A' ('C')	'A' ('C')	'A' ('C')	'A' ('C')
Estimated Construction Cost (in thousands)	$2,744	$3,619	$2,744	$3,619
Estimated 20-Year Study Period Cost (PC, in thousands)	**$3,744**	**$5,080**	**$3,754**	**$5,337**

Table ii: Summary Evaluation – Speedsville Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'C' ('D')	'A' ('A')	'C' ('C')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'C' ('D')	'A' ('D')	'C' ('D')	'A' ('E')
Estimated Construction Cost (in thousands)	$4,072	$4,350	$4,072	$4,350
Estimated 20-Year Study Period Cost (PC, in thousands)	**$5,687**	**$8,762**	**$5,686**	**$8,821**

Table iii: Summary Evaluation – Old Maple Grove Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'A' ('A')	'A' ('A')	'B' ('C')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'A' ('B')	'A' ('A')	'B' ('D')	'A' ('B')
Estimated Construction Cost (in thousands)	$2,354	$2,712	$2,354	$2,712
Estimated 20-Year Study Period Cost (PC, in thousands)	**$4,679**	**$3,043**	**$5,503**	**$4,054**

Table iv: Summary Evaluation – Beaverdale Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'B' ('C')	'A' ('A')	'A' ('B')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'B' ('C')	'A' ('C')	'B' ('B')	'A' ('A')
Estimated Construction Cost (in thousands)	$1,119	$2,056	$988	$2,139
Estimated 20-Year Study Period Cost (PC, in thousands)	**$4,425**	**$6,120**	**$4,293**	**$6,203**

Expressed as present costs, a signalized intersection is estimated to have a lower 20-year study period cost at three of the locations:

- Boxwood Drive, by a margin of $1,336,000 under Scenario 1 and $1,583,000 under Scenario 2.
- Speedsville Road, by a margin of $3,075,000 under Scenario 1 and $3,135,000 under Scenario 2.
- Beaverdale Road, by a margin of $1,695,000 under Scenario 1 and $1,910,000 under Scenario 2.

A roundabout is estimated to have a lower 20-year study period cost at Old Maple Grove Road by a margin of $1,636,000 under Scenario 1 and $1,449,000 under Scenario 2.

Historically, the Region may consider implementation of a roundabout if its 20-year study period cost is less than 1.5 times the cost of the signalized intersection alternative. This is because of the advantages roundabouts have with various qualitative criteria (mainly off-peak traffic operations and speed control). A roundabout is about 1.4 times the cost at Boxwood Drive and Beaverdale Road, and 1.5 to 1.6 times the cost at Speedsville Road.

In looking at Maple Grove Road between Fountain Street and Hespeler Road, a roundabout is currently planned for construction at Fountain Street and a signalized intersection is preferred in terms of 20-year study period costs at Speedsville Road. A roundabout was screened out at

Vondrau Drive. Therefore in terms of corridor continuity it may make sense to implement a signalized intersection at Boxwood Drive rather than a roundabout, so that east of Fountain Street there are three signalized intersections in succession. Farther east could be roundabouts at Old Maple Grove Road and Beaverdale Road. There are residential properties on all four corners at Beaverdale Road that would be impacted to varying degrees with implementation of a roundabout, but it is assumed the impacts could be managed.

Accordingly, it is recommended that with the widening of Maple Grove Road the intersections of Boxwood Drive and Speedsville Road be under traffic signal control, and the intersections of Old Maple Grove Road and Beaverdale Road be converted to roundabouts.

2. Introduction

2.1 Purpose of this Report

The Region of Waterloo has requested an Intersection Control Study (ICS) for four locations along Maple Grove Road in Cambridge: Boxwood Drive, Speedsville Road, Old Maple Grove Road and Beaverdale Road. The ICS is further to the planned widening and reconstruction of Maple Grove Road between Fountain Street and Hespeler Road.

The ICS compares signalized intersections and roundabouts at each location. The quantitative criteria formally evaluated consist of:

- Peak hour operational performance for motorists
- Estimated construction costs
- Study period costs (which include motor vehicle collision and intersection maintenance costs).

A number of other qualitative criteria are discussed but not formally evaluated: peak and off-peak environmental considerations, aesthetics, public outreach, off-peak traffic operations and corridor travel times, speed control, access management, truck accommodation and driver expectancy.

2.2 Site Context

Maple Grove Road is a major east-west arterial road in northern Cambridge. At its western extent it becomes Sportsworld Drive, interchanges with Highway 8, and continues to King Street. At its eastern extent it becomes Fisher Mills Road past Hespeler Road and continues to Guelph Avenue. Maple Grove Road has a four-lane urban section from Fountain Street to just east of Vondrau Drive, and a two-lane predominately rural section easterly to Hespeler Road (urban at certain intersections). The posted speed limit is 70 km/h.

Boxwood Drive is a north-south industrial collector road with a two-lane mainly urban section within the study area and a statutory speed limit of 50 km/h. It is under stop control at Maple Grove Road.

Speedsville Road is a north-south arterial road with a two-lane rural section within the study area and a posted speed limit of 70 km/h. It is under traffic signal control at Maple Grove Road. Speedsville Road extends northerly to Kossuth Road and southerly beyond Highway 401 (no interchange) where it becomes Concession Road. It is rural in character and is assumed to be eventually widened to a four-lane section.

Old Maple Grove Road is a residential collector road with a two-lane rural section within the study area and a statutory speed limit of 50 km/h. It is under stop control on the south side of Maple Grove Road, and connects to the west side of Beaverdale Road.

Beaverdale Road (Regional Road 32) is a north-south arterial road with a two-lane urban section within the study area and a posted speed limit of 50 km/h. It is under traffic signal control at Maple Grove Road. Beaverdale Road extends northerly to Kossuth Road and southerly to tie into Hespeler Road. It is rural residential in character and is assumed to be eventually widened to a four-lane section.

Area land use is industrial west of Boxwood Drive, with a major Toyota manufacturing plant to the south and a Loblaws distribution centre (among other uses) to the north. To the east it transitions to woodlot, agricultural and low-density residential land uses.

The site context is shown in Figure 1. A roundabout is currently planned for construction at Fountain Street, and several intersection control alternatives are currently being explored at Hespeler Road.



Figure 1: Maple Grove Rd. Study Area

2.3 Intersection Alternatives

2.3.1 Signalized Intersections

Conceptual designs for the four intersections under traffic signal control were developed such that a reasonable future peak hour level of service (LOS) for motorists could be achieved, but not result in excess off-peak capacity and poorer-than-necessary conditions for any pedestrians and cyclists. The signalized intersection concepts are at the end of this report as Figures 2, 5, 8 and 11.

At Boxwood Drive existing and future lane configurations are:

- Eastbound – currently one left-turn, one through and right-turn lane, changing the right-turn lane to a shared through/right-turn lane.
- Westbound – currently one left-turn and one shared through/right-turn lane, widening to one through lane plus a shared through/right-turn lane.
- Northbound – currently one lane, widening to one left-turn plus a shared through/right-turn lane.
- Southbound – currently one left-turn and one shared through/right-turn lane, maintaining as-is.

At Speedsville Road existing and future lane configurations are:

- Eastbound – currently one left-turn, one through and one right-turn lane, widening to three through lanes plus a right-turn lane.
- Westbound – currently one left-turn and one shared through/right-turn lane, widening to two through lanes plus a shared through/right-turn lane.
- Northbound – currently one lane, widening to two left-turn, two through and one right-turn lane.
- Southbound – currently one lane, widening to one left-turn, one through and one shared through/right-turn lane.

At Old Maple Grove Road existing and future lane configurations are:

- Eastbound – currently one lane, widening to two through lanes plus a right-turn lane.
- Westbound – currently one left-turn and one through lane, widening to two through lanes.
- Northbound – currently one lane, widening to one left-turn and one right-turn lane.

At Beaverdale Road existing and future lane configurations are:

- Eastbound – currently one left-turn, one through and one right-turn lane, widening to one through lane plus a shared through/right-turn lane.
- Westbound – currently one left-turn and one shared through/right-turn lane, widening to one through lane plus a shared through/right-turn lane.
- Northbound – currently one left-turn and one shared through/right-turn lane, widening to one through and one shared through/right-turn lane.
- Southbound – currently one left-turn and one shared through/right-turn lane, widening to one through and one shared through/right-turn lane.

2.3.2 Roundabouts

Conceptual designs for the roundabouts were developed similar to the signalized intersections. This resulted in interim/ultimate configurations at all four locations.

At Boxwood Drive the interim roundabout has an inscribed circle diameter (ICD) of 52 metres. There are two-lane entries and exits eastbound and westbound, single-lane entries and exits northbound and southbound, and a northbound yield-controlled right-turn bypass. The ultimate roundabout widens (flares) to three-lane entries eastbound and westbound, two-lane entries northbound and southbound, and retains the northbound right-turn bypass.

At Speedsville Road the interim roundabout has an ICD of 56 metres. There are two-lane entries and exits in all directions, and eastbound and northbound yield-controlled right-turn bypasses. The ultimate roundabout widens (flares) to three-lane entries in all directions, and retains the eastbound and northbound right-turn bypasses.

At Old Maple Grove Road the interim roundabout has an ICD of 52 metres. There are two-lane entries and exits in all directions. The ultimate roundabout widens (flares) to three-lane entries eastbound and westbound.

At Beaverdale Road the interim roundabout has an ICD of 52 metres. There are two-lane entries and exits in all directions. The ultimate roundabout widens (flares) to three-lane entries eastbound and westbound. There are residential properties on all four corners of the intersection that would be impacted to varying degrees with implementation of a roundabout, most notably in the northwest corner.

The horizontal geometry for each roundabout concept achieves appropriate speed control and accommodates a WB-20 design vehicle for all movements. Interim and ultimate roundabout concepts are at the end of this report as Figures 3, 4, 6, 7, 9, 10, 12 and 13.

3. Performance Evaluation

3.1 Analysis Inputs

Forecast average annual daily traffic (AADT) and AM and PM peak hour turning movements were provided by the Region (dated January 25, 2019 for Boxwood Drive, and dated October 22, 2018 for the other three intersections) for incorporation into the following capacity and safety analyses. The forecasts are for the 2036 and 2041 horizon years, each without a Maple Grove Road bypass (Scenario 1) and with a bypass (Scenario 2).

3.2 Operational Performance Comparison

The signalized intersections were modelled using Synchro 9 under Highway Capacity Manual (HCM) 2000 methodology. The ultimate roundabouts were modelled using ARCADY 9 with a y-intercept adjustment of the capacity prediction of 5% downwards. Heavy vehicle percentages for the eastbound and westbound through movements were obtained from the Maple Grove Road Traffic Data sheet provided by the Region. For all other movements, a value of 2% was assumed. Results are summarized in Tables 1A to 1D. Synchro and ARCADY output sheets are provided in Appendix A.

At Boxwood Drive, peak hour delays and 95th percentile queues for motorists are roughly comparable between the signalized intersection and roundabout alternatives, and are generally low during the AM peak hour. During the PM peak hour:

- For a signalized intersection, moderate delays and queues are predicted eastbound and westbound for all scenarios. The highest is 2041 Scenario 1, with a 95th percentile queue of 248 metres (or more) eastbound and 174 metres (or more) westbound.

Table 1A: Predicted Peak Hour Traffic Operations – Boxwood Dr.

Measure and Direction		2036 Scenario 1		2036 Scenario 2		2041 Scenario 1		2041 Scenario 2	
		Signals	Rbt.	Signals	Rbt.	Signals	Rbt.	Signals	Rbt.
AM Peak Hour	**Delay**								
	SB	31 s	4 s	31 s	5 s	31 s	5 s	31 s	6 s
	EB	4 s	3 s	4 s	3 s	5 s	3 s	5 s	4 s
	NB	32 s	4 s	32 s	4 s	32 s	4 s	32 s	5 s
	WB	5 s	4 s	5 s	4 s	6 s	4 s	6 s	6 s
	Queue								
	SB	10 m	<25 m	10 m	<25 m	10 m	<25 m	10 m	<25 m
	EB	45 m	<25 m	46 m	<25 m	53 m	<25 m	60 m	<25 m
	NB	14 m	<25 m	16 m	<25 m	16 m	<25 m	16 m	<25 m
	WB	62 m	<25 m	60 m	<25 m	84 m	<25 m	79 m	<25 m
	Overall LOS	**'A'**	**'A'**	**'A'**	**'A'**	**'A'**	**'A'**	**'A'**	**'A'**

Table 1A: Predicted Peak Hour Traffic Operations – Boxwood Dr. (cont'd)

Measure and Direction		2036 Scenario 1		2036 Scenario 2		2041 Scenario 1		2041 Scenario 2	
		Signals	Rbt.	Signals	Rbt.	Signals	Rbt.	Signals	Rbt.
PM Peak Hour	**Delay**								
	SB	28 s	12 s	30 s	11 s	28 s	28 s	28 s	27 s
	EB	16 s	11 s	16 s	10 s	27 s	28 s	27 s	28 s
	NB	33 s	16 s	67 s	15 s	33 s	40 s	33 s	40 s
	WB	12 s	5 s	12 s	5 s	16 s	9 s	17 s	9 s
	Queue								
	SB	35 m	<25 m	51 m	<25 m	35 m	68 m	35 m	<25 m
	EB	#210 m	96 m	#202 m	78 m	#248 m	304 m	#248 m	309 m
	NB	45 m	<25 m	62 m	<25 m	47 m	30 m	47 m	30 m
	WB	121 m	<25 m	117 m	<25 m	#178 m	65 m	#174 m	63 m
	Overall LOS	**'B'**	**'A'**	**'B'**	**'A'**	**'C'**	**'C'**	**'C'**	**'C'**

Notes:

1. SB, EB, NB and WB are southbound, eastbound, northbound and westbound.
2. "Delay" is approach delay for a signalized intersection and average delay for a roundabout.
3. "Queue" corresponds to the longest 95th percentile queue per approach. A "#" denotes that volume exceeds capacity and queues may be longer. Queues are output in ARCADY in total vehicles per approach, and were converted to metres per lane incorporating the storage effects of flared entries where applicable.

- For a roundabout, low to moderate delays and queues are predicted eastbound. The highest is 2041 Scenarios 1 and 2, with a 95th percentile queue of 304 or 309 metres eastbound (approximately 40% of the distance to Vondrau Drive).

At Speedsville Road, peak hour delays and 95th percentile queues for motorists are roughly comparable between the signalized intersection and roundabout alternatives during the AM peak hour. Overall a roundabout is predicted to result in lower peak hour delays and 95th percentile queues except during the 2041 PM peak hour under Scenarios 1 and 2. During the PM peak hour:

- For a signalized intersection, moderate delays and queues are predicted eastbound and westbound for all scenarios. The highest is 2041 Scenario 2, with a 95th percentile queue of 189 metres (or more) eastbound and 139 metres (or more) westbound. Under the same scenario a queue of 120 metres is predicted northbound.
- For a roundabout, low to moderate delays and queues are predicted eastbound and westbound. The highest is 2041 Scenario 2, with a 95th percentile queue of 212 metres eastbound and 419 metres westbound (a 419-metre queue being approximately 50% of the distance to Boxwood Drive).

Table 1B: Predicted Peak Hour Traffic Operations – Speedsville Rd.

Measure and Direction		2036 Scenario 1		2036 Scenario 2		2041 Scenario 1		2041 Scenario 2	
		Signals	Rbt.	Signals	Rbt.	Signals	Rbt.	Signals	Rbt.
AM Peak Hour	**Delay**								
	SB	33 s	4 s	33 s	4 s	33 s	2 s	33 s	4 s
	EB	15 s	3 s	16 s	3 s	17 s	3 s	19 s	2 s
	NB	31 s	3 s	32 s	3 s	34 s	3 s	37 s	3 s
	WB	19 s	5 s	19 s	7 s	25 s	11 s	27 s	38 s
	Queue								
	SB	34 m	<25 m	36 m	<25 m	37 m	<25 m	41 m	<25 m
	EB	52 m	<25 m	55 m	<25 m	58 m	<25 m	70 m	<25 m
	NB	#57 m	<25 m	53 m	<25 m	#72 m	<25 m	#71 m	<25 m
	WB	78 m	<25 m	74 m	<25 m	95 m	27 m	#102 m	122 m
	Overall LOS	**'C'**	**'A'**	**'C'**	**'A'**	**'C'**	**'A'**	**'C'**	**'A'**
PM Peak Hour	**Delay**								
	SB	44 s	6 s	44 s	6 s	57 s	9 s	57 s	9 s
	EB	28 s	10 s	27 s	9 s	39 s	21 s	39 s	24 s
	NB	44 s	7 s	43 s	6 s	53 s	14 s	46 s	16 s
	WB	36 s	10 s	30 s	11 s	43 s	56 s	41 s	79 s
	Queue								
	SB	63 m	<25 m	61 m	<25 m	87 m	<25 m	86 m	<25 m
	EB	138 m	61 m	132 m	43 m	#186 m	<25 m	#189 m	212 m
	NB	#90 m	<25 m	#80 m	<25 m	#118 m	49 m	120 m	60 m
	WB	#114 m	61 m	#107 m	74 m	#137 m	361 m	#139 m	419 m
	Overall LOS	**'D'**	**'A'**	**'C'**	**'A'**	**'D'**	**'D'**	**'D'**	**'E'**

Notes:

1. SB, EB, NB and WB are southbound, eastbound, northbound and westbound.
2. "Delay" is approach delay for a signalized intersection and average delay for a roundabout.
3. "Queue" corresponds to the longest 95th percentile queue per approach. A "#" denotes that volume exceeds capacity and queues may be longer. Queues are output in ARCADY in total vehicles per approach, and were converted to metres per lane incorporating the storage effects of flared entries where applicable.

At Old Maple Grove Road, a roundabout is predicted to result in lower peak hour delays and 95th percentile queues for motorists than a signalized intersection under all scenarios. During the PM peak hour:

- For a signalized intersection, low to moderate delays and queues are predicted under 2036 and 2041 Scenario 1, and moderate to high delays and queues are predicted under 2036 and 2041 Scenario 2 due to the redistribution of traffic with a Maple Grove Road bypass. The highest is 2041 Scenario 2, with a 95th percentile queue of 152 metres (or more) westbound and 194 metres (or more) northbound on Old Maple Grove Road.

Table 1C: Predicted Peak Hour Traffic Operations – Old Maple Grove Rd.

Measure and Direction		2036 Scenario 1		2036 Scenario 2		2041 Scenario 1		2041 Scenario 2	
		Signals	Rbt.	Signals	Rbt.	Signals	Rbt.	Signals	Rbt.
AM Peak Hour	**Delay**								
	EB	4 s	2 s	13 s	2 s	6 s	2 s	14 s	2 s
	NB	27 s	1 s	20 s	2 s	26 s	1 s	22 s	2 s
	WB	5 s	2 s	15 s	2 s	9 s	2 s	18 s	2 s
	Queue								
	EB	42 m	<25 m	43 m	<25 m	64 m	<25 m	52 m	<25 m
	NB	16 m	<25 m	#82 m	<25 m	29 m	<25 m	#106 m	<25 m
	WB	66 m	<25 m	55 m	<25 m	100 m	<25 m	67 m	<25 m
	Overall LOS	**'A'**	**'A'**	**'B'**	**'A'**	**'A'**	**'A'**	**'B'**	**'A'**
PM Peak Hour	**Delay**								
	EB	6 s	6 s	25 s	6 s	12 s	11 s	39 s	10 s
	NB	28 s	8 s	37 s	10 s	26 s	14 s	55 s	27 s
	WB	6 s	4 s	25 s	4 s	10 s	5 s	33 s	4 s
	Queue								
	EB	96 m	<25 m	111 m	<25 m	#161 m	116 m	#152 m	89 m
	NB	25 m	<25 m	#157 m	<25 m	42 m	<25 m	#194 m	267 m
	WB	72 m	<25 m	102 m	<25 m	109 m	<25 m	#126 m	<25 m
	Overall LOS	**'A'**	**'A'**	**'C'**	**'A'**	**'B'**	**'A'**	**'D'**	**'B'**

Notes:

1. SB, EB, NB and WB are southbound, eastbound, northbound and westbound.
2. "Delay" is approach delay for a signalized intersection and average delay for a roundabout.
3. "Queue" corresponds to the longest 95th percentile queue per approach. A "#" denotes that volume exceeds capacity and queues may be longer. Queues are output in ARCADY in total vehicles per approach, and were converted to metres per lane incorporating the storage effects of flared entries where applicable.

At Beaverdale Road, peak hour delays and 95th percentile queues for motorists are roughly comparable between the signalized intersection and roundabout alternatives, and are generally low during the AM peak hour. During the PM peak hour:

- For a signalized intersection, low to moderate delays and queues are predicted eastbound and westbound for all scenarios. The highest is 2041 Scenario 1, with a 95th percentile queue of 214 metres (or more) eastbound.
- For a roundabout, low to moderate delays and queues are predicted eastbound. The highest is 2041 Scenario 1, with a 95th percentile queue of 300 metres eastbound. All other 95th percentile queues are less than 116 metres.

Table 1D: Predicted Peak Hour Traffic Operations – Beaverdale Rd.

Measure and Direction		2036 Scenario 1		2036 Scenario 2		2041 Scenario 1		2041 Scenario 2	
		Signals	Rbt.	Signals	Rbt.	Signals	Rbt.	Signals	Rbt.
AM Peak Hour	**Delay**								
	SB	29 s	4 s	15 s	4 s	29 s	5 s	15 s	4 s
	EB	9 s	3 s	8 s	3 s	10 s	3 s	8 s	3 s
	NB	27 s	3 s	14 s	3 s	27 s	4 s	14 s	3 s
	WB	10 s	4 s	8 s	3 s	10 s	4 s	9 s	3 s
	Queue								
	SB	44 m	<25 m	28 m	<25 m	46 m	<25 m	28 m	<25 m
	EB	70 m	<25 m	30 m	<25 m	79 m	<25 m	38 m	<25 m
	NB	34 m	<25 m	19 m	<25 m	35 m	<25 m	19 m	<25 m
	WB	103 m	<25 m	41 m	<25 m	116 m	<25 m	52 m	<25 m
	Overall LOS	**'B'**	**'A'**	**'A'**	**'A'**	**'B'**	**'A'**	**'B'**	**'A'**
PM Peak Hour	**Delay**								
	SB	35 s	6 s	16 s	4 s	35 s	7 s	16 s	4 s
	EB	20 s	14 s	12 s	4 s	28 s	31 s	15 s	4 s
	NB	27 s	10 s	14 s	5 s	27 s	14 s	14 s	5 s
	WB	14 s	6 s	11 s	3 s	16 s	8 s	12 s	4 s
	Queue								
	SB	#73 m	<25 m	40 m	<25 m	#74 m	<25 m	40 m	<25 m
	EB	#185 m	116 m	71m	<25 m	#214 m	300 m	#103 m	<25 m
	NB	46 m	<25 m	31 m	<25 m	47 m	<25 m	32 m	<25 m
	WB	116 m	<25 m	60 m	<25 m	133 m	29 m	69 m	<25 m
	Overall LOS	**'C'**	**'A'**	**'B'**	**'A'**	**'C'**	**'C'**	**'B'**	**'A'**

Notes:

1. SB, EB, NB and WB are southbound, eastbound, northbound and westbound.
2. "Delay" is approach delay for a signalized intersection and average delay for a roundabout.
3. "Queue" corresponds to the longest 95th percentile queue per approach. A "#" denotes that volume exceeds capacity and queues may be longer. Queues are output in ARCADY in total vehicles per approach, and were converted to metres per lane incorporating the storage effects of flared entries where applicable.

Depending on how quickly area growth results in traffic approaching the 2036 and 2041 forecast levels, all four interim roundabout configurations should result in favourable peak and off-peak operations for motorists, and relatively low delays and queues for a number of years before their ultimate counterparts need to be constructed.

3.3 Safety Performance Comparison

3.3.1 Current Safety performance

Collision history was provided for the corridor for a 5-year period (beginning of January 2013 to end of December 2017):

- Boxwood Drive – 8 collisions were recorded, consisting of 3 non-fatal injury and 5 property-damage-only (PDO). Several were classified as rear-end crashes along Maple Grove Road, possibly suggesting speed was a factor and the need for eastbound and westbound right-turn lanes.
- Speedsville Road – 23 collisions were recorded, consisting of 8 non-fatal injury and 15 PDO or non-reportable (NR). Most of them were classified as rear-end and turning movement crashes.
- Old Maple Grove Road – no collisions were recorded.
- Beaverdale Road – 7 collisions were recorded, consisting of 3 non-fatal injury and 4 PDO under a variety of classifications.

Between the intersections a significant number of collisions were classified as rear-end, with most of the remainder classified as sideswipe and single motor vehicle. There is limited access along Maple Grove Road so it is unclear why there would be so many rear-end crashes, but speed is likely a factor in many of them.

3.3.2 Future Safety Assessment

Future safety performance for motorists was predicted in accordance with the Intersection Control Studies Safety Assessment Methodology (HSM) spreadsheet (last revision March 2017) provided by Region Transportation Services. The spreadsheet uses a Safety Performance Function (SPF) for the prediction of collisions at signalized intersections based on Highway Safety Manual (HSM) methodology using AADT, calibrated using Region crash data at similar intersections. The model is based on multiple-vehicle collisions and has been assumed to apply to single-vehicle collisions as well.

For the roundabout alternative the spreadsheet draws upon an SPF based on a conflict model developed by the Region from current roundabout collision experience. It has been assumed this collision experience will continue in the future, even as driver familiarity with roundabouts increases. Injury crashes are taken to be 10% of the total crashes, with all remaining collisions being property-damage-only (PDO). The model has the following form:

$$\text{Total crash frequency} = 0.0004 \times (Total\ Daily\ Conflicts) + 1.8122$$

The 2036 (Scenario 1 and Scenario 2) forecasts were assumed to be the 10-year horizon forecasts required for input into the spreadsheet. See Appendix B. Predicted fatal, non-fatal injury, PDO and non-reportable (NR) crash frequencies are listed in Tables 2A to 2D, and are based on 2036 AADT.

Note that the total conflicting volume is predicted to be under 100,000 vehicles per day (vpd) in all cases, which is considered an upper threshold for the Region roundabout safety model. Therefore a comparative analysis using the planning-level roundabout safety model in National Cooperative Highway Research Program (NCHRP) Report 888 was not undertaken.

Table 2A: Predicted 2036 Annual Crash Frequencies – Boxwood Dr.

Collision Severity	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	0.01	-	0.01	-
Non-Fatal Injury	0.98	1.19	0.99	1.40
PDO and NR	2.22	10.72	2.27	12.63
Total	**3.20**	**11.91**	**3.26**	**14.03**

Table 2B: Predicted 2036 Annual Crash Frequencies – Speedsville Rd.

Collision Severity	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	0.01	-	0.01	-
Non-Fatal Injury	1.64	3.63	1.64	3.68
PDO and NR	3.29	32.66	3.28	33.11
Total	**4.95**	**36.29**	**4.93**	**36.78**

Table 2C: Predicted 2036 Annual Crash Frequencies – Old Maple Grove Rd.

Collision Severity	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	0.02	-	0.02	-
Non-Fatal Injury	2.41	0.26	3.29	1.09
PDO and NR	4.70	2.31	6.44	9.83
Total	**7.13**	**2.57**	**9.75**	**10.92**

Table 2D: Predicted 2036 Annual Crash Frequencies – Beaverdale Rd.

Collision Severity	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	0.01	-	0.01	-
Non-Fatal Injury	0.96	1.70	0.83	1.77
PDO and NR	2.19	15.29	1.79	15.91
Total	**3.16**	**16.99**	**2.63**	**17.68**

3.3.3 Economic Analysis

Study period costs associated with motor vehicle collisions by severity were calculated as present costs (PC) using a 6% discount rate over 20 years and the formula:

$$\text{PC} = (\text{crash frequency})(\text{crash cost})\left(\frac{1.06^{20}-1}{(0.06)(1.06^{20})}\right)$$

Direct human capital crash costs from the Highway Safety Manual (HSM) Table 4A-1 were used, adjusted using the Consumers Price Index. They are $1,656,000 per fatal, $60,500 per non-fatal injury and $5,000 per PDO collision.

The resulting 20-year study period collision costs are provided in Tables 3A to 3D.

Table 3A: Study Period Collision Costs, in thousands **– Boxwood Dr.**

Collision Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	$133	-	$133	-
Non-Fatal Injury	$680	$826	$687	$974
PDO and NR	$127	$615	$130	$724
Total	**$940**	**$1,441**	**$950**	**$1,698**

Table 3B: Study Period Collision Costs, in thousands **– Speedsville Rd.**

Collision Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	$228	-	$228	-
Non-Fatal Injury	$1,138	$2,519	$1,138	$2,553
PDO and NR	$189	$1,873	$188	$1,899
Total	**$1,555**	**$4,392**	**$1,554**	**$4,451**

Table 3C: Study Period Collision Costs, in thousands **– Old Maple Grove Rd.**

Collision Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	$323	-	$437	-
Non-Fatal Injury	$1,672	$178	$2,283	$758
PDO and NR	$270	$133	$369	$564
Total	**$2,265**	**$311**	**$3,089**	**$1,322**

Table 3D: Study Period Collision Costs, in thousands **– Beaverdale Rd.**

Collision Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Fatal	$133	-	$114	-
Non-Fatal Injury	$666	$1,179	$576	$1,227
PDO and NR	$126	$877	$103	$913
Total	**$925**	**$2,056**	**$793**	**$2,139**

Signalized intersections are predicted to result in lower 20-year study period collision costs at three of the locations. The margin at Boxwood Drive is $501,000 under Scenario 1 and $748,000 under Scenario 2. The margin at Speedsville Road is $2,837,000 under Scenario 1 and $2,897,000 under Scenario 2. The margin at Beaverdale Road is $1,131,000 under Scenario 1 and $1,346,000 under Scenario 2.

A roundabout is predicted to result in a lower 20-year study period collision cost at Old Maple Grove Road. The margin is $1,954,000 under Scenario 1 and $1,767,000 under Scenario 2.

It should be noted that crash costs are mostly a societal cost, and if there are any savings associated with an alternative then only a small portion of that savings may return directly to the Region.

4. Evaluation of Alternatives

4.1 Cost Comparison

4.1.1 Construction and Property Costs

Construction cost estimates were prepared to common match points based on Maple Grove Road, Speedsville Road and Beaverdale Road all being widened to four lanes, and Boxwood Drive and Old Maple Grove Road being maintained at two lanes. Then it was assumed the Region would maintain rather than replace the existing road structure where applicable, and mill and repave or apply a new top lift of asphalt over each intersection.

Estimated construction costs for the alternatives are as follows:

- Boxwood Drive – $2,744,000 for the signalized intersection and $3,619,000 for the roundabout (a difference of $875,000).
- Speedsville Road – $4,072,000 for the signalized intersection and $4,350,000 for the roundabout (a difference of $278,000). This includes removal and replacement of a major culvert on the south side of the intersection.
- Old Maple Grove Road – $2,354,000 for the signalized intersection and $2,712,000 for the roundabout (a difference of $358,000).
- Beaverdale Road – $3,440,000 for the signalized intersection and $4,044,000 for the roundabout (a difference of $604,000).

Another assumption was that the roundabouts would be constructed to their ultimate configurations in terms of road structure, with two sets of outer curbs to demarcate the interim and ultimate configurations. Initially the roundabouts would open with an asphalt overlay between the two sets of curbs, which along with the inner curbs would be removed at such time as traffic conditions warrant conversion to the ultimate configuration. This construction method was used for the roundabout on Hespeler Road at Queen Street/Beaverdale Road. The construction cost estimates for the roundabouts therefore reflect the ultimate footprint and conversion process.

Property acquisition costs were $49 per square metre for woodland, $49 per square metre for industrial and $269 for low-density residential. The estimates include 15% for engineering, 20% for contingency, and 1.76% HST. Details are provided in Appendix C.

4.1.2 Study Period Costs

A comparison of overall capital and study period costs is shown in Tables 4A to 4D. As with the safety comparison a 6% discount rate over a 20-year study period was used for the present cost calculations. A cost of $3,000 per year was assumed for annual traffic signal maintenance, with the assumption that a complete re-build would occur after 20 years. A cost of $1,000 per year was assumed for landscaping maintenance at each roundabout.

Table 4A: Total Study Period Costs, in thousands **– Boxwood Dr.**

Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Total Construction	$2,744	$3,619	$2,744	$3,619
Maintenance (PC)	$60	$20	$60	$20
Total Collision (PC)	$940	$1,441	$950	$1,698
Total Study Period Cost (PC)	**$3,744**	**$5,080**	**$3,754**	**$5,337**

Table 4B: Total Study Period Costs, in thousands **– Speedsville Rd.**

Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Total Construction	$4,072	$4,350	$4,072	$4,350
Maintenance (PC)	$60	$20	$60	$20
Total Collision (PC)	$1,555	$4,392	$1,554	$4,451
Total Study Period Cost (PC)	**$5,687**	**$8,762**	**$5,686**	**$8,821**

Table 4C: Total Study Period Costs, in thousands **– Old Maple Grove Rd.**

Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Total Construction	$2,354	$2,712	$2,354	$2,712
Maintenance (PC)	$60	$20	$60	$20
Total Collision (PC)	$2,265	$311	$3,089	$1,322
Total Study Period Cost (PC)	**$4,679**	**$3,043**	**$5,503**	**$4,054**

Table 4D: Total Study Period Costs, in thousands **– Beaverdale Rd.**

Cost	2036 Scenario 1		2036 Scenario 2	
	Signals	Roundabout	Signals	Roundabout
Total Construction	$3,440	$4,044	$3,440	$4,044
Maintenance (PC)	$60	$20	$60	$20
Total Collision (PC)	$925	$2,056	$793	$2,139
Total Study Period Cost (PC)	**$4,425**	**$6,120**	**$4,293**	**$6,203**

A signalized intersection is estimated to have a lower 20-year study period cost at three of the locations:

- The margin at Boxwood Drive is $1,336,000 under Scenario 1 and $1,583,000 under Scenario 2. A roundabout therefore costs 1.4 times more over 20 years.
- The margin at Speedsville Road is $3,075,000 under Scenario 1 and $3,135,000 under Scenario 2. A roundabout therefore costs 1.5 to 1.6 times more over 20 years.
- The margin at Beaverdale Road is $1,695,000 under Scenario 1 and $1,910,000 under Scenario 2. A roundabout therefore costs 1.4 times more over 20 years.

A roundabout is estimated to have in a lower 20-year study period cost at Old Maple Grove Road. The margin is $1,636,000 under Scenario 1 and $1,449,000 under Scenario 2.

4.2 Corridor Considerations

A number of other criteria were considered but not formally evaluated. They consist of peak and off-peak vehicle noise, fuel consumption and emissions, aesthetics, public outreach, off-peak traffic operations and corridor travel times, speed control, access management, truck accommodation and driver expectancy. Accessibility, and pedestrian and cyclist accommodation, have not been assessed given the lack of corresponding facilities outside of the individual intersections. Table 5 summarizes qualitative comments associated with traffic signals or roundabouts at the four locations along Maple Grove Road.

Table 5: Summary of Qualitative Evaluation

Evaluation Criteria		Signals	Roundabouts
Natural	Peak hour vehicle noise, fuel consumption and emissions	Relatively high, as a function of motor vehicle delays, start/stop cycles and idling.	Relatively moderate, or less than with signals due to generally lower delays and more uniform motor vehicle speeds.
	Off-peak vehicle noise, fuel consumption and emissions	Relatively moderate, as a function of motor vehicle delays, start/stop cycles and idling.	Relatively low. Although all traffic on Maple Grove Rd. would need to slow to navigate the roundabouts, control delay on most approaches would be lower than with signals.
Social	Aesthetics	Continuous centre median provides an opportunity for streetscaping.	Continuous centre median provides an opportunity for streetscaping. More potential for decorative paving materials and landscaping at intersections because of roundabout central islands.
	Public Outreach	Status quo.	Would be included as part of the Region's ongoing roundabout outreach efforts.

Table 5: Summary of Qualitative Evaluation (cont'd)

Evaluation Criteria		Signals	Roundabouts
Operational	Off-Peak Traffic Operations and Corridor Travel Times	Delays to minor road traffic with semi-actuated signals, depending on signal timings and corridor progression. Corridor travel times will depend on number of signalized intersections.	Generally lower off-peak delays for traffic in all directions, and lower corridor travel times with more roundabouts.
	Speed Control	Motor vehicle speeds controlled only during red signal indication.	Motor vehicle speeds controlled at all times due to geometry of roundabout. This will influence speeds upstream and downstream of each roundabout, but not necessarily mid-block along Maple Grove Rd. Nevertheless there may be a decrease in mid-block speed-related crashes with roundabouts.
	Access Management	Status quo.	Status quo, as Maple Grove Rd. will have controlled access.
	Large Truck Accommodation	Large trucks may encroach on adjacent lanes as they make left or right turns.	Large trucks may encroach on adjacent lanes as they enter, circulate and exit each roundabout.
	Driver Expectancy	Status quo.	A multi-lane roundabout is planned at the west end of the corridor at Fountain St. and one is in place to the south on Hespeler Rd.

4.3 Summary Evaluation

Tables 6A to 6D summarize findings in terms of peak hour traffic operations, estimated construction costs, and 20-year study period costs including the societal costs of motor vehicle collisions.

Table 6A: Summary Evaluation – Boxwood Dr.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'A' ('B')	'A' ('A')	'A' ('B')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'A' ('C')	'A' ('C')	'A' ('C')	'A' ('C')
Estimated Construction Cost (in thousands)	$2,744	$3,619	$2,744	$3,619
Estimated 20-Year Study Period Cost (PC, in thousands)	**$3,744**	**$5,080**	**$3,754**	**$5,337**

Table 6B: Summary Evaluation – Speedsville Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'C' ('D')	'A' ('A')	'C' ('C')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'C' ('D')	'A' ('D')	'C' ('D')	'A' ('E')
Estimated Construction Cost (in thousands)	$4,072	$4,350	$4,072	$4,350
Estimated 20-Year Study Period Cost (PC, in thousands)	**$5,687**	**$8,762**	**$5,686**	**$8,821**

Table 6C: Summary Evaluation – Old Maple Grove Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'A' ('A')	'A' ('A')	'B' ('C')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'A' ('B')	'A' ('A')	'B' ('D')	'A' ('B')
Estimated Construction Cost (in thousands)	$2,354	$2,712	$2,354	$2,712
Estimated 20-Year Study Period Cost (PC, in thousands)	**$4,679**	**$3,043**	**$5,503**	**$4,054**

Table 6D: Summary Evaluation – Beaverdale Rd.

Evaluation Criteria	Scenario 1		Scenario 2	
	Signals	Roundabout	Signals	Roundabout
2036 Peak Hour LOS, AM (PM)	'B' ('C')	'A' ('A')	'A' ('B')	'A' ('A')
2041 Peak Hour LOS, AM (PM)	'B' ('C')	'A' ('C')	'B' ('B')	'A' ('A')
Estimated Construction Cost (in thousands)	$1,119	$2,056	$988	$2,139
Estimated 20-Year Study Period Cost (PC, in thousands)	**$4,425**	**$6,120**	**$4,293**	**$6,203**

In looking at individual locations in terms of the quantitative evaluation, signalized intersections are preferred at Boxwood Drive, Speedsville Road and Beaverdale Road, while a roundabout is preferred at Old Maple Grove Road.

Historically, the Region may consider implementation of a roundabout if its 20-year study period cost is less than 1.5 times the cost of the signalized intersection alternative. This is because of the advantages roundabouts have with various qualitative criteria (mainly off-peak traffic operations and speed control). A roundabout is about 1.4 times the cost at Boxwood Drive and Beaverdale Road, and 1.5 to 1.6 times the cost at Speedsville Road.

The safety performance of a roundabout at Boxwood Drive may be better than predicted using the Region roundabout model. The Region model data set is mostly comprised of full multi-lane roundabouts, whereas this roundabout would be a partial multi-lane design for a number of years in its interim configuration with a corresponding reduction in conflict points (and, presumably, collisions).

In looking at the Maple Grove Road corridor between Fountain Street and Hespeler Road, a roundabout is currently planned for construction at Fountain Street and a signalized intersection is preferred in terms of 20-year study period costs at Speedsville Road. A roundabout was screened out at Vondrau Drive. Therefore in terms of corridor continuity it may make sense to implement a signalized intersection at Boxwood Drive rather than a roundabout, so that east of Fountain Street there are three signalized intersections in succession. Farther east could be roundabouts at Old Maple Grove Road and Beaverdale Road.

5. Conclusions

Expressed as present costs, a signalized intersection is estimated to have a lower 20-year study period cost at three of the locations:

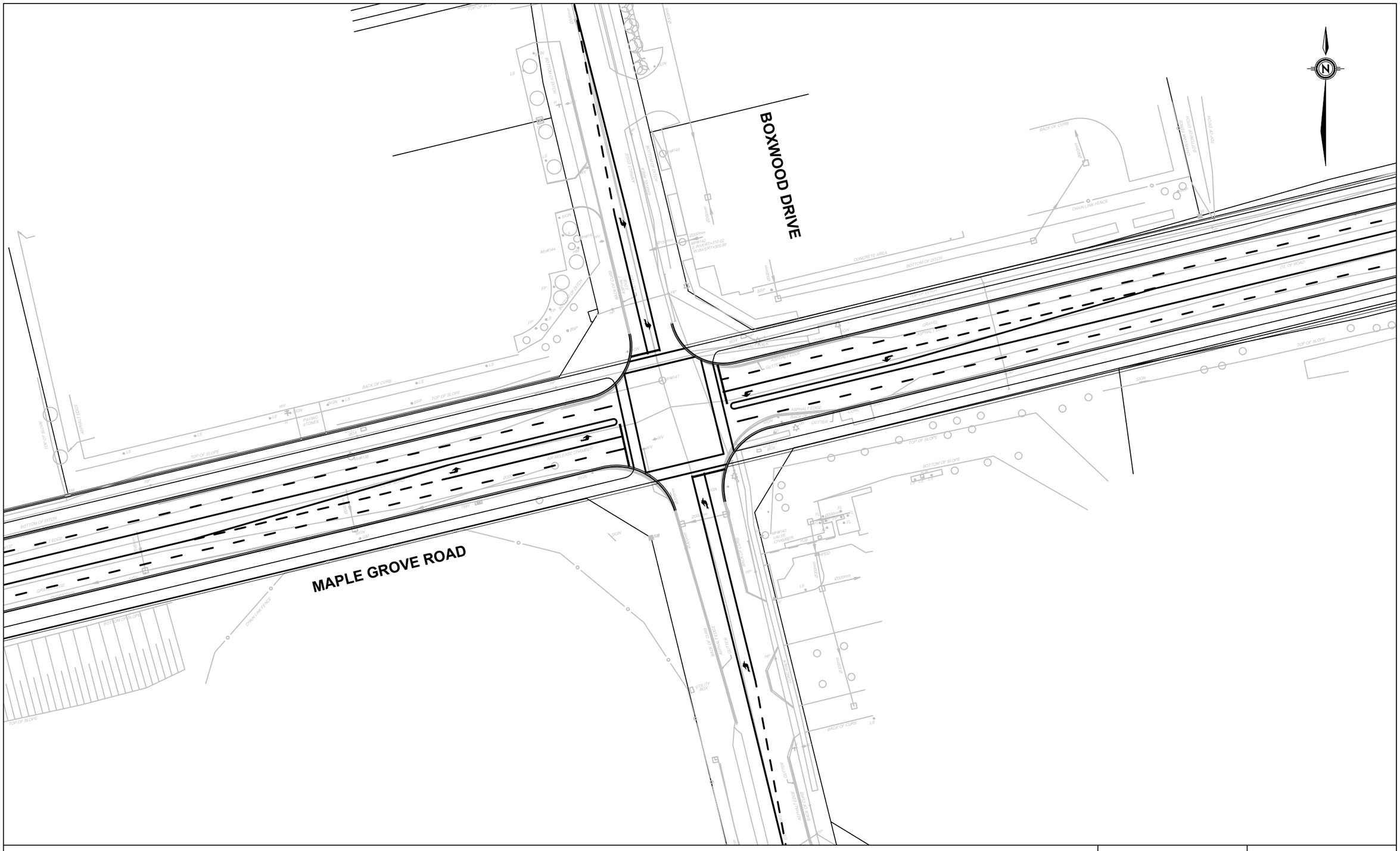
- Boxwood Drive, by a margin of $1,336,000 under Scenario 1 and $1,583,000 under Scenario 2.
- Speedsville Road, by a margin of $3,075,000 under Scenario 1 and $3,135,000 under Scenario 2.
- Beaverdale Road, by a margin of $1,695,000 under Scenario 1 and $1,910,000 under Scenario 2.

A roundabout is estimated to have a lower 20-year study period cost at Old Maple Grove Road by a margin of $1,636,000 under Scenario 1 and $1,449,000 under Scenario 2.

Historically, the Region may consider implementation of a roundabout if its 20-year study period cost is less than 1.5 times the cost of the signalized intersection alternative. This is because of the advantages roundabouts have with various qualitative criteria (mainly off-peak traffic operations and speed control). A roundabout is about 1.4 times the cost at Boxwood Drive and Beaverdale Road, and 1.5 to 1.6 times the cost at Speedsville Road.

In looking at Maple Grove Road between Fountain Street and Hespeler Road, a roundabout is currently planned for construction at Fountain Street and a signalized intersection is preferred in terms of 20-year study period costs at Speedsville Road. A roundabout was screened out at Vondrau Drive. Therefore in terms of corridor continuity it may make sense to implement a signalized intersection at Boxwood Drive rather than a roundabout, so that east of Fountain Street there are three signalized intersections in succession. Farther east could be roundabouts at Old Maple Grove Road and Beaverdale Road. There are residential properties on all four corners at Beaverdale Road that would be impacted to varying degrees with implementation of a roundabout, but it is assumed the impacts could be managed.

Accordingly, it is recommended that with the widening of Maple Grove Road the intersections of Boxwood Drive and Speedsville Road be under traffic signal control, and the intersections of Old Maple Grove Road and Beaverdale Road be converted to roundabouts.



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FIGURE 2/DRAWING 2
TRAFFIC SIGNAL CONCEPT
MAPLE GROVE ROAD AND BOXWOOD DRIVE

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AUGUST 2019	**B001016**
SCALE	DRAWING NO.
1:1000	**2**

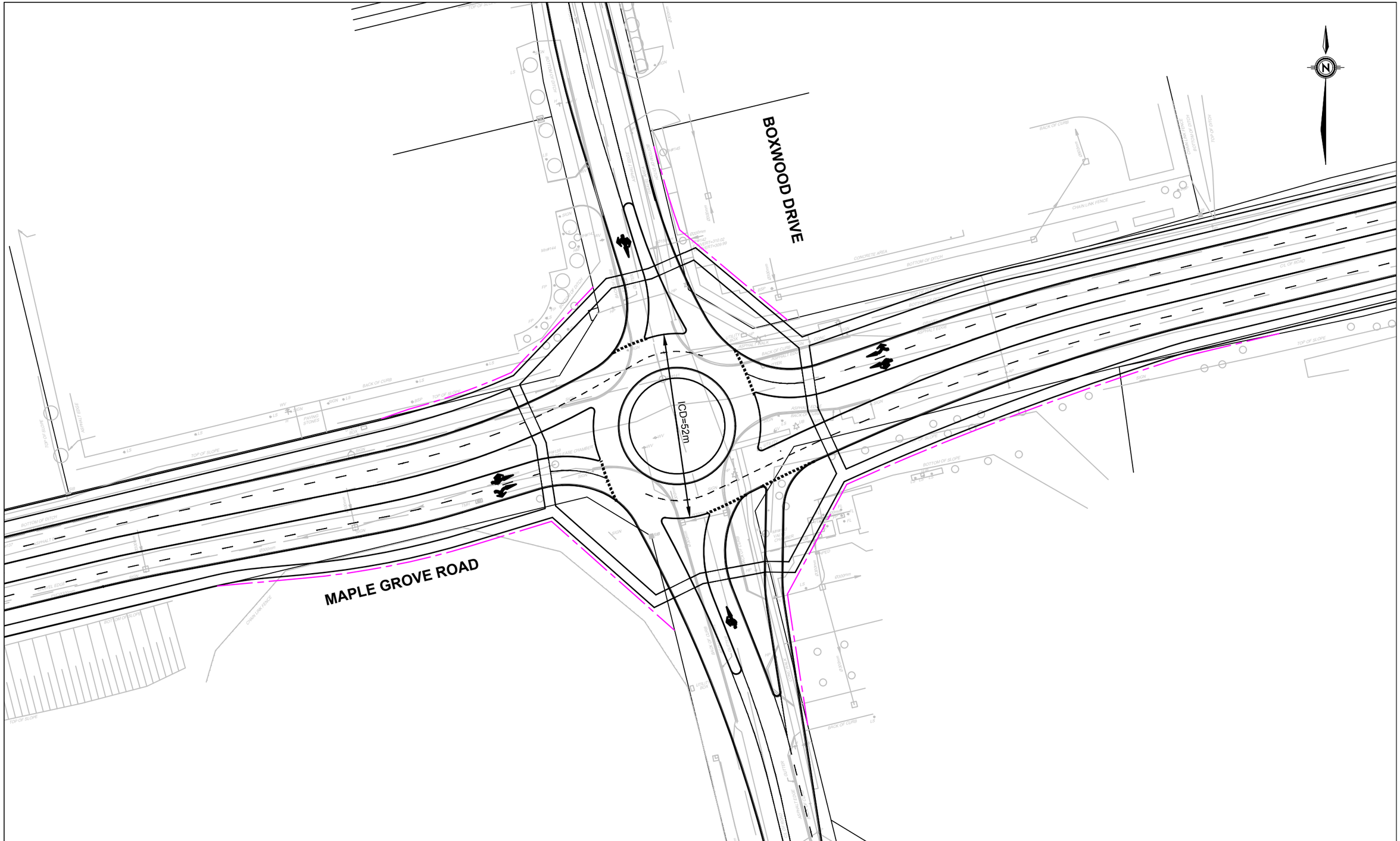


FIGURE 3/DRAWING 3
INTERIM ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND BOXWOOD DRIVE

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AUGUST 2019	B001016
SCALE	DRAWING NO.
1:1000	3

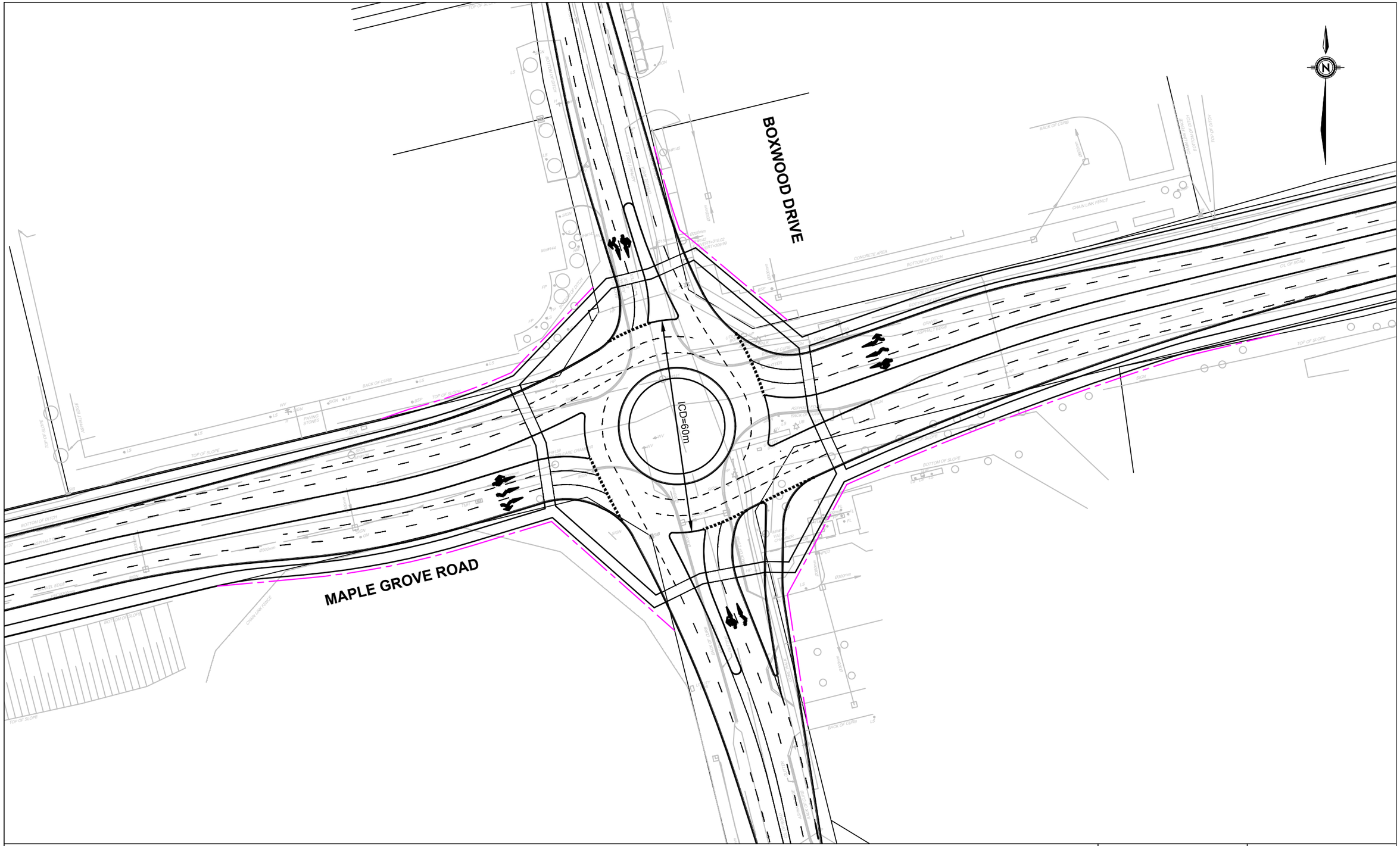


FIGURE 4/DRAWING 4
ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND BOXWOOD DRIVE

DATE	PROJECT NO.
AUGUST 2019	B001016
SCALE	DRAWING NO.
1:1000	4

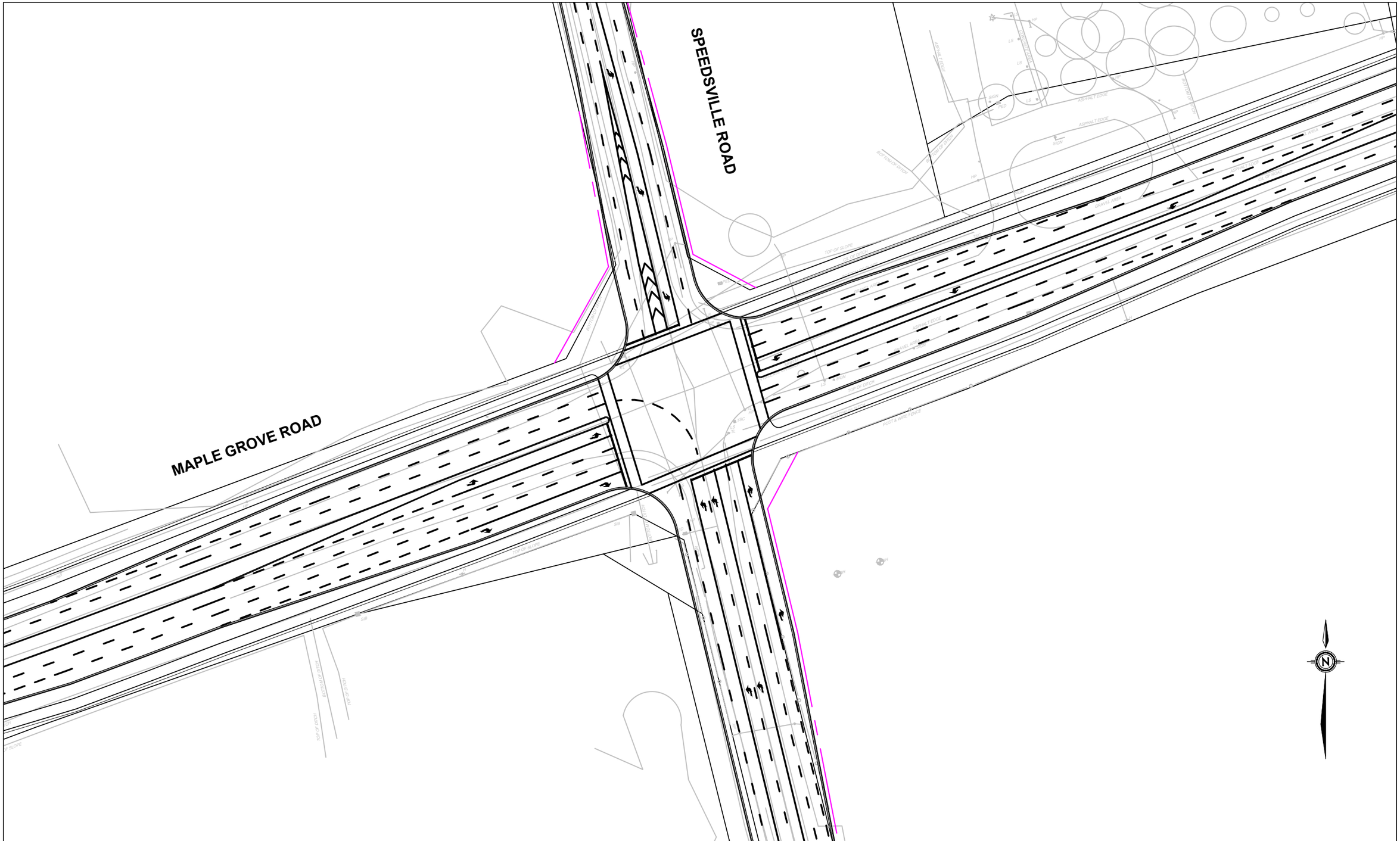
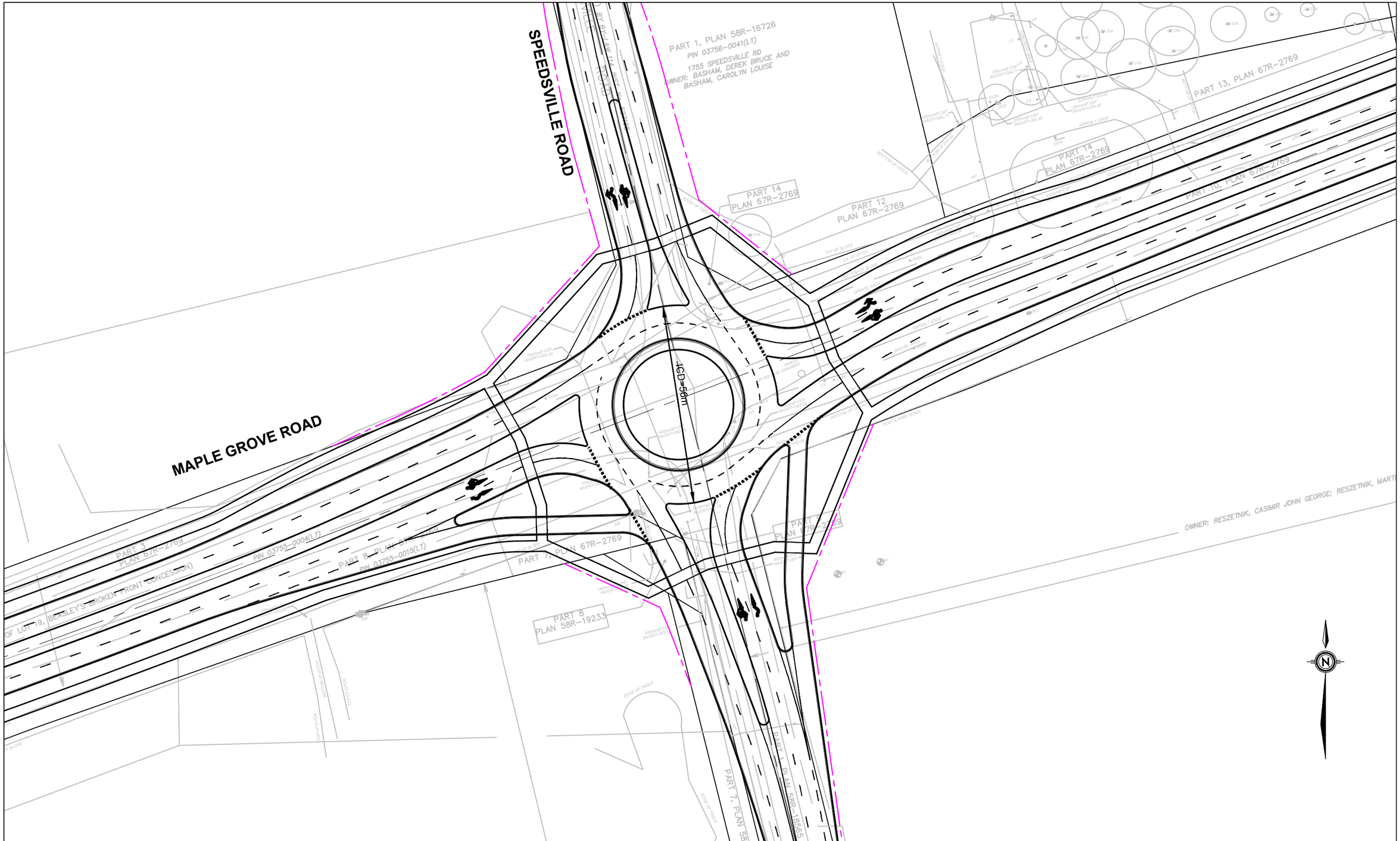


FIGURE 5/DRAWING 5
TRAFFIC SIGNAL CONCEPT
MAPLE GROVE ROAD AND SPEEDSVILLE ROAD

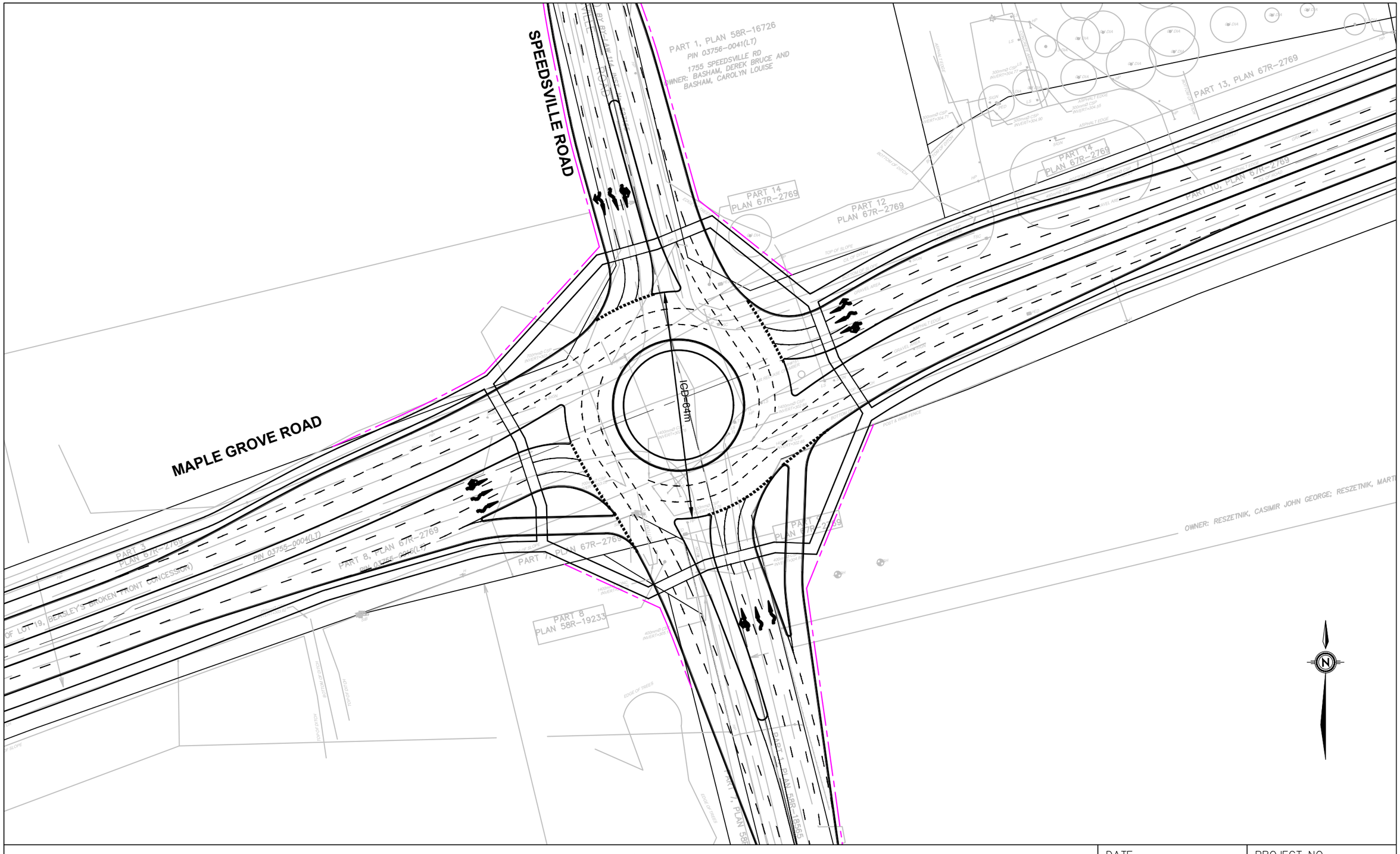
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SCALE **1:1000**	DRAWING NO. **5**



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FIGURE 6/DRAWING 6
INTERIM ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND SPEEDSVILLE ROAD

DATE	PROJECT NO.
AUGUST 2019	B001016
SCALE	DRAWING NO.
1:1000	6



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FIGURE 7/DRAWING 7
ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND SPEEDSVILLE ROAD

DATE	PROJECT NO.
AUGUST 2019	B001016
SCALE	DRAWING NO.
1:1000	7

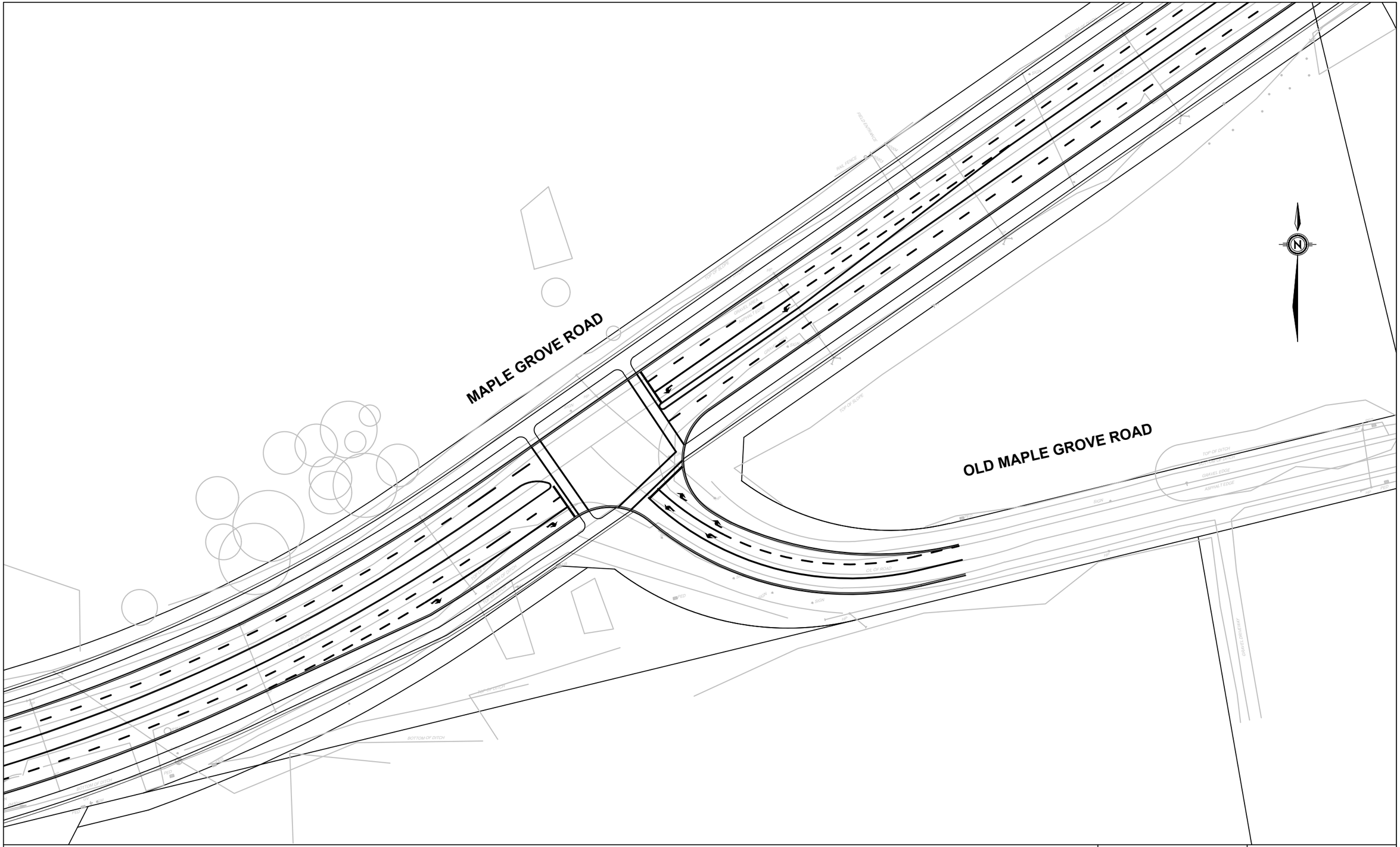


FIGURE 8/DRAWING 8
TRAFFIC SIGNAL CONCEPT
MAPLE GROVE ROAD AND OLD MAPLE GROVE ROAD

DATE **AUGUST 2019**	PROJECT NO. **B001016**
SCALE **1:1000**	DRAWING NO. **8**

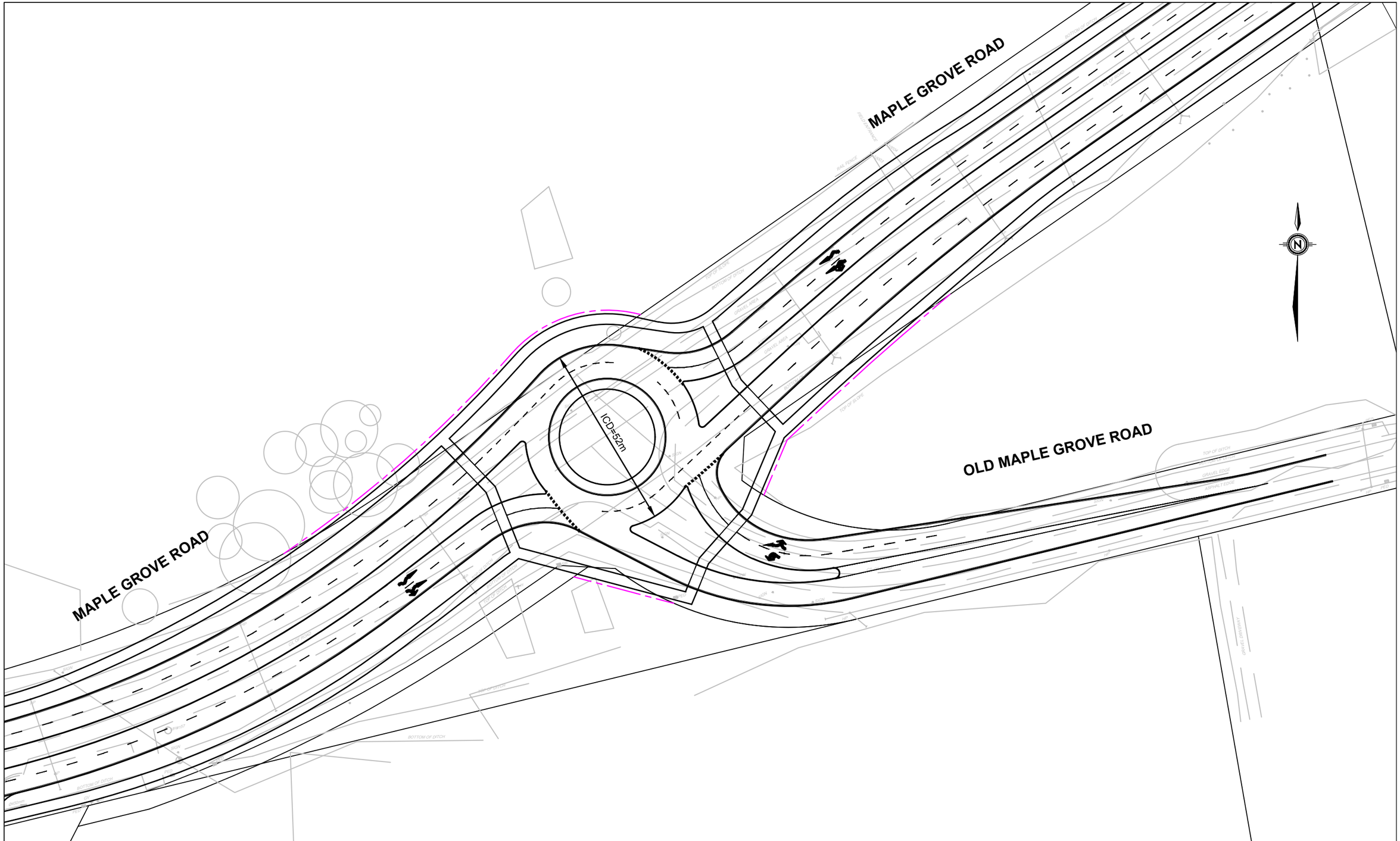


FIGURE 9/DRAWING 9
INTERIM ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND OLD MAPLE GROVE ROAD

DATE **AUGUST 2019**	PROJECT NO. **B001016**
SCALE **1:1000**	DRAWING NO. **9**

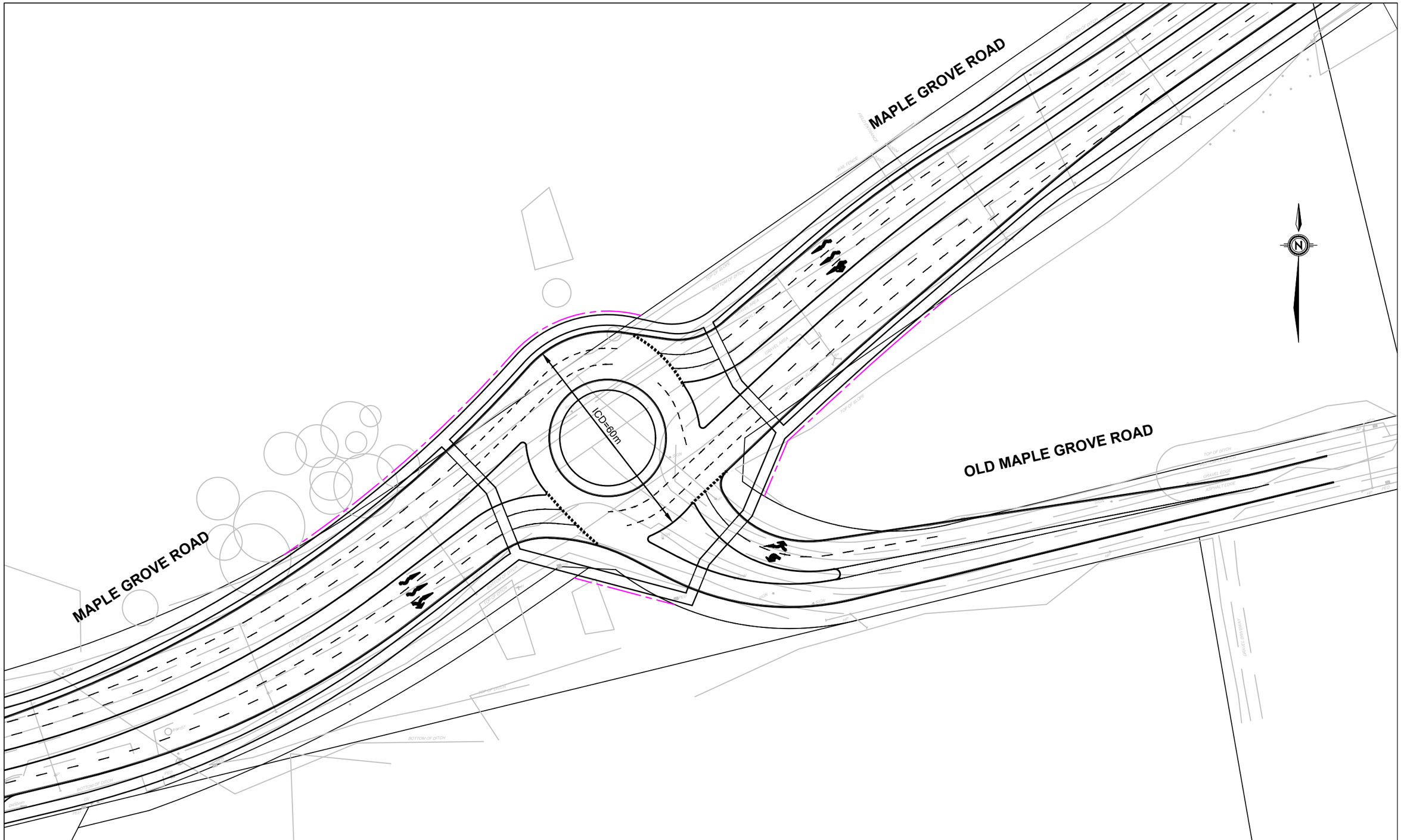


FIGURE 10/DRAWING 10
ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND OLD MAPLE GROVE ROAD

DATE **AUGUST 2019**	PROJECT NO. **B001016**
SCALE **1:1000**	DRAWING NO. **10**

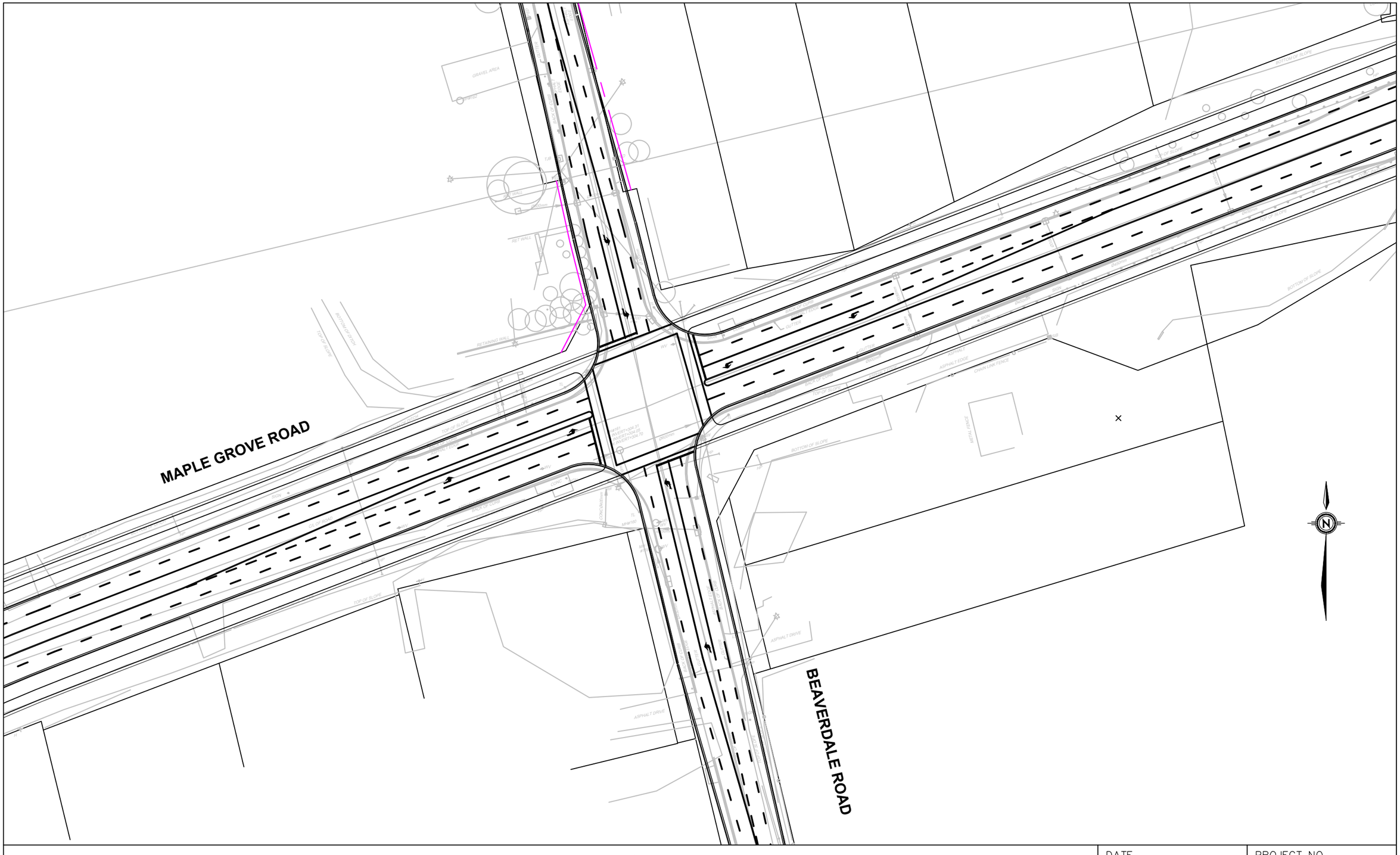


FIGURE 11/DRAWING 11
TRAFFIC SIGNAL CONCEPT
MAPLE GROVE ROAD AND BEAVERDALE ROAD

DATE **AUGUST 2019**	PROJECT NO. **B001016**
SCALE **1:1000**	DRAWING NO. **11**

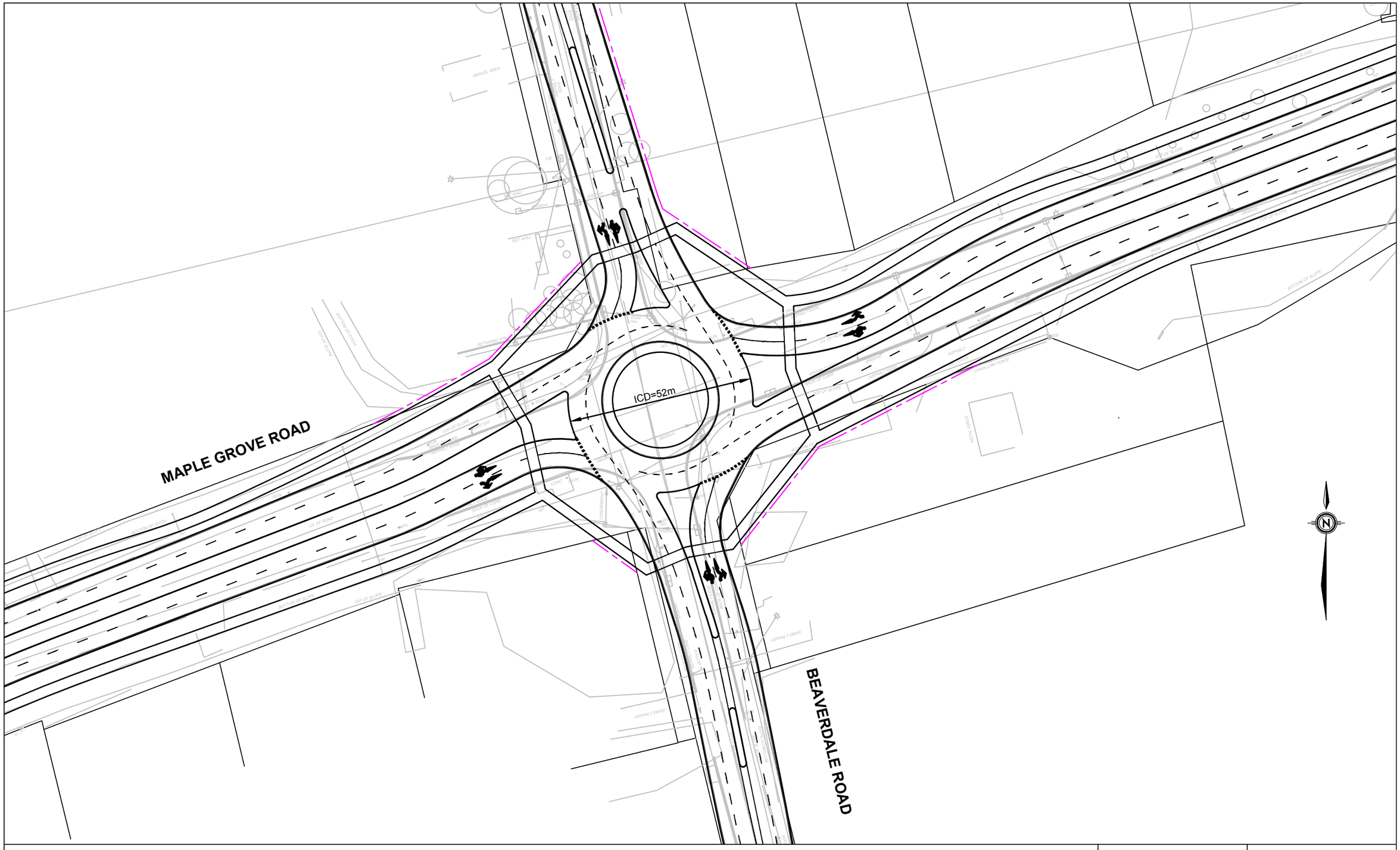


FIGURE 12/DRAWING 12
INTERIM ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND BEAVERDALE ROAD

DATE **AUGUST 2019**	PROJECT NO. **B001016**
SCALE **1:1000**	DRAWING NO. **12**

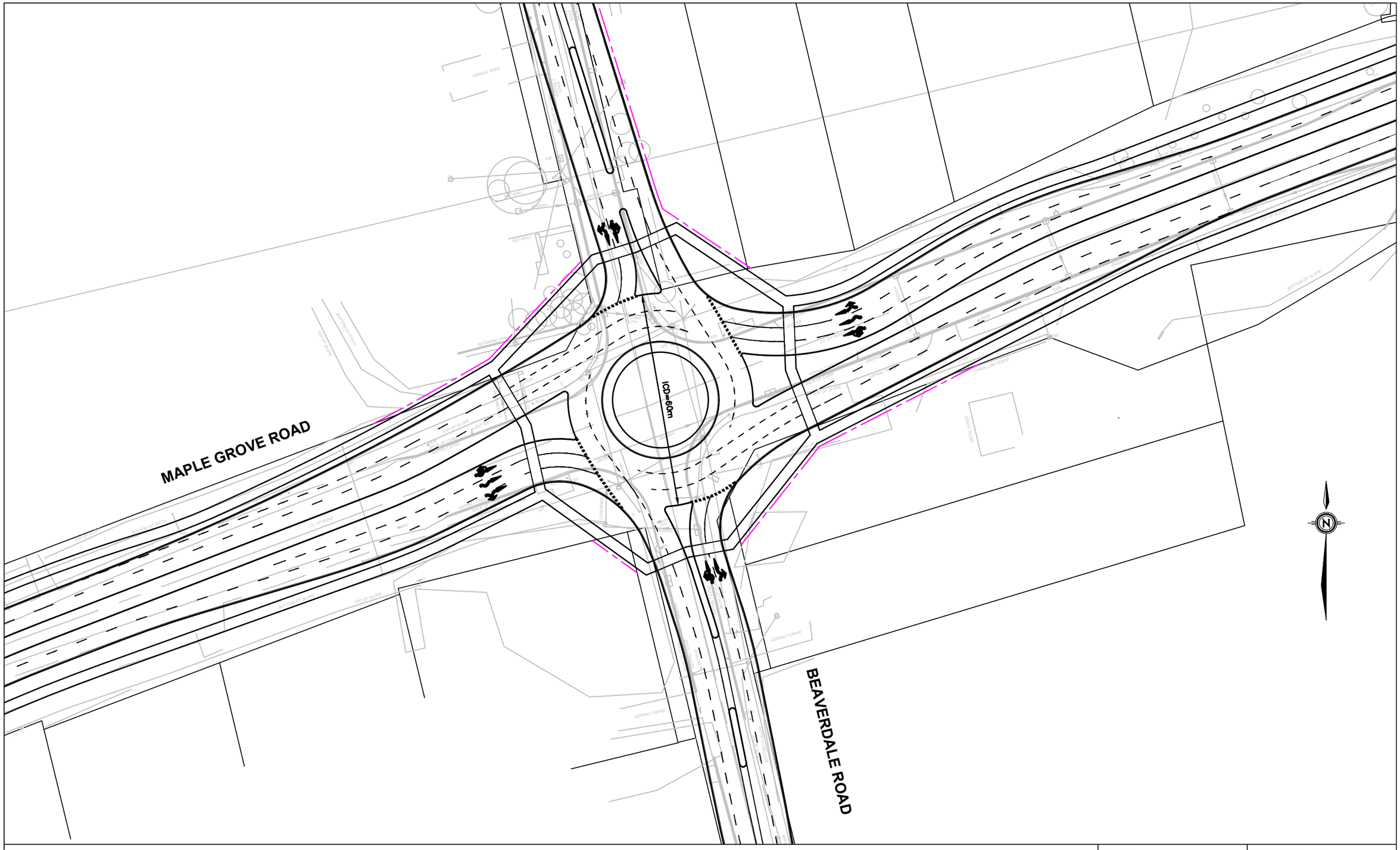


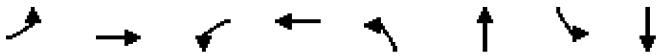
FIGURE 13/DRAWING 13
ROUNDABOUT CONCEPT
MAPLE GROVE ROAD AND BEAVERDALE ROAD

DATE	PROJECT NO.
AUGUST 2019	B001016
SCALE	DRAWING NO.
1:1000	13

A

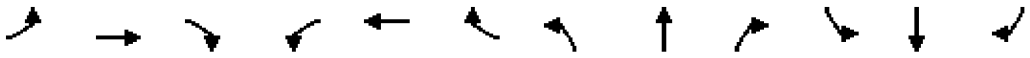
Appendix A

Capacity Analysis



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	95	1205	60	1455	45	70	25	30
v/c Ratio	0.45	0.47	0.21	0.58	0.25	0.28	0.14	0.14
Control Delay	12.4	4.2	5.2	5.1	32.3	13.2	30.0	14.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.4	4.2	5.2	5.1	32.3	13.2	30.0	14.7
Queue Length 50th (m)	3.8	26.0	1.9	36.0	5.7	1.2	3.1	0.6
Queue Length 95th (m)	19.3	44.5	6.7	62.1	14.4	11.5	9.5	7.4
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	213	2557	292	2524	431	512	415	491
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.47	0.21	0.58	0.10	0.14	0.06	0.06

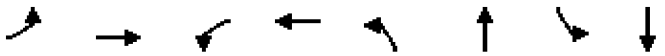
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	95	1155	50	60	1335	120	45	10	60	25	5	25
Future Volume (vph)	95	1155	50	60	1335	120	45	10	60	25	5	25
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3189		1635	3144		1635	1394		1635	1400	
Flt Permitted	0.15	1.00		0.21	1.00		0.74	1.00		0.71	1.00	
Satd. Flow (perm)	267	3189		366	3144		1269	1394		1224	1400	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	95	1155	50	60	1335	120	45	10	60	25	5	25
RTOR Reduction (vph)	0	2	0	0	4	0	0	53	0	0	22	0
Lane Group Flow (vph)	95	1203	0	60	1451	0	45	17	0	25	8	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	59.0	59.0		59.0	59.0		7.3	7.3		7.5	7.5	
Effective Green, g (s)	61.2	61.2		61.2	61.2		9.5	9.5		9.5	9.5	
Actuated g/C Ratio	0.78	0.78		0.78	0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	207	2479		284	2444		153	168		147	168	
v/s Ratio Prot		0.38			c0.46			0.01			0.01	
v/s Ratio Perm	0.36			0.16			c0.04			0.02		
v/c Ratio	0.46	0.49		0.21	0.59		0.29	0.10		0.17	0.05	
Uniform Delay, d1	3.0	3.1		2.3	3.6		31.5	30.8		31.1	30.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	7.2	0.7		1.7	1.1		1.1	0.3		0.6	0.1	
Delay (s)	10.2	3.8		4.0	4.7		32.6	31.1		31.6	30.7	
Level of Service	B	A		A	A		C	C		C	C	
Approach Delay (s)		4.3			4.7			31.7			31.1	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	6.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	78.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

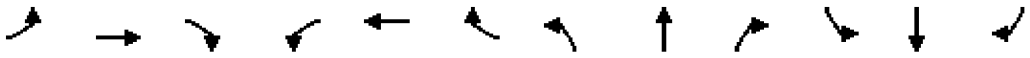
c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	40	1865	55	1525	170	120	135	145
v/c Ratio	0.31	0.87	0.67	0.72	0.69	0.35	0.50	0.40
Control Delay	15.6	18.7	55.9	12.4	43.6	24.1	34.1	21.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.6	18.7	55.9	12.4	43.6	24.1	34.1	21.2
Queue Length 50th (m)	2.4	111.9	4.7	73.2	24.7	13.0	18.6	13.1
Queue Length 95th (m)	11.2	#209.6	#29.3	121.2	45.3	26.9	35.1	28.4
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	129	2132	82	2112	333	454	360	477
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.87	0.67	0.72	0.51	0.26	0.38	0.30

Intersection Summary

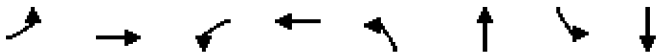
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1790	75	55	1465	60	170	15	105	135	30	115
Future Volume (vph)	40	1790	75	55	1465	60	170	15	105	135	30	115
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3190		1635	3161		1635	1390		1635	1409	
Flt Permitted	0.11	1.00		0.07	1.00		0.61	1.00		0.66	1.00	
Satd. Flow (perm)	195	3190		123	3161		1052	1390		1137	1409	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	40	1790	75	55	1465	60	170	15	105	135	30	115
RTOR Reduction (vph)	0	3	0	0	3	0	0	16	0	0	34	0
Lane Group Flow (vph)	40	1862	0	55	1522	0	170	104	0	135	111	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	53.6	53.6		53.6	53.6		17.6	17.6		17.8	17.8	
Effective Green, g (s)	55.8	55.8		55.8	55.8		19.8	19.8		19.8	19.8	
Actuated g/C Ratio	0.67	0.67		0.67	0.67		0.24	0.24		0.24	0.24	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	130	2129		82	2109		249	329		269	333	
v/s Ratio Prot		c0.58			0.48			0.07			0.08	
v/s Ratio Perm	0.21			0.45			c0.16			0.12		
v/c Ratio	0.31	0.87		0.67	0.72		0.68	0.32		0.50	0.33	
Uniform Delay, d1	5.8	11.1		8.4	8.9		29.0	26.3		27.6	26.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.0	5.4		36.0	2.2		7.5	0.6		1.5	0.6	
Delay (s)	11.9	16.5		44.3	11.1		36.5	26.9		29.1	27.0	
Level of Service	B	B		D	B		D	C		C	C	
Approach Delay (s)		16.4			12.3			32.5			28.0	
Approach LOS		B			B			C			C	

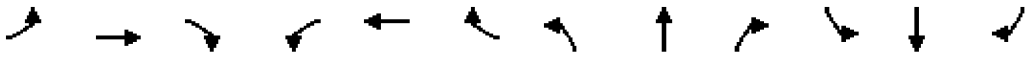
Intersection Summary			
HCM 2000 Control Delay	16.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	83.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	95	1205	60	1405	50	70	25	30
v/c Ratio	0.42	0.47	0.21	0.56	0.27	0.27	0.14	0.13
Control Delay	11.2	4.3	5.3	5.1	32.6	13.1	29.7	14.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	11.2	4.3	5.3	5.1	32.6	13.1	29.7	14.6
Queue Length 50th (m)	3.8	26.6	1.9	34.6	6.4	1.2	3.1	0.6
Queue Length 95th (m)	17.7	46.0	7.0	60.1	15.6	11.5	9.5	7.3
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	226	2547	291	2512	430	512	415	491
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.42	0.47	0.21	0.56	0.12	0.14	0.06	0.06

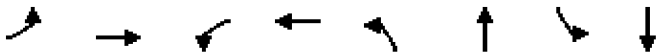
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	95	1155	50	60	1285	120	50	10	60	25	5	25
Future Volume (vph)	95	1155	50	60	1285	120	50	10	60	25	5	25
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3189		1635	3143		1635	1394		1635	1400	
Flt Permitted	0.16	1.00		0.21	1.00		0.74	1.00		0.71	1.00	
Satd. Flow (perm)	284	3189		365	3143		1269	1394		1224	1400	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	95	1155	50	60	1285	120	50	10	60	25	5	25
RTOR Reduction (vph)	0	2	0	0	5	0	0	53	0	0	22	0
Lane Group Flow (vph)	95	1203	0	60	1400	0	50	17	0	25	8	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	58.7	58.7		58.7	58.7		7.5	7.5		7.7	7.7	
Effective Green, g (s)	60.9	60.9		60.9	60.9		9.7	9.7		9.7	9.7	
Actuated g/C Ratio	0.77	0.77		0.77	0.77		0.12	0.12		0.12	0.12	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	220	2470		282	2435		156	172		151	172	
v/s Ratio Prot		0.38			c0.45			0.01			0.01	
v/s Ratio Perm	0.34			0.16			c0.04			0.02		
v/c Ratio	0.43	0.49		0.21	0.58		0.32	0.10		0.17	0.05	
Uniform Delay, d1	3.0	3.2		2.4	3.6		31.4	30.6		30.8	30.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.1	0.7		1.7	1.0		1.2	0.3		0.5	0.1	
Delay (s)	9.1	3.9		4.1	4.6		32.6	30.8		31.3	30.5	
Level of Service	A	A		A	A		C	C		C	C	
Approach Delay (s)		4.3			4.6			31.6			30.9	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	6.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	78.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		

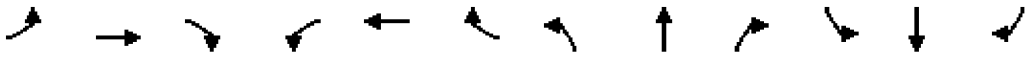
c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	40	1830	55	1505	170	120	135	245
v/c Ratio	0.30	0.86	0.68	0.71	0.98	0.34	0.50	0.63
Control Delay	14.9	17.9	58.4	12.3	98.5	23.5	34.0	30.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.9	17.9	58.4	12.3	98.5	23.5	34.0	30.1
Queue Length 50th (m)	2.4	108.5	4.9	72.6	27.1	12.7	18.7	28.1
Queue Length 95th (m)	10.8	#202.1	#29.5	117.3	#61.5	26.7	35.2	50.9
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	133	2128	81	2108	227	450	355	498
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.30	0.86	0.68	0.71	0.75	0.27	0.38	0.49

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1755	75	55	1445	60	170	15	105	135	130	115
Future Volume (vph)	40	1755	75	55	1445	60	170	15	105	135	130	115
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3190		1635	3161		1635	1390		1635	1487	
Flt Permitted	0.12	1.00		0.07	1.00		0.42	1.00		0.66	1.00	
Satd. Flow (perm)	201	3190		123	3161		727	1390		1137	1487	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	40	1755	75	55	1445	60	170	15	105	135	130	115
RTOR Reduction (vph)	0	3	0	0	3	0	0	18	0	0	37	0
Lane Group Flow (vph)	40	1827	0	55	1502	0	170	102	0	135	208	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	53.8	53.8		53.8	53.8		17.8	17.8		18.0	18.0	
Effective Green, g (s)	56.0	56.0		56.0	56.0		20.0	20.0		20.0	20.0	
Actuated g/C Ratio	0.67	0.67		0.67	0.67		0.24	0.24		0.24	0.24	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	134	2126		82	2107		173	330		270	354	
v/s Ratio Prot		c0.57			0.48			0.07			0.14	
v/s Ratio Perm	0.20			0.45			c0.23			0.12		
v/c Ratio	0.30	0.86		0.67	0.71		0.98	0.31		0.50	0.59	
Uniform Delay, d1	5.8	10.9		8.4	8.9		31.8	26.3		27.7	28.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.6	4.8		36.0	2.1		62.9	0.5		1.5	2.5	
Delay (s)	11.4	15.7		44.4	11.0		94.8	26.9		29.1	30.9	
Level of Service	B	B		D	B		F	C		C	C	
Approach Delay (s)		15.6			12.2			66.7			30.2	
Approach LOS		B			B			E			C	

Intersection Summary			
HCM 2000 Control Delay	19.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	84.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	95	1310	60	1650	50	50	25	30
v/c Ratio	0.58	0.51	0.23	0.65	0.27	0.21	0.14	0.13
Control Delay	24.8	4.6	6.1	6.3	32.9	14.3	29.8	14.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.8	4.6	6.1	6.3	32.9	14.3	29.8	14.6
Queue Length 50th (m)	4.7	30.7	1.9	47.5	6.4	1.2	3.1	0.6
Queue Length 95th (m)	#34.5	52.8	7.6	83.6	15.6	9.8	9.5	7.3
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	164	2554	256	2523	426	499	418	487
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.58	0.51	0.23	0.65	0.12	0.10	0.06	0.06

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	95	1260	50	60	1525	125	50	10	40	25	5	25
Future Volume (vph)	95	1260	50	60	1525	125	50	10	40	25	5	25
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.88		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3191		1635	3147		1635	1408		1635	1400	
Flt Permitted	0.12	1.00		0.19	1.00		0.74	1.00		0.72	1.00	
Satd. Flow (perm)	204	3191		321	3147		1269	1408		1247	1400	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	95	1260	50	60	1525	125	50	10	40	25	5	25
RTOR Reduction (vph)	0	2	0	0	4	0	0	35	0	0	22	0
Lane Group Flow (vph)	95	1308	0	60	1646	0	50	15	0	25	8	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	59.6	59.6		59.6	59.6		7.5	7.5		7.7	7.7	
Effective Green, g (s)	61.8	61.8		61.8	61.8		9.7	9.7		9.7	9.7	
Actuated g/C Ratio	0.78	0.78		0.78	0.78		0.12	0.12		0.12	0.12	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	158	2480		249	2446		154	171		152	170	
v/s Ratio Prot		0.41			c0.52			0.01			0.01	
v/s Ratio Perm	0.47			0.19			c0.04			0.02		
v/c Ratio	0.60	0.53		0.24	0.67		0.32	0.09		0.16	0.05	
Uniform Delay, d1	3.7	3.3		2.4	4.1		31.9	31.0		31.3	30.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	15.8	0.8		2.3	1.5		1.2	0.2		0.5	0.1	
Delay (s)	19.5	4.1		4.7	5.6		33.1	31.2		31.8	30.9	
Level of Service	B	A		A	A		C	C		C	C	
Approach Delay (s)		5.2			5.6			32.2			31.3	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	6.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	79.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	40	2065	60	1780	175	120	135	145
v/c Ratio	0.49	0.97	0.74	0.84	0.70	0.35	0.50	0.41
Control Delay	36.0	29.6	68.3	17.1	44.4	26.0	34.0	25.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	36.0	29.6	68.3	17.1	44.4	26.0	34.0	25.0
Queue Length 50th (m)	2.9	149.0	5.8	103.6	25.6	14.2	18.7	15.9
Queue Length 95th (m)	#20.8	#248.2	#19.5	#177.8	47.0	28.3	35.2	31.6
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	81	2127	81	2108	328	443	355	458
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.49	0.97	0.74	0.84	0.53	0.27	0.38	0.32

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1990	75	60	1715	65	175	15	105	135	30	115
Future Volume (vph)	40	1990	75	60	1715	65	175	15	105	135	30	115
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3192		1635	3162		1635	1390		1635	1409	
Flt Permitted	0.07	1.00		0.07	1.00		0.61	1.00		0.66	1.00	
Satd. Flow (perm)	123	3192		123	3162		1052	1390		1137	1409	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	40	1990	75	60	1715	65	175	15	105	135	30	115
RTOR Reduction (vph)	0	3	0	0	3	0	0	10	0	0	20	0
Lane Group Flow (vph)	40	2062	0	60	1777	0	175	110	0	135	125	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	53.8	53.8		53.8	53.8		17.9	17.9		18.1	18.1	
Effective Green, g (s)	56.0	56.0		56.0	56.0		20.1	20.1		20.1	20.1	
Actuated g/C Ratio	0.67	0.67		0.67	0.67		0.24	0.24		0.24	0.24	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	81	2125		81	2105		251	332		271	336	
v/s Ratio Prot		c0.65			0.56			0.08			0.09	
v/s Ratio Perm	0.33			0.49			c0.17			0.12		
v/c Ratio	0.49	0.97		0.74	0.84		0.70	0.33		0.50	0.37	
Uniform Delay, d1	7.0	13.3		9.3	10.7		29.2	26.4		27.6	26.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	19.9	13.7		45.6	4.4		8.2	0.6		1.4	0.7	
Delay (s)	26.9	27.0		54.9	15.1		37.4	27.0		29.1	27.4	
Level of Service	C	C		D	B		D	C		C	C	
Approach Delay (s)		27.0			16.4			33.2			28.2	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	23.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	84.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	91.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	95	1415	60	1605	50	70	25	30
v/c Ratio	0.55	0.55	0.27	0.64	0.27	0.28	0.14	0.13
Control Delay	21.7	5.1	7.2	6.1	32.6	13.9	29.7	14.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.7	5.1	7.2	6.1	32.6	13.9	29.7	14.6
Queue Length 50th (m)	4.5	35.0	2.0	44.8	6.4	1.6	3.1	0.6
Queue Length 95th (m)	#33.1	60.4	8.4	78.7	15.6	11.9	9.5	7.3
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	173	2550	224	2514	430	510	415	491
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.55	0.55	0.27	0.64	0.12	0.14	0.06	0.06

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	95	1365	50	60	1480	125	50	10	60	25	5	25
Future Volume (vph)	95	1365	50	60	1480	125	50	10	60	25	5	25
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3192		1635	3146		1635	1394		1635	1400	
Flt Permitted	0.13	1.00		0.16	1.00		0.74	1.00		0.71	1.00	
Satd. Flow (perm)	217	3192		280	3146		1269	1394		1224	1400	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	95	1365	50	60	1480	125	50	10	60	25	5	25
RTOR Reduction (vph)	0	2	0	0	4	0	0	50	0	0	22	0
Lane Group Flow (vph)	95	1413	0	60	1601	0	50	20	0	25	8	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	58.7	58.7		58.7	58.7		7.5	7.5		7.7	7.7	
Effective Green, g (s)	60.9	60.9		60.9	60.9		9.7	9.7		9.7	9.7	
Actuated g/C Ratio	0.77	0.77		0.77	0.77		0.12	0.12		0.12	0.12	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	168	2473		216	2437		156	172		151	172	
v/s Ratio Prot		0.44			c0.51			0.01			0.01	
v/s Ratio Perm	0.44			0.21			c0.04			0.02		
v/c Ratio	0.57	0.57		0.28	0.66		0.32	0.12		0.17	0.05	
Uniform Delay, d1	3.5	3.6		2.5	4.1		31.4	30.6		30.8	30.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	13.1	1.0		3.2	1.4		1.2	0.3		0.5	0.1	
Delay (s)	16.6	4.5		5.7	5.5		32.6	30.9		31.3	30.5	
Level of Service	B	A		A	A		C	C		C	C	
Approach Delay (s)		5.3			5.5			31.6			30.9	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	6.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	78.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	40	2065	65	1770	175	120	135	145
v/c Ratio	0.49	0.97	0.80	0.84	0.70	0.35	0.50	0.41
Control Delay	36.0	29.6	79.7	16.9	44.4	26.0	34.0	25.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	36.0	29.6	79.7	16.9	44.4	26.0	34.0	25.0
Queue Length 50th (m)	2.9	149.0	6.8	102.5	25.6	14.2	18.7	15.9
Queue Length 95th (m)	#20.8	#248.2	#22.1	#174.0	47.0	28.3	35.2	31.6
Internal Link Dist (m)		700.7		475.4		126.4		214.9
Turn Bay Length (m)	93.6		51.7		60.0		40.0	
Base Capacity (vph)	81	2127	81	2105	328	443	355	458
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.49	0.97	0.80	0.84	0.53	0.27	0.38	0.32

Intersection Summary

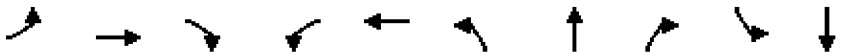
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	1990	75	65	1705	65	175	15	105	135	30	115
Future Volume (vph)	40	1990	75	65	1705	65	175	15	105	135	30	115
Ideal Flow (vphpl)	1775	1775	1750	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.87		1.00	0.88	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3192		1635	3162		1635	1390		1635	1409	
Flt Permitted	0.07	1.00		0.07	1.00		0.61	1.00		0.66	1.00	
Satd. Flow (perm)	123	3192		123	3162		1052	1390		1137	1409	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	40	1990	75	65	1705	65	175	15	105	135	30	115
RTOR Reduction (vph)	0	3	0	0	3	0	0	10	0	0	20	0
Lane Group Flow (vph)	40	2062	0	65	1767	0	175	110	0	135	125	0
Heavy Vehicles (%)	2%	4%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	53.8	53.8		53.8	53.8		17.9	17.9		18.1	18.1	
Effective Green, g (s)	56.0	56.0		56.0	56.0		20.1	20.1		20.1	20.1	
Actuated g/C Ratio	0.67	0.67		0.67	0.67		0.24	0.24		0.24	0.24	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.2	6.2		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	81	2125		81	2105		251	332		271	336	
v/s Ratio Prot		c0.65			0.56			0.08			0.09	
v/s Ratio Perm	0.33			0.53			c0.17			0.12		
v/c Ratio	0.49	0.97		0.80	0.84		0.70	0.33		0.50	0.37	
Uniform Delay, d1	7.0	13.3		10.1	10.6		29.2	26.4		27.6	26.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	19.9	13.7		55.6	4.2		8.2	0.6		1.4	0.7	
Delay (s)	26.9	27.0		65.6	14.9		37.4	27.0		29.1	27.4	
Level of Service	C	C		E	B		D	C		C	C	
Approach Delay (s)		27.0			16.7			33.2			28.2	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	23.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	84.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	91.8%	ICU Level of Service	F
Analysis Period (min)	15		

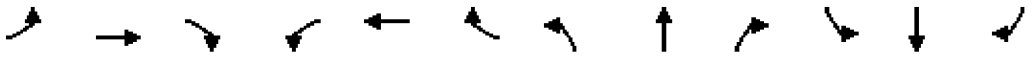
c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	35	730	475	300	1180	360	270	270	95	300
v/c Ratio	0.15	0.47	0.33	0.71	0.55	0.80	0.39	0.38	0.49	0.48
Control Delay	13.5	25.5	0.6	23.7	19.4	51.8	21.2	4.0	40.1	31.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.5	25.5	0.6	23.7	19.4	51.8	21.2	4.0	40.1	31.6
Queue Length 50th (m)	2.5	34.7	0.0	25.9	52.6	29.6	32.0	0.0	14.1	22.0
Queue Length 95th (m)	8.0	52.0	0.0	#59.9	77.8	#57.4	50.6	13.7	28.7	33.6
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	239	1541	1442	434	2138	448	1002	907	362	1150
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.47	0.33	0.69	0.55	0.80	0.27	0.30	0.26	0.26

Intersection Summary

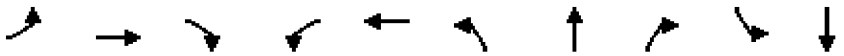
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	730	475	300	1115	65	360	270	270	95	260	40
Future Volume (vph)	35	730	475	300	1115	65	360	270	270	95	260	40
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4648		3172	1842	1442	1635	3204	
Flt Permitted	0.22	1.00	1.00	0.24	1.00		0.95	1.00	1.00	0.59	1.00	
Satd. Flow (perm)	382	4885	1442	415	4648		3172	1842	1442	1021	3204	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	35	730	475	300	1115	65	360	270	270	95	260	40
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	170	0	14	0
Lane Group Flow (vph)	35	730	475	300	1174	0	360	270	100	95	286	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	30.0	26.4	86.9	44.5	36.9		10.0	30.0	30.0	14.0	14.0	
Effective Green, g (s)	30.0	28.6	86.9	44.5	39.1		12.0	32.2	32.2	16.2	16.2	
Actuated g/C Ratio	0.35	0.33	1.00	0.51	0.45		0.14	0.37	0.37	0.19	0.19	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	183	1607	1442	410	2091		438	682	534	190	597	
v/s Ratio Prot	0.01	0.15		c0.12	0.25		c0.11	0.15			0.09	
v/s Ratio Perm	0.06		0.33	c0.26					0.07	c0.09		
v/c Ratio	0.19	0.45	0.33	0.73	0.56		0.82	0.40	0.19	0.50	0.48	
Uniform Delay, d1	19.0	23.0	0.0	13.8	17.6		36.4	20.2	18.5	31.7	31.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.5	0.9	0.6	6.6	1.1		11.8	0.4	0.2	2.1	0.6	
Delay (s)	19.5	23.9	0.6	20.4	18.7		48.2	20.6	18.7	33.8	32.2	
Level of Service	B	C	A	C	B		D	C	B	C	C	
Approach Delay (s)		14.9			19.0			31.0			32.6	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	86.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

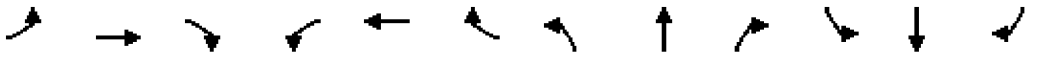
c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	65	1445	520	290	1185	465	305	350	90	445
v/c Ratio	0.31	0.84	0.36	0.98	0.55	0.92	0.42	0.48	0.45	0.67
Control Delay	19.4	39.4	0.7	80.2	23.9	71.9	26.3	8.3	46.7	45.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.4	39.4	0.7	80.2	23.9	71.9	26.3	8.3	46.7	45.3
Queue Length 50th (m)	6.7	105.4	0.0	48.9	68.0	52.3	47.7	11.6	17.5	46.3
Queue Length 95th (m)	15.4	137.5	0.0	#113.7	92.6	#89.6	70.1	33.9	33.3	63.0
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3		125.0			40.0	
Base Capacity (vph)	209	1725	1442	295	2137	506	853	810	264	868
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.84	0.36	0.98	0.55	0.92	0.36	0.43	0.34	0.51

Intersection Summary

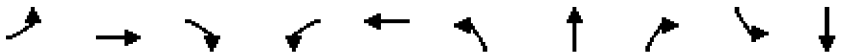
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	65	1445	520	290	1045	140	465	305	350	90	380	65
Future Volume (vph)	65	1445	520	290	1045	140	465	305	350	90	380	65
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4612		3172	1842	1442	1635	3198	
Flt Permitted	0.20	1.00	1.00	0.09	1.00		0.95	1.00	1.00	0.57	1.00	
Satd. Flow (perm)	346	4885	1442	162	4612		3172	1842	1442	988	3198	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	65	1445	520	290	1045	140	465	305	350	90	380	65
RTOR Reduction (vph)	0	0	0	0	13	0	0	0	161	0	12	0
Lane Group Flow (vph)	65	1445	520	290	1172	0	465	305	189	90	433	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	43.2	38.5	113.6	58.5	49.8		16.0	42.7	42.7	20.7	20.7	
Effective Green, g (s)	43.2	40.7	113.6	58.5	52.0		18.0	44.9	44.9	22.9	22.9	
Actuated g/C Ratio	0.38	0.36	1.00	0.51	0.46		0.16	0.40	0.40	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	184	1750	1442	290	2111		502	728	569	199	644	
v/s Ratio Prot	0.01	0.30		c0.14	0.25		c0.15	0.17			c0.14	
v/s Ratio Perm	0.12		0.36	c0.37					0.13	0.09		
v/c Ratio	0.35	0.83	0.36	1.00	0.56		0.93	0.42	0.33	0.45	0.67	
Uniform Delay, d1	22.8	33.2	0.0	34.3	22.4		47.1	24.9	23.9	39.8	41.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.2	4.6	0.7	52.8	1.1		23.1	0.4	0.3	1.6	2.8	
Delay (s)	24.0	37.8	0.7	87.2	23.5		70.3	25.3	24.3	41.5	44.7	
Level of Service	C	D	A	F	C		E	C	C	D	D	
Approach Delay (s)		27.9			36.0			43.7			44.1	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	35.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	113.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	86.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	35	755	450	310	1125	370	280	280	95	325
v/c Ratio	0.15	0.51	0.31	0.74	0.53	0.83	0.40	0.39	0.49	0.52
Control Delay	13.7	26.8	0.6	25.4	19.1	53.9	21.3	3.9	39.8	32.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.7	26.8	0.6	25.4	19.1	53.9	21.3	3.9	39.8	32.1
Queue Length 50th (m)	2.5	36.9	0.0	27.1	49.7	30.7	33.3	0.0	14.1	24.1
Queue Length 95th (m)	8.0	54.9	0.0	#66.8	73.3	#59.5	52.6	14.0	28.5	36.2
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	244	1480	1442	437	2125	447	1000	910	358	1147
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.51	0.31	0.71	0.53	0.83	0.28	0.31	0.27	0.28

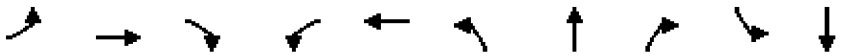
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	755	450	310	1050	75	370	280	280	95	280	45
Future Volume (vph)	35	755	450	310	1050	75	370	280	280	95	280	45
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4641		3172	1842	1442	1635	3202	
Flt Permitted	0.24	1.00	1.00	0.22	1.00		0.95	1.00	1.00	0.59	1.00	
Satd. Flow (perm)	414	4885	1442	385	4641		3172	1842	1442	1011	3202	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	35	755	450	310	1050	75	370	280	280	95	280	45
RTOR Reduction (vph)	0	0	0	0	7	0	0	0	176	0	15	0
Lane Group Flow (vph)	35	755	450	310	1118	0	370	280	104	95	310	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	29.0	25.4	87.1	44.4	36.8		10.0	30.3	30.3	14.3	14.3	
Effective Green, g (s)	29.0	27.6	87.1	44.4	39.0		12.0	32.5	32.5	16.5	16.5	
Actuated g/C Ratio	0.33	0.32	1.00	0.51	0.45		0.14	0.37	0.37	0.19	0.19	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	188	1547	1442	411	2078		437	687	538	191	606	
v/s Ratio Prot	0.01	0.15		c0.13	0.24		c0.12	0.15			c0.10	
v/s Ratio Perm	0.05		0.31	c0.25					0.07	0.09		
v/c Ratio	0.19	0.49	0.31	0.75	0.54		0.85	0.41	0.19	0.50	0.51	
Uniform Delay, d1	19.8	24.0	0.0	14.3	17.5		36.7	20.2	18.5	31.6	31.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.5	1.1	0.6	7.7	1.0		14.1	0.4	0.2	2.0	0.7	
Delay (s)	20.3	25.1	0.6	21.9	18.5		50.7	20.6	18.6	33.6	32.4	
Level of Service	C	C	A	C	B		D	C	B	C	C	
Approach Delay (s)		16.1			19.2			32.0			32.7	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	22.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	87.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	70	1400	530	300	1230	410	310	330	90	430
v/c Ratio	0.32	0.82	0.37	0.90	0.56	0.90	0.44	0.44	0.46	0.66
Control Delay	18.4	38.7	0.7	59.8	23.2	71.5	28.2	4.9	47.5	44.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	18.4	38.7	0.7	59.8	23.2	71.5	28.2	4.9	47.5	44.9
Queue Length 50th (m)	6.8	101.3	0.0	49.0	69.8	45.8	50.2	1.5	17.5	44.4
Queue Length 95th (m)	15.3	131.6	0.0	#107.2	94.1	#80.0	74.0	19.0	33.3	60.7
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	224	1703	1442	341	2188	456	831	825	267	878
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.82	0.37	0.88	0.56	0.90	0.37	0.40	0.34	0.49

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	70	1400	530	300	1095	135	410	310	330	90	365	65
Future Volume (vph)	70	1400	530	300	1095	135	410	310	330	90	365	65
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4617		3172	1842	1442	1635	3195	
Flt Permitted	0.20	1.00	1.00	0.10	1.00		0.95	1.00	1.00	0.57	1.00	
Satd. Flow (perm)	340	4885	1442	165	4617		3172	1842	1442	984	3195	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	70	1400	530	300	1095	135	410	310	330	90	365	65
RTOR Reduction (vph)	0	0	0	0	12	0	0	0	199	0	13	0
Lane Group Flow (vph)	70	1400	530	300	1218	0	410	310	131	90	417	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	43.2	37.6	112.4	60.0	50.4		14.0	40.0	40.0	20.0	20.0	
Effective Green, g (s)	43.2	39.8	112.4	60.0	52.6		16.0	42.2	42.2	22.2	22.2	
Actuated g/C Ratio	0.38	0.35	1.00	0.53	0.47		0.14	0.38	0.38	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	195	1729	1442	328	2160		451	691	541	194	631	
v/s Ratio Prot	0.02	0.29		c0.15	0.26		c0.13	0.17			c0.13	
v/s Ratio Perm	0.12		0.37	c0.34					0.09	0.09		
v/c Ratio	0.36	0.81	0.37	0.91	0.56		0.91	0.45	0.24	0.46	0.66	
Uniform Delay, d1	22.3	32.9	0.0	32.4	21.6		47.5	26.4	24.1	39.8	41.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.1	4.2	0.7	28.8	1.1		21.9	0.5	0.2	1.8	2.6	
Delay (s)	23.4	37.1	0.7	61.1	22.7		69.3	26.8	24.3	41.6	44.2	
Level of Service	C	D	A	E	C		E	C	C	D	D	
Approach Delay (s)		27.0			30.2			42.6			43.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	32.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	112.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	32	760	530	340	1300	445	320	320	105	330
v/c Ratio	0.16	0.56	0.37	0.84	0.64	0.88	0.43	0.41	0.54	0.50
Control Delay	15.8	29.4	0.7	37.1	23.0	56.6	20.4	3.6	41.8	32.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.8	29.4	0.7	37.1	23.0	56.6	20.4	3.6	41.8	32.1
Queue Length 50th (m)	2.5	39.0	0.0	33.1	64.7	37.4	37.5	0.0	15.9	24.7
Queue Length 95th (m)	8.2	58.3	0.0	#91.6	95.4	#72.0	57.6	13.8	31.2	36.8
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	202	1366	1442	404	2022	508	1017	939	337	1121
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.16	0.56	0.37	0.84	0.64	0.88	0.31	0.34	0.31	0.29

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	760	530	340	1225	75	445	320	320	105	290	40
Future Volume (vph)	32	760	530	340	1225	75	445	320	320	105	290	40
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4647		3172	1842	1442	1635	3210	
Flt Permitted	0.18	1.00	1.00	0.21	1.00		0.95	1.00	1.00	0.57	1.00	
Satd. Flow (perm)	307	4885	1442	356	4647		3172	1842	1442	975	3210	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	32	760	530	340	1225	75	445	320	320	105	290	40
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	192	0	12	0
Lane Group Flow (vph)	32	760	530	340	1294	0	445	320	128	105	318	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	27.6	24.0	89.2	43.4	35.8		12.0	33.4	33.4	15.4	15.4	
Effective Green, g (s)	27.6	26.2	89.2	43.4	38.0		14.0	35.6	35.6	17.6	17.6	
Actuated g/C Ratio	0.31	0.29	1.00	0.49	0.43		0.16	0.40	0.40	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	148	1434	1442	394	1979		497	735	575	192	633	
v/s Ratio Prot	0.01	0.16		c0.15	0.28		c0.14	0.17			0.10	
v/s Ratio Perm	0.06		0.37	c0.27					0.09	c0.11		
v/c Ratio	0.22	0.53	0.37	0.86	0.65		0.90	0.44	0.22	0.55	0.50	
Uniform Delay, d1	21.7	26.3	0.0	16.5	20.4		36.9	19.5	17.7	32.2	31.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	1.4	0.7	17.4	1.7		18.4	0.4	0.2	3.2	0.6	
Delay (s)	22.5	27.8	0.7	34.0	22.1		55.3	19.9	17.9	35.4	32.5	
Level of Service	C	C	A	C	C		E	B	B	D	C	
Approach Delay (s)		16.8			24.5			33.8			33.2	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	25.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	89.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	70	1560	600	315	1350	560	375	470	85	500
v/c Ratio	0.40	0.94	0.42	1.00	0.62	0.97	0.50	0.60	0.46	0.78
Control Delay	25.4	55.3	0.9	92.6	29.5	85.9	32.5	13.1	57.2	59.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	25.4	55.3	0.9	92.6	29.5	85.9	32.5	13.1	57.2	59.7
Queue Length 50th (m)	9.3	153.0	0.0	~76.6	103.5	80.0	74.4	30.4	20.5	66.6
Queue Length 95th (m)	17.7	#185.8	0.0	#137.3	121.1	#117.7	103.5	65.5	38.0	86.5
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3		125.0			40.0	
Base Capacity (vph)	177	1668	1442	314	2170	578	795	801	204	714
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.40	0.94	0.42	1.00	0.62	0.97	0.47	0.59	0.42	0.70

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	70	1560	600	315	1205	145	560	375	470	85	430	70
Future Volume (vph)	70	1560	600	315	1205	145	560	375	470	85	430	70
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4618		3172	1842	1442	1635	3201	
Flt Permitted	0.16	1.00	1.00	0.08	1.00		0.95	1.00	1.00	0.54	1.00	
Satd. Flow (perm)	274	4885	1442	139	4618		3172	1842	1442	927	3201	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	70	1560	600	315	1205	145	560	375	470	85	430	70
RTOR Reduction (vph)	0	0	0	0	10	0	0	0	187	0	10	0
Lane Group Flow (vph)	70	1560	600	315	1340	0	560	375	283	85	490	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	50.9	45.4	137.8	71.4	61.9		23.0	54.0	54.0	25.0	25.0	
Effective Green, g (s)	50.9	47.6	137.8	71.4	64.1		25.0	56.2	56.2	27.2	27.2	
Actuated g/C Ratio	0.37	0.35	1.00	0.52	0.47		0.18	0.41	0.41	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	155	1687	1442	310	2148		575	751	588	182	631	
v/s Ratio Prot	0.02	0.32		c0.16	0.29		c0.18	0.20			c0.15	
v/s Ratio Perm	0.15		0.42	c0.36					0.20	0.09		
v/c Ratio	0.45	0.92	0.42	1.02	0.62		0.97	0.50	0.48	0.47	0.78	
Uniform Delay, d1	28.9	43.4	0.0	44.8	27.8		56.1	30.3	30.1	48.9	52.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.1	10.1	0.9	55.3	1.4		30.7	0.5	0.6	1.9	6.0	
Delay (s)	31.0	53.5	0.9	100.1	29.1		86.8	30.9	30.7	50.8	58.4	
Level of Service	C	D	A	F	C		F	C	C	D	E	
Approach Delay (s)		38.6			42.6			53.1			57.3	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM 2000 Control Delay	45.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	137.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	94.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	35	900	515	345	1275	425	315	315	105	365
v/c Ratio	0.17	0.66	0.36	0.89	0.62	0.91	0.43	0.41	0.53	0.54
Control Delay	15.6	31.5	0.7	47.9	22.0	62.8	21.0	3.7	40.8	32.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.6	31.5	0.7	47.9	22.0	62.8	21.0	3.7	40.8	32.7
Queue Length 50th (m)	2.7	47.9	0.0	39.7	61.9	36.0	37.5	0.0	15.9	27.7
Queue Length 95th (m)	8.6	70.1	0.0	#102.2	91.0	#70.8	58.0	14.1	31.1	40.7
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	209	1362	1442	387	2062	469	989	920	336	1114
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.17	0.66	0.36	0.89	0.62	0.91	0.32	0.34	0.31	0.33

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	35	900	515	345	1195	80	425	315	315	105	320	45
Future Volume (vph)	35	900	515	345	1195	80	425	315	315	105	320	45
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4644		3172	1842	1442	1635	3209	
Flt Permitted	0.20	1.00	1.00	0.15	1.00		0.95	1.00	1.00	0.57	1.00	
Satd. Flow (perm)	338	4885	1442	259	4644		3172	1842	1442	979	3209	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	35	900	515	345	1195	80	425	315	315	105	320	45
RTOR Reduction (vph)	0	0	0	0	6	0	0	0	192	0	13	0
Lane Group Flow (vph)	35	900	515	345	1269	0	425	315	123	105	352	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	27.7	24.1	89.7	44.4	36.8		11.0	32.9	32.9	15.9	15.9	
Effective Green, g (s)	27.7	26.3	89.7	44.4	39.0		13.0	35.1	35.1	18.1	18.1	
Actuated g/C Ratio	0.31	0.29	1.00	0.49	0.43		0.14	0.39	0.39	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	156	1432	1442	378	2019		459	720	564	197	647	
v/s Ratio Prot	0.01	0.18		c0.17	0.27		c0.13	0.17			c0.11	
v/s Ratio Perm	0.06		0.36	c0.29					0.09	0.11		
v/c Ratio	0.22	0.63	0.36	0.91	0.63		0.93	0.44	0.22	0.53	0.54	
Uniform Delay, d1	21.9	27.5	0.0	21.8	19.7		37.9	20.0	18.2	32.0	32.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	2.1	0.7	25.7	1.5		24.6	0.4	0.2	2.8	0.9	
Delay (s)	22.6	29.6	0.7	47.6	21.2		62.5	20.5	18.4	34.8	33.0	
Level of Service	C	C	A	D	C		E	C	B	C	C	
Approach Delay (s)		19.1			26.8			36.8			33.4	
Approach LOS		B			C			D			C	

Intersection Summary			
HCM 2000 Control Delay	27.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	89.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	70	1585	580	325	1385	525	415	400	95	495
v/c Ratio	0.39	0.94	0.40	0.98	0.62	0.98	0.57	0.52	0.54	0.77
Control Delay	24.2	55.0	0.8	86.1	28.5	92.3	35.9	8.4	61.4	59.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.2	55.0	0.8	86.1	28.5	92.3	35.9	8.4	61.4	59.4
Queue Length 50th (m)	9.0	155.1	0.0	75.1	105.1	75.2	86.9	12.1	23.3	65.7
Queue Length 95th (m)	17.1	#188.9	0.0	#138.7	123.1	#113.5	119.7	39.0	42.1	85.6
Internal Link Dist (m)		744.3			654.9		342.1			494.3
Turn Bay Length (m)	49.8		38.6	50.3						
Base Capacity (vph)	183	1691	1442	331	2227	533	769	793	196	715
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.94	0.40	0.98	0.62	0.98	0.54	0.50	0.48	0.69

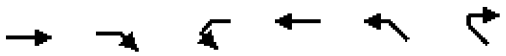
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	70	1585	580	325	1245	140	525	415	400	95	425	70
Future Volume (vph)	70	1585	580	325	1245	140	525	415	400	95	425	70
Ideal Flow (vphpl)	1775	1900	1750	1775	1820	1900	1775	1900	1750	1775	1775	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	0.91	1.00	1.00	0.91		0.97	1.00	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1635	4885	1442	1635	4622		3172	1842	1442	1635	3200	
Flt Permitted	0.16	1.00	1.00	0.08	1.00		0.95	1.00	1.00	0.52	1.00	
Satd. Flow (perm)	268	4885	1442	137	4622		3172	1842	1442	894	3200	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	70	1585	580	325	1245	140	525	415	400	95	425	70
RTOR Reduction (vph)	0	0	0	0	9	0	0	0	200	0	10	0
Lane Group Flow (vph)	70	1585	580	325	1376	0	525	415	200	95	485	0
Heavy Vehicles (%)	2%	5%	2%	2%	5%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA	Free	pm+pt	NA		Prot	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6		3	8			4	
Permitted Phases	2		Free	6					8	4		
Actuated Green, G (s)	52.1	46.1	137.8	73.5	63.5		21.0	51.9	51.9	24.9	24.9	
Effective Green, g (s)	52.1	48.3	137.8	73.5	65.7		23.0	54.1	54.1	27.1	27.1	
Actuated g/C Ratio	0.38	0.35	1.00	0.53	0.48		0.17	0.39	0.39	0.20	0.20	
Clearance Time (s)	4.0	6.2		4.0	6.2		6.0	6.2	6.2	6.2	6.2	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	160	1712	1442	327	2203		529	723	566	175	629	
v/s Ratio Prot	0.02	0.32		c0.17	0.30		c0.17	0.23			c0.15	
v/s Ratio Perm	0.15		0.40	c0.36					0.14	0.11		
v/c Ratio	0.44	0.93	0.40	0.99	0.62		0.99	0.57	0.35	0.54	0.77	
Uniform Delay, d1	28.1	43.0	0.0	44.9	26.9		57.3	32.8	29.5	49.8	52.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.9	10.1	0.8	47.9	1.3		37.0	1.1	0.4	3.4	5.8	
Delay (s)	30.0	53.1	0.8	92.7	28.2		94.3	33.9	29.9	53.2	58.3	
Level of Service	C	D	A	F	C		F	C	C	D	E	
Approach Delay (s)		38.8			40.5			56.4			57.4	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM 2000 Control Delay	45.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	137.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



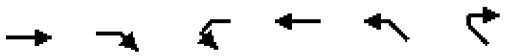
Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1125	60	5	1380	65	5
v/c Ratio	0.45	0.06	0.02	0.59	0.27	0.02
Control Delay	4.2	1.3	4.4	5.8	25.2	14.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.2	1.3	4.4	5.8	25.2	14.0
Queue Length 50th (m)	23.8	0.0	0.2	35.9	6.5	0.0
Queue Length 95th (m)	42.3	2.7	1.2	66.2	15.6	2.4
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	2510	1066	286	2323	566	503
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.06	0.02	0.59	0.11	0.01

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1125	60	5	1380	65	5
Future Volume (vph)	1125	60	5	1380	65	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3089	1298	1471	2859	1471	1298
Flt Permitted	1.00	1.00	0.23	1.00	0.95	1.00
Satd. Flow (perm)	3089	1298	361	2859	1471	1298
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1125	60	5	1380	65	5
RTOR Reduction (vph)	0	15	0	0	0	4
Lane Group Flow (vph)	1125	45	5	1380	65	1
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	46.8	46.8	46.8	46.8	5.7	5.7
Effective Green, g (s)	49.0	49.0	46.8	49.0	7.7	7.7
Actuated g/C Ratio	0.76	0.76	0.72	0.76	0.12	0.12
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2339	983	261	2165	175	154
v/s Ratio Prot	0.36			c0.48	c0.04	
v/s Ratio Perm		0.04	0.01			0.00
v/c Ratio	0.48	0.05	0.02	0.64	0.37	0.00
Uniform Delay, d1	3.0	2.0	2.5	3.7	26.3	25.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.7	0.1	0.1	1.4	1.3	0.0
Delay (s)	3.7	2.1	2.6	5.1	27.6	25.1
Level of Service	A	A	A	A	C	C
Approach Delay (s)	3.6			5.1	27.4	
Approach LOS	A			A	C	

Intersection Summary			
HCM 2000 Control Delay	5.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	64.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



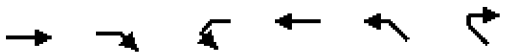
Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1735	125	5	1435	110	5
v/c Ratio	0.67	0.11	0.04	0.60	0.39	0.02
Control Delay	7.6	1.3	5.8	6.6	28.7	14.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.6	1.3	5.8	6.6	28.7	14.6
Queue Length 50th (m)	54.2	0.3	0.2	40.5	12.5	0.0
Queue Length 95th (m)	95.7	4.8	1.4	72.3	25.3	2.5
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	2600	1120	118	2405	572	508
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.67	0.11	0.04	0.60	0.19	0.01

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1735	125	5	1435	110	5
Future Volume (vph)	1735	125	5	1435	110	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3433	1442	1635	3176	1635	1442
Flt Permitted	1.00	1.00	0.09	1.00	0.95	1.00
Satd. Flow (perm)	3433	1442	162	3176	1635	1442
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1735	125	5	1435	110	5
RTOR Reduction (vph)	0	31	0	0	0	4
Lane Group Flow (vph)	1735	94	5	1435	110	1
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	48.9	48.9	48.9	48.9	8.7	8.7
Effective Green, g (s)	51.1	51.1	48.9	51.1	10.7	10.7
Actuated g/C Ratio	0.73	0.73	0.70	0.73	0.15	0.15
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2513	1055	113	2325	250	221
v/s Ratio Prot	c0.51			0.45	c0.07	
v/s Ratio Perm		0.07	0.03			0.00
v/c Ratio	0.69	0.09	0.04	0.62	0.44	0.00
Uniform Delay, d1	5.1	2.7	3.2	4.6	26.8	25.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.6	0.2	0.7	1.2	1.2	0.0
Delay (s)	6.6	2.8	4.0	5.8	28.1	25.0
Level of Service	A	A	A	A	C	C
Approach Delay (s)	6.4			5.8	27.9	
Approach LOS	A			A	C	

Intersection Summary			
HCM 2000 Control Delay	6.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	69.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	700	520	5	840	560	5
v/c Ratio	0.48	0.57	0.02	0.62	0.79	0.01
Control Delay	13.8	4.3	12.8	15.9	23.3	5.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.8	4.3	12.8	15.9	23.3	5.8
Queue Length 50th (m)	28.2	0.0	0.4	36.7	46.4	0.0
Queue Length 95th (m)	42.7	15.6	2.2	55.2	#82.1	1.4
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	1468	914	207	1359	821	727
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.48	0.57	0.02	0.62	0.68	0.01

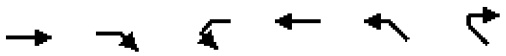
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	700	520	5	840	560	5
Future Volume (vph)	700	520	5	840	560	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	3.8	3.8
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3433	1442	1635	3176	1635	1442
Flt Permitted	1.00	1.00	0.31	1.00	0.95	1.00
Satd. Flow (perm)	3433	1442	533	3176	1635	1442
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	700	520	5	840	560	5
RTOR Reduction (vph)	0	297	0	0	0	3
Lane Group Flow (vph)	700	223	5	840	560	2
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	21.9	21.9	21.9	21.9	22.2	22.2
Effective Green, g (s)	24.1	24.1	21.9	24.1	24.4	24.4
Actuated g/C Ratio	0.43	0.43	0.39	0.43	0.43	0.43
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1469	617	207	1359	708	624
v/s Ratio Prot	0.20			c0.26	c0.34	
v/s Ratio Perm		0.15	0.01			0.00
v/c Ratio	0.48	0.36	0.02	0.62	0.79	0.00
Uniform Delay, d1	11.6	10.9	10.6	12.5	13.8	9.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.1	1.6	0.2	2.1	6.0	0.0
Delay (s)	12.7	12.5	10.8	14.6	19.8	9.1
Level of Service	B	B	B	B	B	A
Approach Delay (s)	12.6			14.6	19.7	
Approach LOS	B			B	B	

Intersection Summary			
HCM 2000 Control Delay	14.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	56.3	Sum of lost time (s)	7.8
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

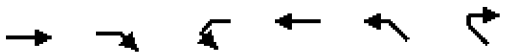
c Critical Lane Group



Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1075	720	5	980	620	5
v/c Ratio	0.79	0.77	0.05	0.78	0.91	0.01
Control Delay	26.7	9.2	17.4	26.6	40.5	7.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.7	9.2	17.4	26.6	40.5	7.4
Queue Length 50th (m)	84.2	6.5	0.5	76.2	90.7	0.0
Queue Length 95th (m)	110.8	49.9	2.8	102.0	#156.8	1.7
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	1366	940	95	1264	753	667
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.79	0.77	0.05	0.78	0.82	0.01

Intersection Summary

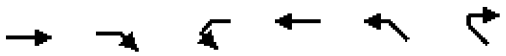
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1075	720	5	980	620	5
Future Volume (vph)	1075	720	5	980	620	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3089	1298	1471	2859	1471	1298
Flt Permitted	1.00	1.00	0.14	1.00	0.95	1.00
Satd. Flow (perm)	3089	1298	217	2859	1471	1298
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1075	720	5	980	620	5
RTOR Reduction (vph)	0	366	0	0	0	3
Lane Group Flow (vph)	1075	354	5	980	620	2
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	36.0	36.0	36.0	36.0	38.1	38.1
Effective Green, g (s)	38.2	38.2	38.2	38.2	40.1	40.1
Actuated g/C Ratio	0.44	0.44	0.44	0.44	0.46	0.46
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1367	574	96	1265	683	603
v/s Ratio Prot	c0.35			0.34	c0.42	
v/s Ratio Perm		0.27	0.02			0.00
v/c Ratio	0.79	0.62	0.05	0.77	0.91	0.00
Uniform Delay, d1	20.6	18.4	13.7	20.4	21.4	12.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.6	4.9	1.0	4.7	15.8	0.0
Delay (s)	25.2	23.4	14.7	25.1	37.2	12.4
Level of Service	C	C	B	C	D	B
Approach Delay (s)	24.5			25.0	37.0	
Approach LOS	C			C	D	

Intersection Summary			
HCM 2000 Control Delay	26.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	86.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	80.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



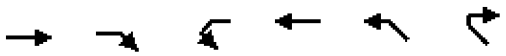
Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1210	65	5	1465	140	5
v/c Ratio	0.54	0.07	0.02	0.71	0.46	0.02
Control Delay	7.1	1.7	6.0	10.3	27.3	13.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	7.1	1.7	6.0	10.3	27.3	13.0
Queue Length 50th (m)	34.1	0.0	0.2	51.5	14.7	0.0
Queue Length 95th (m)	63.5	3.7	1.5	100.0	28.9	2.2
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	2237	958	212	2070	544	483
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.54	0.07	0.02	0.71	0.26	0.01

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1210	65	5	1465	140	5
Future Volume (vph)	1210	65	5	1465	140	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3089	1298	1471	2859	1471	1298
Flt Permitted	1.00	1.00	0.20	1.00	0.95	1.00
Satd. Flow (perm)	3089	1298	303	2859	1471	1298
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1210	65	5	1465	140	5
RTOR Reduction (vph)	0	20	0	0	0	4
Lane Group Flow (vph)	1210	45	5	1465	140	1
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	44.0	44.0	44.0	44.0	10.0	10.0
Effective Green, g (s)	46.2	46.2	44.0	46.2	12.0	12.0
Actuated g/C Ratio	0.70	0.70	0.66	0.70	0.18	0.18
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2155	905	201	1995	266	235
v/s Ratio Prot	0.39			c0.51	c0.10	
v/s Ratio Perm		0.03	0.02			0.00
v/c Ratio	0.56	0.05	0.02	0.73	0.53	0.00
Uniform Delay, d1	5.0	3.1	3.8	6.2	24.5	22.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.1	0.1	0.2	2.4	1.9	0.0
Delay (s)	6.0	3.2	4.0	8.6	26.4	22.2
Level of Service	A	A	A	A	C	C
Approach Delay (s)	5.9			8.6	26.3	
Approach LOS	A			A	C	

Intersection Summary			
HCM 2000 Control Delay	8.3	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	66.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1890	200	5	1535	200	5
v/c Ratio	0.83	0.20	0.05	0.73	0.55	0.02
Control Delay	14.3	2.0	8.2	11.2	30.7	13.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.3	2.0	8.2	11.2	30.7	13.2
Queue Length 50th (m)	84.1	1.3	0.2	59.6	24.1	0.0
Queue Length 95th (m)	#161.2	8.9	1.9	109.1	42.4	2.4
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	2288	1017	95	2117	544	483
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.83	0.20	0.05	0.73	0.37	0.01

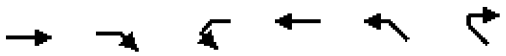
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1890	200	5	1535	200	5
Future Volume (vph)	1890	200	5	1535	200	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3433	1442	1635	3176	1635	1442
Flt Permitted	1.00	1.00	0.09	1.00	0.95	1.00
Satd. Flow (perm)	3433	1442	150	3176	1635	1442
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1890	200	5	1535	200	5
RTOR Reduction (vph)	0	56	0	0	0	4
Lane Group Flow (vph)	1890	144	5	1535	200	1
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	45.9	45.9	45.9	45.9	14.1	14.1
Effective Green, g (s)	48.1	48.1	45.9	48.1	16.1	16.1
Actuated g/C Ratio	0.67	0.67	0.64	0.67	0.22	0.22
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2287	960	95	2115	364	321
v/s Ratio Prot	c0.55			0.48	c0.12	
v/s Ratio Perm		0.10	0.03			0.00
v/c Ratio	0.83	0.15	0.05	0.73	0.55	0.00
Uniform Delay, d1	8.9	4.5	5.0	7.8	24.8	21.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.6	0.3	1.1	2.2	1.7	0.0
Delay (s)	12.5	4.8	6.0	10.0	26.5	21.8
Level of Service	B	A	A	B	C	C
Approach Delay (s)	11.8			10.0	26.4	
Approach LOS	B			A	C	

Intersection Summary			
HCM 2000 Control Delay	11.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	72.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	820	590	5	965	610	5
v/c Ratio	0.57	0.62	0.03	0.73	0.84	0.01
Control Delay	15.4	4.8	13.2	18.6	26.5	5.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.4	4.8	13.2	18.6	26.5	5.8
Queue Length 50th (m)	35.8	0.0	0.3	46.2	53.1	0.0
Queue Length 95th (m)	51.6	16.5	2.2	66.6	#106.2	1.4
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	1434	945	157	1326	802	710
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.57	0.62	0.03	0.73	0.76	0.01

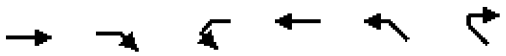
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	820	590	5	965	610	5
Future Volume (vph)	820	590	5	965	610	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	6.2	4.0	3.8	3.8
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3433	1442	1635	3176	1635	1442
Flt Permitted	1.00	1.00	0.24	1.00	0.95	1.00
Satd. Flow (perm)	3433	1442	413	3176	1635	1442
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	820	590	5	965	610	5
RTOR Reduction (vph)	0	343	0	0	0	3
Lane Group Flow (vph)	820	247	5	965	610	2
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	21.9	21.9	21.9	21.9	23.5	23.5
Effective Green, g (s)	24.1	24.1	21.9	24.1	25.7	25.7
Actuated g/C Ratio	0.42	0.42	0.38	0.42	0.45	0.45
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1436	603	157	1328	729	643
v/s Ratio Prot	0.24			c0.30	c0.37	
v/s Ratio Perm		0.17	0.01			0.00
v/c Ratio	0.57	0.41	0.03	0.73	0.84	0.00
Uniform Delay, d1	12.8	11.8	11.2	14.0	14.1	8.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.7	2.1	0.4	3.5	8.3	0.0
Delay (s)	14.5	13.8	11.6	17.5	22.4	8.8
Level of Service	B	B	B	B	C	A
Approach Delay (s)	14.2			17.5	22.3	
Approach LOS	B			B	C	

Intersection Summary			
HCM 2000 Control Delay	16.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	57.6	Sum of lost time (s)	7.8
Intersection Capacity Utilization	71.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBT	EBR	WBL	WBT	NWL	NWR
Lane Group Flow (vph)	1240	815	5	1065	715	5
v/c Ratio	0.95	0.89	0.07	0.88	0.99	0.01
Control Delay	41.9	18.8	19.0	34.3	57.1	8.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	41.9	18.8	19.0	34.3	57.1	8.4
Queue Length 50th (m)	105.8	23.3	0.5	86.7	117.7	0.1
Queue Length 95th (m)	#151.6	#126.7	2.9	#126.4	#194.2	1.8
Internal Link Dist (m)	192.3			509.6	517.9	
Turn Bay Length (m)		49.0	46.0			50.0
Base Capacity (vph)	1304	919	68	1207	719	636
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.95	0.89	0.07	0.88	0.99	0.01

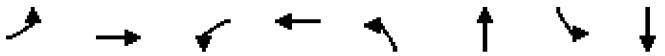
Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Traffic Volume (vph)	1240	815	5	1065	715	5
Future Volume (vph)	1240	815	5	1065	715	5
Ideal Flow (vphpl)	1900	1750	1775	1775	1775	1750
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3089	1298	1471	2859	1471	1298
Flt Permitted	1.00	1.00	0.11	1.00	0.95	1.00
Satd. Flow (perm)	3089	1298	163	2859	1471	1298
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	1240	815	5	1065	715	5
RTOR Reduction (vph)	0	372	0	0	0	2
Lane Group Flow (vph)	1240	443	5	1065	715	3
Heavy Vehicles (%)	4%	2%	2%	5%	2%	2%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	2			6	8	
Permitted Phases		2	6			8
Actuated Green, G (s)	35.8	35.8	35.8	35.8	42.0	42.0
Effective Green, g (s)	38.0	38.0	38.0	38.0	44.0	44.0
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.49	0.49
Clearance Time (s)	6.2	6.2	6.2	6.2	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1304	548	68	1207	719	634
v/s Ratio Prot	c0.40			0.37	c0.49	
v/s Ratio Perm		0.34	0.03			0.00
v/c Ratio	0.95	0.81	0.07	0.88	0.99	0.00
Uniform Delay, d1	25.1	22.8	15.5	23.9	22.9	11.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.7	12.2	2.1	9.5	32.0	0.0
Delay (s)	40.8	35.0	17.6	33.4	54.9	11.8
Level of Service	D	D	B	C	D	B
Approach Delay (s)	38.5			33.4	54.6	
Approach LOS	D			C	D	

Intersection Summary			
HCM 2000 Control Delay	40.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	91.9%	ICU Level of Service	F
Analysis Period (min)	15		

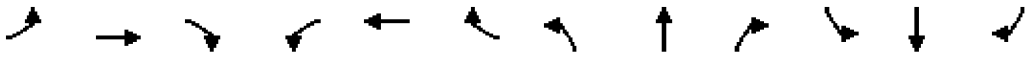
c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	85	1050	20	1335	135	85	185	165
v/c Ratio	0.50	0.51	0.08	0.64	0.56	0.22	0.63	0.41
Control Delay	22.7	8.9	7.8	10.9	35.1	16.3	36.7	20.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.7	8.9	7.8	10.9	35.1	16.3	36.7	20.0
Queue Length 50th (m)	5.6	35.6	1.0	52.8	17.8	5.9	24.9	14.2
Queue Length 95th (m)	#31.3	70.1	4.7	103.1	34.0	16.0	44.3	29.7
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	171	2061	259	2081	379	589	457	595
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.50	0.51	0.08	0.64	0.36	0.14	0.40	0.28

Intersection Summary

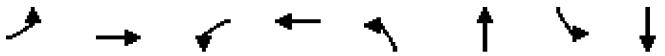
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	85	915	135	20	1180	155	135	50	35	185	90	75
Future Volume (vph)	85	915	135	20	1180	155	135	50	35	185	90	75
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98		1.00	0.94		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3126		1635	3158		1635	1501		1635	1491	
Flt Permitted	0.15	1.00		0.23	1.00		0.58	1.00		0.70	1.00	
Satd. Flow (perm)	261	3126		396	3158		1002	1501		1208	1491	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	85	915	135	20	1180	155	135	50	35	185	90	75
RTOR Reduction (vph)	0	11	0	0	9	0	0	26	0	0	38	0
Lane Group Flow (vph)	85	1039	0	20	1326	0	135	59	0	185	127	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	50.1	50.1		50.1	50.1		17.4	17.4		17.4	17.4	
Effective Green, g (s)	52.3	52.3		52.3	52.3		19.4	19.4		19.4	19.4	
Actuated g/C Ratio	0.66	0.66		0.66	0.66		0.24	0.24		0.24	0.24	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	171	2051		259	2072		243	365		294	362	
v/s Ratio Prot		0.33			c0.42			0.04			0.09	
v/s Ratio Perm	0.33			0.05			0.13			c0.15		
v/c Ratio	0.50	0.51		0.08	0.64		0.56	0.16		0.63	0.35	
Uniform Delay, d1	7.0	7.1		5.0	8.1		26.4	23.7		26.9	24.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	10.0	0.9		0.6	1.5		2.7	0.2		4.2	0.6	
Delay (s)	17.0	8.0		5.5	9.6		29.1	23.9		31.1	25.5	
Level of Service	B	A		A	A		C	C		C	C	
Approach Delay (s)		8.6			9.6			27.1			28.5	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	12.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	79.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.9%	ICU Level of Service	D
Analysis Period (min)	15		

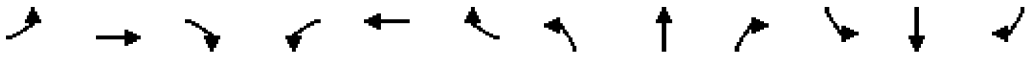
c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	70	1665	25	1415	175	165	250	190
v/c Ratio	0.57	0.87	0.31	0.74	0.61	0.35	0.81	0.39
Control Delay	35.2	21.3	22.7	15.2	35.6	23.0	49.6	16.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	35.2	21.3	22.7	15.2	35.6	23.0	49.6	16.0
Queue Length 50th (m)	6.9	118.5	2.0	84.0	24.4	18.8	37.6	13.9
Queue Length 95th (m)	#29.9	#184.7	9.7	115.5	45.5	34.6	#73.0	30.7
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	123	1918	81	1924	338	554	363	561
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.57	0.87	0.31	0.74	0.52	0.30	0.69	0.34

Intersection Summary

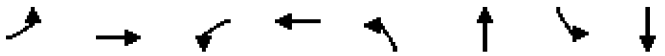
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	70	1485	180	25	1145	270	175	130	35	250	75	115
Future Volume (vph)	70	1485	180	25	1145	270	175	130	35	250	75	115
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.97		1.00	0.97		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3134		1635	3126		1635	1549		1635	1454	
Flt Permitted	0.12	1.00		0.08	1.00		0.56	1.00		0.60	1.00	
Satd. Flow (perm)	203	3134		132	3126		964	1549		1032	1454	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	70	1485	180	25	1145	270	175	130	35	250	75	115
RTOR Reduction (vph)	0	10	0	0	21	0	0	11	0	0	55	0
Lane Group Flow (vph)	70	1655	0	25	1394	0	175	154	0	250	135	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	50.0	50.0		50.0	50.0		23.5	23.5		23.5	23.5	
Effective Green, g (s)	52.2	52.2		52.2	52.2		25.5	25.5		25.5	25.5	
Actuated g/C Ratio	0.61	0.61		0.61	0.61		0.30	0.30		0.30	0.30	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	123	1908		80	1904		286	460		307	432	
v/s Ratio Prot		c0.53			0.45			0.10			0.09	
v/s Ratio Perm	0.35			0.19			0.18			c0.24		
v/c Ratio	0.57	0.87		0.31	0.73		0.61	0.33		0.81	0.31	
Uniform Delay, d1	10.0	13.9		8.1	11.8		25.9	23.5		27.9	23.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	17.7	5.6		9.9	2.5		3.8	0.4		15.2	0.4	
Delay (s)	27.7	19.5		18.0	14.3		29.7	23.9		43.1	23.7	
Level of Service	C	B		B	B		C	C		D	C	
Approach Delay (s)		19.9			14.4			26.9			34.7	
Approach LOS		B			B			C			C	

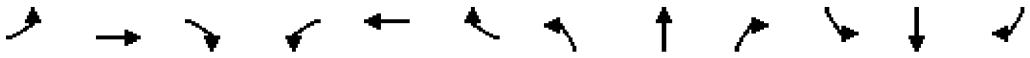
Intersection Summary			
HCM 2000 Control Delay	20.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	85.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	95.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	90	620	20	805	125	85	190	185
v/c Ratio	0.32	0.36	0.05	0.47	0.38	0.18	0.52	0.37
Control Delay	12.3	7.8	8.1	8.7	16.9	9.0	19.7	10.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.3	7.8	8.1	8.7	16.9	9.0	19.7	10.6
Queue Length 50th (m)	3.9	13.0	0.7	18.4	8.6	3.2	13.8	7.6
Queue Length 95th (m)	15.8	29.7	4.1	41.2	19.1	10.2	28.1	19.0
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	284	1699	370	1712	648	901	713	916
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.32	0.36	0.05	0.47	0.19	0.09	0.27	0.20

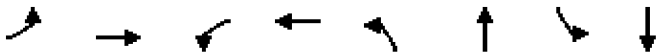
Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	90	505	115	20	650	155	125	50	35	190	110	75
Future Volume (vph)	90	505	115	20	650	155	125	50	35	190	110	75
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	0.97		1.00	0.94		1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3104		1635	3126		1635	1501		1635	1502	
Flt Permitted	0.31	1.00		0.40	1.00		0.64	1.00		0.70	1.00	
Satd. Flow (perm)	529	3104		687	3126		1098	1501		1208	1502	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	90	505	115	20	650	155	125	50	35	190	110	75
RTOR Reduction (vph)	0	24	0	0	25	0	0	24	0	0	49	0
Lane Group Flow (vph)	90	596	0	20	780	0	125	61	0	190	136	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	25.3	25.3		25.3	25.3		13.4	13.4		13.4	13.4	
Effective Green, g (s)	27.5	27.5		27.5	27.5		15.4	15.4		15.4	15.4	
Actuated g/C Ratio	0.54	0.54		0.54	0.54		0.30	0.30		0.30	0.30	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	285	1677		371	1688		332	454		365	454	
v/s Ratio Prot		0.19			c0.25			0.04			0.09	
v/s Ratio Perm	0.17			0.03			0.11			c0.16		
v/c Ratio	0.32	0.36		0.05	0.46		0.38	0.13		0.52	0.30	
Uniform Delay, d1	6.5	6.7		5.5	7.2		14.0	12.9		14.7	13.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.9	0.6		0.3	0.9		0.7	0.1		1.3	0.4	
Delay (s)	9.4	7.2		5.8	8.1		14.7	13.0		16.0	14.0	
Level of Service	A	A		A	A		B	B		B	B	
Approach Delay (s)		7.5			8.0			14.0			15.0	
Approach LOS		A			A			B			B	

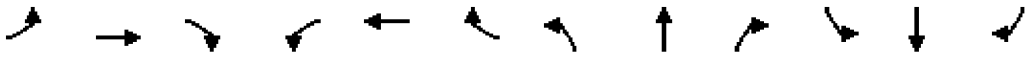
Intersection Summary			
HCM 2000 Control Delay	9.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	50.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	75	1000	25	940	205	210	250	190
v/c Ratio	0.38	0.64	0.14	0.59	0.52	0.37	0.67	0.32
Control Delay	19.2	13.8	13.2	12.0	18.6	12.9	23.9	6.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.2	13.8	13.2	12.0	18.6	12.9	23.9	6.9
Queue Length 50th (m)	4.2	33.5	1.2	27.4	15.5	13.2	20.1	5.2
Queue Length 95th (m)	18.7	71.0	6.6	60.3	30.6	25.5	39.7	15.3
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	196	1558	176	1582	597	865	572	851
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.64	0.14	0.59	0.34	0.24	0.44	0.22

Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	75	830	170	25	665	275	205	175	35	250	80	110
Future Volume (vph)	75	830	170	25	665	275	205	175	35	250	80	110
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.97		1.00	0.96		1.00	0.97		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3110		1635	3083		1635	1560		1635	1461	
Flt Permitted	0.23	1.00		0.21	1.00		0.63	1.00		0.61	1.00	
Satd. Flow (perm)	397	3110		357	3083		1089	1560		1042	1461	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	75	830	170	25	665	275	205	175	35	250	80	110
RTOR Reduction (vph)	0	23	0	0	60	0	0	13	0	0	70	0
Lane Group Flow (vph)	75	977	0	25	880	0	205	197	0	250	120	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	25.1	25.1		25.1	25.1		17.9	17.9		17.9	17.9	
Effective Green, g (s)	27.3	27.3		27.3	27.3		19.9	19.9		19.9	19.9	
Actuated g/C Ratio	0.49	0.49		0.49	0.49		0.36	0.36		0.36	0.36	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	196	1538		176	1524		392	562		375	526	
v/s Ratio Prot		c0.31			0.29			0.13			0.08	
v/s Ratio Perm	0.19			0.07			0.19			c0.24		
v/c Ratio	0.38	0.64		0.14	0.58		0.52	0.35		0.67	0.23	
Uniform Delay, d1	8.7	10.3		7.6	9.9		13.9	12.9		14.9	12.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.6	2.0		1.7	1.6		1.3	0.4		4.4	0.2	
Delay (s)	14.3	12.3		9.3	11.5		15.2	13.3		19.3	12.5	
Level of Service	B	B		A	B		B	B		B	B	
Approach Delay (s)		12.4			11.4			14.2			16.4	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM 2000 Control Delay	12.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	55.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	90	1120	20	1405	140	85	190	165
v/c Ratio	0.60	0.55	0.09	0.68	0.56	0.21	0.64	0.41
Control Delay	32.1	9.5	8.3	11.8	35.2	16.1	36.8	19.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	32.1	9.5	8.3	11.8	35.2	16.1	36.8	19.8
Queue Length 50th (m)	6.7	40.3	1.0	59.2	18.6	5.9	25.7	14.2
Queue Length 95th (m)	#37.4	79.2	4.9	115.5	35.4	16.0	45.5	29.7
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	151	2051	233	2070	378	586	454	592
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.60	0.55	0.09	0.68	0.37	0.15	0.42	0.28

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	90	980	140	20	1250	155	140	50	35	190	90	75
Future Volume (vph)	90	980	140	20	1250	155	140	50	35	190	90	75
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.98		1.00	0.94		1.00	0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3128		1635	3160		1635	1501		1635	1491	
Flt Permitted	0.13	1.00		0.21	1.00		0.58	1.00		0.70	1.00	
Satd. Flow (perm)	232	3128		358	3160		1005	1501		1208	1491	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	90	980	140	20	1250	155	140	50	35	190	90	75
RTOR Reduction (vph)	0	10	0	0	9	0	0	26	0	0	38	0
Lane Group Flow (vph)	90	1110	0	20	1396	0	140	59	0	190	127	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	50.1	50.1		50.1	50.1		17.8	17.8		17.8	17.8	
Effective Green, g (s)	52.3	52.3		52.3	52.3		19.8	19.8		19.8	19.8	
Actuated g/C Ratio	0.65	0.65		0.65	0.65		0.25	0.25		0.25	0.25	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	151	2042		233	2063		248	371		298	368	
v/s Ratio Prot		0.35			c0.44			0.04			0.09	
v/s Ratio Perm	0.39			0.06			0.14			c0.16		
v/c Ratio	0.60	0.54		0.09	0.68		0.56	0.16		0.64	0.35	
Uniform Delay, d1	7.9	7.5		5.1	8.6		26.4	23.6		26.9	24.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	16.2	1.0		0.7	1.8		2.9	0.2		4.4	0.6	
Delay (s)	24.1	8.5		5.8	10.4		29.3	23.8		31.4	25.4	
Level of Service	C	A		A	B		C	C		C	C	
Approach Delay (s)		9.7			10.4			27.2			28.6	
Approach LOS		A			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	13.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	80.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	75	1815	25	1515	180	170	250	190
v/c Ratio	0.75	0.95	0.31	0.79	0.62	0.36	0.82	0.40
Control Delay	63.3	29.2	22.9	17.0	36.2	23.2	50.6	18.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	63.3	29.2	22.9	17.0	36.2	23.2	50.6	18.0
Queue Length 50th (m)	9.0	146.1	2.0	97.2	25.2	19.5	37.8	16.0
Queue Length 95th (m)	#36.8	#214.2	9.7	132.5	46.9	35.6	#73.8	33.2
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	100	1915	80	1922	338	553	357	550
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.75	0.95	0.31	0.79	0.53	0.31	0.70	0.35

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	75	1630	185	25	1240	275	180	135	35	250	75	115
Future Volume (vph)	75	1630	185	25	1240	275	180	135	35	250	75	115
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.97		1.00	0.97		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3137		1635	3130		1635	1550		1635	1454	
Flt Permitted	0.10	1.00		0.08	1.00		0.56	1.00		0.59	1.00	
Satd. Flow (perm)	166	3137		132	3130		965	1550		1019	1454	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	75	1630	185	25	1240	275	180	135	35	250	75	115
RTOR Reduction (vph)	0	9	0	0	20	0	0	11	0	0	43	0
Lane Group Flow (vph)	75	1806	0	25	1495	0	180	159	0	250	147	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	50.0	50.0		50.0	50.0		23.7	23.7		23.7	23.7	
Effective Green, g (s)	52.2	52.2		52.2	52.2		25.7	25.7		25.7	25.7	
Actuated g/C Ratio	0.61	0.61		0.61	0.61		0.30	0.30		0.30	0.30	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	100	1906		80	1902		288	463		304	435	
v/s Ratio Prot		c0.58			0.48			0.10			0.10	
v/s Ratio Perm	0.45			0.19			0.19			c0.25		
v/c Ratio	0.75	0.95		0.31	0.79		0.62	0.34		0.82	0.34	
Uniform Delay, d1	12.1	15.6		8.2	12.7		25.9	23.5		28.0	23.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	39.9	11.5		9.9	3.4		4.2	0.4		16.2	0.5	
Delay (s)	52.0	27.1		18.1	16.0		30.1	24.0		44.2	23.9	
Level of Service	D	C		B	B		C	C		D	C	
Approach Delay (s)		28.0			16.1			27.1			35.4	
Approach LOS		C			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	24.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	85.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	100.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	90	730	20	920	125	90	190	195
v/c Ratio	0.38	0.43	0.06	0.54	0.38	0.19	0.52	0.39
Control Delay	15.2	8.7	8.6	9.8	16.9	9.1	19.5	11.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.2	8.7	8.6	9.8	16.9	9.1	19.5	11.3
Queue Length 50th (m)	4.0	16.6	0.7	22.9	8.7	3.5	13.8	8.8
Queue Length 95th (m)	18.4	38.4	4.4	51.7	19.2	10.7	27.9	20.6
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	236	1687	314	1701	634	906	711	918
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.43	0.06	0.54	0.20	0.10	0.27	0.21

Intersection Summary



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	90	615	115	20	765	155	125	55	35	190	120	75
Future Volume (vph)	90	615	115	20	765	155	125	55	35	190	120	75
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.97		1.00	0.94		1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3115		1635	3136		1635	1506		1635	1507	
Flt Permitted	0.26	1.00		0.34	1.00		0.62	1.00		0.70	1.00	
Satd. Flow (perm)	443	3115		588	3136		1072	1506		1202	1507	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	90	615	115	20	765	155	125	55	35	190	120	75
RTOR Reduction (vph)	0	19	0	0	21	0	0	24	0	0	44	0
Lane Group Flow (vph)	90	711	0	20	899	0	125	66	0	190	151	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	25.2	25.2		25.2	25.2		13.6	13.6		13.6	13.6	
Effective Green, g (s)	27.4	27.4		27.4	27.4		15.6	15.6		15.6	15.6	
Actuated g/C Ratio	0.54	0.54		0.54	0.54		0.31	0.31		0.31	0.31	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	238	1673		315	1684		327	460		367	460	
v/s Ratio Prot		0.23			c0.29			0.04			0.10	
v/s Ratio Perm	0.20			0.03			0.12			c0.16		
v/c Ratio	0.38	0.43		0.06	0.53		0.38	0.14		0.52	0.33	
Uniform Delay, d1	6.9	7.1		5.7	7.7		13.9	12.8		14.6	13.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.5	0.8		0.4	1.2		0.7	0.1		1.2	0.4	
Delay (s)	11.4	7.9		6.0	8.9		14.7	13.0		15.8	14.1	
Level of Service	B	A		A	A		B	B		B	B	
Approach Delay (s)		8.3			8.8			14.0			14.9	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	10.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	51.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	75	1165	25	1015	210	210	250	195
v/c Ratio	0.44	0.75	0.20	0.64	0.54	0.37	0.67	0.33
Control Delay	23.5	17.1	16.0	13.1	19.2	12.9	23.9	7.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.5	17.1	16.0	13.1	19.2	12.9	23.9	7.5
Queue Length 50th (m)	4.4	43.3	1.3	31.7	16.0	13.2	20.1	6.0
Queue Length 95th (m)	#23.4	#103.1	7.4	69.0	31.6	25.5	39.7	16.4
Internal Link Dist (m)		520.9		699.9		163.9		107.8
Turn Bay Length (m)	47.3		52.0		54.7		29.8	
Base Capacity (vph)	171	1559	127	1577	590	865	572	846
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.44	0.75	0.20	0.64	0.36	0.24	0.44	0.23

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



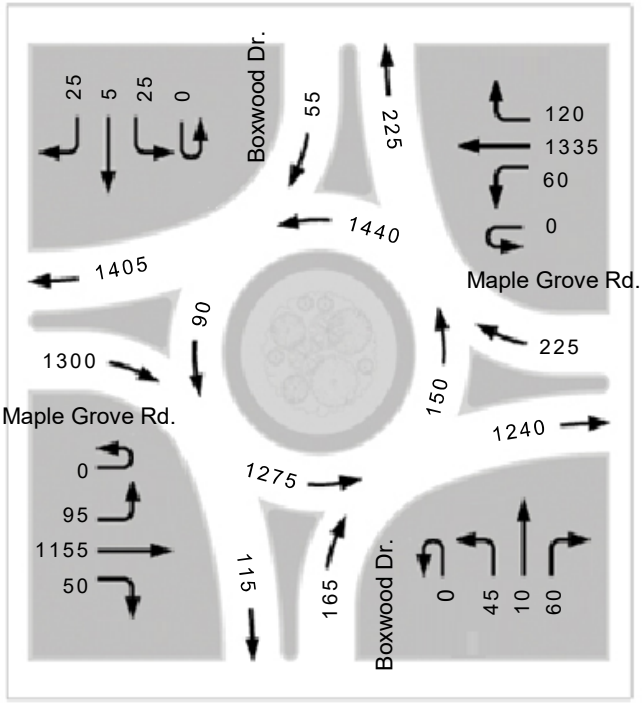
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	75	1010	155	25	740	275	210	175	35	250	80	115
Future Volume (vph)	75	1010	155	25	740	275	210	175	35	250	80	115
Ideal Flow (vphpl)	1775	1775	1900	1775	1775	1900	1775	1650	1900	1775	1650	1900
Lane Width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.96		1.00	0.97		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1635	3125		1635	3093		1635	1560		1635	1458	
Flt Permitted	0.20	1.00		0.15	1.00		0.63	1.00		0.61	1.00	
Satd. Flow (perm)	348	3125		259	3093		1077	1560		1042	1458	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	75	1010	155	25	740	275	210	175	35	250	80	115
RTOR Reduction (vph)	0	16	0	0	51	0	0	13	0	0	66	0
Lane Group Flow (vph)	75	1149	0	25	964	0	210	197	0	250	129	0
Heavy Vehicles (%)	2%	5%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	25.1	25.1		25.1	25.1		17.9	17.9		17.9	17.9	
Effective Green, g (s)	27.3	27.3		27.3	27.3		19.9	19.9		19.9	19.9	
Actuated g/C Ratio	0.49	0.49		0.49	0.49		0.36	0.36		0.36	0.36	
Clearance Time (s)	6.2	6.2		6.2	6.2		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	172	1545		128	1529		388	562		375	525	
v/s Ratio Prot		c0.37			0.31			0.13			0.09	
v/s Ratio Perm	0.22			0.10			0.19			c0.24		
v/c Ratio	0.44	0.74		0.20	0.63		0.54	0.35		0.67	0.25	
Uniform Delay, d1	9.0	11.2		7.8	10.2		14.0	12.9		14.9	12.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	7.8	3.3		3.4	2.0		1.5	0.4		4.4	0.2	
Delay (s)	16.8	14.4		11.2	12.2		15.6	13.3		19.3	12.6	
Level of Service	B	B		B	B		B	B		B	B	
Approach Delay (s)		14.6			12.2			14.4			16.4	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM 2000 Control Delay	14.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	55.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		

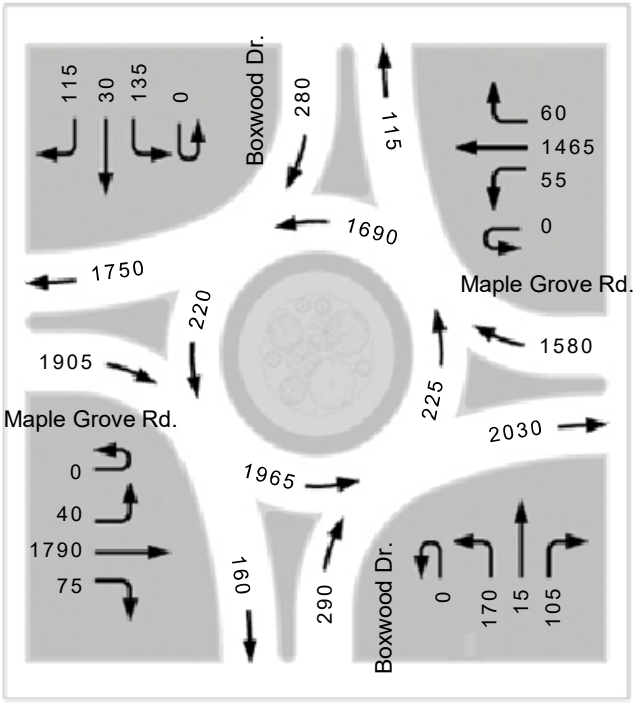
c Critical Lane Group

A1 Turning Movement Forecasts

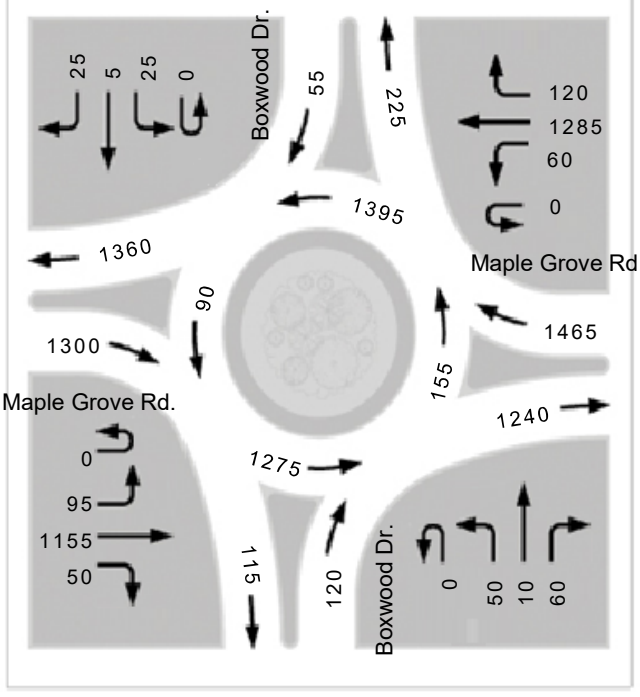
2036 AM Peak Hour, Scenario 1



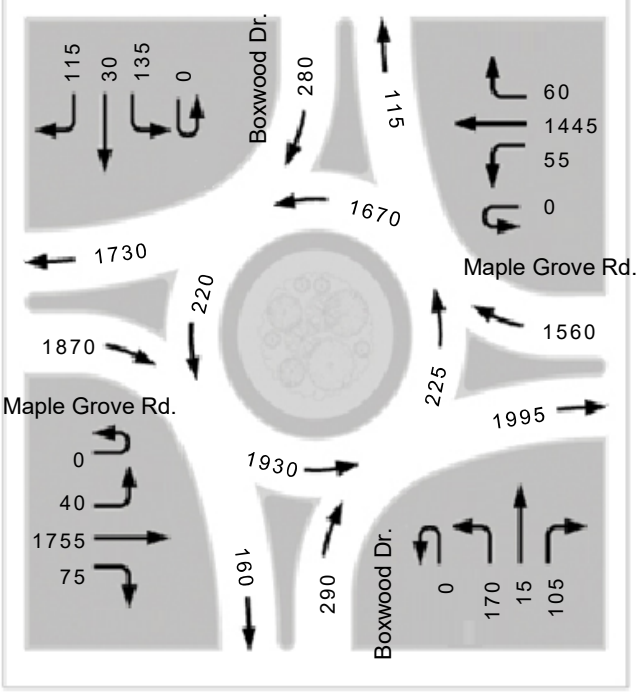
2036 PM Peak Hour, Scenario 1



2036 AM Peak Hour, Scenario 2



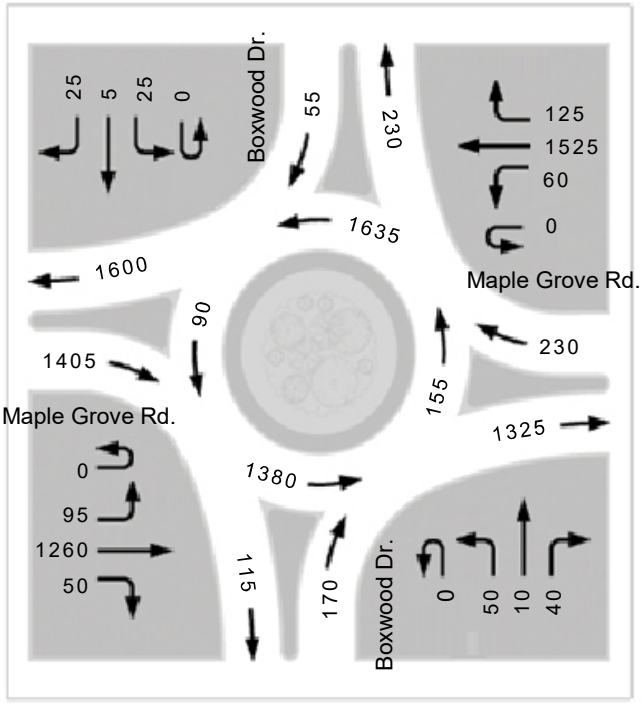
2036 PM Peak Hour, Scenario 2



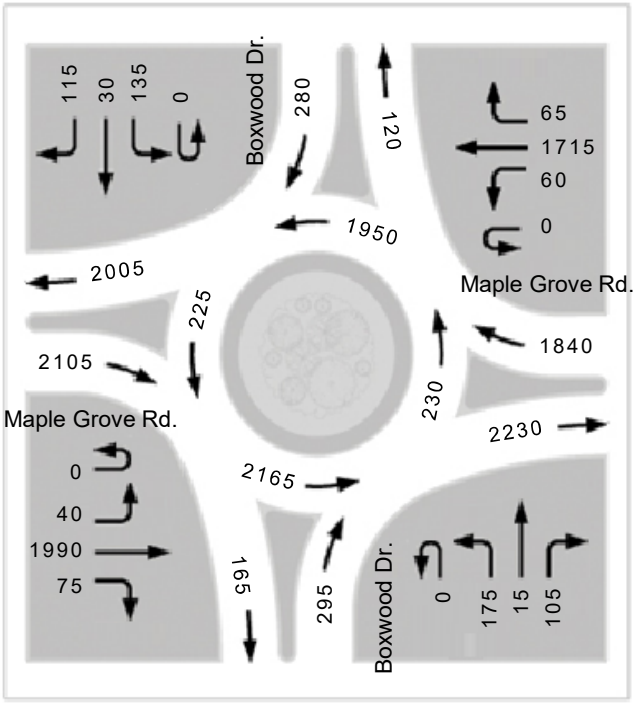
Source: Region of Waterloo, January 18, 2019

A1 Turning Movement Forecasts

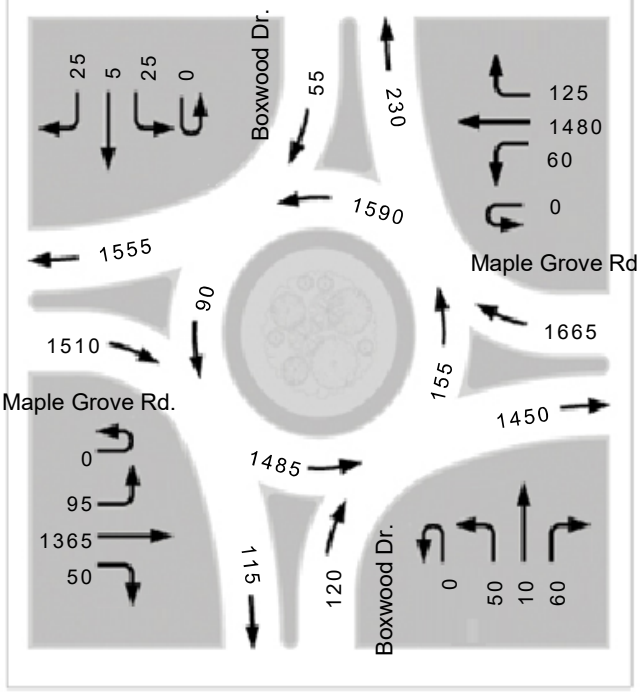
2041 AM Peak Hour, Scenario 1



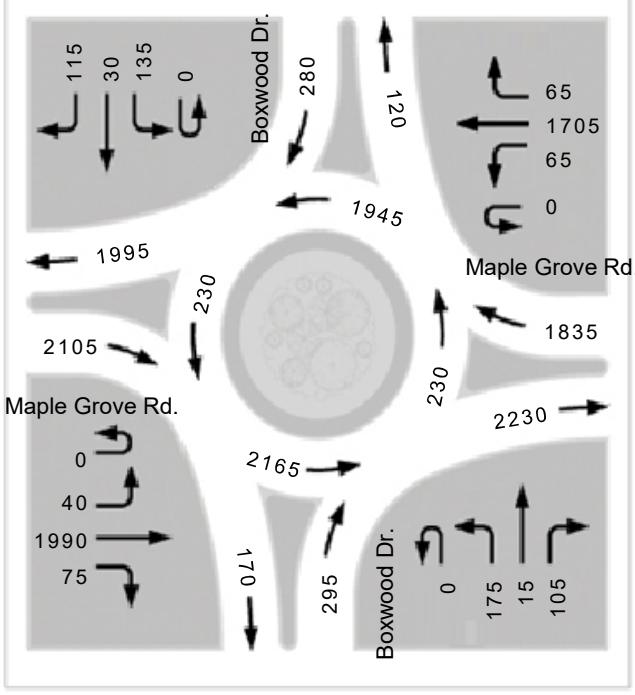
2041 PM Peak Hour, Scenario 1



2041 AM Peak Hour, Scenario 2



2041 PM Peak Hour, Scenario 2



Source: Region of Waterloo, January 18, 2019

A2 Roundabout Geometry

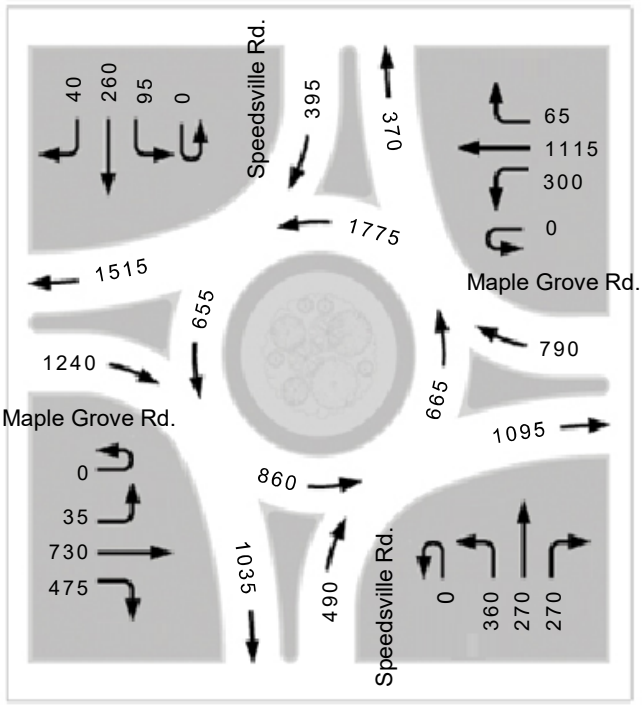
Leg	V - Approach road half-width (m)	E - Entry width (m)	l' - Effective flare length (m)	R - Entry radius (m)	D - Inscribed circle diameter (m)	PHI - Conflict (entry) angle (deg)	Exit only	Leg has bypass
SB - Boxwood Dr	3.75	8.00	30.0	20.0	55.0	20.0	☐	☐
EB - Maple Grov...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☐
NB - Boxwood Dr	3.75	8.00	30.0	20.0	55.0	20.0	☐	☑
WB - Maple Gro...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☐

A3 Analysis Results

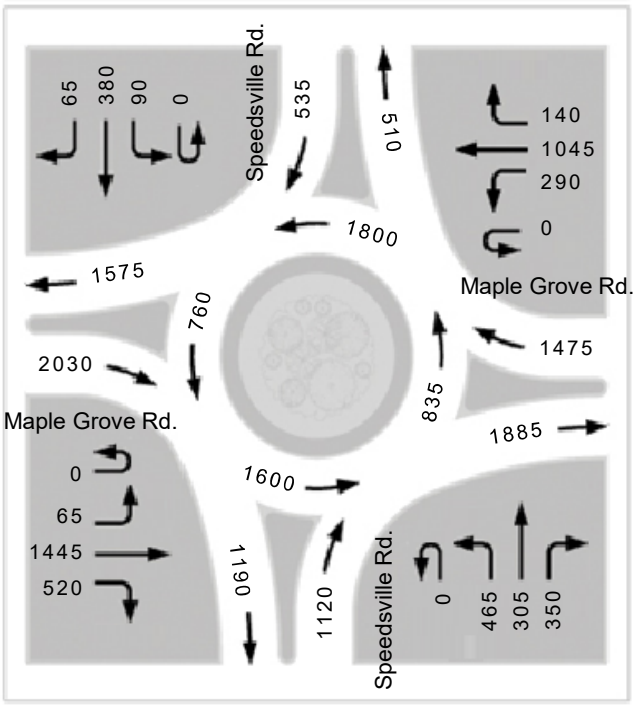
	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
C-95 3x2 + NB Bypass - 2036 - Scenario 1														
SB - Boxwood Dr	0.5	4.32	0.06	A	3.28	A	59 % [WB - Maple Grove Rd]	4.7	11.85	0.50	B	9.17	A	8 % [NB - Boxwood Dr]
EB - Maple Grove Rd	1.5	2.86	0.50	A				30.3	10.94	0.87	B			
NB - Boxwood Dr	0.5	3.86	0.05	A				4.5	16.26	0.48	C			
WB - Maple Grove Rd	2.4	3.57	0.60	A				5.5	5.29	0.72	A			
C-95 3x2 + NB Bypass - 2036 - Scenario 2														
SB - Boxwood Dr	0.5	4.81	0.07	A	3.80	A	46 % [WB - Maple Grove Rd]	4.5	11.34	0.49	B	8.43	A	10 % [NB - Boxwood Dr]
EB - Maple Grove Rd	1.8	3.29	0.57	A				25.0	9.82	0.85	A			
NB - Boxwood Dr	0.5	4.36	0.07	A				4.0	14.70	0.45	B			
WB - Maple Grove Rd	3.6	4.17	0.65	A				5.2	5.12	0.71	A			
C-95 3x2 + NB Bypass - 2041 - Scenario 1														
SB - Boxwood Dr	0.5	5.04	0.07	A	3.86	A	42 % [WB - Maple Grove Rd]	11.8	27.58	0.71	D	20.98	C	-1 % [NB - Boxwood Dr]
EB - Maple Grove Rd	1.6	3.11	0.54	A				89.8	27.85	0.96	D			
NB - Boxwood Dr	0.5	4.17	0.06	A				11.4	40.15	0.71	E			
WB - Maple Grove Rd	4.2	4.43	0.67	A				21.4	9.15	0.84	A			
C-95 3x2 + NB Bypass - 2041 - Scenario 2														
SB - Boxwood Dr	0.5	5.84	0.09	A	4.95	A	30 % [WB - Maple Grove Rd]	**11.5**	**26.89**	**0.70**	D	**21.18**	C	**-1 % [NB - Boxwood Dr]**
EB - Maple Grove Rd	3.9	4.18	0.66	A				**91.2**	**28.46**	**0.96**	D			
NB - Boxwood Dr	0.5	5.27	0.09	A				**11.3**	**40.01**	**0.71**	E			
WB - Maple Grove Rd	6.3	5.60	0.74	A				**20.8**	**9.02**	**0.84**	A			

A1 Turning Movement Forecasts

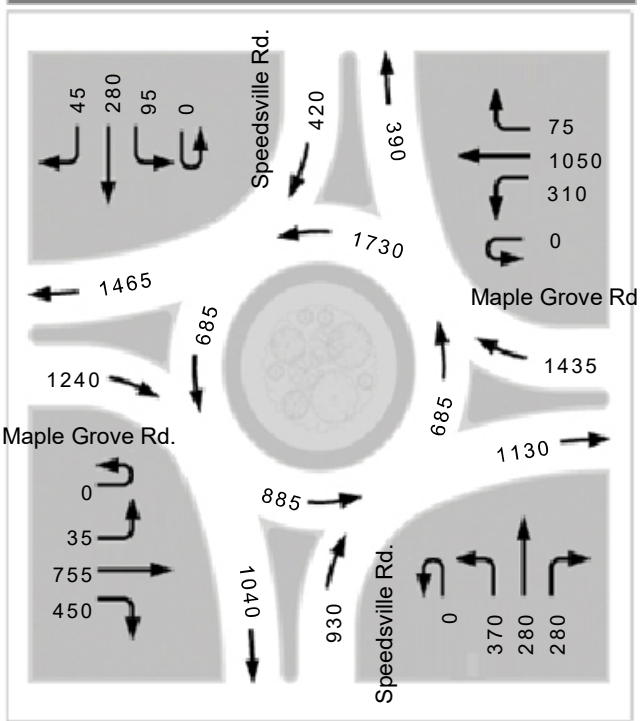
2036 AM Peak Hour, Scenario 1



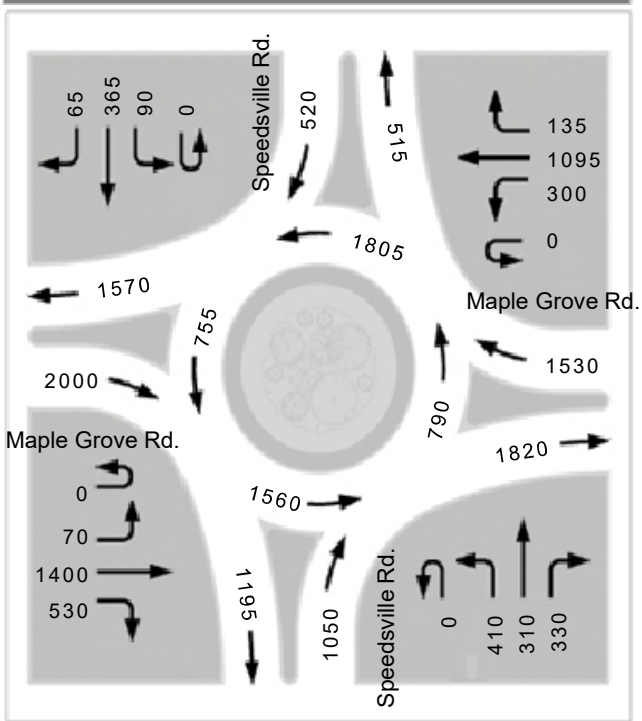
2036 PM Peak Hour, Scenario 1



2036 AM Peak Hour, Scenario 2



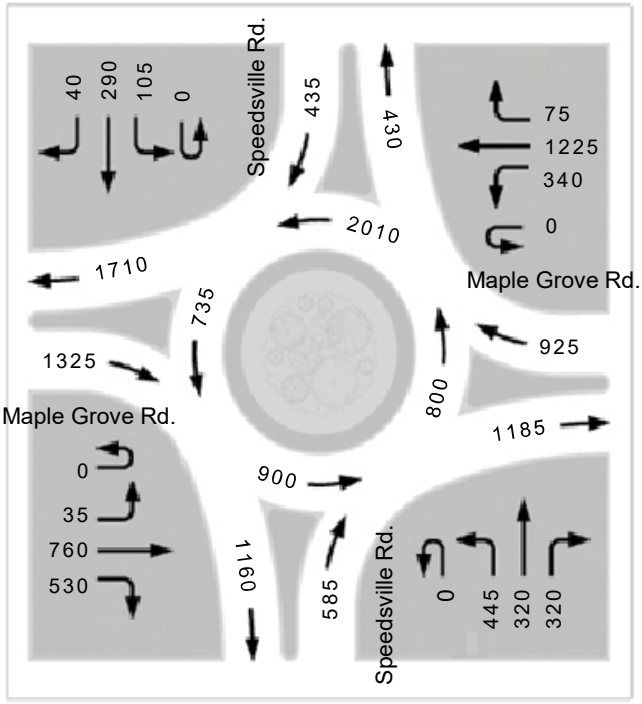
2036 PM Peak Hour, Scenario 2



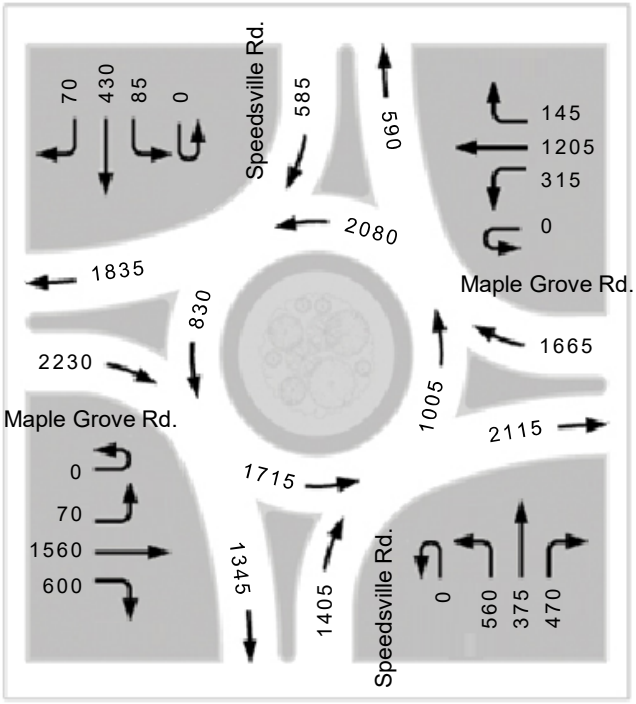
Source: Region of Waterloo, January 18, 2019

A1 Turning Movement Forecasts

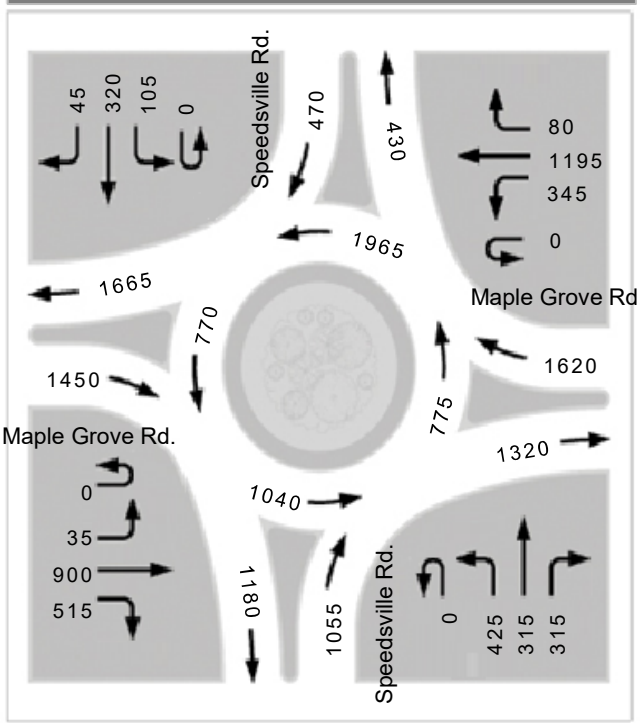
2041 AM Peak Hour, Scenario 1



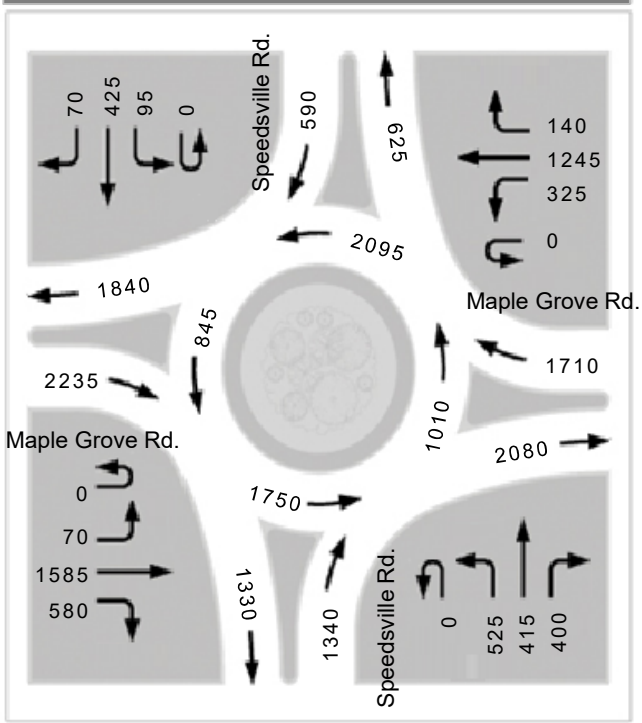
2041 PM Peak Hour, Scenario 1



2041 AM Peak Hour, Scenario 2



2041 PM Peak Hour, Scenario 2



Source: Region of Waterloo, January 18, 2019

A2 Roundabout Geometry

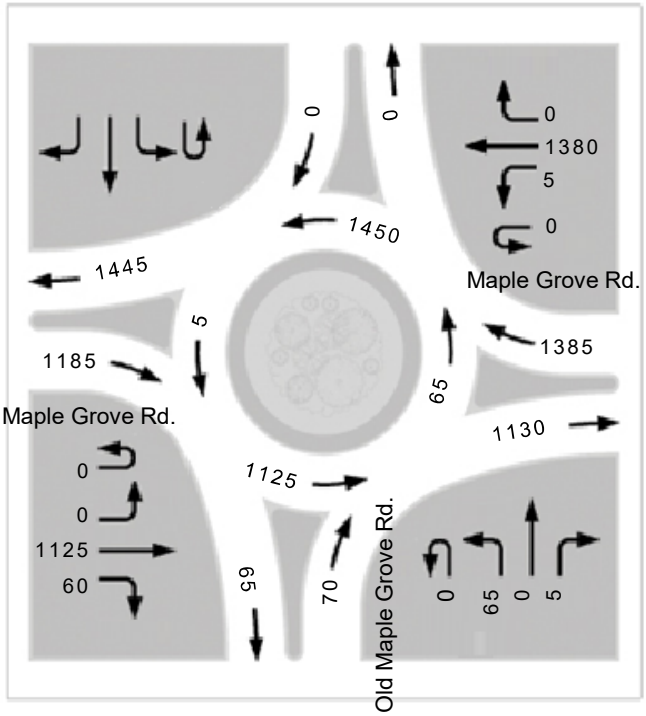
Leg	V - Approach road half-width (m)	E - Entry width (m)	l' - Effective flare length (m)	R - Entry radius (m)	D - Inscribed circle diameter (m)	PHI - Conflict (entry) angle (deg)	Exit only	Leg has bypass
SB - Speedsville ...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☐
EB - Maple Grov...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☑
NB - Speedsville...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☑
WB - Maple Gro...	7.40	11.25	30.0	20.0	64.0	20.0	☐	☐

A3 Analysis Results

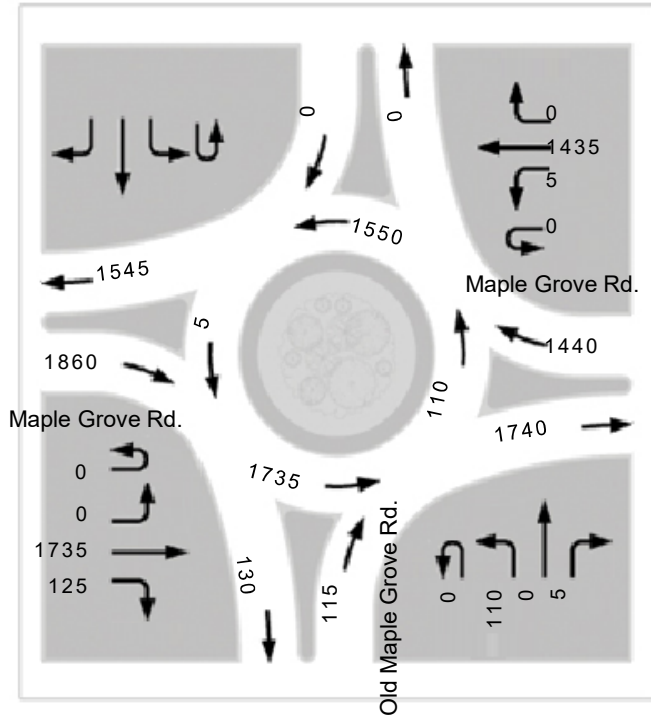
	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
C-95 3x3 + EB, NB Bypasses - 2036 - Scenario 1														
SB - Speedsville Rd	1.5	3.54	0.28	A	3.61	A	33 % [WB - Maple Grove Rd]	3.6	5.61	0.48	A	9.09	A	12 % [EB - Maple Grove Rd]
EB - Maple Grove Rd	2.5	2.58	0.35	A				20.4	10.27	0.83	B			
NB - Speedsville Rd	1.5	2.51	0.30	A				2.2	6.79	0.62	A			
WB - Maple Grove Rd	3.8	5.13	0.67	A				20.3	10.40	0.83	B			
C-95 3x3 + EB, NB Bypasses - 2036 - Scenario 2														
SB - Speedsville Rd	2.5	4.38	0.36	A	4.62	A	20 % [WB - Maple Grove Rd]	3.6	5.51	0.47	A	8.70	A	10 % [WB - Maple Grove Rd]
EB - Maple Grove Rd	2.7	3.00	0.42	A				15.1	9.04	0.80	A			
NB - Speedsville Rd	2.7	2.91	0.37	A				2.3	5.83	0.56	A			
WB - Maple Grove Rd	7.2	7.17	0.76	A				24.1	11.25	0.84	B			
C-95 3x3 + EB, NB Bypasses - 2041 - Scenario 1														
SB - Speedsville Rd	2.2	4.44	0.34	A	4.84	A	17 % [WB - Maple Grove Rd]	4.9	9.30	0.63	A	27.65	D	-3 % [WB - Maple Grove Rd]
EB - Maple Grove Rd	2.8	2.74	0.37	A				50.7	20.09	0.91	C			
NB - Speedsville Rd	2.8	2.83	0.37	A				16.8	13.79	0.80	B			
WB - Maple Grove Rd	10.6	7.93	0.78	A				106.1	55.55	1.00	F			
C-95 3x3 + EB, NB Bypasses - 2041 - Scenario 2														
SB - Speedsville Rd	3.8	6.19	0.47	A	8.06	A	6 % [WB - Maple Grove Rd]	4.6	9.21	0.62	A	36.70	E	-5 % [WB - Maple Grove Rd]
EB - Maple Grove Rd	1.4	3.70	0.51	A				63.3	24.10	0.93	C			
NB - Speedsville Rd	2.7	3.55	0.45	A				20.1	15.64	0.82	C			
WB - Maple Grove Rd	37.7	15.37	0.89	C				122.6	78.62	1.03	F			

A1 Turning Movement Forecasts

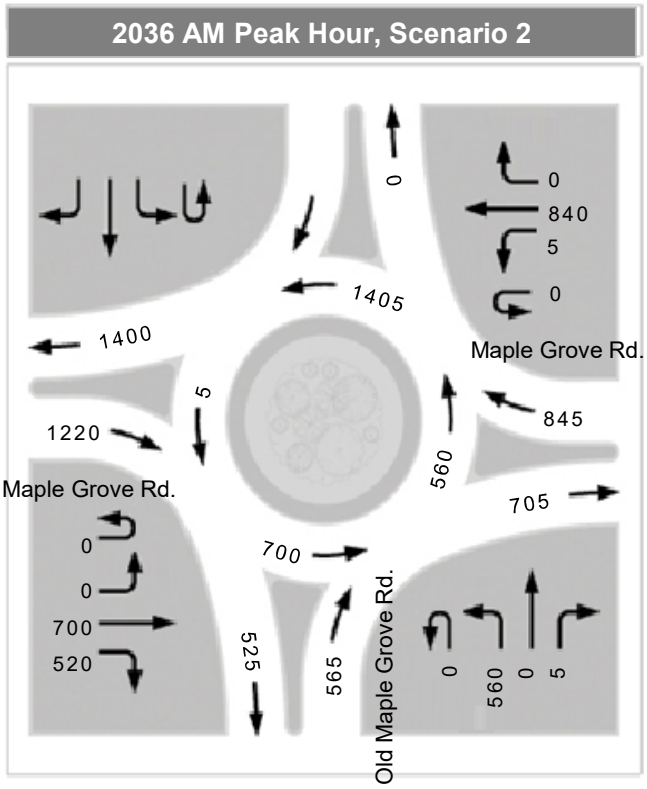
2036 AM Peak Hour, Scenario 1



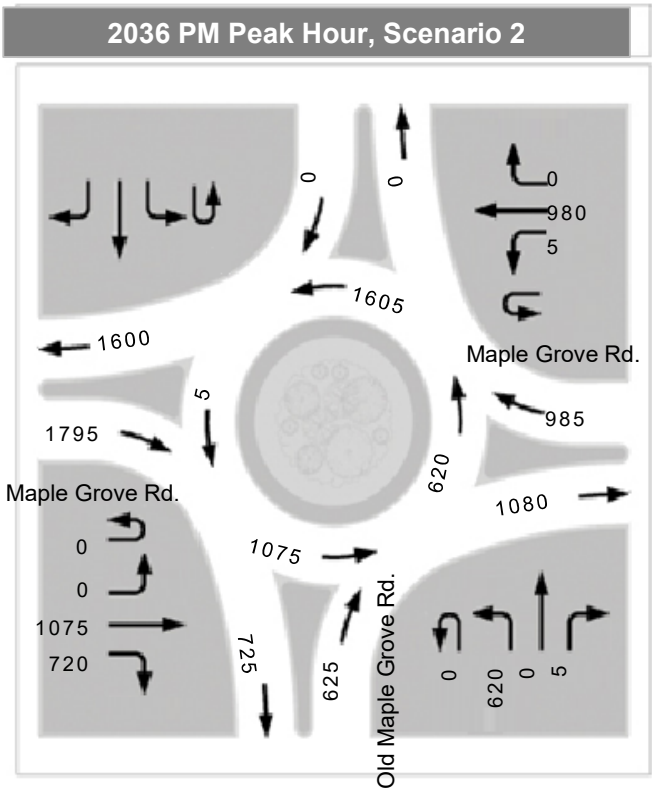
2036 PM Peak Hour, Scenario 1



2036 AM Peak Hour, Scenario 2



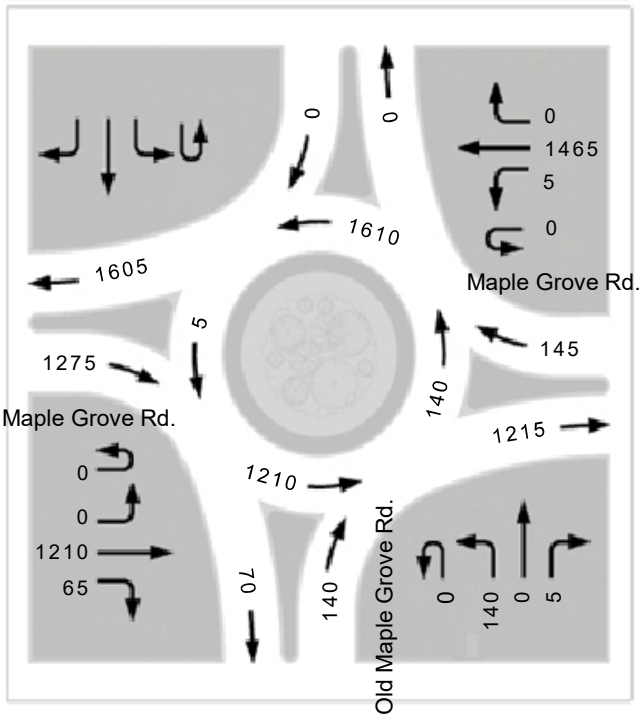
2036 PM Peak Hour, Scenario 2



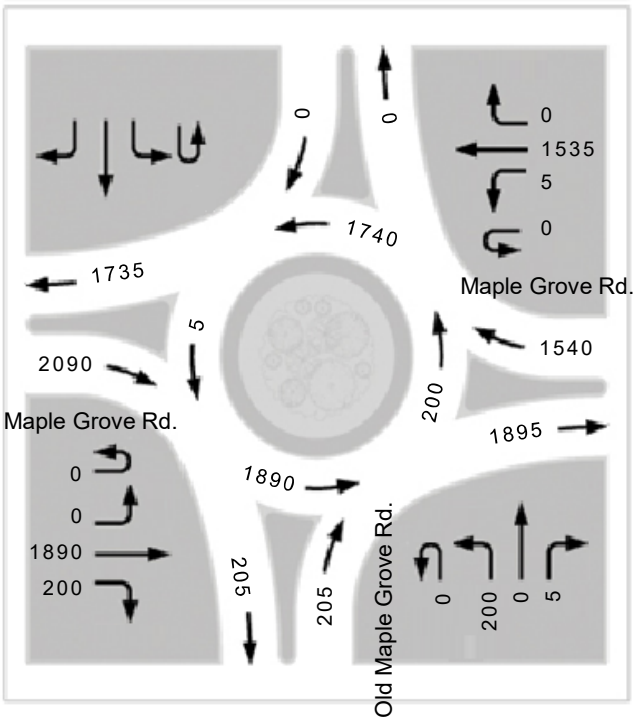
Source: Region of Waterloo, January 18, 2019

A1 Turning Movement Forecasts

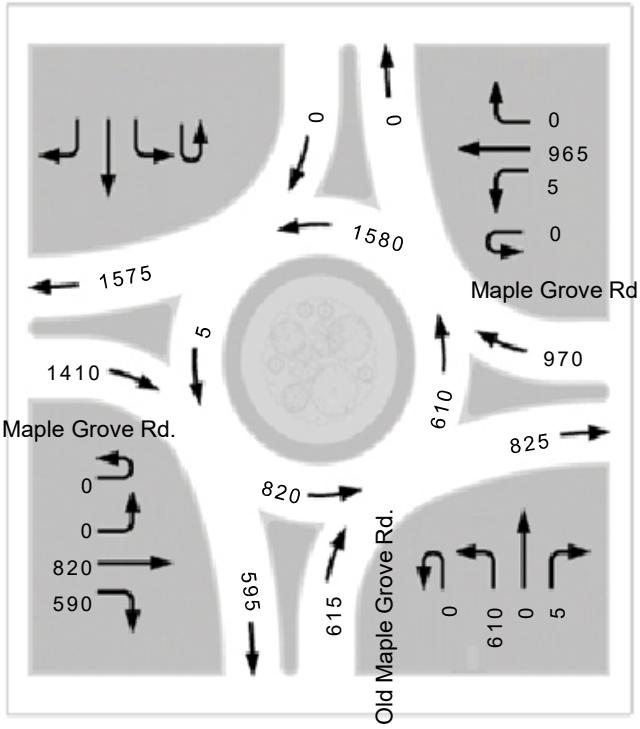
2041 AM Peak Hour, Scenario 1



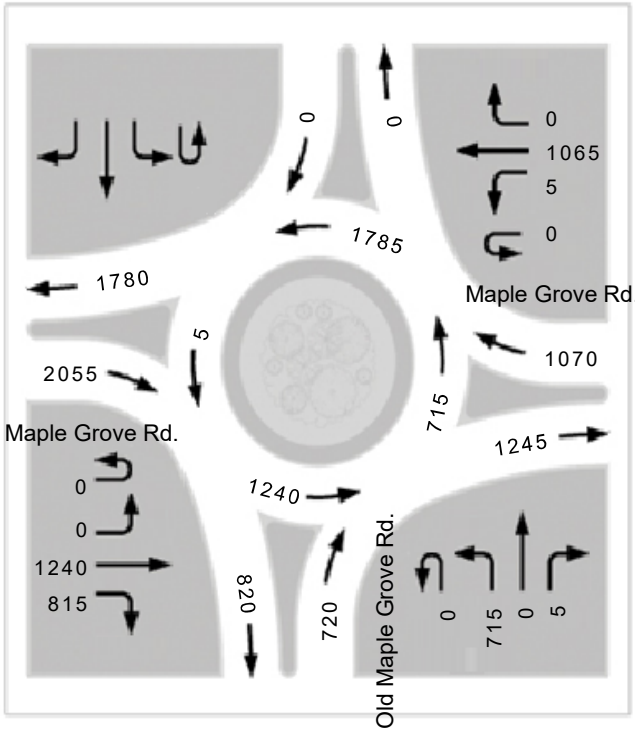
2041 PM Peak Hour, Scenario 1



2041 AM Peak Hour, Scenario 2



2041 PM Peak Hour, Scenario 2



Source: Region of Waterloo, January 18, 2019

A2 Roundabout Geometry

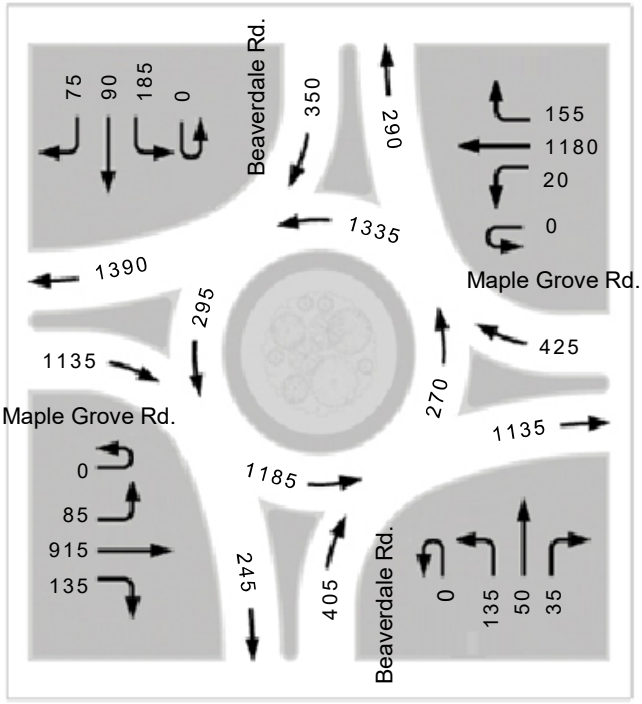
Leg	V - Approach road half-width (m)	E - Entry width (m)	l' - Effective flare length (m)	R - Entry radius (m)	D - Inscribed circle diameter (m)	PHI - Conflict (entry) angle (deg)	Exit only	Leg has bypass
EB - Maple Grov...	7.40	11.25	30.0	20.0	55.0	20.0	☐	☐
NB - Old Maple G...	3.75	8.00	30.0	20.0	55.0	20.0	☐	☐
WB - Maple Grov...	7.40	11.25	30.0	20.0	55.0	20.0	☐	☐

A3 Analysis Results

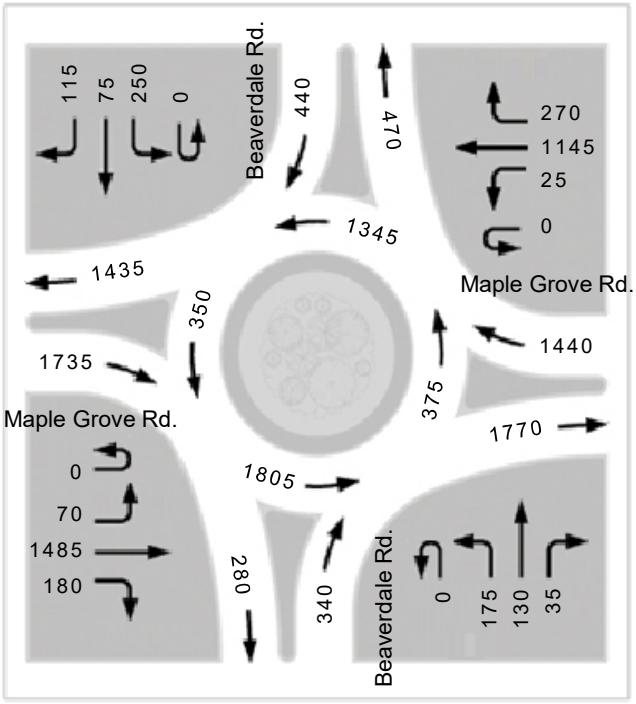
	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
C-95 3x2 - 2036 - Scenario 1														
EB - Maple Grove Rd	1.8	2.48	0.44	A	2.81	A	80 % [WB - Maple Grove Rd]	8.2	6.40	0.78	A	5.41	A	24 % [EB - Maple Grove Rd]
NB - Old Maple Grove	0.5	3.55	0.06	A				1.1	7.80	0.22	A			
WB - Maple Grove Rd	1.5	3.05	0.53	A				3.2	3.96	0.64	A			
C-95 3x2 - 2036 - Scenario 2														
EB - Maple Grove Rd	1.5	2.80	0.51	A	3.43	A	52 % [NB - Old Maple Grove]	7.0	5.53	0.75	A	5.87	A	18 % [NB - Old Maple Grove]
NB - Old Maple Grove	2.3	5.44	0.48	A				4.5	10.47	0.67	B			
WB - Maple Grove Rd	2.4	3.02	0.44	A				1.5	3.64	0.52	A			
C-95 3x2 - 2041 - Scenario 1														
EB - Maple Grove Rd	1.5	2.65	0.48	A	3.13	A	63 % [WB - Maple Grove Rd]	35.9	11.44	0.88	B	8.95	A	11 % [EB - Maple Grove Rd]
NB - Old Maple Grove	0.5	4.05	0.14	A				4.2	13.90	0.47	B			
WB - Maple Grove Rd	2.0	3.45	0.58	A				4.9	4.96	0.70	A			
C-95 3x2 - 2041 - Scenario 2														
EB - Maple Grove Rd	2.4	3.35	0.59	A	4.12	A	35 % [NB - Old Maple Grove]	**28.2**	**9.81**	**0.86**	**A**	**11.42**	**B**	**2 % [NB - Old Maple Grove]**
NB - Old Maple Grove	1.8	6.85	0.56	A				**29.6**	**26.78**	**0.86**	**D**			
WB - Maple Grove Rd	1.5	3.56	0.51	A				**1.8**	**4.41**	**0.59**	**A**			

A1 Turning Movement Forecasts

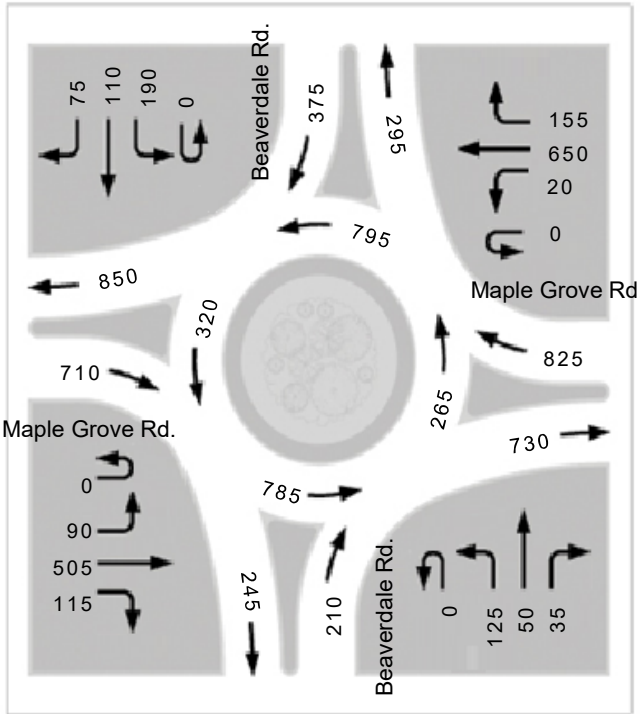
2036 AM Peak Hour, Scenario 1



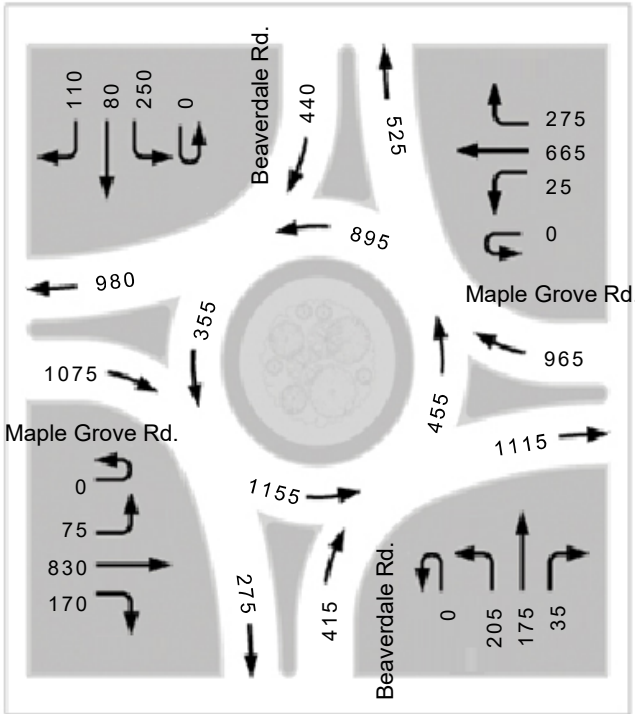
2036 PM Peak Hour, Scenario 1



2036 AM Peak Hour, Scenario 2



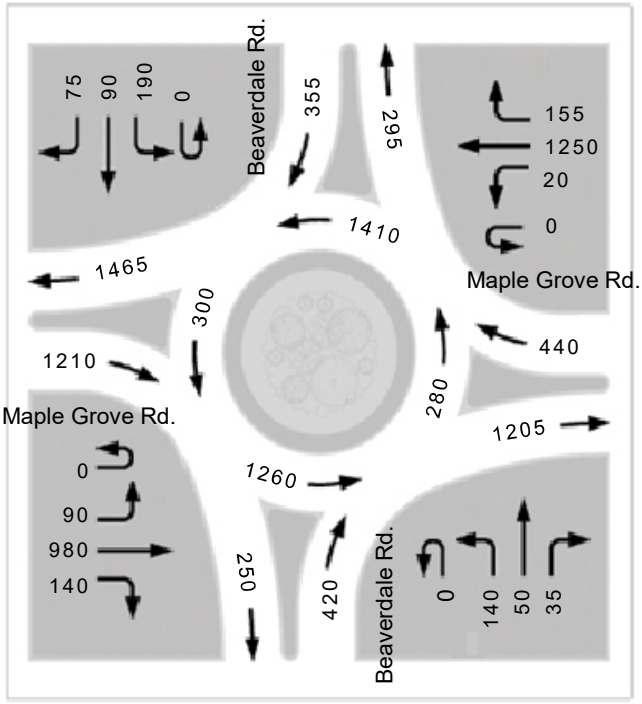
2036 PM Peak Hour, Scenario 2



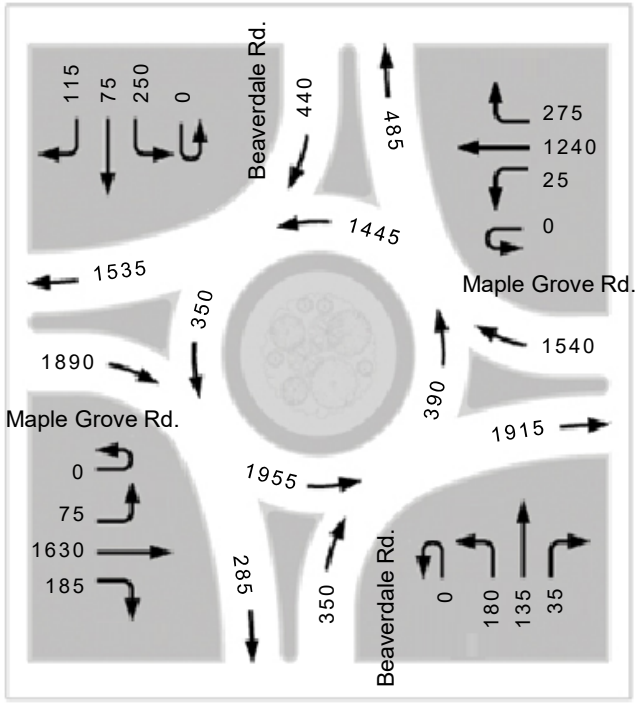
Source: Region of Waterloo, January 18, 2019

A1 Turning Movement Forecasts

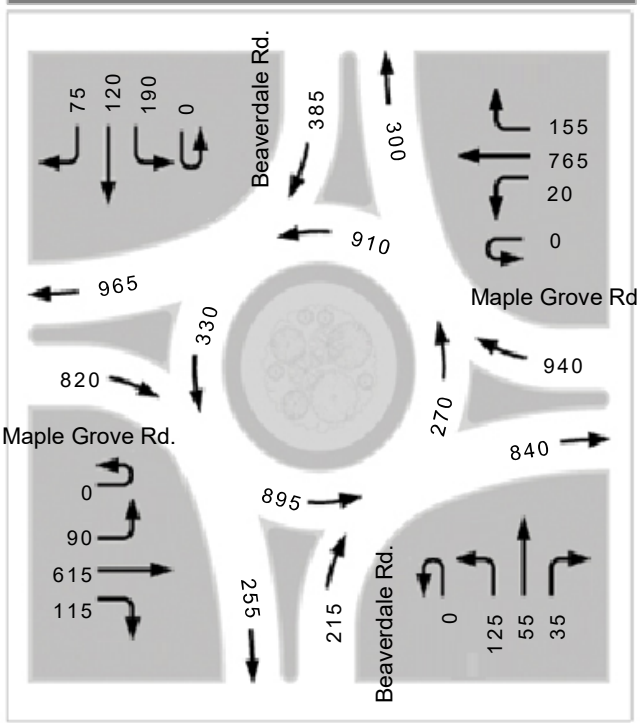
2041 AM Peak Hour, Scenario 1



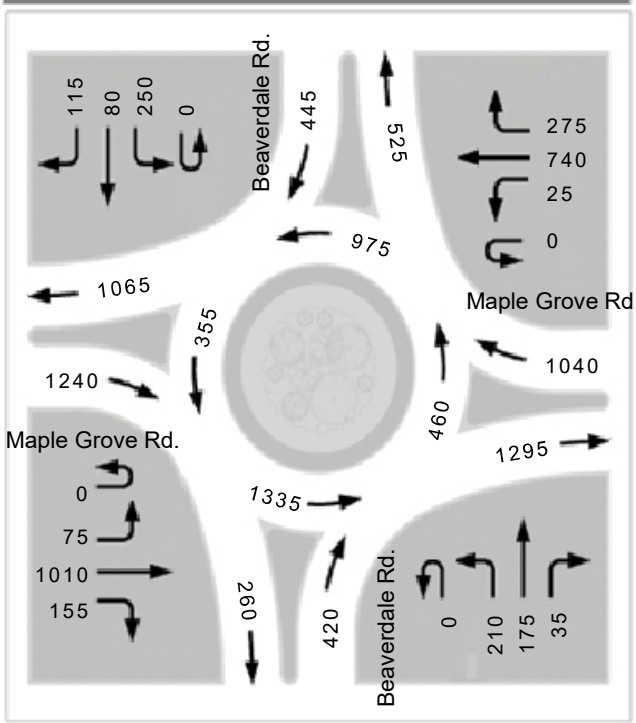
2041 PM Peak Hour, Scenario 1



2041 AM Peak Hour, Scenario 2



2041 PM Peak Hour, Scenario 2



Source: Region of Waterloo, January 18, 2019

A2 Roundabout Geometry

Leg	V - Approach road half-width (m)	E - Entry width (m)	l' - Effective flare length (m)	R - Entry radius (m)	D - Inscribed circle diameter (m)	PHI - Conflict (entry) angle (deg)	Exit only	Leg has bypass
SB - Beaverdale ...	7.40	8.00	10.0	20.0	64.0	20.0	☐	☐
EB - Maple Grov...	7.40	11.25	30.0	20.0	55.0	20.0	☐	☐
NB - Beaverdale...	7.40	8.00	10.0	20.0	64.0	20.0	☐	☐
WB - Maple Gro...	7.40	11.25	30.0	20.0	55.0	20.0	☐	☐

A3 Analysis Results

	AM							PM						
	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity	95% Queue (Veh)	Delay (s)	V/C Ratio	LOS	Intersection Delay (s)	Intersection LOS	Network Residual Capacity
C-95 3x2 - 2036 - Scenario 1														
SB - Beaverdale Rd	1.5	4.40	0.30	A	3.61	A	57 % [WB - Maple Grove Rd]	3.4	6.30	0.46	A	9.83	A	8 % [EB - Maple Grove Rd]
EB - Maple Grove Rd	1.4	3.18	0.50	A				36.1	13.69	0.88	B			
NB - Beaverdale Rd	0.5	3.49	0.17	A				4.5	9.97	0.51	A			
WB - Maple Grove Rd	1.9	3.79	0.58	A				5.5	6.18	0.73	A			
C-95 3x2 - 2036 - Scenario 2														
SB - Beaverdale Rd	1.4	3.54	0.29	A	2.80	A	97 % [SB - Beaverdale Rd]	2.6	4.10	0.36	A	3.84	A	51 % [NB - Beaverdale Rd]
EB - Maple Grove Rd	2.6	2.53	0.35	A				1.5	3.65	0.55	A			
NB - Beaverdale Rd	0.5	2.99	0.16	A				2.9	4.97	0.39	A			
WB - Maple Grove Rd	2.7	2.66	0.40	A				1.5	3.45	0.50	A			
C-95 3x2 - 2041 - Scenario 1														
SB - Beaverdale Rd	1.8	4.69	0.31	A	3.88	A	50 % [WB - Maple Grove Rd]	3.5	7.15	0.49	A	18.79	C	0 % [EB - Maple Grove Rd]
EB - Maple Grove Rd	1.5	3.41	0.53	A				88.5	31.13	0.96	D			
NB - Beaverdale Rd	0.5	3.66	0.18	A				6.6	14.20	0.60	B			
WB - Maple Grove Rd	2.6	4.12	0.62	A				11.0	7.81	0.79	A			
C-95 3x2 - 2041 - Scenario 2														
SB - Beaverdale Rd	1.8	3.88	0.31	A	3.07	A	80 % [SB - Beaverdale Rd]	**2.8**	**4.40**	**0.37**	**A**	**4.45**	**A**	**36 % [NB - Beaverdale Rd]**
EB - Maple Grove Rd	2.6	2.79	0.41	A				**2.8**	**4.49**	**0.63**	**A**			
NB - Beaverdale Rd	0.5	3.21	0.17	A				**3.3**	**6.05**	**0.44**	**A**			
WB - Maple Grove Rd	1.7	2.95	0.46	A				**1.4**	**3.77**	**0.55**	**A**			

B

Appendix B

Safety Analysis



INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 1

Major Road: Maple Grove Road

Minor Road: Boxwood Drive

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	No RT Lanes
Minor	2 Approaches	Minor	No RT Lanes

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 8

5-Year PDO Collisions: 5

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 30,581

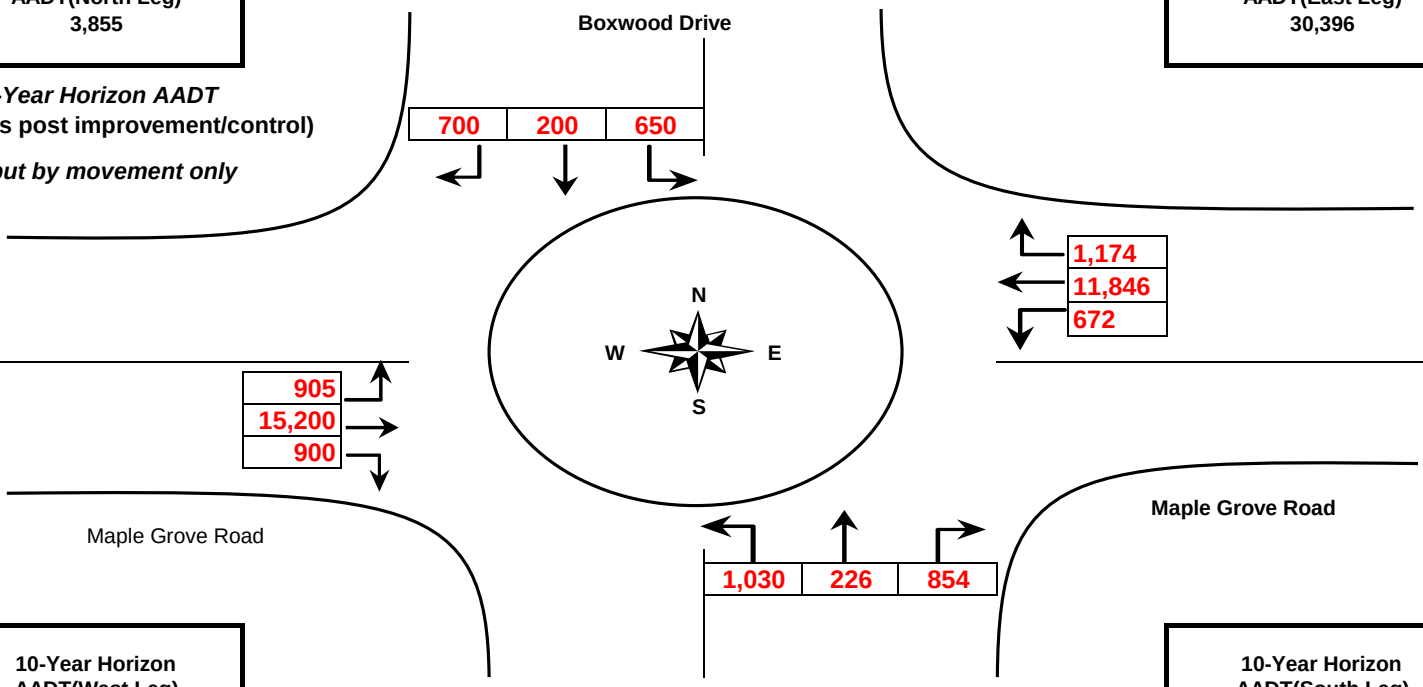
Minor Road (mid-block) 10-Year Horizon AADT: 3,882

10-Year Horizon AADT(North Leg) 3,855

10-Year Horizon AADT(East Leg) 30,396

***10-Year Horizon AADT (10ys post improvement/control)**

***Input by movement only**



10-Year Horizon AADT(West Leg) 30,581

Boxwood Drive

10-Year Horizon AADT(South Leg) 3,882

Direct Capital Costs

Fatal = $1,656,500

Injury = $60,500

PDO = $5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$940,367.23	$127,316.13	$680,051.63	$132,999.47
Roundabout	$1,441,019.13	$614,652.71	$826,366.42	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 1**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Boxwood Drive**
Major Road Direction:	East / West	**Roundabout Conflicts:**	**24489**
Urban or Rural:	Rural		
Proposed Control:	Signalized	**5-Year Total Collisions:**	**8**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**5**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**3.20**	**2.22**	**0.98**	**0.01**
Roundabout	**11.91**	**10.72**	**1.19**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**		**0.64**	Total	PDO
				0.823595998	**0.865562**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 2

Major Road: Maple Grove Road

Minor Road: Boxwood Drive

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	No RT Lanes
Minor	2 Approaches	Minor	No RT Lanes

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 8

5-Year PDO Collisions: 5

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 30,462

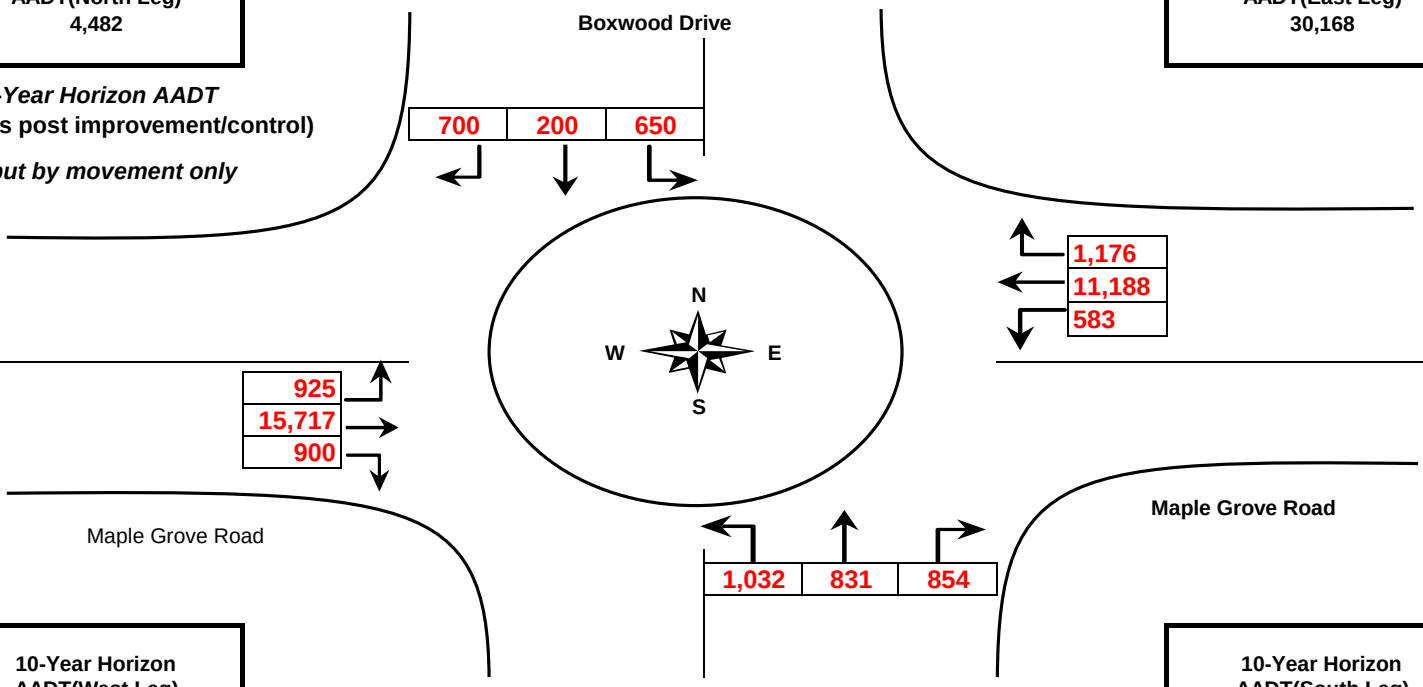
Minor Road (mid-block) 10-Year Horizon AADT: 4,482

10-Year Horizon AADT(North Leg) 4,482

10-Year Horizon AADT(East Leg) 30,168

**** 10-Year Horizon AADT***
(10ys post improvement/control)

**** Input by movement only***



10-Year Horizon AADT(West Leg) 30,462

Boxwood Drive

10-Year Horizon AADT(South Leg) 4,400

Direct Capital Costs

Fatal = $1,656,500
Injury = $60,500
PDO = $5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$950,174.01	$130,183.61	$686,990.93	$132,999.47
Roundabout	$1,698,146.49	$724,327.89	$973,818.60	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 2**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Boxwood Drive**
Major Road Direction:	East / West		
Urban or Rural:	Rural	**Roundabout Conflicts:**	**29956**
Proposed Control:	Signalized	**5-Year Total Collisions:**	**8**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**5**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**3.26**	**2.27**	**0.99**	**0.01**
Roundabout	**14.03**	**12.63**	**1.40**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**		**0.64**	Total	PDO
				0.817045071	**0.860491909**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 1

Major Road: Maple Grove Road

Minor Road: Speedsville Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	1 Approach
Minor	2 Approaches	Minor	1 Approach

Is there going to be any fully protected left-turn phasing?	YES
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 23

5-Year PDO Collisions: 15

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 30,575

Minor Road (mid-block) 10-Year Horizon AADT: 23,750

10-Year Horizon AADT(North Leg) 8,550

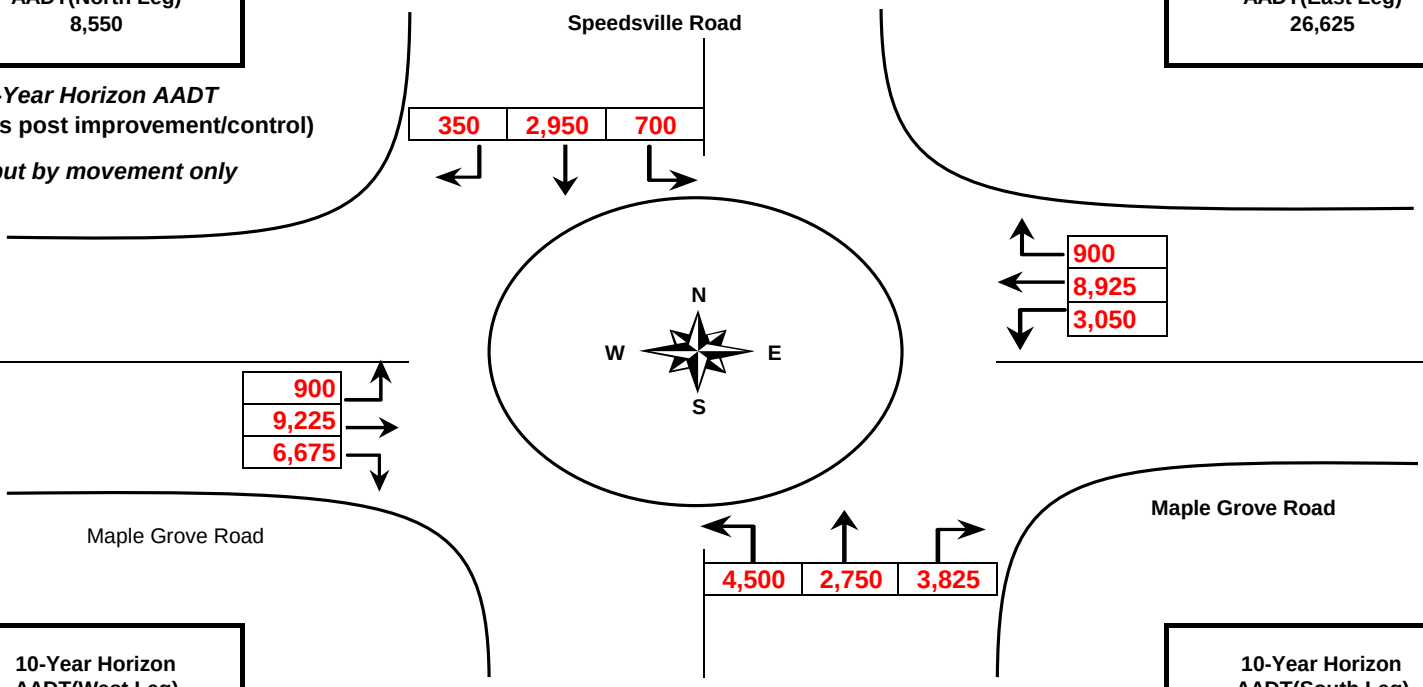
10-Year Horizon AADT(East Leg) 26,625

10-Year Horizon AADT(West Leg) 30,575

10-Year Horizon AADT(South Leg) 23,750

** 10-Year Horizon AADT*
(10ys post improvement/control)

** Input by movement only*



Direct Capital Costs

Fatal =	$1,656,500
Injury =	$60,500
PDO =	$5,000
Discount Rate =	0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$1,554,724.88	$188,680.20	$1,138,045.58	$227,999.09
Roundabout	$4,391,806.66	$1,873,282.46	$2,518,524.20	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 1**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Speedsville Road**
Major Road Direction:	East / West	**Roundabout Conflicts:**	**96150**
Urban or Rural:	Rural		
Proposed Control:	Signalized	**5-Year Total Collisions:**	**23**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**15**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**4.95**	**3.29**	**1.64**	**0.01**
Roundabout	**36.29**	**32.66**	**3.63**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**	**0.92**	**0.64**	Total	PDO
				0.962031134	**0.968548382**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 2

Major Road: Maple Grove Road

Minor Road: Speedsville Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	1 Approach
Minor	2 Approaches	Minor	1 Approach

Is there going to be any fully protected left-turn phasing?	YES
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 23

5-Year PDO Collisions: 15

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 30,375

Minor Road (mid-block) 10-Year Horizon AADT: 23,700

10-Year Horizon AADT(North Leg) 9,000

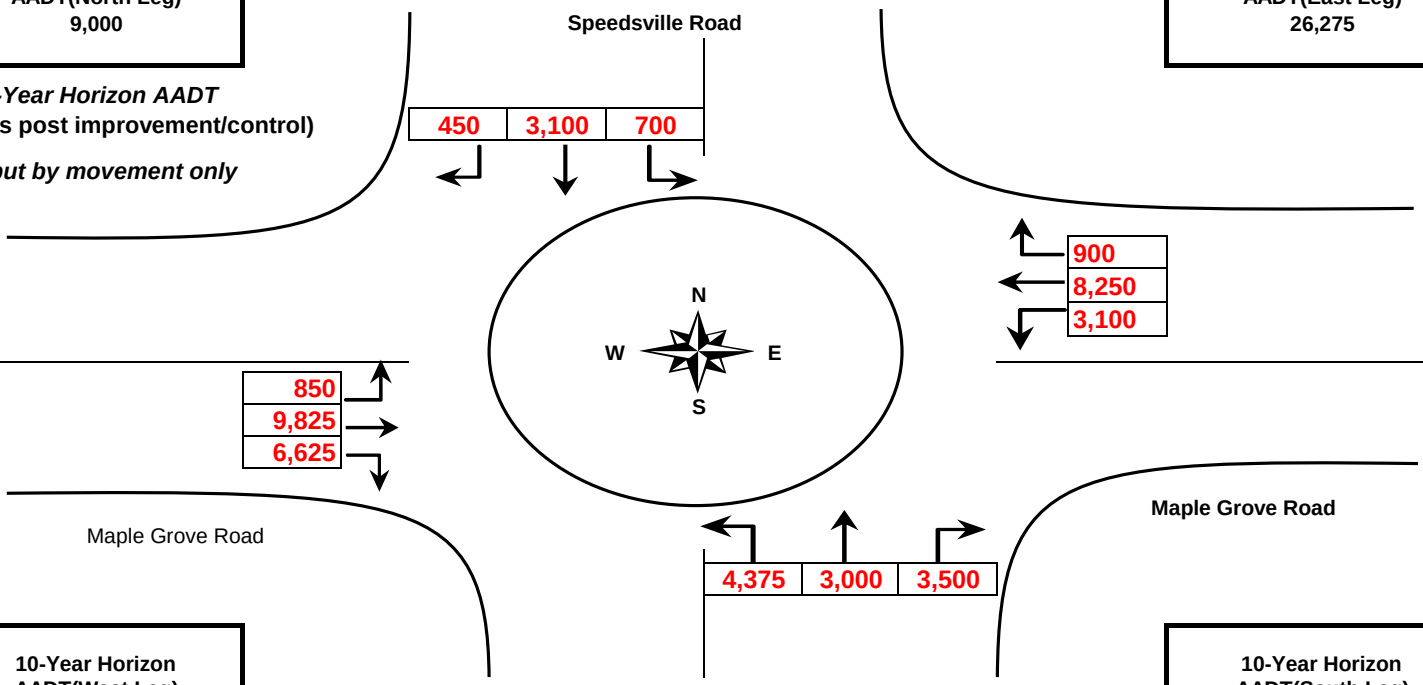
10-Year Horizon AADT(East Leg) 26,275

10-Year Horizon AADT(West Leg) 30,375

10-Year Horizon AADT(South Leg) 23,700

** 10-Year Horizon AADT*
(10ys post improvement/control)

** Input by movement only*



Direct Capital Costs

Fatal =	$1,656,500
Injury =	$60,500
PDO =	$5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$1,554,151.39	$188,106.71	$1,138,045.58	$227,999.09
Roundabout	$4,451,263.19	$1,898,643.07	$2,552,620.12	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 2**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Speedsville Road**
Major Road Direction:	East / West		
Urban or Rural:	Rural	**Roundabout Conflicts:**	**97750**
Proposed Control:	Signalized	**5-Year Total Collisions:**	**23**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**15**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**4.93**	**3.28**	**1.64**	**0.01**
Roundabout	**36.78**	**33.11**	**3.68**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**	**0.92**	**0.64**	Total	PDO
				0.963544967	**0.969694662**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 1

Major Road: Maple Grove Road

Minor Road: Old Maple Grove Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	3-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	1 Approach	Major	1 Approach
Minor	1 Approach	Minor	1 Approach

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	NO
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 0

5-Year PDO Collisions: 0

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 26,700

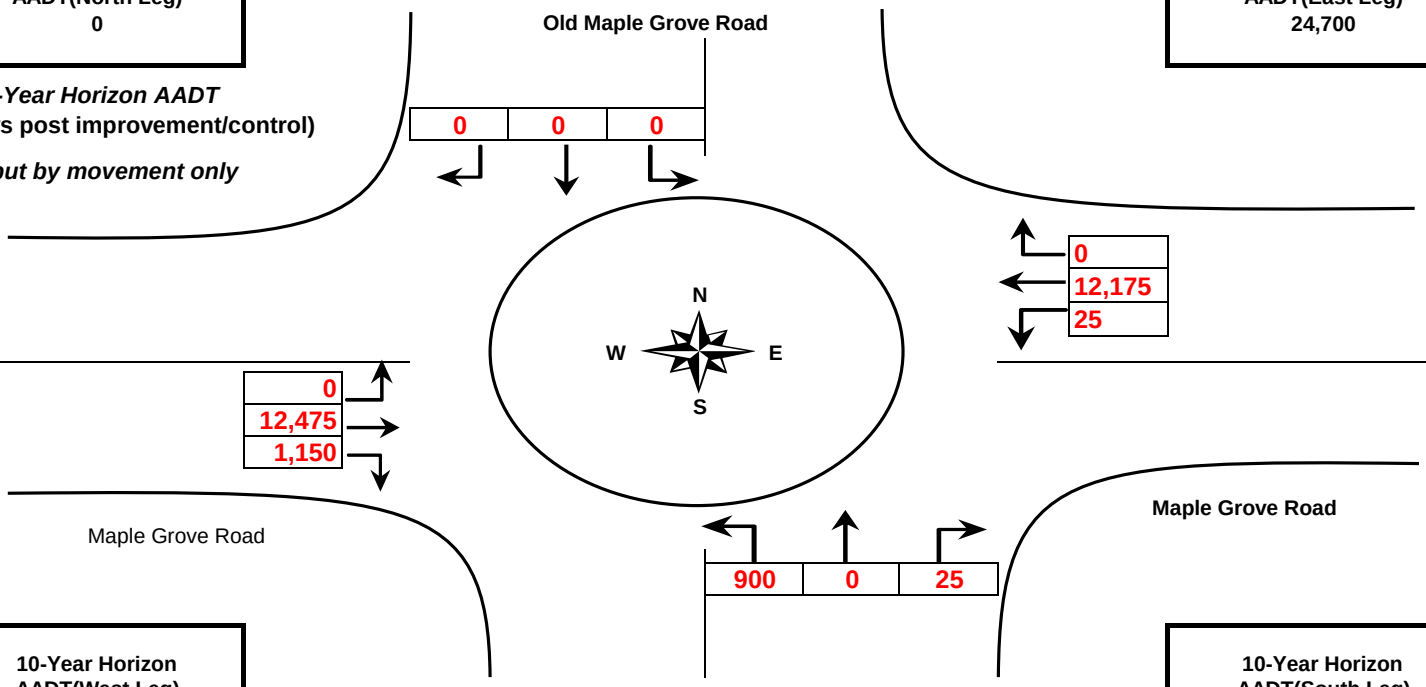
Minor Road (mid-block) 10-Year Horizon AADT: 2,100

10-Year Horizon AADT(North Leg)
0

10-Year Horizon AADT(East Leg)
24,700

***10-Year Horizon AADT**
(10ys post improvement/control)

***Input by movement only**



10-Year Horizon AADT(West Leg)
26,700

10-Year Horizon AADT(South Leg)
2,100

Direct Capital Costs

Fatal = $1,656,500
Injury = $60,500
PDO = $5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$2,264,913.73	$269,543.15	$1,672,371.86	$322,998.72
Roundabout	$310,663.21	$132,510.37	$178,152.84	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 1**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Old Maple Grove Road**
Major Road Direction:	East / West		
Urban or Rural:	Rural	**Roundabout Conflicts:**	**3725**
Proposed Control:	Signalized	**5-Year Total Collisions:**	**0**
Proposed Config.	3-Leg Intersection	**5-Year PDO Collisions:**	**0**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**7.13**	**4.70**	**2.41**	**0.02**
Roundabout	**2.57**	**2.31**	**0.26**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	3-Leg Intersection	**-5.13**	**0.6**	**0.2**	**N/A**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	3-Leg Intersection	**-5.13**	**0.6**	**0.2**	**N/A**	**0.007**	**0.66**

Collision Modification Factors (cmf's)	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
			0.64	Total	PDO
				N/A	**N/A**
	Illumination	Protected LT Phasing			
	0.90	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 2

Major Road: Maple Grove Road

Minor Road: Old Maple Grove Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	3-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	1 Approach	Major	1 Approach
Minor	1 Approach	Minor	1 Approach

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	NO
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 0

5-Year PDO Collisions: 0

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 26,350

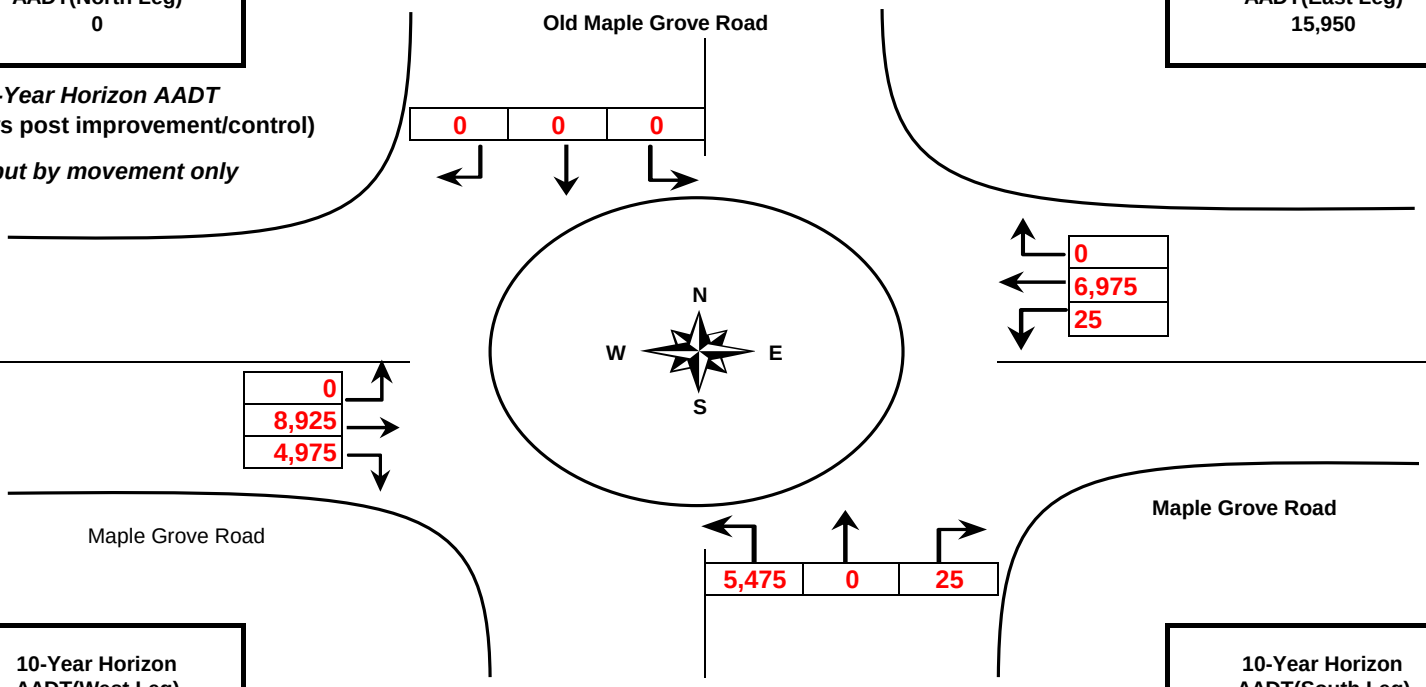
Minor Road (mid-block) 10-Year Horizon AADT: 10,500

10-Year Horizon AADT(North Leg)
0

10-Year Horizon AADT(East Leg)
15,950

***10-Year Horizon AADT**
(10ys post improvement/control)

***Input by movement only**



10-Year Horizon AADT(West Leg)
26,350

Old Maple Grove Road

10-Year Horizon AADT(South Leg)
10,500

Direct Capital Costs

Fatal = $1,656,500
Injury = $60,500
PDO = $5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$3,089,360.20	$369,331.46	$2,283,030.47	$436,998.26
Roundabout	$1,321,733.88	$563,772.74	$757,961.13	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 2**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Old Maple Grove Road**
Major Road Direction:	East / West		
Urban or Rural:	Rural	**Roundabout Conflicts:**	**22025**
Proposed Control:	Signalized	**5-Year Total Collisions:**	**0**
Proposed Config.	3-Leg Intersection	**5-Year PDO Collisions:**	**0**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**9.75**	**6.44**	**3.29**	**0.02**
Roundabout	**10.92**	**9.83**	**1.09**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	3-Leg Intersection	**-5.13**	**0.6**	**0.2**	**N/A**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	3-Leg Intersection	**-5.13**	**0.6**	**0.2**	**N/A**	**0.007**	**0.66**

Collision Modification Factors (cmf's)	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
			0.64	Total	PDO
				N/A	**N/A**
	Illumination	Protected LT Phasing			
	0.90	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 1

Major Road: Maple Grove Road

Minor Road: Beaverdale Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	No RT Lanes
Minor	2 Approaches	Minor	No RT Lanes

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 7

5-Year PDO Collisions: 4

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 25,260

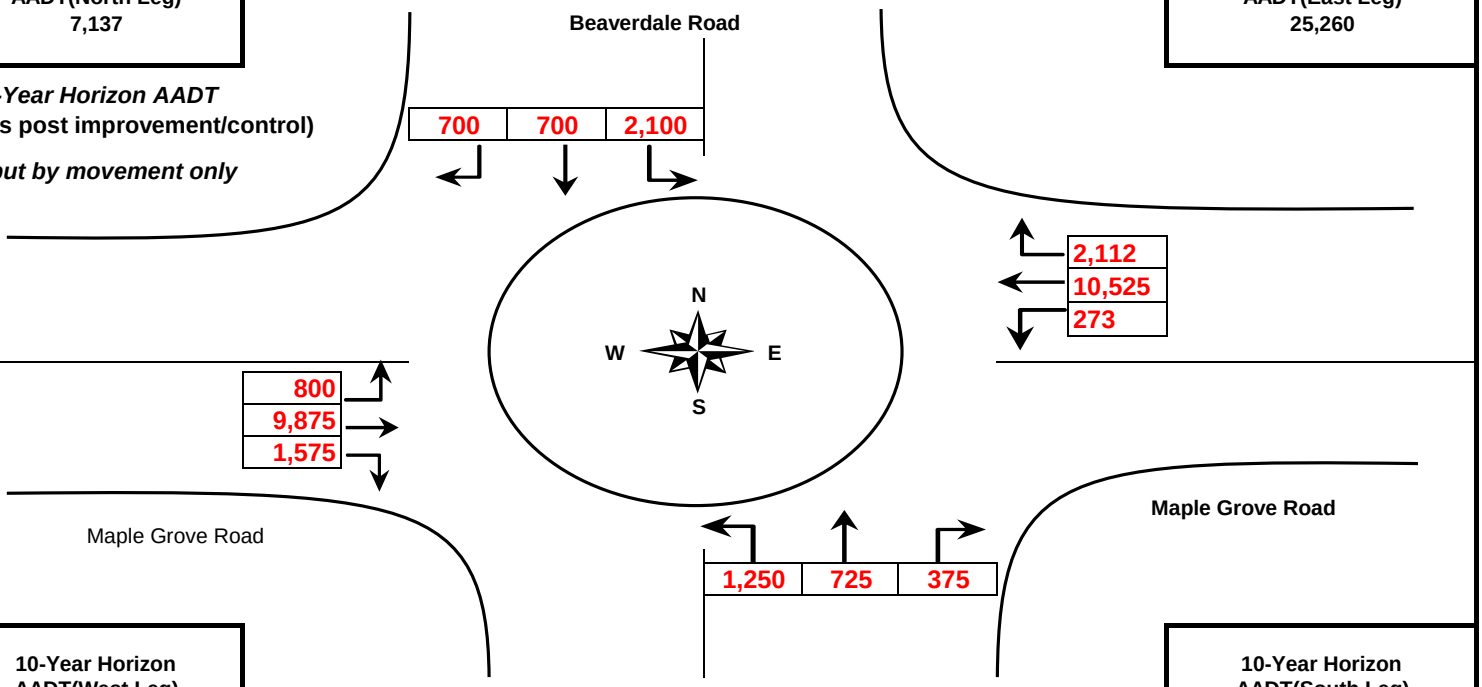
Minor Road (mid-block) 10-Year Horizon AADT: 7,137

10-Year Horizon AADT(North Leg) 7,137

10-Year Horizon AADT(East Leg) 25,260

***10-Year Horizon AADT**
(10ys post improvement/control)

***Input by movement only**



10-Year Horizon AADT(West Leg) 24,725

10-Year Horizon AADT(South Leg) 4,898

Direct Capital Costs

Fatal =	$1,656,500
Injury =	$60,500
PDO =	$5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$924,768.13	$125,595.64	$666,173.02	$132,999.47
Roundabout	$2,055,918.49	$876,932.06	$1,178,986.43	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 1**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Beaverdale Road**
Major Road Direction:	East / West	**Roundabout Conflicts:**	**37878**
Urban or Rural:	Rural		
Proposed Control:	Signalized	**5-Year Total Collisions:**	**7**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**4**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**3.16**	**2.19**	**0.96**	**0.01**
Roundabout	**16.99**	**15.29**	**1.70**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**		**0.64**	Total	PDO
				0.806468014	**0.847078642**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Region of Waterloo

Last Rev Jan 2019

Scenario: 2036 Scenario 2

Major Road: Maple Grove Road

Minor Road: Beaverdale Road

Major Road Direction:	East / West
Urban or Rural:	Rural
Proposed Control:	Signalized
Proposed Config.	4-Leg Intersection

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	No RT Lanes
Minor	2 Approaches	Minor	No RT Lanes

Is there going to be any fully protected left-turn phasing?	NO
Number of approaches with FPLTP:	N/A
Is the proposed intersection "new" or is it existing:	EXISTING
Does control and number of approaches remain the same:	YES
Will the proposed intersection have illumination:	YES

5-Year Total Collisions: 7

5-Year PDO Collisions: 4

Proposed Multi-Lane or Single Lane RA? MULTI-LANE ROUNDABOUT

Major Road (mid-block) 10-Year Horizon AADT: 16,375

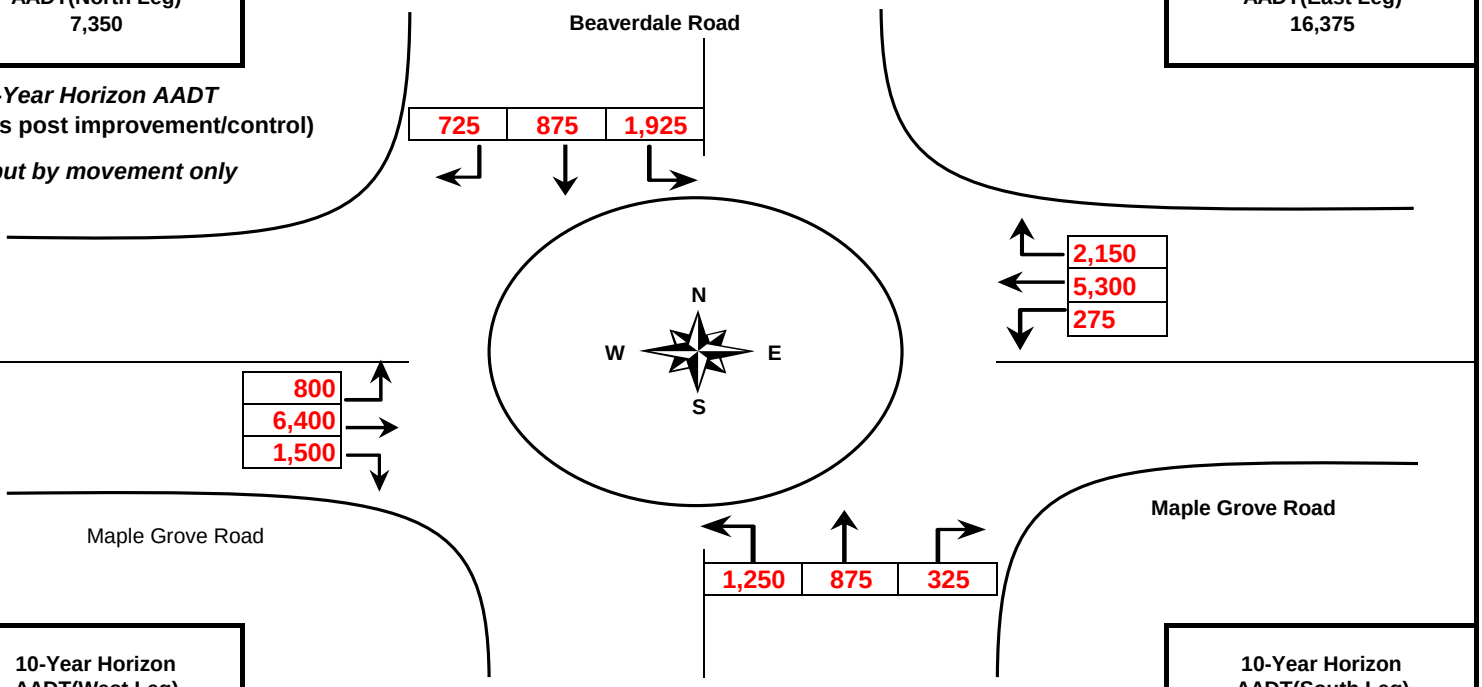
Minor Road (mid-block) 10-Year Horizon AADT: 7,350

10-Year Horizon AADT(North Leg) 7,350

10-Year Horizon AADT(East Leg) 16,375

***10-Year Horizon AADT**
(10ys post improvement/control)

***Input by movement only**



10-Year Horizon AADT(West Leg) 15,975

Beaverdale Road

10-Year Horizon AADT(South Leg) 5,100

Direct Capital Costs

Fatal = $1,656,500
Injury = $60,500
PDO = $5,000

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	$792,617.44	$102,655.79	$575,962.09	$113,999.55
Roundabout	$2,139,432.13	$912,553.99	$1,226,878.14	$0.00

INTERSECTION CONTROL STUDIES
SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev Jan 2019

Scenario:	**2036 Scenario 2**	**Major Road:**	**Maple Grove Road**
		Minor Road:	**Beaverdale Road**
Major Road Direction:	East / West	**Roundabout Conflicts:**	**39775**
Urban or Rural:	Rural		
Proposed Control:	Signalized	**5-Year Total Collisions:**	**7**
Proposed Config.	4-Leg Intersection	**5-Year PDO Collisions:**	**4**

Estimated **ANNUAL (1-YEAR ONLY)** Collisions				
Future Expected Collisions by Severity	**Total**	**PDO**	**Injury**	**Fatal**
Signalized	**2.63**	**1.79**	**0.83**	**0.01**
Roundabout	**17.68**	**15.91**	**1.77**	**0.00**

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**n/a**

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	**-5.13**	**0.6**	**0.2**	**0.11**	**0.007**	**0.66**

	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
Collision Modification Factors (cmf's)	**0.45**		**0.64**	Total	PDO
				0.864935648	**0.891383757**
	Illumination	Protected LT Phasing			
	0.89	**1.00**			

Comments:

C

Appendix C

Construction Cost Estimates



Summary

Section	Description	Estimated Cost	
		SIG	RBT
A	Property acquisition subtotal	$ -	$ 149,940
B	General requirements	$ 123,406	$ 132,759
C	Utility relocations and adjustments	$ 226,340	$ 419,050
D	Remove, dispose or reinstall	$ 46,240	$ 88,360
E	Road construction	$ 1,234,086	$ 1,656,668
F	Pavement markings and signage	$ 65,720	$ 69,260
G	Street lighting, signals and electrical	$ 266,500	$ 27,500
H	Landscaping, erosion control and maintenance	$ 35,101	$ 39,686
I	Construction subtotal	$ 1,997,392	$ 2,433,283
J	Engineering fees 15%	$ 299,609	$ 364,992
K	Contingency 20%	$ 399,478	$ 486,657
L	Construction total	$ 2,696,480	$ 3,284,932
M	HST 1.76%	$ 47,458	$ 57,815
N	**Grand total (including property acquisition)**	**$ 2,743,938**	**$ 3,492,686**
O	Constructuction of interim boundary curb		$ 100,800
P	Removal Interim Boundary Curb		$ 23,100

Final Total: $ 2,743,938 $ 3,618,767

Section A - Property Acquisition							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
A - 1	School			m^2	$ 248	$ -	$ -
A - 2	Industrial		3060	m^2	$ 49	$ -	$ 149,940
A - 3	Commercial			m^2	$ 296	$ -	$ -
A - 4	Residential - low density			m^2	$ 269	$ -	$ -
A - 5	Residential - high density			m^2	$ 270	$ -	$ -
A - 6	Sports Park			m^2	$ 226	$ -	$ -
A - 7	Additional impacts			LS	$ 100,000	$ -	$ -
Subtotal						**$ -**	**$ 149,940**

Section B - General Requirements							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
B - 1	Mobilization and demobilization	1	1	LS	$ 16,000	$ 16,000	$ 16,000
B - 2	Construction layout by contractor	1	1	LS	$ 9,000	$ 9,000	$ 9,000
B - 3	Traffic control and construction staging (incl. materials)	1	1	LS	$ 32,500	$ 32,500	$ 32,500
B - 4	Bonds (assumes 2% of parts D-H)	1	1	LS	2%	$ 32,953	$ 37,629
B - 5	Insurance (assumes 2% of parts D-H)	1	1	LS	2%	$ 32,953	$ 37,629
B - 6	Supply and place contract admin. office	1	1	LS	$ 29,500	$ 29,500	$ 29,500
Subtotal						**$ 123,406**	**$ 132,759**

Section C - Utility Relocations and Adjustments							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
C - 1	Remove and dispose of existing hydro poles	8	15	ea	$ 25,000	$ 200,000	$ 375,000
C - 2	Adjust to grade existing hydro poles			ea	$ 4,000	$ -	$ -
C - 3	Relocation of underground power supply			LS	$ 10,000	$ -	$ -
C - 4	Relocate or adjust to grade existing phone pedestals			ea	$ 500	$ -	$ -
C - 5	Relocate existing gas mains (incl. adjustments to valves)			LS	$ 25,000	$ -	$ -
C - 6	Relocate or adjust to grade existing light standards	1	1	ea	$ 1,500	$ 1,500	$ 1,500
C - 7	Relocate existing fibre-optic cables			LS	$ 30,000	$ -	$ -
C - 8	Relocate or adjust existing watermains (major)			LS	$ 10,000	$ -	$ -
C - 9	Relocate or adjust existing watermains (minor)			LS	$ 15,000	$ -	$ -
C - 10	Adjust watermain appurtenances (incl. valves, chambers and manholes)			ea	$ 200	$ -	$ -
C - 11	Relocate hydrant and valve		4	ea	$ 4,000	$ -	$ 16,000
C - 12	Adjust manholes to grade (all types)	8	10	ea	$ 855	$ 6,840	$ 8,550
C - 13	Relocate storm sewer catchbasins	6	6	ea	$ 3,000	$ 18,000	$ 18,000
Subtotal						**$ 226,340**	**$ 419,050**

Section D - Remove, Dispose and Reinstall								
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
D - 1	Clearing and grubbing (estimated 5.0 m back from face of curb)	5000	8400	m^2	$ 1.3	$ 6,500	$ 10,920
D - 2	Stripping and stockpiling of topsoil and sod (300 mm depth)	1500	2760	m^3	$ 20	$ 30,000	$ 55,200
D - 3	Remove, dispose or store and reinstall existing fence (all types)			m	$ 8	$ -	$ -
D - 4	Remove, dispose or store and reinstall existing signs	10	16	ea	$ 150	$ 1,500	$ 2,400
D - 5	Remove and dispose of existing sidewalk	60	210	m^2	$ 7	$ 420	$ 1,470
D - 6	Sawcut existing road asphalt (any thickness)	1	1	LS	$ 1,000	$ 1,000	$ 1,000
D - 7	Mill existing pavement surface (avg. 50 mm depth, 3.0 m wide at limit of asphalt incl. HL-3 asphalt for restoration)	1	1	LS	$ 1,500	$ 1,500	$ 1,500
D - 8	Pulverization and stockpiling of existing asphalt (min. 300 mm depth, incl. grade and compact pulverized section)			m^2	$ 3	$ -	$ -
D - 9	Remove existing road pavement (full depth incl. all granular material)		1020	m^2	$ 5	$ -	$ 5,100
D - 10	Remove and dispose of existing conc. curb (all types incl. conc. gutters)	220	470	m	$ 11	$ 2,420	$ 5,170
D - 11	Remove and dispose of other existing conc. or asphalt (median islands, splash pads, etc.)			m^2	$ 14	$ -	$ -
D - 12	Remove and dispose of minor culverts	30	120	m	$ 30	$ 900	$ 3,600
D - 13	Remove and dispose of major culverts			m	$ 40	$ -	$ -
D - 14	Remove existing signal light poles			ea	$ 250	$ -	$ -
D - 15	Remove existing signal appurtenances (handwells, wire loop sensors, etc.)			ea	$ 100	$ -	$ -
D - 16	Remove, salvage and restore miscellaneous appurtenances	1	1	LS	$ 2,000	$ 2,000	$ 2,000
Subtotal						**$ 46,240**	**$ 88,360**

Section E - Road Construction							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
E - 1	Imported fill for road construction	4500	4500	m^3	$ 25	$ 112,500	$ 112,500
E - 2	Prepare subgrade surface for road construction	10500	17800	m^2	$ 2	$ 21,000	$ 35,600
E - 3	Granular 'A' for roadworks (assume 150 mm depth - incl. shoulders)	3938	6675	ton	$ 17.00	$ 66,938	$ 113,475
E - 4	Granular 'A' for miscellaneous items (incl. driveways, splash pads, sidewalks, etc., avg 200 mm depth)	1450	1500	ton	$ 17.00	$ 24,650	$ 25,500
E - 5	Granular 'B' for roadworks (assume 450 mm depth - incl. shoulders)	11813	20025	ton	$ 12.00	$ 141,750	$ 240,300
E - 6	Surface course asphalt (assume HL-3, min. 50 mm depth)	1260	1680	ton	$ 115.0	$ 144,900	$ 193,200
E - 7	Heavy duty binder course (HDBC) - (PG64-28) 100 mm depth	2520	3360	ton	$ 82.0	$ 206,640	$ 275,520
E - 8	Miscellaneous asphalt (assume HL3, min. 75 mm depth, for driveways, splash pads, splitter islands, etc.)	200	200	m	$ 16.54	$ 3,308	$ 3,308
E - 9	Concrete curb and gutter (all types)	2200	3400	m	$ 48	$ 105,600	$ 163,200
E - 10	Reconstruction of existing driveways (asphalt or gravel)	300	300	m^2	$ 52	$ 15,600	$ 15,600
E - 11	Perforated subdrains under concrete curbs	2200	2100	m	$ 25	$ 55,000	$ 52,500
E - 12	Concrete for splitter islands	2450	3300	m^2	$ 50	$ 122,500	$ 165,000
E - 13	Concrete - coloured and stamped for truck apron (200 mm thick)		255	m^2	$ 123	$ -	$ 31,365
E - 14	Concrete sidewalk (assume 3.0 m width)	2900	3200	m^2	$ 53	$ 153,700	$ 169,600
E - 15	Rip-rap for roadway spillways and along ditches (incl. geotextile fabric)			m^2	$ 30	$ -	$ -
E - 16	Allowance for night paving	1	1	LS	$ 20,000	$ 20,000	$ 20,000
E - 17	Short-term lane closure	1	1	LS	$ 20,000	$ 20,000	20000
E - 18	Supply and install CSP culverts (minor)	200	200	m	$ 100	$ 20,000	$ 20,000
E - 19	Supply and install CSP culverts (major)			m	$ 125	$ -	$ -
E - 20	Retaining Wall & Noise Wall			m	$ 1,200	$ -	$ -
Subtotal						**$ 1,234,086**	**$ 1,656,668**

Section F - Pavement Markings and Signage							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
F - 1	Temporary pavement marking for construction staging	4000	4000	m	$ 6	$ 24,000	$ 24,000
F - 2	Painted pavement markings	2500	2700	m	$ 10	$ 25,000	$ 27,000
F - 3	Durable pavement markigns	230	200	m	$ 20	$ 4,600	$ 4,000
F - 4	Durable pavement messages (arrows, crosswalk markings, etc.)	60	31	ea	$ 180	$ 10,800	$ 5,580
F - 5	Supply and install custom map-type signs (incl. base and posts)		4	ea	$ 1,200	$ -	$ 4,800
F - 6	Supply and install signs (incl. base and posts)	2	18	ea	$ 160	$ 320	$ 2,880
F - 7	Supply and install temporary project sign board (incl. base and posts)	4	4	ea	$ 250	$ 1,000	$ 1,000
Subtotal						**$ 65,720**	**$ 69,260**

Section G - Street Lighting, Signals and Electrical							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
G - 1	Supply and install light standards (all types incl. appurtenances)	14	20	ea	$ 1,000	$ 14,000	$ 20,000
G - 2	Supply and install signals for intersections	1		LS	$ 200,000	$ 200,000	$ -
G - 3	Electrical service to central island		1	LS	$ 5,000	$ -	$ 5,000
G - 4	Connect to grid	1	1	LS	$ 2,500	$ 2,500	$ 2,500
G - 5	Temporary signals	1		LS	$ 50,000	$ 50,000	$ -
Subtotal						**$ 266,500**	**$ 27,500**

Section H - Landscaping, Erosion Control and Miscellaneous							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
H - 1	Utility locates or dig-ups	3	3	ea	$ 450	$ 1,350	$ 1,350
H - 2	Supply, install and maintain sediment control fence (OPSD 219.110)			m	$ 12	$ -	$ -
H - 3	Supply and install straw bale check dams (OPSD 219.180)			ea	$ 150	$ -	$ -
H - 4	Landscaping (incl. topsoil, sod, seeding and central island plantings, assume 2% of parts D-G)	1	1	LS	2%	$ 32,251	$ 36,836
H - 5	Supply and install new or reinstated fences			m	40	$ -	$ -
H - 6	Dust and noise control	1	1	LS	$ 1,500	$ 1,500	$ 1,500
Subtotal						**$ 35,101**	**$ 39,686**

Summary

Section	Description	Estimated Cost	
		SIG	RBT
A	Property acquisition subtotal	$ 58,387	$ 324,442
B	General requirements	$ 154,378	$ 148,219
C	Utility relocations and adjustments	$ 345,340	$ 420,340
D	Remove, dispose or reinstall	$ 88,330	$ 102,570
E	Road construction	$ 1,890,897	$ 1,973,427
F	Pavement markings and signage	$ 118,000	$ 108,780
G	Street lighting, signals and electrical	$ 274,000	$ 35,500
H	Landscaping, erosion control and maintenance	$ 50,725	$ 47,706
I	Construction subtotal	$ 2,921,669	$ 2,836,542
J	Engineering fees 15%	$ 438,250	$ 425,481
K	Contingency 20%	$ 584,334	$ 567,308
L	Construction total	$ 3,944,253	$ 3,829,331
M	HST 1.76%	$ 69,419	$ 67,396
N	**Grand total (including property acquisition)**	**$ 4,072,059**	**$ 4,221,169**
O	Constructuction of interim boundary curb		$ 103,200
P	Removal Interim Boundary Curb		$ 23,650

Final Total: $ 4,072,059 $ 4,350,251

Section A - Property Acquisition							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
A - 1	School			m^2	$ 248	$ -	$ -
A - 2	Woodland	560	2420	m^2	$ 49	$ 27,440	$ 118,580
A - 3	Commercial			m^2	$ 296	$ -	$ -
A - 4	Residential - low density	115	765	m^2	$ 269	$ 30,947	$ 205,862
A - 5	Residential - high density			m^2	$ 270	$ -	$ -
A - 6	Sports Park			m^2	$ 226	$ -	$ -
A - 7	Additional impacts			LS	$ 100,000	$ -	$ -
Subtotal						**$ 58,387**	**$ 324,442**

Section B - General Requirements							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
B - 1	Mobilization and demobilization	1	1	LS	$ 16,000	$ 16,000	$ 16,000
B - 2	Construction layout by contractor	1	1	LS	$ 9,000	$ 9,000	$ 9,000
B - 3	Traffic control and construction staging (incl. materials)	1	1	LS	$ 32,500	$ 32,500	$ 32,500
B - 4	Bonds (assumes 2% of parts D-H)	1	1	LS	2%	$ 48,439	$ 45,360
B - 5	Insurance (assumes 2% of parts D-H)	1	1	LS	2%	$ 48,439	$ 45,360
B - 6	Supply and place contract admin. office	1	1	LS	$ 29,500	$ 29,500	$ 29,500
Subtotal						**$ 154,378**	**$ 148,219**

Section C - Utility Relocations and Adjustments							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
C - 1	Remove and dispose of existing hydro poles	13	16	ea	$ 25,000	$ 325,000	$ 400,000
C - 2	Adjust to grade existing hydro poles			ea	$ 4,000	$ -	$ -
C - 3	Relocation of underground power supply			LS	$ 10,000	$ -	$ -
C - 4	Relocate or adjust to grade existing phone pedestals			ea	$ 500	$ -	$ -
C - 5	Relocate existing gas mains (incl. adjustments to valves)			LS	$ 25,000	$ -	$ -
C - 6	Relocate or adjust to grade existing light standards	1	1	ea	$ 1,500	$ 1,500	$ 1,500
C - 7	Relocate existing fibre-optic cables			LS	$ 30,000	$ -	$ -
C - 8	Relocate or adjust existing watermains (major)			LS	$ 10,000	$ -	$ -
C - 9	Relocate or adjust existing watermains (minor)			LS	$ 15,000	$ -	$ -
C - 10	Adjust watermain appurtenances (incl. valves, chambers and manholes)			ea	$ 200	$ -	$ -
C - 11	Relocate hydrant and valve	3	3	ea	$ 4,000	$ 12,000	$ 12,000
C - 12	Adjust manholes to grade (all types)	8	8	ea	$ 855	$ 6,840	$ 6,840
C - 13	Relocate storm sewer catchbasins			ea	$ 3,000	$ -	$ -
Subtotal						**$ 345,340**	**$ 420,340**

Section D - Remove, Dispose and Reinstall							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
D - 1	Clearing and grubbing (estimated 5.0 m back from face of curb)	10500	11800	m^2	$ 1.3	$ 13,650	$ 15,340
D - 2	Stripping and stockpiling of topsoil and sod (300 mm depth)	3150	3540	m^3	$ 20	$ 63,000	$ 70,800
D - 3	Remove, dispose or store and reinstall existing fence (all types)			m	$ 8	$ -	$ -
D - 4	Remove, dispose or store and reinstall existing signs	15	10	ea	$ 150	$ 2,250	$ 1,500
D - 5	Remove and dispose of existing sidewalk			m^2	$ 7	$ -	$ -
D - 6	Sawcut existing road asphalt (any thickness)	1	1	LS	$ 1,000	$ 1,000	$ 1,000
D - 7	Mill existing pavement surface (avg. 50 mm depth, 3.0 m wide at limit of asphalt incl. HL-3 asphalt for restoration)	1	1	LS	$ 1,500	$ 1,500	$ 1,500
D - 8	Pulverization and stockpiling of existing asphalt (min. 300 mm depth, incl. grade and compact pulverized section)			m^2	$ 3	$ -	$ -
D - 9	Remove existing road pavement (full depth incl. all granular material)		1100	m^2	$ 5	$ -	$ 5,500
D - 10	Remove and dispose of existing conc. curb (all types incl. conc. gutters)			m	$ 11	$ -	$ -
D - 11	Remove and dispose of other existing conc. or asphalt (median islands, splash pads, etc.)			m^2	$ 14	$ -	$ -
D - 12	Remove and dispose of minor culverts	30	30	m	$ 30	$ 900	$ 900
D - 13	Remove and dispose of major culverts	32	32	m	$ 40	$ 1,280	$ 1,280
D - 14	Remove existing signal light poles	5	5	ea	$ 250	$ 1,250	$ 1,250
D - 15	Remove existing signal appurtenances (handwells, wire loop sensors, etc.)	15	15	ea	$ 100	$ 1,500	$ 1,500
D - 16	Remove, salvage and restore miscellaneous appurtenances	1	1	LS	$ 2,000	$ 2,000	$ 2,000
Subtotal						**$ 88,330**	**$ 102,570**

Section E - Road Construction							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
E - 1	Imported fill for road construction	6000	6000	m^3	$ 25	$ 150,000	$ 150,000
E - 2	Prepare subgrade surface for road construction	21870	21180	m^2	$ 2	$ 43,740	$ 42,360
E - 3	Granular 'A' for roadworks (assume 150 mm depth - incl. shoulders)	8201	7942.5	ton	$ 17.00	$ 139,421	$ 135,023
E - 4	Granular 'A' for miscellaneous items (incl. driveways, splash pads, sidewalks, etc., avg 200 mm depth)	2000	2000	ton	$ 17.00	$ 34,000	$ 34,000
E - 5	Granular 'B' for roadworks (assume 450 mm depth - incl. shoulders)	24604	23828	ton	$ 12.00	$ 295,245	$ 285,930
E - 6	Surface course asphalt (assume HL-3, min. 50 mm depth)	2406	2329.8	ton	$ 115.0	$ 276,656	$ 267,927
E - 7	Heavy duty binder course (HDBC) - (PG64-28) 100 mm depth	4811	4659.6	ton	$ 82.0	$ 394,535	$ 382,087
E - 8	Miscellaneous asphalt (assume HL3, min. 75 mm depth, for driveways, splash pads, splitter islands, etc.)			m	$ 16.54	$ -	$ -
E - 9	Concrete curb and gutter (all types)	3000	3400	m	$ 48	$ 144,000	$ 163,200
E - 10	Reconstruction of existing driveways (asphalt or gravel)	300	300	m^2	$ 52	$ 15,600	$ 15,600
E - 11	Perforated subdrains under concrete curbs	3000	2150	m	$ 25	$ 75,000	$ 53,750
E - 12	Concrete for splitter islands	2400	3450	m^2	$ 50	$ 120,000	$ 172,500
E - 13	Concrete - coloured and stamped for truck apron (200 mm thick)		400	m^2	$ 123	$ -	$ 49,200
E - 14	Concrete sidewalk (assume 3.0 m width)	2900	3200	m^2	$ 53	$ 153,700	$ 169,600
E - 15	Rip-rap for roadway spillways and along ditches (incl. geotextile fabric)	50	50	m^2	$ 30	$ 1,500	$ 1,500
E - 16	Allowance for night paving	1	1	LS	$ 20,000	$ 20,000	$ 20,000
E - 17	Short-term lane closure	1	1	LS	$ 20,000	$ 20,000	20000
E - 18	Supply and install CSP culverts (minor)	30	30	m	$ 100	$ 3,000	$ 3,000
E - 19	Supply and install CSP culverts (major)	36	62	m	$ 125	$ 4,500	$ 7,750
E - 20	Retaining Wall & Noise Wall			m	$ 1,200	$ -	$ -
Subtotal						**$ 1,890,897**	**$ 1,973,427**

Section F - Pavement Markings and Signage							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
F - 1	Temporary pavement marking for construction staging	7500	7000	m	$ 6	$ 45,000	$ 42,000
F - 2	Painted pavement markings	5500	4500	m	$ 10	$ 55,000	$ 45,000
F - 3	Durable pavement markigns	230	250	m	$ 20	$ 4,600	$ 5,000
F - 4	Durable pavement messages (arrows, crosswalk markings, etc.)	60	45	ea	$ 180	$ 10,800	$ 8,100
F - 5	Supply and install custom map-type signs (incl. base and posts)		4	ea	$ 1,200	$ -	$ 4,800
F - 6	Supply and install signs (incl. base and posts)	10	18	ea	$ 160	$ 1,600	$ 2,880
F - 7	Supply and install temporary project sign board (incl. base and posts)	4	4	ea	$ 250	$ 1,000	$ 1,000
Subtotal						**$ 118,000**	**$ 108,780**

Section G - Street Lighting, Signals and Electrical							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
G - 1	Supply and install light standards (all types incl. appurtenances)	24	28	ea	$ 1,000	$ 24,000	$ 28,000
G - 2	Supply and install signals for intersections	1		LS	$ 200,000	$ 200,000	$ -
G - 3	Electrical service to central island		1	LS	$ 5,000	$ -	$ 5,000
G - 4	Connect to grid		1	LS	$ 2,500	$ -	$ 2,500
G - 5	Temporary signals	1		LS	$ 50,000	$ 50,000	$ -
Subtotal						**$ 274,000**	**$ 35,500**

Section H - Landscaping, Erosion Control and Miscellaneous							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
H - 1	Utility locates or dig-ups	4	4	ea	$ 450	$ 1,800	$ 1,800
H - 2	Supply, install and maintain sediment control fence (OPSD 219.110)			m	$ 12	$ -	$ -
H - 3	Supply and install straw bale check dams (OPSD 219.180)			ea	$ 150	$ -	$ -
H - 4	Landscaping (incl. topsoil, sod, seeding and central island plantings, assume 2% of parts D-G)	1	1	LS	2%	$ 47,425	$ 44,406
H - 5	Supply and install new or reinstated fences			m	40	$ -	$ -
H - 6	Dust and noise control	1	1	LS	$ 1,500	$ 1,500	$ 1,500
Subtotal						**$ 50,725**	**$ 47,706**

Summary

Section	Description	Estimated Cost	
		SIG	RBT
A	Property acquisition subtotal	$ -	$ 63,210
B	General requirements	$ 118,323	$ 117,399
C	Utility relocations and adjustments	$ 75,000	$ 250,000
D	Remove, dispose or reinstall	$ 103,260	$ 108,750
E	Road construction	$ 1,064,491	$ 1,270,818
F	Pavement markings and signage	$ 55,220	$ 63,260
G	Street lighting, signals and electrical	$ 265,000	$ 22,500
H	Landscaping, erosion control and maintenance	$ 32,609	$ 32,157
I	Construction subtotal	$ 1,713,903	$ 1,864,883
J	Engineering fees 15%	$ 257,085	$ 279,733
K	Contingency 20%	$ 342,781	$ 372,977
L	Construction total	$ 2,313,769	$ 2,517,593
M	HST 1.76%	$ 40,722	$ 44,310
N	**Grand total (including property acquisition)**	**$ 2,354,492**	**$ 2,625,112**
O	Constructuction of interim boundary curb		$ 69,600
P	Removal Interim Boundary Curb		$ 15,950

Final Total: $ 2,354,492 $ 2,712,168

Section A - Property Acquisition							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
A - 1	School			m^2	$ 248	$ -	$ -
A - 2	Woodland		1290	m^2	$ 49	$ -	$ 63,210
A - 3	Commercial			m^2	$ 296	$ -	$ -
A - 4	Residential - low density			m^2	$ 269	$ -	$ -
A - 5	Residential - high density			m^2	$ 270	$ -	$ -
A - 6	Sports Park			m^2	$ 226	$ -	$ -
A - 7	Additional impacts			LS	$ 100,000	$ -	$ -
Subtotal						**$ -**	**$ 63,210**

Section B - General Requirements							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
B - 1	Mobilization and demobilization	1	1	LS	$ 16,000	$ 16,000	$ 16,000
B - 2	Construction layout by contractor	1	1	LS	$ 9,000	$ 9,000	$ 9,000
B - 3	Traffic control and construction staging (incl. materials)	1	1	LS	$ 32,500	$ 32,500	$ 32,500
B - 4	Bonds (assumes 2% of parts D-H)	1	1	LS	2%	$ 30,412	$ 29,950
B - 5	Insurance (assumes 2% of parts D-H)	1	1	LS	2%	$ 30,412	$ 29,950
B - 6	Supply and place contract admin. office	1	1	LS	$ 29,500	$ 29,500	$ 29,500
Subtotal						**$ 118,323**	**$ 117,399**

Section C - Utility Relocations and Adjustments							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
C - 1	Remove and dispose of existing hydro poles	3	10	ea	$ 25,000	$ 75,000	$ 250,000
C - 2	Adjust to grade existing hydro poles			ea	$ 4,000	$ -	$ -
C - 3	Relocation of underground power supply			LS	$ 10,000	$ -	$ -
C - 4	Relocate or adjust to grade existing phone pedestals			ea	$ 500	$ -	$ -
C - 5	Relocate existing gas mains (incl. adjustments to valves)			LS	$ 25,000	$ -	$ -
C - 6	Relocate or adjust to grade existing light standards			ea	$ 1,500	$ -	$ -
C - 7	Relocate existing fibre-optic cables			LS	$ 30,000	$ -	$ -
C - 8	Relocate or adjust existing watermains (major)			LS	$ 10,000	$ -	$ -
C - 9	Relocate or adjust existing watermains (minor)			LS	$ 15,000	$ -	$ -
C - 10	Adjust watermain appurtenances (incl. valves, chambers and manholes)			ea	$ 200	$ -	$ -
C - 11	Relocate hydrant and valve			ea	$ 4,000	$ -	$ -
C - 12	Adjust manholes to grade (all types)			ea	$ 855	$ -	$ -
C - 13	Relocate storm sewer catchbasins			ea	$ 3,000	$ -	$ -
Subtotal						**$ 75,000**	**$ 250,000**

Section D - Remove, Dispose and Reinstall							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
D - 1	Clearing and grubbing (estimated 5.0 m back from face of curb)	13200	13500	m^2	$ 1.3	$ 17,160	$ 17,550
D - 2	Stripping and stockpiling of topsoil and sod (300 mm depth)	3960	4050	m^3	$ 20	$ 79,200	$ 81,000
D - 3	Remove, dispose or store and reinstall existing fence (all types)			m	$ 8	$ -	$ -
D - 4	Remove, dispose or store and reinstall existing signs	16	8	ea	$ 150	$ 2,400	$ 1,200
D - 5	Remove and dispose of existing sidewalk			m^2	$ 7	$ -	$ -
D - 6	Sawcut existing road asphalt (any thickness)	1	1	LS	$ 1,000	$ 1,000	$ 1,000
D - 7	Mill existing pavement surface (avg. 50 mm depth, 3.0 m wide at limit of asphalt incl. HL-3 asphalt for restoration)	1	1	LS	$ 1,500	$ 1,500	$ 1,500
D - 8	Pulverization and stockpiling of existing asphalt (min. 300 mm depth, incl. grade and compact pulverized section)			m^2	$ 3	$ -	$ -
D - 9	Remove existing road pavement (full depth incl. all granular material)		900	m^2	$ 5	$ -	$ 4,500
D - 10	Remove and dispose of existing conc. curb (all types incl. conc. gutters)			m	$ 11	$ -	$ -
D - 11	Remove and dispose of other existing conc. or asphalt (median islands, splash pads, etc.)			m^2	$ 14	$ -	$ -
D - 12	Remove and dispose of minor culverts			m	$ 30	$ -	$ -
D - 13	Remove and dispose of major culverts			m	$ 40	$ -	$ -
D - 14	Remove existing signal light poles			ea	$ 250	$ -	$ -
D - 15	Remove existing signal appurtenances (handwells, wire loop sensors, etc.)			ea	$ 100	$ -	$ -
D - 16	Remove, salvage and restore miscellaneous appurtenances	1	1	LS	$ 2,000	$ 2,000	$ 2,000
Subtotal						**$ 103,260**	**$ 108,750**

Section E - Road Construction							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
E - 1	Imported fill for road construction	6600	6750	m^3	$ 25	$ 165,000	$ 168,750
E - 2	Prepare subgrade surface for road construction	10200	13500	m^2	$ 2	$ 20,400	$ 27,000
E - 3	Granular 'A' for roadworks (assume 150 mm depth - incl. shoulders)	2888	3562.5	ton	$ 17.00	$ 49,088	$ 60,563
E - 4	Granular 'A' for miscellaneous items (incl. driveways, splash pads, sidewalks, etc., avg 200 mm depth)	1500	1500	ton	$ 17.00	$ 25,500	$ 25,500
E - 5	Granular 'B' for roadworks (assume 450 mm depth - incl. shoulders)	8663	10688	ton	$ 12.00	$ 103,950	$ 128,250
E - 6	Surface course asphalt (assume HL-3, min. 50 mm depth)	847	1045	ton	$ 115.0	$ 97,405	$ 120,175
E - 7	Heavy duty binder course (HDBC) - (PG64-28) 100 mm depth	1694	2090	ton	$ 82.0	$ 138,908	$ 171,380
E - 8	Miscellaneous asphalt (assume HL3, min. 75 mm depth, for driveways, splash pads, splitter islands, etc.)			m	$ 16.54	$ -	$ -
E - 9	Concrete curb and gutter (all types)	2230	2800	m	$ 48	$ 107,040	$ 134,400
E - 10	Reconstruction of existing driveways (asphalt or gravel)	100	100	m^2	$ 52	$ 5,200	$ 5,200
E - 11	Perforated subdrains under concrete curbs	1120	1450	m	$ 25	$ 28,000	$ 36,250
E - 12	Concrete for splitter islands	2500	2920	m^2	$ 50	$ 125,000	$ 146,000
E - 13	Concrete - coloured and stamped for truck apron (200 mm thick)		350	m^2	$ 123	$ -	$ 43,050
E - 14	Concrete sidewalk (assume 3.0 m width)	3000	3100	m^2	$ 53	$ 159,000	$ 164,300
E - 15	Rip-rap for roadway spillways and along ditches (incl. geotextile fabric)			m^2	$ 30	$ -	$ -
E - 16	Allowance for night paving	1	1	LS	$ 20,000	$ 20,000	$ 20,000
E - 17	Short-term lane closure	1	1	LS	$ 20,000	$ 20,000	20000
E - 18	Supply and install CSP culverts (minor)			m	$ 100	$ -	$ -
E - 19	Supply and install CSP culverts (major)			m	$ 125	$ -	$ -
E - 20	Retaining Wall & Noise Wall			m	$ 1,200	$ -	$ -
Subtotal						**$ 1,064,491**	**$ 1,270,818**

Section F - Pavement Markings and Signage							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
F - 1	Temporary pavement marking for construction staging	3500	3500	m	$ 6	$ 21,000	$ 21,000
F - 2	Painted pavement markings	1750	2400	m	$ 10	$ 17,500	$ 24,000
F - 3	Durable pavement markigns	230	200	m	$ 20	$ 4,600	$ 4,000
F - 4	Durable pavement messages (arrows, crosswalk markings, etc.)	60	31	ea	$ 180	$ 10,800	$ 5,580
F - 5	Supply and install custom map-type signs (incl. base and posts)		4	ea	$ 1,200	$ -	$ 4,800
F - 6	Supply and install signs (incl. base and posts)	2	18	ea	$ 160	$ 320	$ 2,880
F - 7	Supply and install temporary project sign board (incl. base and posts)	4	4	ea	$ 250	$ 1,000	$ 1,000
Subtotal						**$ 55,220**	**$ 63,260**

Section G - Street Lighting, Signals and Electrical							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
G - 1	Supply and install light standards (all types incl. appurtenances)	15	15	ea	$ 1,000	$ 15,000	$ 15,000
G - 2	Supply and install signals for intersections	1		LS	$ 200,000	$ 200,000	$ -
G - 3	Electrical service to central island		1	LS	$ 5,000	$ -	$ 5,000
G - 4	Connect to grid		1	LS	$ 2,500	$ -	$ 2,500
G - 5	Temporary signals	1		LS	$ 50,000	$ 50,000	$ -
Subtotal						**$ 265,000**	**$ 22,500**

Section H - Landscaping, Erosion Control and Miscellaneous							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
H - 1	Utility locates or dig-ups	3	3	ea	$ 450	$ 1,350	$ 1,350
H - 2	Supply, install and maintain sediment control fence (OPSD 219.110)			m	$ 12	$ -	$ -
H - 3	Supply and install straw bale check dams (OPSD 219.180)			ea	$ 150	$ -	$ -
H - 4	Landscaping (incl. topsoil, sod, seeding and central island plantings, assume 2% of parts D-G)	1	1	LS	2%	$ 29,759	$ 29,307
H - 5	Supply and install new or reinstated fences			m	40	$ -	$ -
H - 6	Dust and noise control	1	1	LS	$ 1,500	$ 1,500	$ 1,500
Subtotal						**$ 32,609**	**$ 32,157**

Summary

Section	Description	Estimated Cost	
		SIG	RBT
A	Property acquisition subtotal	$ 36,329	$ 500,526
B	General requirements	$ 142,246	$ 137,109
C	Utility relocations and adjustments	$ 217,000	$ 367,000
D	Remove, dispose or reinstall	$ 132,190	$ 128,190
E	Road construction	$ 1,585,413	$ 1,710,453
F	Pavement markings and signage	$ 82,720	$ 78,260
G	Street lighting, signals and electrical	$ 274,000	$ 31,500
H	Landscaping, erosion control and maintenance	$ 44,336	$ 41,818
I	Construction subtotal	$ 2,477,905	$ 2,494,329
J	Engineering fees 15%	$ 371,686	$ 374,149
K	Contingency 20%	$ 495,581	$ 498,866
L	Construction total	$ 3,345,172	$ 3,367,345
M	HST 1.76%	$ 58,875	$ 59,265
N	**Grand total (including property acquisition)**	**$ 3,440,376**	**$ 3,927,136**
O	Constructuction of interim boundary curb		$ 93,600
P	Removal Interim Boundary Curb		$ 21,450

Final Total: $ 3,440,376 $ 4,044,211

Section A - Property Acquisition							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
A - 1	School			m^2	$ 248	$ -	$ -
A - 2	Woodland			m^2	$ 49	$ -	$ -
A - 3	Commercial			m^2	$ 296	$ -	$ -
A - 4	Residential - low density	135	1860	m^2	$ 269	$ 36,329	$ 500,526
A - 5	Residential - high density			m^2	$ 270	$ -	$ -
A - 6	Sports Park			m^2	$ 226	$ -	$ -
A - 7	Additional impacts			LS	$ 100,000	$ -	$ -
Subtotal						**$ 36,329**	**$ 500,526**

Section B - General Requirements							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
B - 1	Mobilization and demobilization	1	1	LS	$ 16,000	$ 16,000	$ 16,000
B - 2	Construction layout by contractor	1	1	LS	$ 9,000	$ 9,000	$ 9,000
B - 3	Traffic control and construction staging (incl. materials)	1	1	LS	$ 32,500	$ 32,500	$ 32,500
B - 4	Bonds (assumes 2% of parts D-H)	1	1	LS	2%	$ 42,373	$ 39,804
B - 5	Insurance (assumes 2% of parts D-H)	1	1	LS	2%	$ 42,373	$ 39,804
B - 6	Supply and place contract admin. office	1	1	LS	$ 29,500	$ 29,500	$ 29,500
Subtotal						**$ 142,246**	**$ 137,109**

Section C - Utility Relocations and Adjustments							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
C - 1	Remove and dispose of existing hydro poles	7	13	ea	$ 25,000	$ 175,000	$ 325,000
C - 2	Adjust to grade existing hydro poles			ea	$ 4,000	$ -	$ -
C - 3	Relocation of underground power supply			LS	$ 10,000	$ -	$ -
C - 4	Relocate or adjust to grade existing phone pedestals			ea	$ 500	$ -	$ -
C - 5	Relocate existing gas mains (incl. adjustments to valves)			LS	$ 25,000	$ -	$ -
C - 6	Relocate or adjust to grade existing light standards			ea	$ 1,500	$ -	$ -
C - 7	Relocate existing fibre-optic cables			LS	$ 30,000	$ -	$ -
C - 8	Relocate or adjust existing watermains (major)			LS	$ 10,000	$ -	$ -
C - 9	Relocate or adjust existing watermains (minor)			LS	$ 15,000	$ -	$ -
C - 10	Adjust watermain appurtenances (incl. valves, chambers and manholes)			ea	$ 200	$ -	$ -
C - 11	Relocate hydrant and valve			ea	$ 4,000	$ -	$ -
C - 12	Adjust manholes to grade (all types)			ea	$ 855	$ -	$ -
C - 13	Relocate storm sewer catchbasins	14	14	ea	$ 3,000	$ 42,000	$ 42,000
Subtotal						**$ 217,000**	**$ 367,000**

Section D - Remove, Dispose and Reinstall								
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost		
		SIG	RBT			SIG	RBT	
D - 1	Clearing and grubbing (estimated 5.0 m back from face of curb)	14500	13500	m^2	$ 1.3	$ 18,850	$ 17,550	
D - 2	Stripping and stockpiling of topsoil and sod (300 mm depth)	4350	4050	m^3	$ 20	$ 87,000	$ 81,000	
D - 3	Remove, dispose or store and reinstall existing fence (all types)	250	250	m	$ 8	$ 2,000	$ 2,000	
D - 4	Remove, dispose or store and reinstall existing signs	16	8	ea	$ 150	$ 2,400	$ 1,200	
D - 5	Remove and dispose of existing sidewalk			m^2	$ 7	$ -	$ -	
D - 6	Sawcut existing road asphalt (any thickness)	1	1	LS	$ 1,000	$ 1,000	$ 1,000	
D - 7	Mill existing pavement surface (avg. 50 mm depth, 3.0 m wide at limit of asphalt incl. HL-3 asphalt for restoration)	1	1	LS	$ 1,500	$ 1,500	$ 1,500	
D - 8	Pulverization and stockpiling of existing asphalt (min. 300 mm depth, incl. grade and compact pulverized section)			m^2	$ 3	$ -	$ -	
D - 9	Remove existing road pavement (full depth incl. all granular material)		900	m^2	$ 5	$ -	$ 4,500	
D - 10	Remove and dispose of existing conc. curb (all types incl. conc. gutters)	1130	1130	m	$ 11	$ 12,430	$ 12,430	
D - 11	Remove and dispose of other existing conc. or asphalt (median islands, splash pads, etc.)	40	40	m^2	$ 14	$ 560	$ 560	
D - 12	Remove and dispose of minor culverts	35	35	m	$ 30	$ 1,050	$ 1,050	
D - 13	Remove and dispose of major culverts			m	$ 40	$ -	$ -	
D - 14	Remove existing signal light poles	8	8	ea	$ 250	$ 2,000	$ 2,000	
D - 15	Remove existing signal appurtenances (handwells, wire loop sensors, etc.)	14	14	ea	$ 100	$ 1,400	$ 1,400	
D - 16	Remove, salvage and restore miscellaneous appurtenances	1	1	LS	$ 2,000	$ 2,000	$ 2,000	
Subtotal						**$ 132,190**	**$ 128,190**	

Section E - Road Construction							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
E - 1	Imported fill for road construction	3500	3500	m^3	$ 25	$ 87,500	$ 87,500
E - 2	Prepare subgrade surface for road construction	18270	18500	m^2	$ 2	$ 36,540	$ 37,000
E - 3	Granular 'A' for roadworks (assume 150 mm depth - incl. shoulders)	6851	6937.5	ton	$ 17.00	$ 116,471	$ 117,938
E - 4	Granular 'A' for miscellaneous items (incl. driveways, splash pads, sidewalks, etc., avg 200 mm depth)	1500	1500	ton	$ 17.00	$ 25,500	$ 25,500
E - 5	Granular 'B' for roadworks (assume 450 mm depth - incl. shoulders)	20554	20813	ton	$ 12.00	$ 246,645	$ 249,750
E - 6	Surface course asphalt (assume HL-3, min. 50 mm depth)	2010	2035	ton	$ 115.0	$ 231,116	$ 234,025
E - 7	Heavy duty binder course (HDBC) - (PG64-28) 100 mm depth	4019	4070	ton	$ 82.0	$ 329,591	$ 333,740
E - 8	Miscellaneous asphalt (assume HL3, min. 75 mm depth, for driveways, splash pads, splitter islands, etc.)			m	$ 16.54	$ -	$ -
E - 9	Concrete curb and gutter (all types)	2950	3300	m	$ 48	$ 141,600	$ 158,400
E - 10	Reconstruction of existing driveways (asphalt or gravel)	100	100	m^2	$ 52	$ 5,200	$ 5,200
E - 11	Perforated subdrains under concrete curbs	1950	1950	m	$ 25	$ 48,750	$ 48,750
E - 12	Concrete for splitter islands	2350	3200	m^2	$ 50	$ 117,500	$ 160,000
E - 13	Concrete - coloured and stamped for truck apron (200 mm thick)		350	m^2	$ 123	$ -	$ 43,050
E - 14	Concrete sidewalk (assume 3.0 m width)	3000	3200	m^2	$ 53	$ 159,000	$ 169,600
E - 15	Rip-rap for roadway spillways and along ditches (incl. geotextile fabric)			m^2	$ 30	$ -	$ -
E - 16	Allowance for night paving	1	1	LS	$ 20,000	$ 20,000	$ 20,000
E - 17	Short-term lane closure	1	1	LS	$ 20,000	$ 20,000	20000
E - 18	Supply and install CSP culverts (minor)			m	$ 100	$ -	$ -
E - 19	Supply and install CSP culverts (major)			m	$ 125	$ -	$ -
E - 20	Retaining Wall & Noise Wall			m	$ 1,200	$ -	$ -
Subtotal						**$ 1,585,413**	**$ 1,710,453**

Section F - Pavement Markings and Signage							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
F - 1	Temporary pavement marking for construction staging	6000	6000	m	$ 6	$ 36,000	$ 36,000
F - 2	Painted pavement markings	3000	2400	m	$ 10	$ 30,000	$ 24,000
F - 3	Durable pavement markigns	230	200	m	$ 20	$ 4,600	$ 4,000
F - 4	Durable pavement messages (arrows, crosswalk markings, etc.)	60	31	ea	$ 180	$ 10,800	$ 5,580
F - 5	Supply and install custom map-type signs (incl. base and posts)		4	ea	$ 1,200	$ -	$ 4,800
F - 6	Supply and install signs (incl. base and posts)	2	18	ea	$ 160	$ 320	$ 2,880
F - 7	Supply and install temporary project sign board (incl. base and posts)	4	4	ea	$ 250	$ 1,000	$ 1,000
Subtotal						**$ 82,720**	**$ 78,260**

Section G - Street Lighting, Signals and Electrical							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
G - 1	Supply and install light standards (all types incl. appurtenances)	24	24	ea	$ 1,000	$ 24,000	$ 24,000
G - 2	Supply and install signals for intersections	1		LS	$ 200,000	$ 200,000	$ -
G - 3	Electrical service to central island		1	LS	$ 5,000	$ -	$ 5,000
G - 4	Connect to grid		1	LS	$ 2,500	$ -	$ 2,500
G - 5	Temporary signals	1		LS	$ 50,000	$ 50,000	$ -
Subtotal						**$ 274,000**	**$ 31,500**

Section H - Landscaping, Erosion Control and Miscellaneous							
Item	Description	Est. Quantity		Unit	Unit Rate	Estimated Cost	
		SIG	RBT			SIG	RBT
H - 1	Utility locates or dig-ups	3	3	ea	$ 450	$ 1,350	$ 1,350
H - 2	Supply, install and maintain sediment control fence (OPSD 219.110)			m	$ 12	$ -	$ -
H - 3	Supply and install straw bale check dams (OPSD 219.180)			ea	$ 150	$ -	$ -
H - 4	Landscaping (incl. topsoil, sod, seeding and central island plantings, assume 2% of parts D-G)	1	1	LS	2%	$ 41,486	$ 38,968
H - 5	Supply and install new or reinstated fences			m	40	$ -	$ -
H - 6	Dust and noise control	1	1	LS	$ 1,500	$ 1,500	$ 1,500
Subtotal						**$ 44,336**	**$ 41,818**

SUBMITTED BY CIMA CANADA INC.
500-5935 Airport Road
Mississauga, ON L4V 1W5
T 905 695 1005 F 905 695 0525
cima.ca

Appendix R – Public Consultation Centre #1 Materials, Comments and Project Team Responses

September 2023

Region of Waterloo

WELCOME

To Public Consultation Centre #1 for

Maple Grove Road Improvements

from Hespeler Road to Vondrau Drive, City of Cambridge

Municipal Class Environmental Assessment, Schedule C



July 27, 2020

IBI GROUP

Study Purpose

Investigate alternative solutions for required improvement opportunities to Maple Grove Road between Hespeler Road and Vondrau Drive, including:

- Ongoing development and community growth leading to higher traffic volumes
- The need for new and future Active Transportation facility improvements
- Localized concerns at various intersections requiring operational improvements
- Planned/future Grand River Transit (GRT) routes and stops
- Previous corridor improvements between King Street and Fountain Street



Maple Grove Rd at Hespeler Rd (facing east)

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Study Team

Region of Waterloo

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Regional Councilor

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Senior Engineer
Design and Construction, Transportation Expansion

Mike Jones
Supervisor
Traffic Engineering

Darryl Spencer
Senior Engineer
Transportation Planning

Marcos Kroker
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Design and Construction, Transportation Expansion

CAMBRIDGE CANADA
PEOPLE • PLACE • PROSPERITY

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Councilor
Ward 1

Alex Nichols
Project Engineer
Development Engineering

IBI GROUP
(Consultant)

John Bayley
Consultant Lead
Municipal Engineering

Scott Johnston
Transportation Lead
Transportation Planning

Patrick Garel
Environmental Assessment Lead
Transportation Planning

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Study Area

Maple Grove Rd and immediately adjacent lands between Hespeler Rd to Vondrau Dr

Typical Cross-section

- 2 lanes
- Rural (drainage ditches on each side)

Posted Speed Limit

- 70 km/h Hespeler Rd to Beaverdale Rd
- 60 km/h Beaverdale Rd to Boxwood Dr
- 70 km/h Boxwood Dr to Vondrau Dr

Recorded average daily speed

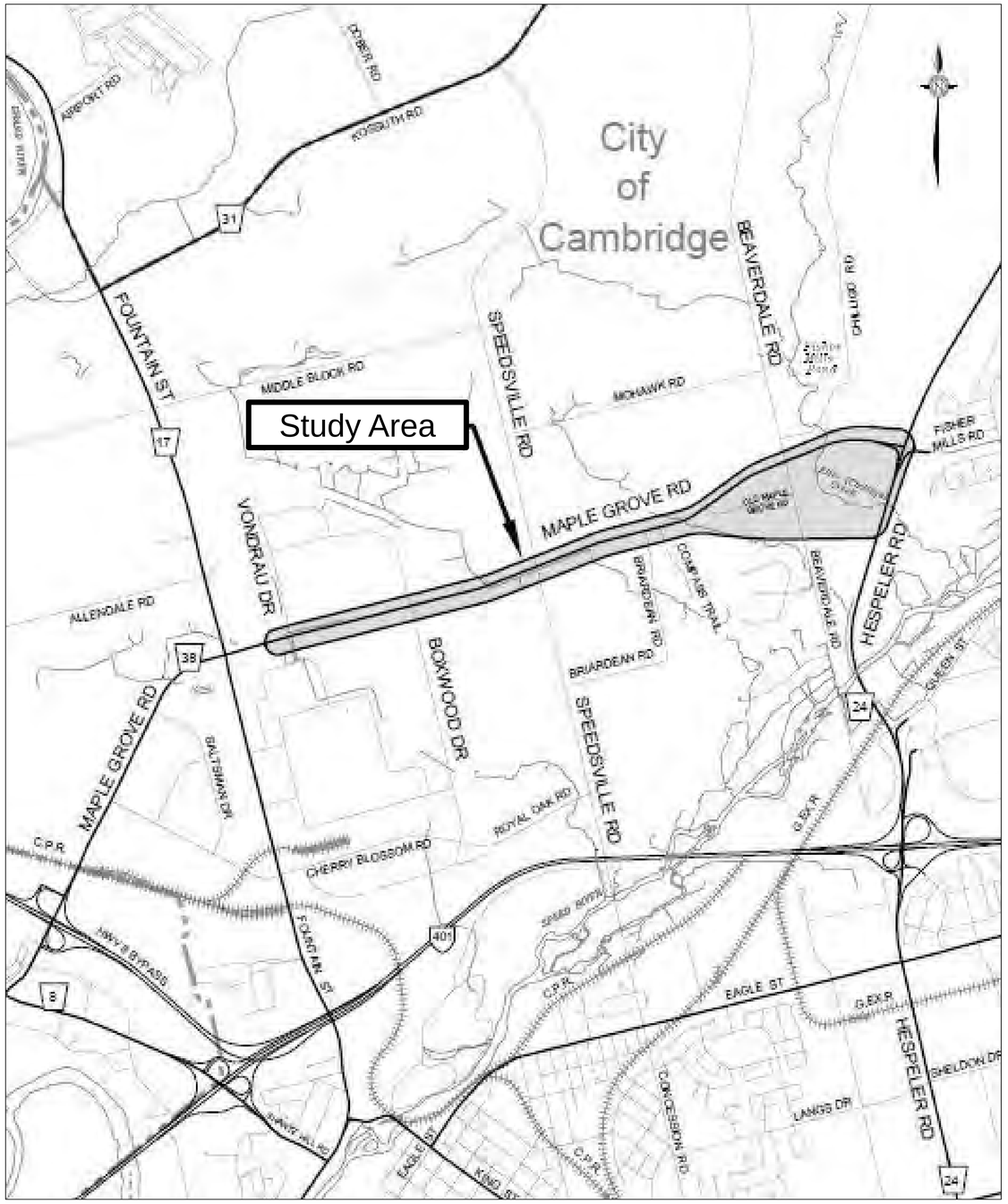
- 71 km/h or less

Mid-block Pedestrian Crossings

- Implementation of mid-block pedestrian crossings require a posted speed limit of 60 km/h or less

Detailed Plan of Existing Conditions

- Please see detailed roll plan here: www.engagewr.ca/11379/widgets/53279/documents/37476



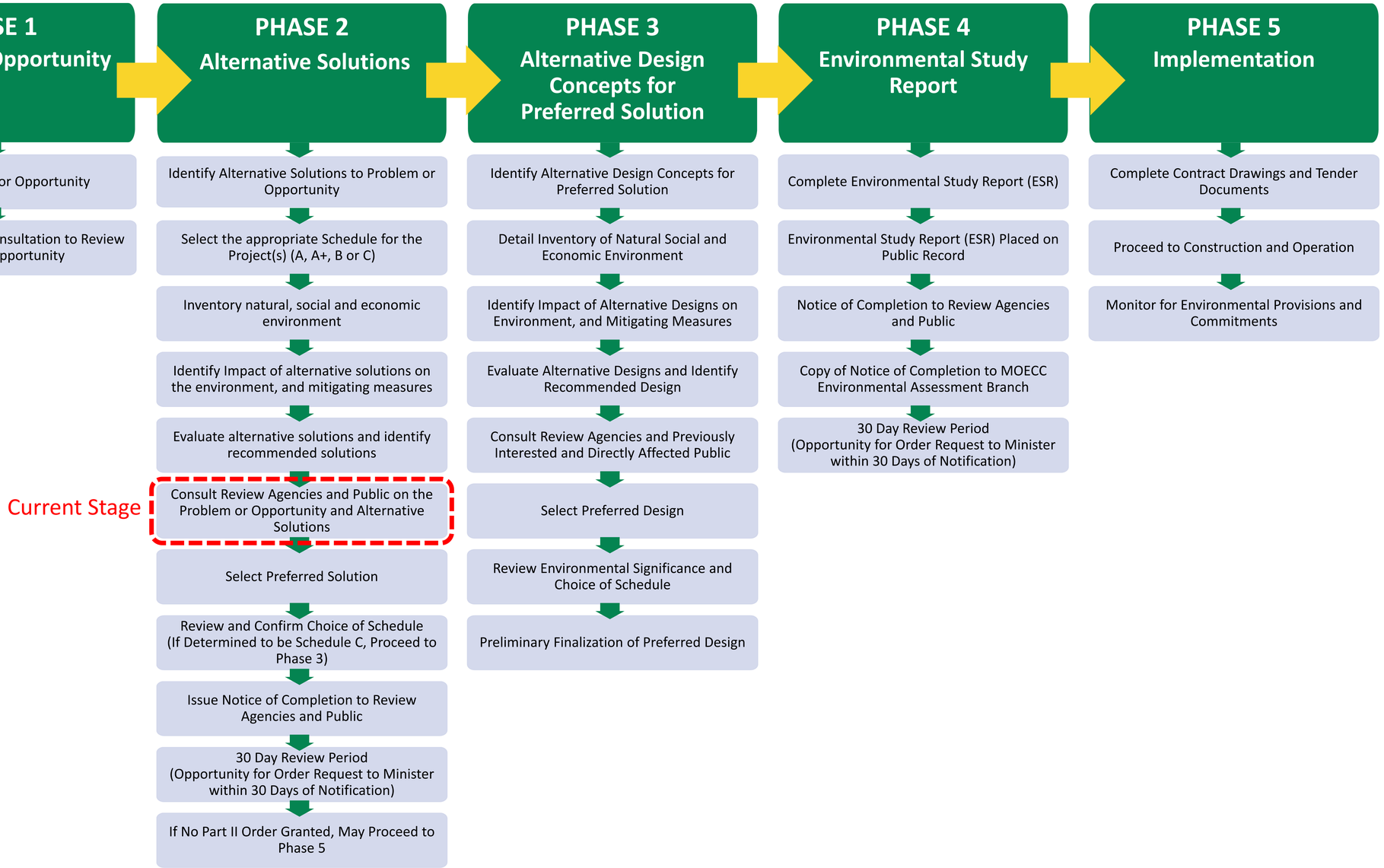
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Study Process

Following the Municipal Class Environmental Assessment (Class EA) Process:

Municipal Engineers Association (MEA)
Prepared and maintained by MEA

Schedule "C" Project
Concludes at the end of Phase 4



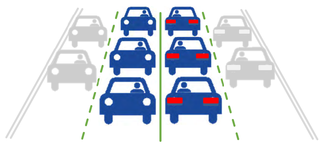
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How does this Project fit with the 2018 Transportation Master Plan?

Plan identifies need for Maple Grove Rd (Hespeler Rd to Vondrau Dr) to:

Widen to four (4) lanes



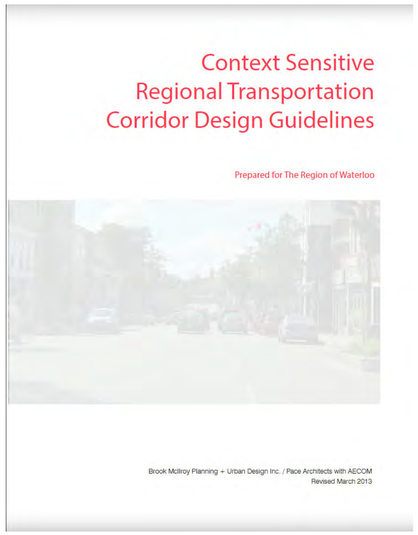
Improve active transportation facilities
(cycling and pedestrian)



Add GRT routes/stops



Construction funding for 2022 and from 2024 to 2027 (from Region's 2020 Transportation Capital Program budget)



Features identified in Context Sensitive Regional Transportation Corridor Design Guidelines

Maple Grove Road classified as a "Community Connector":

Connects to 400 series highway, Conestoga Pkwy, or other community connectors	Crosses several communities	High degree of access control	Focus on moving vehicles and higher order transit	Active transportation can be accommodated but consider separating from roadway	Incorporation of wide landscaped centre median

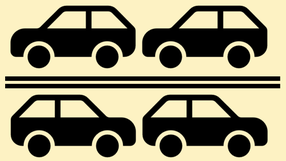
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Existing Conditions - Transportation



High traffic volumes (existing and forecasted)



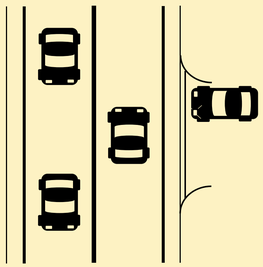
Existing asphalt in fair to poor condition – in need of rehabilitation or replacement



Limited pedestrian and cycling facilities



High percentage of heavy trucks use on corridor



Limited driveways



Limited local transit

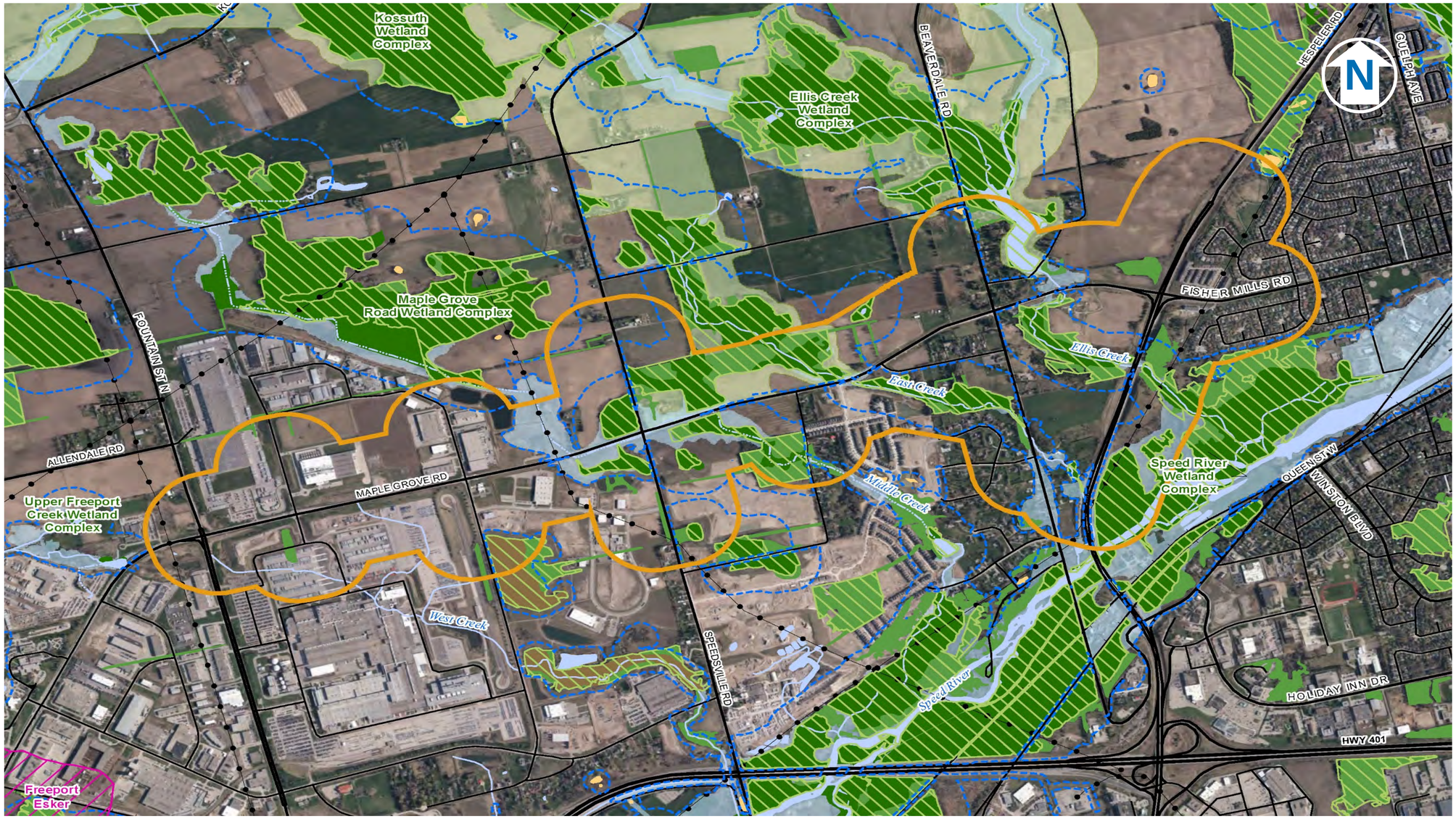
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Natural Environment – Local Features



Legend

Study Area	Permanent Watercourse	Regulation Limit
Utility Line	Intermittent Watercourse	Floodplain
Railway	Water Body	ANSI, Earth Science
Highway	Wooded Area	Region of Waterloo Core Environmental Feature (Region of Waterloo 2015)
Primary Road	Other Wetland (Non-PSW)	
Secondary Road	Provincially Significant Wetland (PSW)	Natural Heritage System (Growth Plan for the Greater Golden Horseshoe 2019)
Alleyway / Laneway	Unevaluated Wetland	

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Natural Environment – Vegetation Communities



Forest		Wetland				Cultural	
FOC3	Fresh-Moist Hemlock Coniferous Forest	SWM4-1	White Cedar-Hardwood Organic Mixed Swamp	SWT2	Mineral Thicket Swamp	CUM1	Mineral Cultural Meadow
FOC4-1	Fresh-Moist White Cedar Coniferous Forest	SWD3-3	Swamp Maple Mineral Deciduous Swamp	MAM2	Mineral Meadow Marsh	CUM2	Bedrock Cultural Meadow
FOD4	Dry-Fresh Deciduous Forest	SWD304	Manitoba Maple Mineral Deciduous Swamp	MAM2-2	Reed-canary Grass Mineral Meadow Marsh	CUT1	Mineral Cultural Thicket
FOM4	Dry-Fresh White Cedar Mixed Forest	SWD4	Mineral Deciduous Swamp	MAS2	Mineral Shallow Marsh	CUW1	Mineral Cultural Woodland
FOD5	Dry-Fresh Sugar Maple Deciduous Forest	SWD4-1	Willow Mineral Deciduous Swamp	MAS2-1	Cattail Mineral Shallow Marsh	CUP3	Coniferous Plantation
FOD7	Fresh-Moist Lowland Deciduous Forest	SWD6-1	Red Maple Organic Deciduous Swamp	OA	Open Water	**Hedgerow**	
FOD7-3	Fresh-Moist Willow Lowland Deciduous Forest	SWD6-3	Swamp Maple Organic Deciduous Swamp			HD	Deciduous Hedgerow

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Natural Environment – Vascular Flora and Trees

Vascular Flora Inventoried

- 359 vegetation species
- Background review of area
  - 5 Species at Risk
  - 70 Species of Conservation Concern
- In-field study
  - 1 Species at Risk
  - 2 Species of Conservation Concern
  - 13 regionally significant species

Legend

- Study Area
- Utility Line
- Railway
- Permanent Watercourse
- Intermittent Watercourse

Regionally Significant Plant Observations

1	American Prickly-ash	8	
2	Bulbous Cress	9	Swamp Candles
3	Eastern Cottonwood	10	Virginia Stickseed
4	Golden Alexanders	11	Wood's Sedge
5	Hackberry	12	Black Walnut*
6	Large-leaved Pondweed	14	Eastern Cottonwood
7	Rough Sedge	15	White Spruce

Confirmed Habitat of Threatened and Endangered Species

- B Butternut**
- Butternut**
- Eastern Meadowlark Category 2 Habitat**

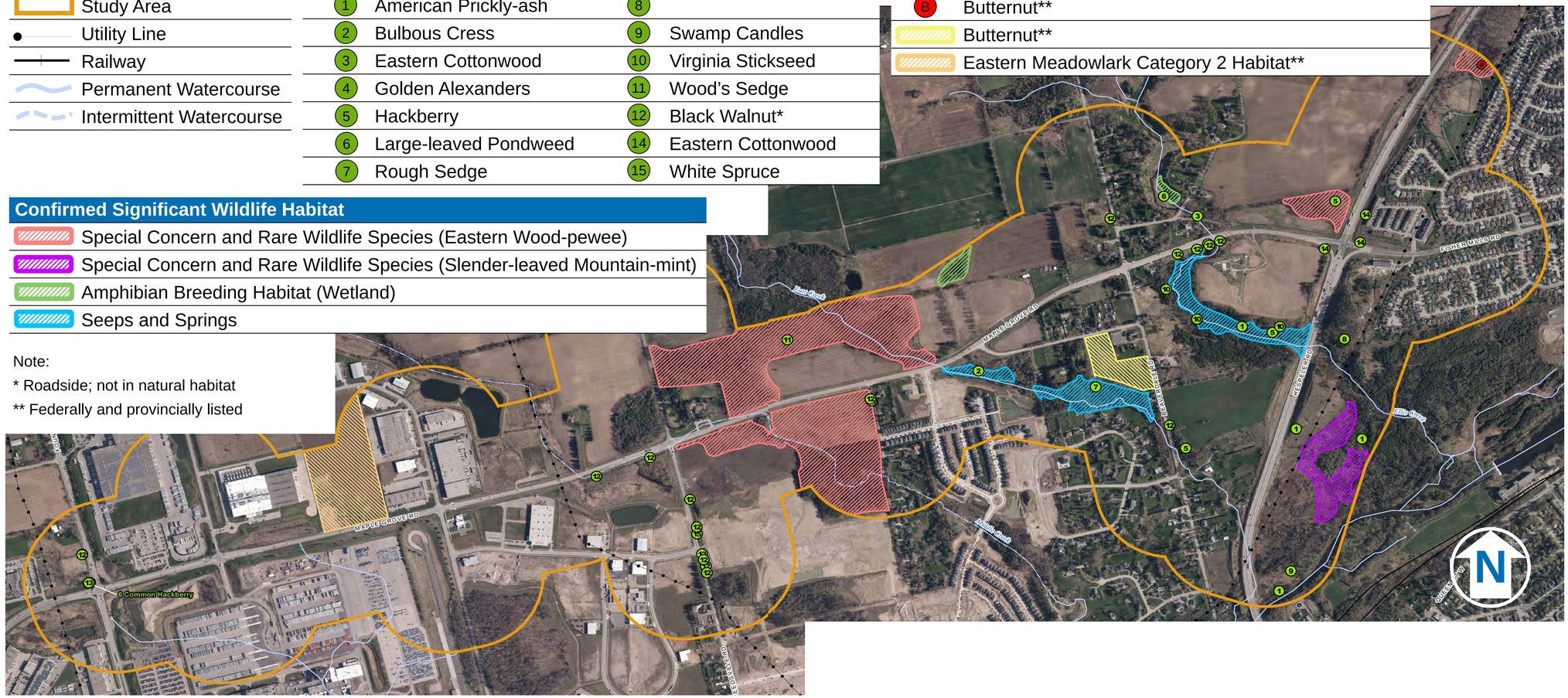
Confirmed Significant Wildlife Habitat

- Special Concern and Rare Wildlife Species (Eastern Wood-pewee)
- Special Concern and Rare Wildlife Species (Slender-leaved Mountain-mint)
- Amphibian Breeding Habitat (Wetland)
- Seeps and Springs

Note:

* Roadside; not in natural habitat

** Federally and provincially listed



Trees Inventoried

- 452 trees - 265 (59%) native species, 187 (31%) non-native, 40 different species

Natural Environment – Wildlife



Barn swallow (source: ontario.ca)

Birds inventoried

- Background review of area
  - 124 total species documented
  - 11 Species at Risk
  - 8 Species of Conservation Concern
- In-field study
  - 56 previously documented species
  - 2 additional species
  - 4 Species at Risk
  - 2 Species of Conservation Concern
  - 9 regionally significant



Gray treefrog
(source: canadianherpetology.ca)

Amphibians and reptiles inventoried

- Background review of area
  - 28 total species documented
  - 3 Species at Risk
  - 6 Species of Conservation Concern
- In-field study
  - 7 previously documented species
  - 0 Species at Risk
  - 0 Species of Conservation Concern
  - 0 regionally significant

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Natural Environment – Wildlife



Coyote (source: C. Bruno - commons.wikimedia.org)

Mammals inventoried

- Background review of area
  - 45 total species documented
  - 5 Species at Risk
  - 1 Species of Conservation Concern
- In-field study
  - 8 previously documented species
  - 0 Species at Risk
  - 0 Species of Conservation Concern
  - 0 regionally significant



Little brown myotis (source: ontario.ca)

Bat habitat inventoried (in-field study)

- 6 potential bat roost trees (contain cavities, loose bark, cracks and/or crevices)
  - West side of Fountain St, north of Maple Grove Rd
  - West side of Beaverdale Rd, south of Maple Grove Rd
  - North side of Old Maple Grove Rd, southeast of Maple Grove Rd (4 trees)



Monarch (source: ontario.ca)

Butterflies inventoried (background review)

- 82 total species documented
- 0 Species at Risk
- 4 Species of Conservation Concern

Insects inventoried (background review)

- 75 total species documented
- 0 Species at Risk
- 9 Species of Conservation Concern

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Natural Environment – Aquatic Species



Silver shiner
(source: ontario.ca)



Rainbow
(source: ontario.ca)

Fish communities inventoried

- Background review of area
  - 24 total fish species documented
  - 2 Species at Risk
  - 0 Species of Conservation Concern
- In-field study
  - 14 previously documented species
  - 4 additional species
  - 0 Species at Risk
  - 0 Species of Conservation Concern

Freshwater mussel communities inventoried

- Background review of area
  - 2 total mussel species documented
  - 1 Species at Risk
  - 1 Species of Conservation Concern
- In-field study
  - 0 previously documented species
  - 0 Species at Risk
  - 0 Species of Conservation Concern

Aquatic Habitat

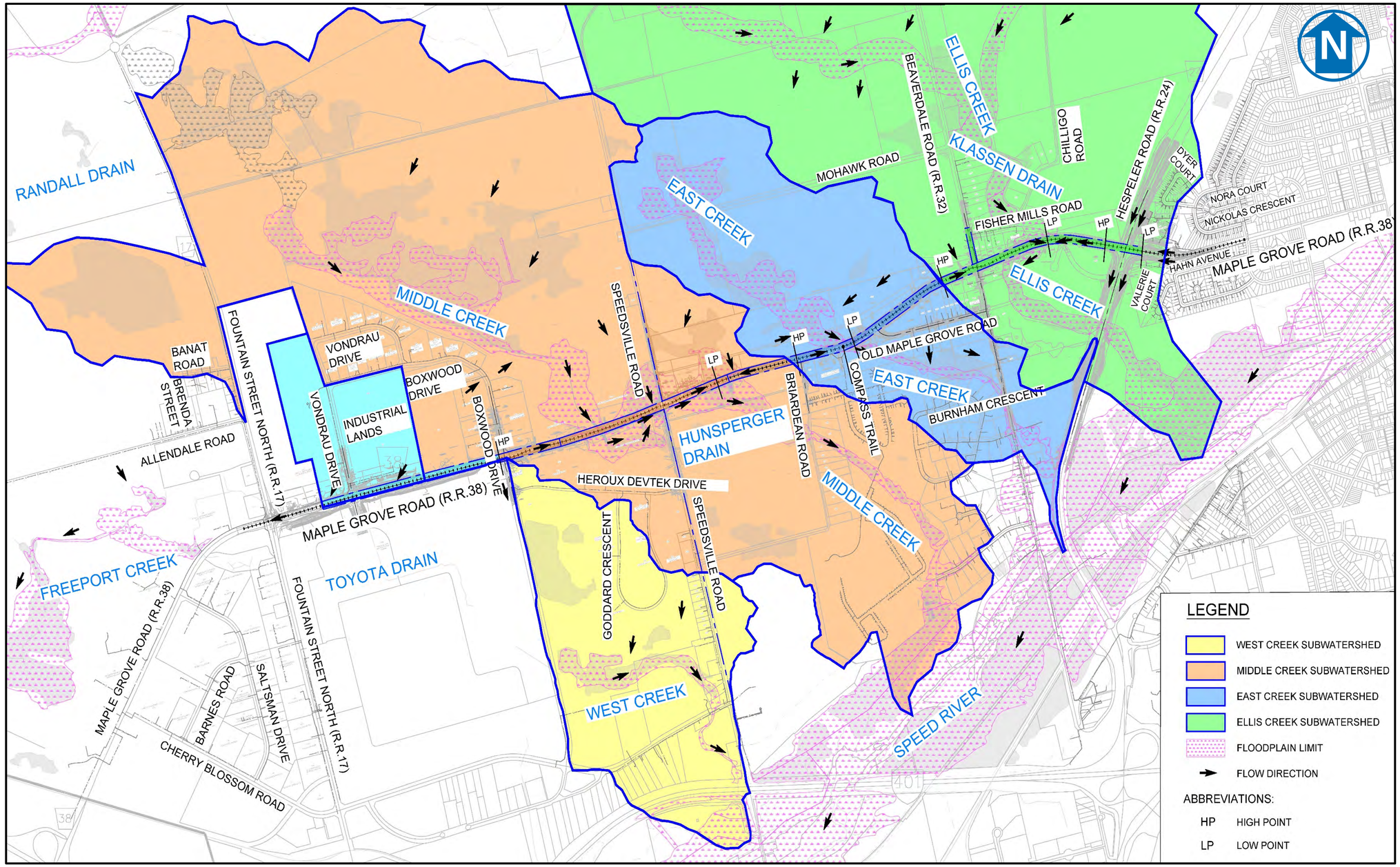
- East Creek (warmwater watercourse)
- Middle Creek (warmwater watercourse)
- West Creek (warmwater watercourse)
- Ellis Creek (warmwater watercourse)

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Water Resources – Local Drainage Areas



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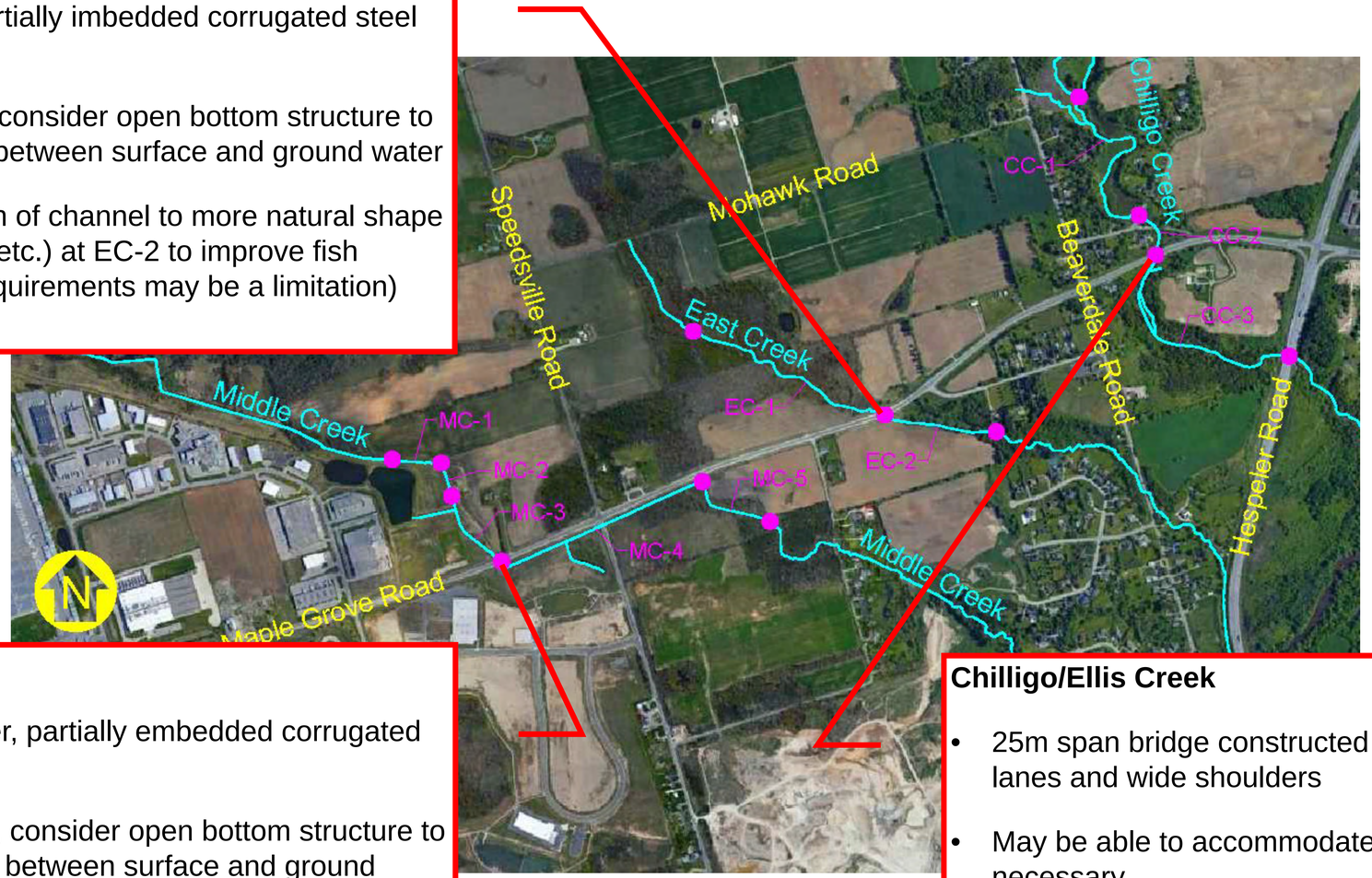
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Geomorphological Conditions

There are three major water crossings along Maple Grove Road in the Study Area:

East Creek

- 1.25m diameter, partially imbedded corrugated steel pipe culvert
- If replacing culvert, consider open bottom structure to restore connection between surface and ground water
- Consider restoration of channel to more natural shape (meandering, riffle, etc.) at EC-2 to improve fish habitat (property requirements may be a limitation)



Middle Creek

- Twin 1.4m diameter, partially embedded corrugated steel pipe culvert
- If replacing culvert, consider open bottom structure to restore connection between surface and ground water
- Consider restoration of channel to more natural shape (meandering, riffle, etc.) at MC-4 to improve fish habitat (property requirements may be a limitation)

Chilligo/Ellis Creek

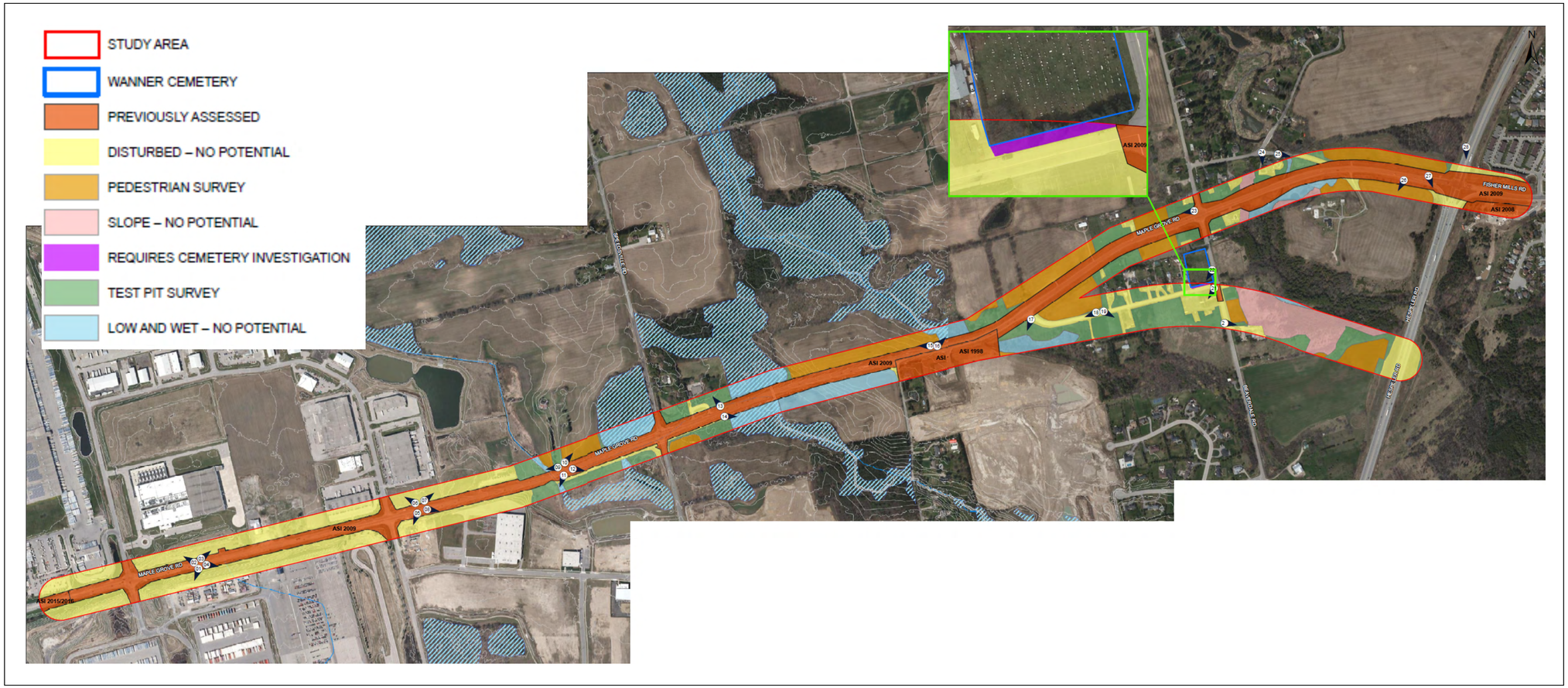
- 25m span bridge constructed in early 2000s with four lanes and wide shoulders
- May be able to accommodate additional lane if necessary
- Currently lacks woody riparian vegetation immediately upstream and downstream of bridge
- If widening, consider installation of riparian plantings

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Archaeology and Cultural Heritage

Stage 1 Archaeological Assessment

- Stage 1 desktop study (completed January 2019) identified potential for archaeological artifacts in areas previously undisturbed by past corridor expansion:



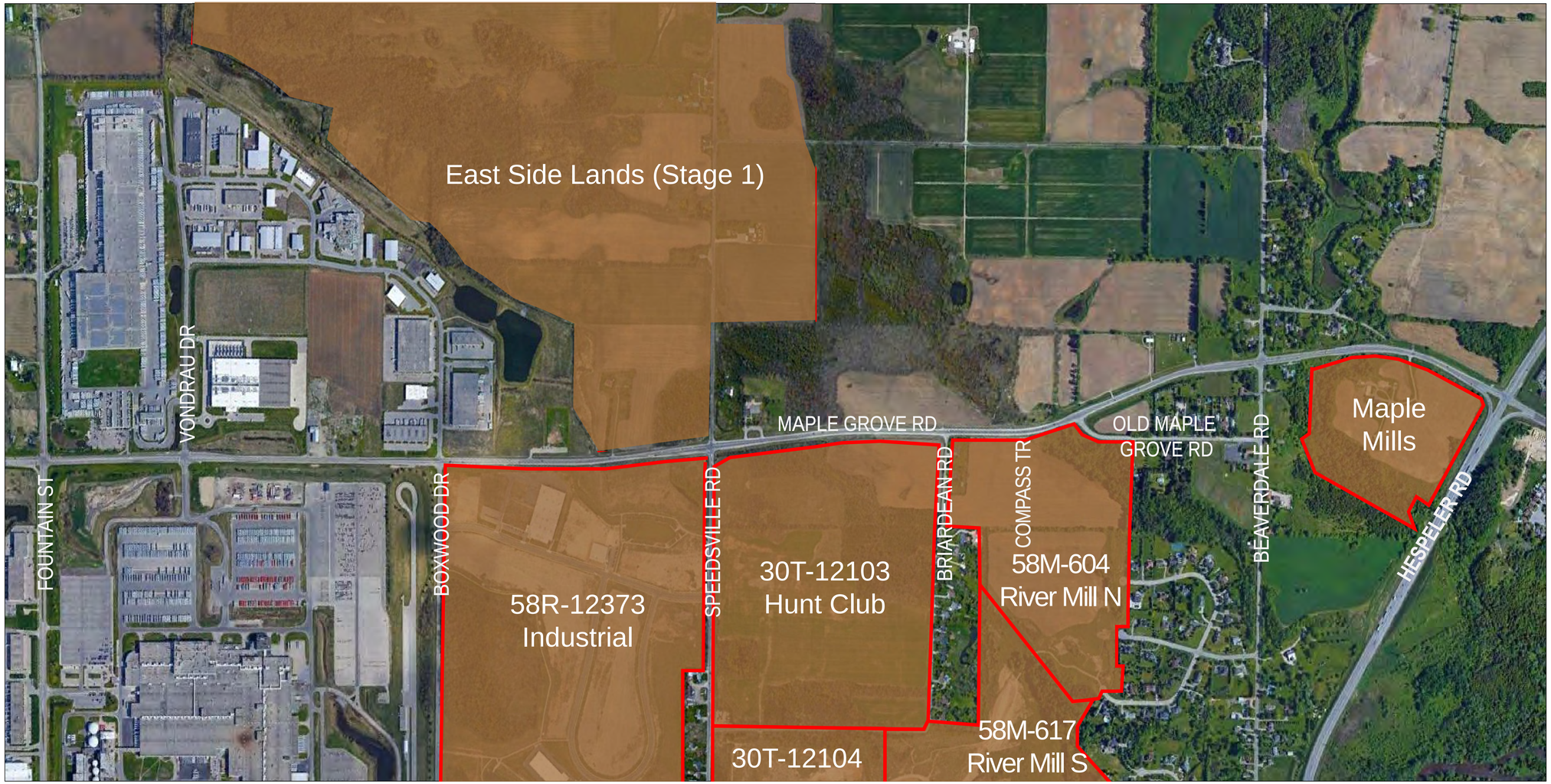
Stage 2 Archaeological Assessment

- Stage 2 field investigation recommended in areas noted for test pit and pedestrian surveys

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Area Development and Development Planning

Proposed and ongoing developments adjacent to Study Area:



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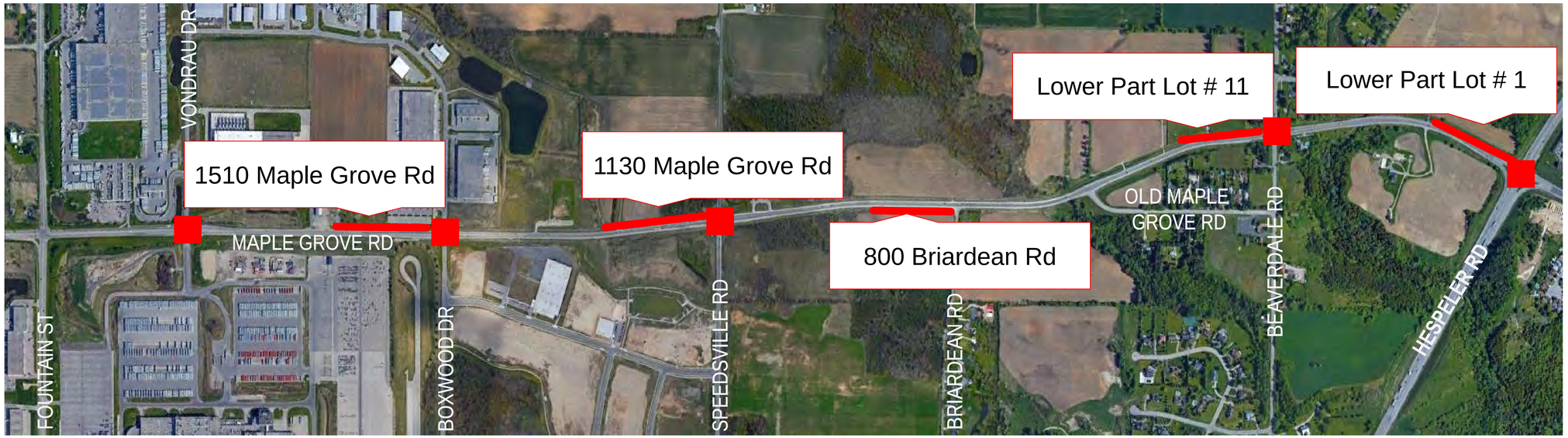
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Property Requirements and Noise

Property Requirements (Initial Review)

- Primary goal to avoid or limit impacts on adjacent private property
- Road right-of-way is generally adequate for proposed improvements
- Some locations where intersections may be expanded or converted to a roundabout may require minor acquisition of private property
- Small number of properties along Maple Grove Rd where purchase may be required*:



(*Property list will be updated at the second Public Consultation Centre when the preferred design alternative and intersection controls are presented)

Noise

- A noise study will be completed for the preferred design
- Noise levels for construction and operation will meet Ministry of Environment, Conservation and Parks regulations, and local noise by-laws

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Geotechnical and Hydrogeological Conditions

Pavement

- Existing pavement structures of Maple Grove Rd are not adequate to carry future design traffic volumes
- New pavement will need to be strengthened

Backfill

- Majority of soils are native silty sand and gravel, generally suitable for reuse as backfill material (provided they are free of organics)

Groundwater

- Low potential for effect on local groundwater
- Potential for stormwater infiltration, given permeable silty sand and gravel soils
- In-situ granular soils are moderately permeable and not suitable for use in low permeability or impermeable stormwater management pond liner
- Groundwater levels observed between 0.3 m and 4.7 m below the surface



Pavement along Maple Grove Rd

Region of Waterloo

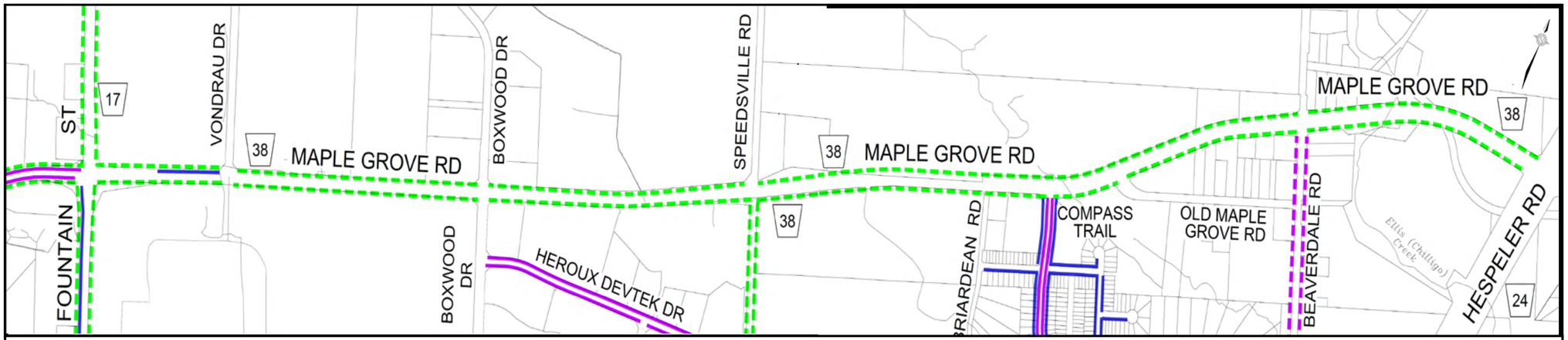
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Active Transportation – Existing and Planned

Existing and planned active transportation facilities identified in *Moving Forward*, the 2018 Regional Transportation Master Plan Update



* DASHED LINE IS PROPOSED





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Existing Traffic Operations – Maple Grove Road

Level of Service (LOS) at Intersections (a letter designation describing operating conditions experienced by road users) for morning and afternoon peak hours:

Morning (AM) Peak Hour



Afternoon (PM) Peak Hour



Legend:

- A Free flow (limited delays)
- B Reasonably free flow
- C Stable flow
- D Approaching unstable flow
- E Unstable flow
- F Forced or breakdown flow

Best ⟷ Worst

Note:

- Briardean Rd will be closed at Maple Grove Rd as part of the River Mill N development
- *Compass Tr is a recently opened intersection, and no LOS data was available at the time of this study

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Traffic Conditions – Maple Grove Road

Average Annual Daily Traffic (AADT) or average vehicles per day on Maple Grove Rd:

Road Section	Current (2018) AADT	Forecasted (2041) AADT	% Trucks	Posted Speed	Average Speed	85th Percentile*
Hespeler Rd to Beaverdale Rd	19,700	28,090	4%	70 km/h	62 km/h	72 km/h
Beaverdale Rd to Old Maple Grove Rd	18,740	27,710	5%	60 km/h	67 km/h	76 km/h
Old Maple Grove Rd to Compass Tr	20,030	29,980	4%	60 km/h	60 km/h	75 km/h
Compass Tr to Briardean Dr	19,800	29,930	5%	60 km/h	71 km/h	80 km/h
Briardean Dr to Speedsville Rd	18,850	30,190	5%	60 km/h	71 km/h	80 km/h
Speedsville Rd to Boxwood Dr	18,650	34,200	5%	60 km/h	71 km/h	81 km/h
Boxwood Dr to Vondrau Dr	18,180	36,250	4%	70 km/h	64 km/h	76 km/h
Vondrau Dr to Fountain St	19,950	36,250	7%	70 km/h	53 km/h	66 km/h

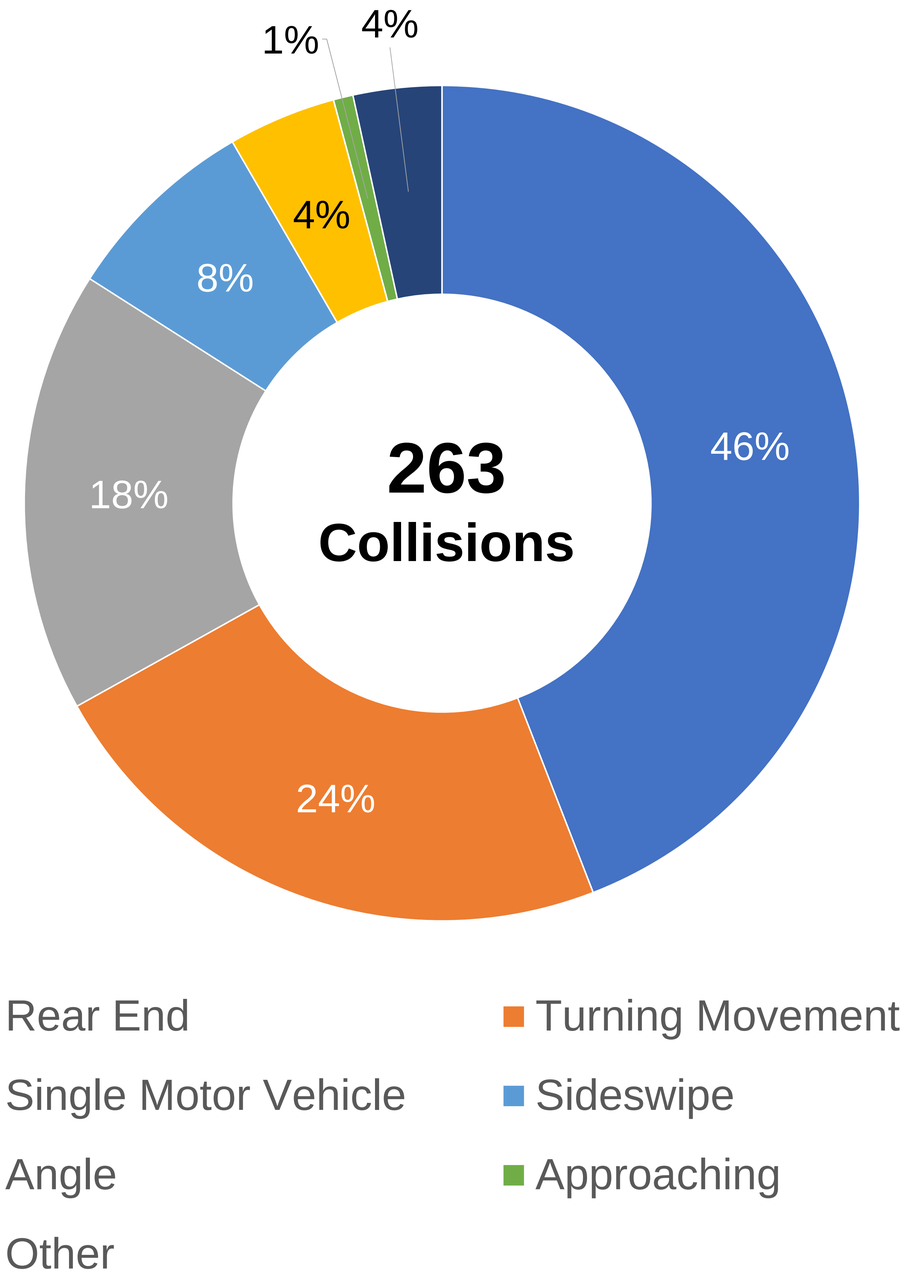
*85th Percentile is the speed at which 85% of vehicles are travelling at or less.

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Collision Data

Maple Grove Rd 5-year collision history data (2013 to 2017):

Intersection or Midblock	Collisions
Hespeler Road	58
Hespeler to Beaverdale	17
Beaverdale Road	7
Beaverdale to Old Maple Grove	11
Old Maple Grove Road	n/a
Old Maple Grove to Briardean	4
Briardean Drive	4
Briardean to Speedsville	18
Speedsville Road	23
Speedsville to Boxwood	25
Boxwood Drive	8
Boxwood to Vondrau	8
Vondrau Drive	26
Vondrau to Fountain	6
Fountain Street	48



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Existing Conditions – Transit Service

Current Grand River Transit Routes:

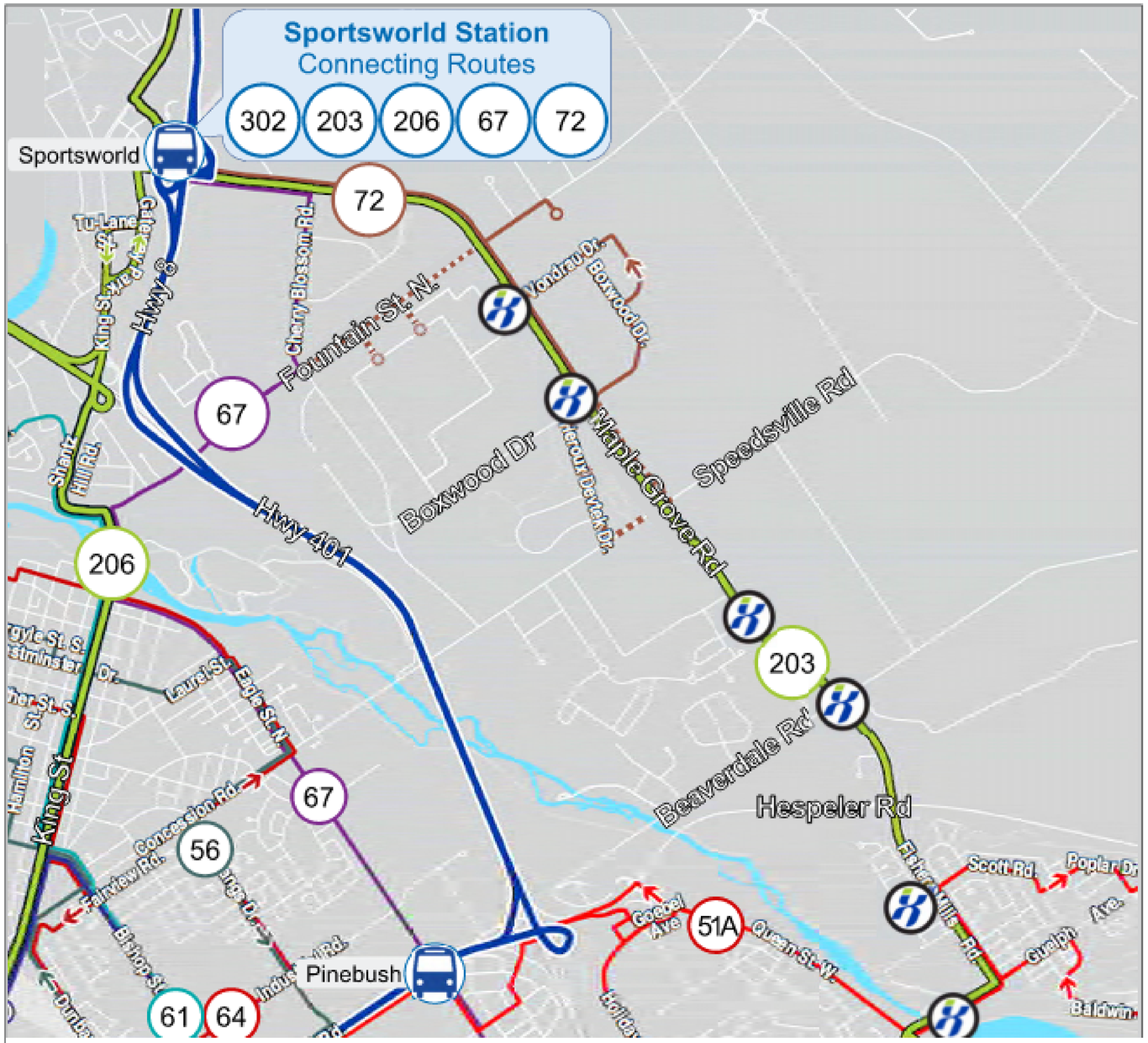
- Bus Route 72
- iXpress Bus Route 203

Both routes connect to Sportsworld Station, with connections to:

- ION Bus Route 302
- iXpress Bus Route 206
- Bus Route 67

Current stops:

- Vondrau Dr (67,72, 203)
- Boxwood Dr (72, 203)
- Compass Tr (203 Eastbound)
- Beaverdale Rd (203)



Project Need

The Region's Transportation Master Plan identified the need to:

- Widen Maple Grove Road from two to four through lanes from Hespeler Road to Vondrau Drive within the next five (5) years to provide adequate capacity for forecasted traffic volumes along this corridor
- Consider a new bypass route from Old Maple Grove Road to Hespeler Road to connect to Hespeler Road approximately 500 m south of Maple Grove Road (including potential impacts for alternate routes due to the future expansion of the Waterloo Region International Airport)
- Provide pedestrian and cycling facilities along Maple Grove Road within the study limits
- Rehabilitate or replace asphalt on Maple Grove Road from Hespeler Road to Vondrau Drive

Statement of Opportunities for Improvement

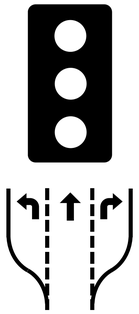
- Local growth and development will lead to increased traffic congestion
- Improvements to vehicular capacity will reduce current traffic concerns at intersections
- Active transportation infrastructure should be added to the corridor to support walking, cycling and public transit use
- Improvements can also support planned Grand River Transit routes and stops

Alternative Solutions

The Region considered ten (10) alternative solutions:

Alternative	Description	Addresses Increase in Traffic and Local Development	Addresses need for Active Transportation Improvements	Addresses need for Public Transit Improvements	Comment
1. Do Nothing 	Reconstruct road to match current two (2) lanes rural cross-section, with shoulders and roadside ditches	✗	✗	✗	Eliminate – does not address any of Region's Objectives
2. Traffic Operations Improvements 	Optimize timing of existing traffic signals on Maple Grove Rd	✓	✗	✗	Carry forward in combination with other solutions
3. Access Management 	Access management through constructing a raised centre median and/or centre left-turn lanes	✓	✗	✗	Carry forward in combination with other solutions
4. Intersection Improvements 	Additional through lanes and turn lanes at existing intersections	✓	✗	✗	Carry forward in combination with other solutions
5. Roundabouts 	Construct new roundabouts in place of traffic signals without widening Maple Grove Rd	✓	✗	✗	Carry forward in combination with other solutions
6. Widening Maple Grove Road 	Widening Maple Grove Rd from two (2) to four (4) lanes between Hespeler Rd and Vondrau Dr	✓	✓	✓	**Preferred Solution**, in combination with other solutions
7. Active Transportation Facilities 	Providing facilities for cyclists and pedestrians on Maple Grove Rd from Hespeler Rd to Vondrau Dr	✗	✓	✗	Carry forward in combination with other solutions
8. Transit Service 	Improve GRT service along the corridor to potentially decrease vehicle traffic on Maple Grove Rd	✓	✗	✓	Carry forward in combination with other solutions
9. Upgrade Other Routes 	Improvements to nearby roads potentially reducing traffic on Maple Grove Rd	✓	✗	✗	Carry forward in combination with other solutions
10. Build Alternative Routes 	Add new or extend existing roads to the road network to reduce traffic on Maple Grove Rd.	✓	✗	✗	Eliminate – does not address any of Region's Objectives

Solutions – Traffic Operations / Intersection Improvements



Signal and intersection improvements are being considered at intersections with:

- existing traffic control signals that require additional through lanes or turn lanes to improve capacity
- projected traffic volumes would warrant new traffic control signals



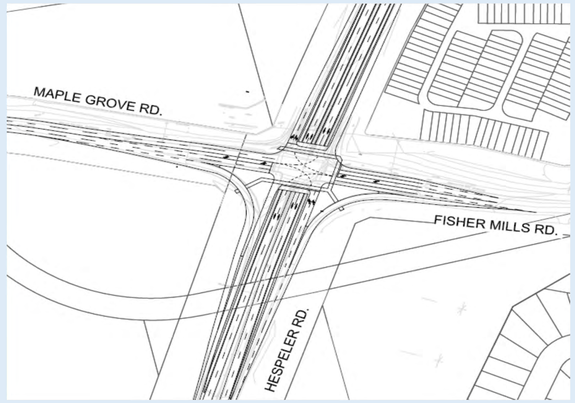
Example of intersection improvements on Maple Grove Rd at Cherry Blossom Rd

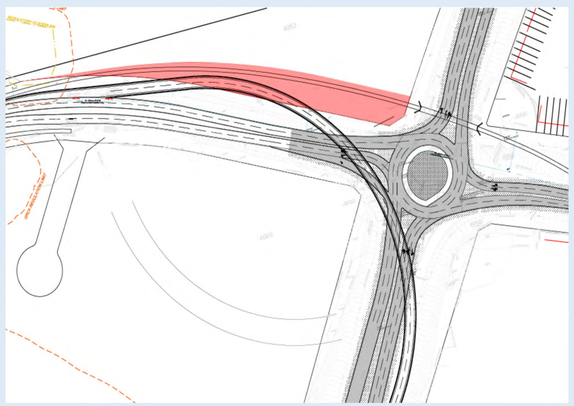
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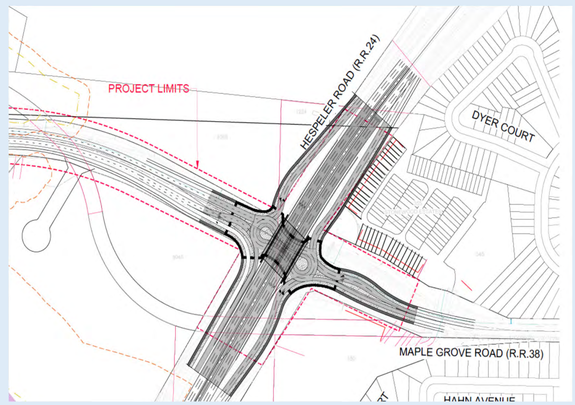
Solutions – Hespeler Rd

To account for the greater amount of long-term traffic growth at Hespeler Rd, other long-term improvements are being considered (will be determined during Phase 3 – Alternative Designs):

Single Point Grade Separation	Roundabout with Fly-Over	Joined Roundabout Grade Separation
Grade separation with traffic control signals on each side of Hespeler Rd at Maple Grove Rd and Fisher-Mills Rd	Roundabout with fly-over to carry traffic from northbound Hespeler Rd to westbound Maple Grove Rd	Grade separation at Hespeler Rd and Maple Grove Rd to allow for future capacity expansion of Hespeler Rd utilizing a double, joined roundabout (“bow-tie” or “dog-bone”) design to provide full movements access between both roads













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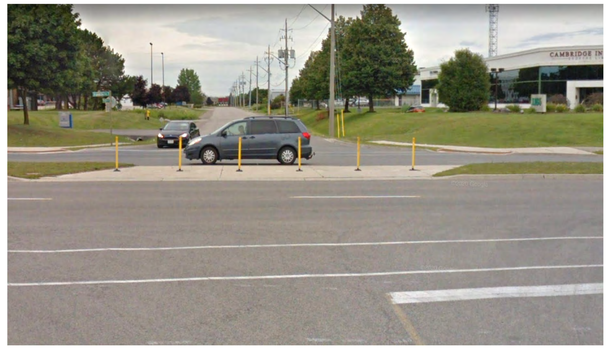
Solutions – Access Management

Access management measures will be considered* at the following intersections:

Old Maple Grove Road:

Consider restricting all left turns to and from Old Maple Grove Rd by extending the raised median on Maple Grove Rd across the intersection

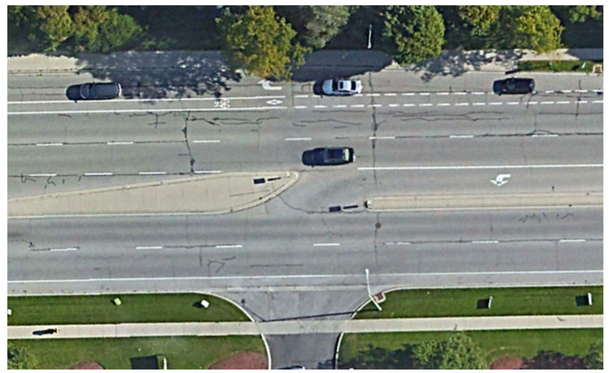
Consider constructing cul-de-sac at Maple Grove Rd (if supported by City of Cambridge) to eliminate traffic bypass to Beaverdale Rd



Example of restricting all left turns on Franklin Blvd at Raglin Rd in Cambridge

Compass Trail:

Consider restricting left-in and/or left-out, but allow right-in and right-out



Example of restricting left-out, but allowing left-in, right-in and right-out turns on Fischer-Hallman Rd near University Ave W

Briardean Road:

Briardean Rd will be closed at Maple Grove Rd (as a condition of the Hunt Club Subdivision Agreement), creating a cul-de-sac or hammerhead turnaround

* (this has been approved)

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Solutions - Roundabouts

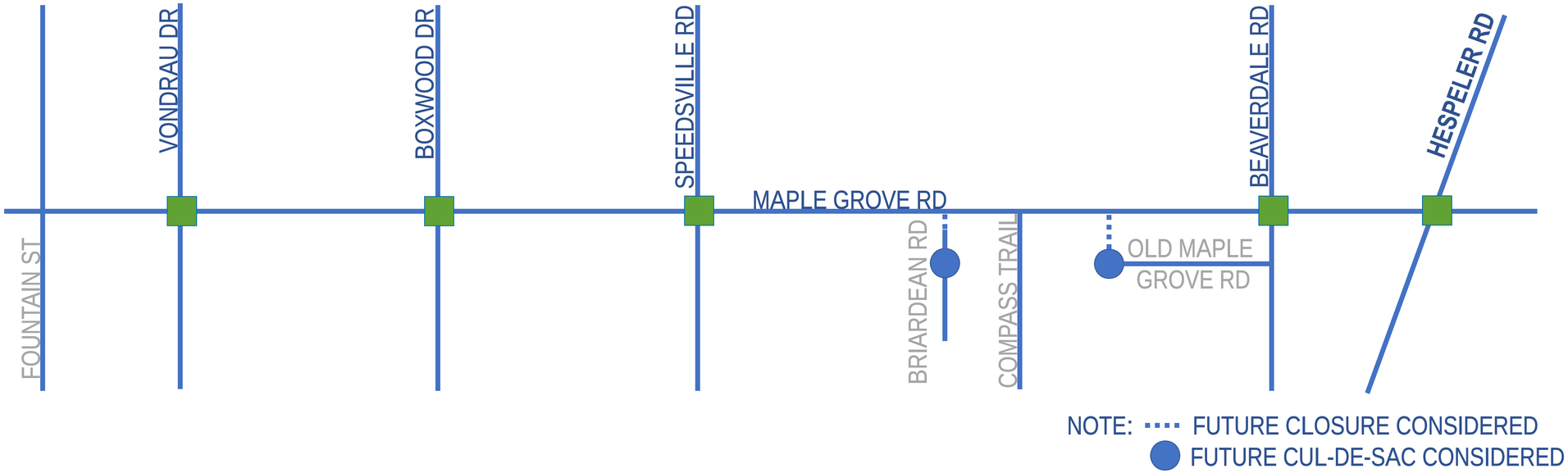
Roundabouts considered at intersections with:

- existing traffic control signals that require additional through lanes or turn lanes to improve capacity
- projected traffic volumes would warrant new traffic control signals



Examples of roundabout on Franklin Blvd (top left) and University Ave (bottom right)

Roundabouts (■) are being considered at:



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Solutions – Widen Maple Grove Rd

Widening between Hespeler Rd and Vondrau Dr:

- Widen from two (2) to four (4) through lanes to improve capacity
- Consider space for other improvements



Example of a four lane section of Maple Grove Rd with left- and right-turning lanes, on-street bike lanes, and sidewalks

Solutions – Active Transportation Facilities

Providing facilities for cyclists and pedestrians on Maple Grove Rd from Hespeler Rd to Vondrau Dr, such as:

<u>Cycling</u>

- Bike lanes (on-road)
- Bike lanes (off-road) – separated cycling lanes or multi-use trails

<u>Pedestrians</u>

- Sidewalks
- Multi-use trails

In Study Area, the Regional Transportation Master Plan has recommended:

- Multi-use trail (for cycling and pedestrians)



Examples of a sidewalk on Maple Grove Rd (top left), on-street bike lane on Maple Grove Rd (top right), multi-use trail on Dundas St (bottom left), separated cycling lane on Manitou Dr (bottom right)

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Solutions - Transit Service Improvements

Improvements to transit service provided by Grand River Transit (GRT) may decrease vehicle traffic on Maple Grove Rd

- Review Grand River Transit planning objectives for Maple Grove Rd corridor
- Grand River Transit will be consulted to obtain feedback for the locations of new bus stops, pedestrian crossing locations related to bus stops and any shelter requirements
- Will be presented at the second Public Consultation Centre (currently scheduled for Fall 2020)



GRT bus with bike rack

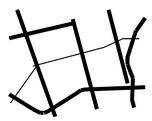
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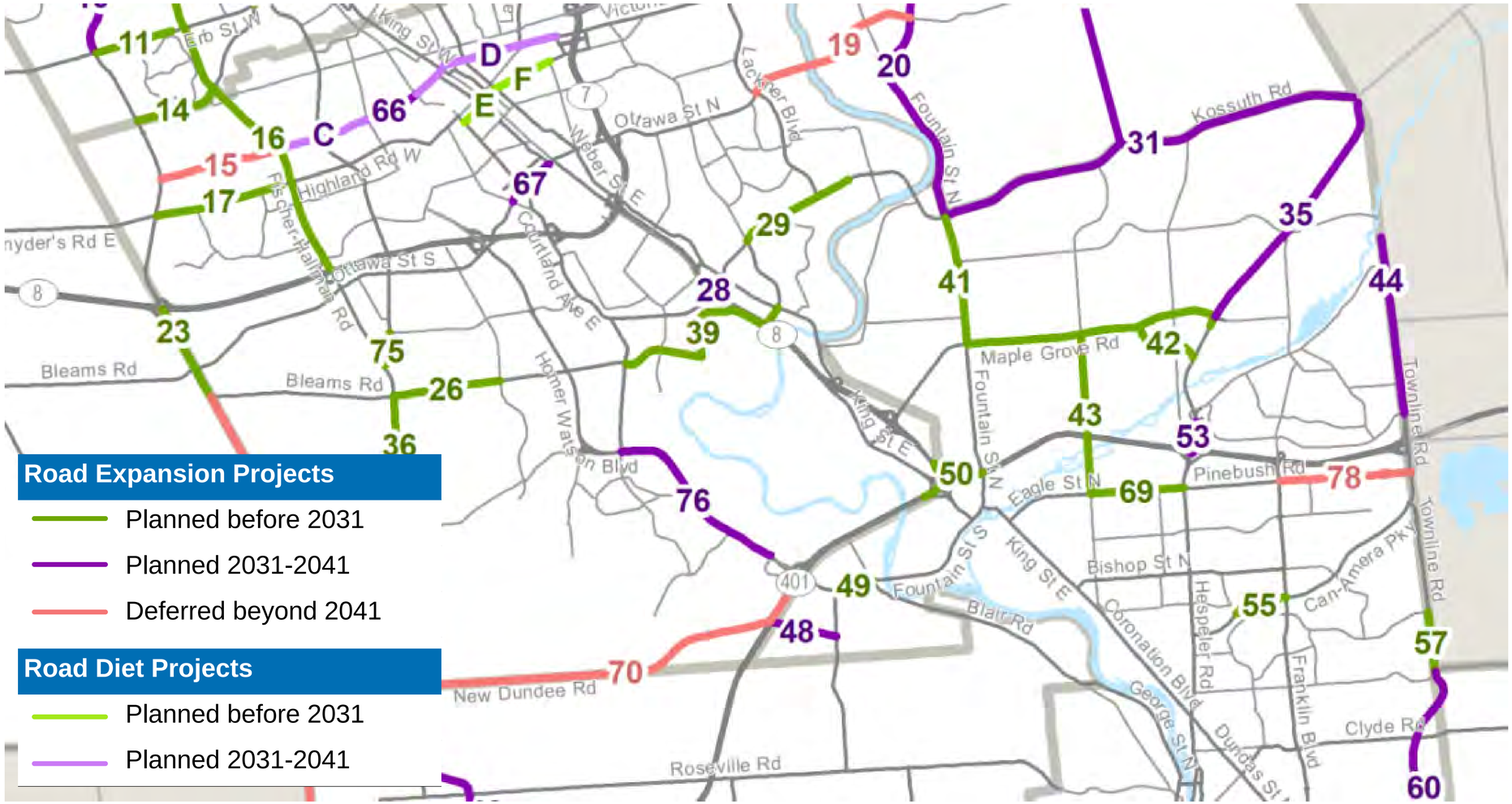
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Solutions – Upgrade Other Routes



Improvements to nearby roads could potentially reduce traffic on Maple Grove Rd:

- May re-direct some traffic away from Maple Grove Rd
- To be addressed by Region's Transportation Master Plan and Transportation Capital Program
- Can only satisfy all of Region's primary objectives for corridor if combined with other solutions



Region of Waterloo Regional Transportation Master Plan (Source: regionofwaterloo.ca)

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Development of Design Alternatives

Based on the recommended solution(s), the Project Team will develop design alternatives that include:

- Traffic operational improvements
- Widening of Maple Grove Road from two (2) to four (4) through lanes
- Addition of active transportation facilities (for pedestrians and cyclists)
- Signalized intersection improvements and/or roundabouts
- Transit service improvements or enhancements
- Access management improvements (if needed)

The Project Team will:

- Develop and evaluate design alternatives over Summer and Fall of 2020
- Consider feedback received at this first Public Consultation Centre
- Present design alternatives including a preliminary preferred design alternative at a second Public Consultation Centre, currently scheduled for Fall 2020

Next Steps

The public will have 2 more opportunities to provide input:



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Evaluation Process

The design alternative evaluation criteria will include the following:

Criteria	Sub-Criteria	Least Preferred	Most Preferred
Natural Environment	Aquatic Species & Habitat	Significant impact to aquatic species or habitat	No impact to aquatic species or habitat
	Terrestrial Species & Habitat	Significant impact to terrestrial species or habitat	No impact to terrestrial species or habitat
	Floodplain	Expansion or construction in floodplain area	Improvements to floodplain storage
	Wetlands	Loss of or impact to wetlands	No loss of, or impact to, wetlands
	Trees & Landscaping	Loss of existing trees and landscaping	Improvements to trees and landscaping
	Wildlife	Significant impact to Species at Risk	Improvements to conditions for Species at Risk
	Property Contamination	Exposure of contaminated materials	Avoidance of contaminated materials
	Drainage	Impact on storm water management and increased drainage	Maintenance or improvements to existing storm water management and drainage
Social Environment	Cultural Heritage & Archaeology	Loss or impact to cultural heritage or archaeological sites	No impact to cultural heritage or archaeological sites
	Culture & Recreation	Loss or impact to cultural or recreational facilities	No impact to cultural or recreational facilities
	Businesses	Reduced access to businesses	Improved access to businesses
	Construction	Lengthy construction period with traffic delays and reduced access	Limited construction duration, traffic delays and access restrictions
	Streetscaping	Loss of Streetscaping space and elements (e.g. plantings, decorative paving materials, decorative streetlights)	Improvements to streetscaping elements (e.g. plantings, decorative paving materials, decorative streetlights)
	Air Quality & Noise	Increased air and noise emissions	Reduced air and noise emissions
	Private Property	Impacts to, or need for, private property	No need for private property

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Evaluation Process (continued)

Criteria	Sub-Criteria	Least Preferred	Most Preferred
Traffic Capacity, Operations and Safety	Traffic Level-of-Service	Increased congestion	Reduced congestion
	Safety	No improvement to safety for users	Improved safety for all users
	Access Management	More difficulty accessing driveways and side roads	Improved access to driveways and side roads
	Transit	Loss of transit service, reduced access to transit stops, potential conflicts with other road users	transit service and access to transit stops maintained or enhanced, reduced conflicts with other road users
	Cycling	No improvement to existing facilities	Separated cycling facilities and pedestrian space
	Pedestrians	Loss of pedestrian space	Separated pedestrian space maintained
	Emergency Services	Increase to emergency response time	Potential reduction in emergency response time
Costs	Utility Relocations / Conflicts	Large number of relocations	No relocations
	Initial Capital Costs	Higher cost	Lower cost
	Life-Cycle Costs	Higher cost	Lower cost
Public Opinion	Public Preference	Low preference	High preference

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Project Costs

- Capital costs depend on:
  - Selected alternative and design solutions/details
  - Infrastructure relocations and replacements
  - Stormwater management requirements
  - Utility relocations
  - Property acquisitions
- Range of possible alternatives varies in cost from $45 Million to $70 Million
- Region's 2020 Transportation Capital Program
  - Approved funding of approx. $58 Million for Maple Grove Rd improvements (Includes approx. $1 Million for active transportation improvements)



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Thank you for your Interest!

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Have Your Say!

Comments and Study Mailing List

Submit your comments or request to join the study mailing list by contacting:

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Fax: (519) 585-2269
Email: john.bayley@ibigroup.com

Study Webpage

Follow the Study: engagewr.ca/cambridge-maple-grove-road

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Online Survey

Take the Online Study Survey:

Click here to take the Survey
https://www.engagewr.ca/cambridge-maple-grove-road/survey_tools/survey1

Please submit comments and/or complete the online survey by: **Monday, August 17, 2020**

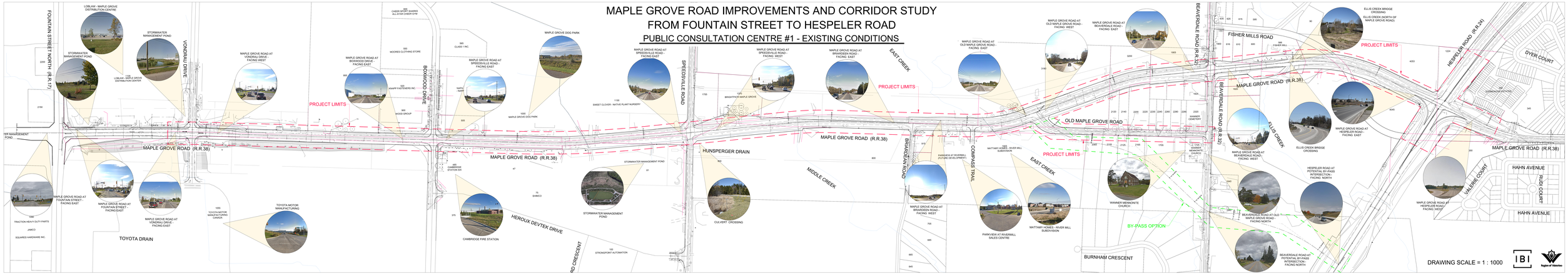
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MAPLE GROVE ROAD IMPROVEMENTS AND CORRIDOR STUDY
FROM FOUNTAIN STREET TO HESPELER ROAD
PUBLIC CONSULTATION CENTRE #1 - EXISTING CONDITIONS



DRAWING SCALE = 1 : 1000

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CLASS ENVIRONMENTAL ASSESSMENT STUDY
MAPLE GROVE ROAD (FOUNTAIN STREET TO HESPELER ROAD)

Public Consultation Centre #1
July 27, 2020

QUESTIONNAIRE / COMMENT SHEET

1. Where do you live?

☐ City of Cambridge ☐ City of Kitchener ☐ City of Waterloo

☐ Region of Waterloo ☐ Other _____

2. How often do you travel on this section of Maple Grove Road (pre-COVID 19)?

☐ Daily ☐ Weekly ☐ Monthly ☐ Rarely

3. What is the travel mode you often use on this section of Maple Grove Road?

☐ Bus (GO Bus) ☐ Walk ☐ Bike ☐ Drive

☐ Other_____

4. What is the general purpose of your travel on this section of Maple Grove Road?

☐ Work ☐ School ☐ Recreational ☐ Other_____

5. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?

6. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?

7. What new information should the Project Team consider when reviewing the Alternative Design Solutions?

For more information, please visit our website at https://www.engagewr.ca/cambridge-maple-grove-road

Please place your completed comment sheet in the Comment Box. You can also send it to the project team members by **Monday, August 17, 2020.**

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Name:

Address:

Email / Telephone:

Note: Personal information, as defined by the Municipal Freedom of Information and Protection of Privacy Act (MFIPPA) is collected under the authority of the Municipal Act, 2001, and in accordance with the provisions of MFIPPA. Personal information on this form will be used for the purpose of completing the CLASS ENVIRONMENTAL ASSESSMENT STUDY MAPLE GROVE ROAD (FOUNTAIN STREET TO HESPELELRT ROAD). The information will be used to identify public and stakeholder concerns and interest and will be documented in the Study as part of the formal Class Environmental Assessment study process. With the exception of personal information, all comments will become a part of the public record. If you have questions about this collection; use, and disclosure of this information, contact Justin Armstrong at 519-575-4757 ext. 3164 or JuArmstrong@regionofwaterloo.ca

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Comment Sheet
Regional Municipality of Waterloo
Maple Grove Road Improvements, Hespeler Road to Vondrau Drive
Public Consultation Centre No. 1 – July 27, 2020

Please complete and place your comments in the comments box at the registration table so that your comments can be considered for this project. If you cannot complete your comments today, please take this home and mail, fax or email your comments by Monday, August 17th, 2020 to:

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Comments regarding this project:

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Name : _____

Address : _____ Postal Code : _____

Phone : _____ Email : _____

Collection Notice:

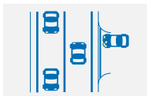
All comments and information received from individuals, stakeholder groups, and agencies regarding these projects and meetings are being collected to assist the Region of Waterloo in making a decision. Under the "Municipal Act", personal information (such as name, address, telephone number and property location) which may be included in a submission becomes part of the public record. Questions regarding the collection should be forwarded to the staff member noted above.

Additional Comments:

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Public Comments and Project Team Responses - Public Consultation Centre #1

No.	Themes	Comment	Project Team Response
1	 	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* Needed to expand # of lands	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative.
2	  	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* Worried about roundabout on Beaverdale/Maple Grove infringing on my property, trees, and privacy *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?* No positives and lots of negatives for residences, more traffic, more noise, more pollution - lived in Cambridge all my life and progress is not my favorite word	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. One of the goals of the planning and design process for this project is to minimize the impact on adjacent properties and the need to acquire private property. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff. Compensation would be provided at fair market rates based on recent similar area sales. The 2018 Regional Transportation Master Plan (RTMP) Update proposes widening Maple Grove from 2 to 4 lanes between Hespeler Road and Vondrau Drive to accommodate existing and forecast traffic volumes and improve operations. Identifying potential environmental (natural, social, and economic) impacts associated with road widening, and recommending mitigating measures to be included as part of the project, are part of the study process. As part of the study process, a Noise Study, to determine current and forecasted sound levels, will be completed per Regional policy.

No.	Themes	Comment	Project Team Response
3	 Road Widening  Active Trans. Improvement  Cul-De-Sac  Streetlighting  Driveway Access  Commercial Vehicles  Road Signage  Development	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* Like double lanes, transit access, cycle and side walk proposal and making it family friendly given that Maple Grove is becoming a residential area between Speedsville Road and Hespeler Road with new subdivisions springing up with River Mill (aka Mattamy homes) and also at the corner of Hespeler Road and Maple Grove Road. - We like the idea of CUL-DESAC on Old Maple Grove Road as we have cars speeding at 60 to over 100 km/h speeds causing a danger to children, pets, pedestrians, cyclists and students crossing the road for school bus pick up/ drop off. - Please consider street lighting for Old Maple Grove Road and name change by adding ""old"" to Old Maple Grove Road. - Since relocation of underground services would be required and we understand that fiberoptic cables run along Maple Grove road, please consider expanding it to improve internet service on Old Maple Grove Road or allowing Rogers to cable our street. The 13 houses on old Maple Grove share 5 MBP from Bell, and it feels worse than a third world country. *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?* Your plan did not discuss Commercials trucks or HTVs. Having reviewed the AADT #s, we noticed that we have 4% or approximately 800 trucks driving through this predominantly residential area so we are requesting Absolutely "NO HTV" OR COMMERCIAL TRUCKS"" and that these trucks be diverted west side to the 401 towards Sports World Drive, given the recent expansion of Highway 8 / 401 intersection. This would save the region a substantial amount by not having to look at a major change at Maple Grove and Hespeler road junction where a well-planned roundabout would suffice and help slow down the speeds at which vehicles sometimes cross that intersection. Two of our family vehicles were crashed into at that intersection over the last 4 years. *Q. What new information should the Project Team consider when reviewing the Alternative Design Solutions?* Our property at (REDACTED) backs onto the proposed road improvements of Maple Grove Road. We have the plans that show we could severe off 0.74 acres and offer it for residential development if roadway access to Maple Grove Road is granted. Our adjacent neighbour to the East and across the road on the Northside of Maple Grove have access to Maple Grove Road for residential purposes. we would encourage our neighbour to the east to consider adding residences to his 2 vacant lots. Altogether these 3 vacant lots (ours +his) is almost 3 acres altogether and can be used for multi-residential purposes.	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Old Maple Grove Road is a local road, with changes subject to City of Cambridge approval and/or implementation, including implementing a cul-de-sac and infrastructure upgrades (e.g. renaming and/or signage changes). These comments have been forwarded to the City of Cambridge for consideration. A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA. Traffic forecasting, including truck traffic, will be included. The Region's truck route policy identifies all Regional roads as truck routes, unless the roadway may be incapable of supporting heavy truck traffic due to design and/or condition of the road. Due to employment lands along, and in proximity to, the study corridor, a truck restriction will not be considered as part of this study. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff. Compensation would be provided at fair market rates based on recent similar area sales.

No.	Themes	Comment	Project Team Response
4	 Environment  Commercial Vehicles  Other Improvements	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* Nothing about this is appealing. The alternate route would be a better solution so that it gets away from the residential areas. Why not consider a ramp from 401 to Speedsville Road. *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?* The noise of the trucks going through the residential areas will be ridiculous. Its already totally annoying when the truck use their engine brakes coming up to the intersections. *Q. What new information should the Project Team consider when reviewing the Alternative Design Solutions?* The truck count you have is not realistic. Living along this road (REDACTED) I would say its more like 20% trucks. I formal noise study needs to be conducted along the residential area. During the last assessment we were promised a noise barrier. Why is not mentioned here?"	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. The 2018 Regional Transportation Master Plan (RTMP) Update proposes widening Maple Grove from 2 to 4 lanes between Hespeler Road and Vondrau Drive to accommodate existing and forecast traffic volumes and improve operations. As part of the study process, a Noise Study, to determine current and forecasted sound levels, will be completed per Regional policy. A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA. Traffic forecasting, including truck traffic, will be included. Truck traffic ratios (%) will be reviewed based on actual count data and forecasting of truck traffic will be based on that ratio.
5	 Active Trans. Improvement  Intersection Improvements	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* Separated bicycle lane and/or multi-user pathway and roundabouts. *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?* Interactions between cyclists and motorists at crossings (right-of-way is ill defined). Bike lights may need to be installed so cyclists can ride in intersection rather than walk across per Ontario HTA. *Q. What new information should the Project Team consider when reviewing the Alternative Design Solutions?* Surface of separated bike lanes are often not as good as on-road lanes. Warping is already evident on Fountain St multiuser pathway. Might consider better subsurface for pathway or keep lane on road to utilize road subsurface."	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Alternative cross-section designs for the corridor (e.g. active transportation concepts) will be evaluated and presented at a second Public Consultation Centre (PCC 2) planned for Spring/Summer 2021. As part of this study, at signalized intersections with continuous active transportation/cycling facilities, cross-rides (for cyclists) will be considered.

No.	Themes	Comment	Project Team Response
6	 Road Widening  Traffic  Intersection Improvements	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* It is overdue to create this roadway for four lanes of traffic. *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?* Widening is not the only matter for consideration in my opinion. The residential development which is currently underway south of the roadway plus the proposed development at the Maple Grove and Highway 24 will bring additional vehicular traffic on top of additional truck traffic related to the future industrial developments. *Q. What new information should the Project Team consider when reviewing the Alternative Design Solutions?* How to integrate traffic flow at the intersections of Speedsville, Briardean and Compass Trail, especially traffic turning into and out of these residential areas Was the recently spent money at Maple Grove and Compass Trial a poor investment of resources considering that much of it will be torn up when the change to four lanes takes place. Would it not have been more prudent to widen the stretch from Briardean east to Old Maple Grove to four lanes now rather than just the left turn lane widening portion at Compass Trail?"	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. The 2018 Regional Transportation Master Plan (RTMP) Update proposes widening Maple Grove from 2 to 4 lanes between Hespeler Road and Vondrau Drive to accommodate existing and forecast traffic volumes and improve operations. A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA. Traffic forecasting, including truck traffic, will be included. Through the Traffic Impact Study, completed as part of the Hunt Club Subdivision development application process, it was determined that a westbound left turn lane off of Maple Grove Road onto Compass Trail was required and funded entirely by development charges (i.e. not tax base). It is a legislated requirement through the *Environmental Assessment Act*, that a study is required prior to proceeding with road widening: this is that study. A requirement of the EA process is to mitigate potential environmental impacts, including economic. As a result, this study will attempt to mitigate potential throwaway costs through recommended improvements, in the context of overall project life cycle costing.
7	 Cul-De-Sac  Intersection Improvements  Development  Traffic	*Q. What do you like about the Alternative Design Solutions that are being carried forward for the Maple Grove Road corridor and intersection improvements?* As much as we would all probably like to keep Maple Grove as it is, I can see that with increased traffic it will become congested. I think it is a good idea to close Old Maple Grove at the end, it does not need to be a through street. Briardean should close as you stated. The most important part is to get a roundabout installed at Maple Grove and Hespeler Road. There are so many accidents at this location, often very bad accidents, there have been a number of deaths. It needs to be a min 2 lane roundabout, so it can move some traffic. This should have a long south merge lane to take south bound Maple Grove Road traffic on to Hespeler Road without using the roundabout. Same with west bound Fishermills from Hespeler Road north (less expensive and almost as good as a fly over) *Q. What challenges or considerations do you see with the Alternative Design Solutions that are being carried forward?*	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. As local roads, closure of Old Maple Grove Road and Briardean Road are subject to City of Cambridge approval and/or implementation. These comments have been forwarded to the City of Cambridge for consideration. A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA, including traffic forecasting based on existing and planned development. Alternative cross-section designs for the corridor (e.g. active transportation concepts) will be evaluated and presented at a second Public Consultation Centre (PCC 2) planned for Spring/Summer 2021.

No.	Themes	Comment	Project Team Response
		I don't like the fly over design proposal for the roundabout at Maple Grove Road and Hespeler Road. Its ugly and not in keeping with the surrounding area, plus it is not required if a roundabout is built correctly. I also don't like the right only proposal at Compass trail, that is just a housing estate, it is fine as it is now, at some point it might need lights. I don't think the idea of a west by pass to miss the roundabout at Maple Grove Road and Hespeler Road is a good idea, its probably not required. I think you need to look at the cross traffic flow at the current intersections, for sure Maple Grove Road is busy at certain times, but other than Speedsville Road most of the other intersections are not that busy. Certainly Maple Grove Road and Beaverdale Road is 95% Maple Grove Road traffic, does that warrant a roundabout? *Q. What new information should the Project Team consider when reviewing the Alternative Design Solutions?* Do you know how much traffic the new Amazon warehouse located on Maple Grove Road will add? I think you should look at the possibility of a separate bike / pedestrian path some distance away from the road, this will create a user friendly alternative to traffic on the road.	
8	   	*General Comment* With the industrial development soon coming behind the Regional Operations Centre on Maple Grove Road plus several significant residential developments around Maple Grove Road, widening of the Roadway will indeed be appropriate. However, the recent roadwork done between Compass Trail and Briardean raises questions to me of its fiscal prudence. All of that work will be wasted when it is dug up to widen all of Maple Grove Road to four lanes. What reasons could there have been to do a half-baked job in that area rather than widening that section to four lanes now? I am interested in participating in discussions as development moves forward.	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Through the Traffic Impact Study, completed as part of the Hunt Club Subdivision development application process, it was determined that a westbound left turn lane off of Maple Grove Road onto Compass Trail was required and funded entirely by development charges (i.e. not tax base). It is a legislated requirement through the *Environmental Assessment Act*, that a study is required prior to proceeding with road widening: this is that study. A requirement of the EA process is to mitigate potential environmental impacts, including economic. As a result, this study will attempt to mitigate potential throwaway costs through recommended improvements, in the context of overall project life cycle costing. Please accept this as confirmation that you have been added to the Project Contact List.
9		*General Comment* Trouble accessing documents on the EngageWR project site on August 14, 2020	Resolved August 14, 2020 - software update required by user.

No.	Themes	Comment	Project Team Response
10	Property	*General Comment* I am the owner of (REDACTED) I have concerns on how the widening Maple Rd will affect my property as it approaches Beaverdale Rd .The extra lane will be at a higher elevation them my land' I have a row of 50 feet high spruces that may be also affected and I also have a stream for run off water that passes through this property that ends up going into a water drain system that crosses under Maple Grove .	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. One of the goals of the planning and design process for this project is to minimize the impact on adjacent properties and the need to acquire private property. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff. Compensation would be provided at fair market rates based on recent similar area sales. Stormwater management will be part of the preliminary design included in this study phase, as well as the subsequent detailed design and construction/implementation phases.
11	Property	*General Comment* I have read the Maple Grove Road Improvements, class EA PCC No.1 Information Package and see that part of my property may be required for the possible roundabout and road widening at the Maple Grove Beaverdale Rd. intersection as I own the corner property on the north side of Maple Grove. At this time, I am not sure if there any more information to read, drawings available for viewing, I also read that the project team will present the preferred design alternatives and intersection controls at the second Public Consultation Center. Any Updates and clarifications would be gratefully Appreciated	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff. Compensation would be provided at fair market rates based on recent similar area sales. Stormwater management will be part of the preliminary design included in this study phase, as well as the subsequent detailed design and construction/implementation phases. Alternative cross-section designs for the corridor (e.g. active transportation concepts) will be evaluated and presented at a second Public Consultation Centre (PCC 2) planned for Spring/Summer 2021.
12	Property Environment	*General Comment* Our home is located (REDACTED). It appears that there will be a roundabout at that corner, we have a large stand of pine trees that hopefully will not come into play leaving our presently private setting exposed to the ongoing traffic. Hopefully the roundabout could be adjusted for us to keep that privacy. We also have 2 (zoned R1) vacant residential building lots behind our home to the west on Maple Grove Road, we have one entrance onto Maple Grove Road which I would assume would continue, we have been paying extreme property taxes on those lots for the last 20 years and would hope to not lose the value on those 2	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. One of the goals of the planning and design process for this project is to minimize the impact on adjacent properties and the need to acquire private property. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff.

No.	Themes	Comment	Project Team Response
		properties. We would appreciate any comments that you would have on our properties, and would like to know if we should be doing anything further at this point to protect our interest.	Compensation would be provided at fair market rates based on recent similar area sales.
13	 Other Improvements  Active Trans. Improvements	*General Comment* Consider future installation of east and west exit only interchange onto 401, now that the Speedsville bridge has been widened. Appears lands available, and will reduce eastbound traffic on Maple Grove Road. just reviewing the plans for the possible proposed bike lanes on Beaverdale Road, in my opinion those lanes would not be necessary as there is limited bike traffic now and should be in the future and I would imagine that the costs to do that would be prohibitive as there are storm sewers and curbs to be moved and possible road widening to some extent to accommodate those lanes.	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Consideration of additional interchanges on Highway 401 is under the Ministry of Transportation of Ontario jurisdiction and is beyond the ability of this EA to address. Widening of Maple Grove Road was found to be required based on the Region's 2018 Transportation Master Plan (TMP) Update. The Region's TMP has aggressive targets to encourage modal shift from automobiles to other forms of transportation, including transit, cycling, and walking. The Region has invested heavily over the past several years in both transit and active transportation infrastructure; however, widening of Maple Grove Road is still required based on future forecast traffic volumes along this section of roadway to adequately accommodate traffic. A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA, including traffic forecasting.
14	 Cul-De-Sac  Driveway Access  Public Engagement	*General Comment* I own the land at (REDACTED) I just wanted to know if the access to the main Maple Grove Road will be closed of or made a cul-de-sac, as I intend to build one day here (REDACTED) is my neighbor but he can't get involved due to conflict. Let me know. I did register in the engage website as well, thanks	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Old Maple Grove Road is a local road, with changes subject to City of Cambridge approval and/or implementation, including implementing a cul-de-sac. If a cul-de-sac were implemented on Old Maple Grove Road, access would remain at Beaverdale Road. Please accept this as confirmation that you have been added to the Project Contact List.

No.	Themes	Comment	Project Team Response
15	 Development  Road Widening  Property  Intersection Improvements  Public Engagement	*General Comment* On behalf of our client Maple Mills (Hespeler) Limited, we have reviewed the information associated with the Online Public Consultation Centre #1 and offer the following comments: The Maple Mills lands are identified as future development lands and are draft approved. As you may be aware, there are conditions of draft approval that relate to the design of the intersection of the public road and Maple Grove Road. Through the draft approval process there was significant discussion with the City and Region and study completed on the intersection. The preferred option to widen Maple Grove Road to 4 lanes is supported in principle. The preliminary information identifies that no land is required from the Maple Mills property. It is noted that a daylight triangle at Maple Grove Road and Hespeler Road is identified for dedication through the plan of subdivision. From our client's perspective, full support will be based on the design of the intersection of the proposed public road and Maple Grove Road. It is unclear how the preliminary designs incorporate the proposed public road from the plan of subdivision to Maple Grove Road. Further discussion needs to occur on the potential for a left-turn lane into the plan of subdivision or a roundabout at the new public road intersection with Maple Grove Road. This discussion will be important as the long-term improvements are proposing a significant change to the intersection of Maple Grove Road and Hespeler Road and for determination of a preferred alternative. We would appreciate the background information that has been used to determine any preliminary noise mitigation considerations. We understand a full noise study will be prepared for the preferred option. The subject lands are designated High Density Residential and consideration should be given that residential uses would be permitted to the full extent on the site, subject to zoning setback provisions. We request that you add us to the mailing list and that we continue to be notified of any future meetings or reports. We would also appreciate the opportunity for discussion on the options as it appears that the options do not fully consider the potential integration of the public road from the proposed subdivision.	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. One of the goals of the planning and design process for this project is to minimize the impact on adjacent properties and the need to acquire private property. In areas where property or temporary access is required, the property owner will be contacted directly by the Region of Waterloo legal services staff. Compensation would be provided at fair market rates based on recent similar area sales. Refer to Conditions 31 and 32 as part of the June 21, 2019 Decision of Draft Approval of Plan of Subdivision for 30T-16101, 4045 Maple Grove Road (Maple Mills (Hespeler) Ltd.): 31. a) That Street A access onto Regional Road No. 38 (Maple Grove Road) shall be right-in/right-out access with a centre median on Maple Grove Road, unless the Owner/Developer can demonstrate that a left-in movement can be accommodated to the satisfaction of the Regional Municipality of Waterloo, through a Transportation Impact Study Addendum and a detailed design that also account for any modifications to the west leg of the Regional Road No. 24 (Hespeler Road) and Regional Road No. 38 (Maple Grove Road) signalized intersection. b) That prior to final approval, the Owner/Developer obtains a Regional Road Access Permit for Street A access and for the proposed Street B right-in/right-out access onto Regional Road No. 38 (Maple Grove Road). 32. That prior to final approval, the Owner/Developer enters into a development agreement with the Regional Municipality of Waterloo to complete a Transportation / Stationary Noise Study for Blocks 1 and 2 prior to Site Plan Approval, to the satisfaction of the Regional Municipality of Waterloo, and if necessary, enters into a subsequent agreement to provide for implementation of the approved noise attenuation measures. Further, the development agreement with the Regional Municipality of Waterloo is to include the provision for the inclusion of the following noise warning clause in all offers of purchase and sale and/or rental agreements for all residential units within Blocks 1 and 2: "Purchasers/tenants are advised that sound levels due to increasing road traffic on Maple Grove Road (Regional Road No. 38) and Hespeler

No.	Themes	Comment	Project Team Response
			Road (Regional Road No. 24) may on occasions interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks. This dwelling unit has been designed with the provision for adding central air conditioning at the occupant's discretion. Installation of central air conditioning by the occupant in low and medium density developments will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks." A Transportation Report will be included in the final study reporting (i.e. Environmental Study Report) for this Schedule C Class EA, including traffic forecasting based on existing and planned development. This is separate and distinct from Draft Plan Condition of Approval 31, which would remain a requirement of the developer as applicable. As part of the study process, a Noise Study, to determine current and forecasted sound levels, will be completed per Regional policy (Part B). This is separate and distinct from Draft Plan Condition of Approval 32, which would remain a requirement of the developer per Regional policy (Part A). Please accept this as confirmation that you have been added to the Project Contact List.
16		*General Comment* We are investigating in the lands identified as 1380 Beaverdale Road which is about 33 acres. We are in the process of undertaking studies for the potential redevelopment for residential uses. Please refer to attached map indicating the location of the property. Secondly, we are reviewing sanitary and water servicing options which would include the extension of these services along Beaverdale Road north to Beaverdale/Maple Grove intersection ,right along Maple Grove to Hespeler Road connecting to services on Fisher Mills Road . A few questions that we have related to Municipal Class EA are as follows; 1. Are the existing and future municipal servicing for the area being investigated as part of the EA? Normally the future servicing would be located in the road right of way of Maple Grove and the two construction works would be undertaken concurrently. 2. Can you clarify and confirm if the road works are undertaken, with the necessary future municipal service (water and sewer) needs of the area?	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Servicing studies would be within the City of Cambridge's scope/jurisdiction and are not included under the scope of the Maple Grove Road Schedule C Class Environmental Assessment. These comments have been forwarded to the City of Cambridge for consideration. The City of Cambridge would need to advise the Region of Waterloo with respect to municipal (i.e. City) servicing needs to accommodate city development. Widening of Hespeler Road is not included in the scope of this study. Old Maple Grove Road and Briardean Road are a local roads, with changes subject to City of Cambridge approval and/or implementation, including implementing a cul-de-sac.

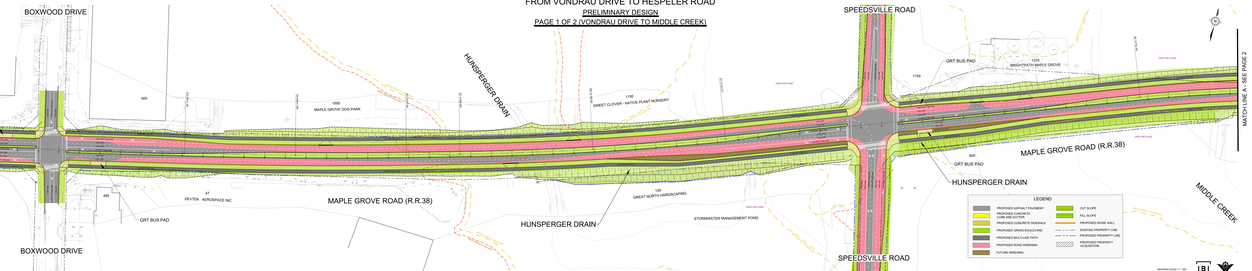
No.	Themes	Comment	Project Team Response
		3. Are their road widenings required along the Hespeler Road corridor required to accommodate the potential plans? If so, is this contemplated in this EA? What is the worst case scenario in terms of road widening from the options you have outlined? 4. I note that on Figure 3B, there is a cul de sac? What is this for? 5. I also note that in your project area, you include a large portion of lands fronting onto Beaverdale Road, what is contemplated to be done in the areas as noted in yellow? We would appreciate response to these questions and please keep us posted on future PPC meetings.	Beaverdale Road is a local (i.e. City of Cambridge) road and, as such, only the intersection with Maple Grove Road is included in the scope of this study. It is unclear what figure/s you are referring to – please advise. Please accept this as confirmation that you have been added to the Project Contact List.
17	Development	*General Comment* Will there be consideration given to the City of Cambridge Official Plan designated future residential areas for the new servicing infrastructure along Maple Grove Road? Specifically, planned low and medium density residential areas are designated along Beaverdale Road and Briardean Road which would outlet north to Maple Grove Road and require capacity in sanitary sewers and watermains.Will the Region be considering stormwater management pond facilities for quantity and quality control of the right-of-way, or will discharge be directly to the creeks?	The Project Team acknowledges these comments and will consider them in developing a Preferred Design Alternative. Servicing studies would be within the City of Cambridge's scope/jurisdiction and are not included under the scope of the Maple Grove Road Schedule C Class Environmental Assessment. The City of Cambridge would need to advise the Region of Waterloo with respect to municipal (i.e. City) servicing needs to accommodate city development. Stormwater management will be considered as part of this study. The SWM study will acknowledge regulatory requirements of the GRCA and requirements of respective sub-watersheds, as applicable.
18	Public Engagement	*General Comment* Please add to mailing list	Please accept this as confirmation that you have been added to the Project Contact List.
19	Public Engagement	*General Comment* Please add to mailing list	Please accept this as confirmation that you have been added to the Project Contact List.

Appendix S – Preliminary Design Drawings

September 2023

MAPLE GROVE ROAD IMPROVEMENTS AND CORRIDOR STUDY
FROM VONDRAU DRIVE TO HESPELER ROAD
PRELIMINARY DESIGN
PAGE 1 OF 2 (VONDRAU DRIVE TO MIDDLE CREEK)



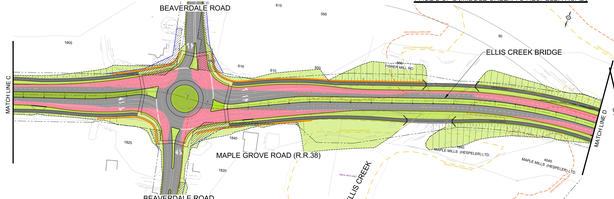


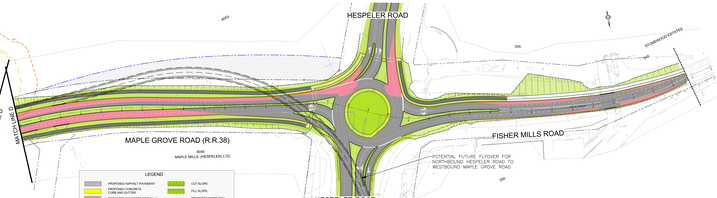
MAPLE GROVE ROAD IMPROVEMENTS AND CORRIDOR STUDY
FROM VONDRAU DRIVE TO HESPELER ROAD
PRELIMINARY DESIGN
PAGE 1 OF 2 (VONDRAU DRIVE TO MIDDLE CREEK)

MAPLE GROVE ROAD IMPROVEMENTS AND CORRIDOR STUDY
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PAGE 2 OF 2 (MIDDLE CREEK TO HESPELER ROAD)









LEGEND

- PROPOSED ASPHALT PAVEMENT
- PROPOSED CONCRETE SIDEWALK / CURB
- PROPOSED CONCRETE SIDEWALK
- PROPOSED GRASS BOULEVARD
- PROPOSED MULTI-USE PATH
- PROPOSED ROAD WIDENING
- CUT SLOPE
- FILL SLOPE
- PROPOSED NOISE WALL
- EXISTING PROPERTY LINE
- PROPOSED PROPERTY LINE
- PROPOSED PROPERTY ACQUISITION

DRAWING SCALE = 1 : 500

IBI