

FINAL

Hydrogeological Report

Highway 413 Preliminary Design and Assessment of Environmental Impacts

March 2026



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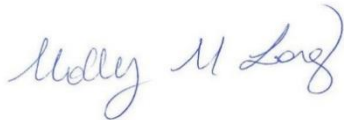
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Authors

Report Prepared By:



Brian Holden, M.Sc., P.Geo.
Hydrogeologist
AECOM



Molly Long, M.Sc.
Environmental Scientist
WSP Canada Inc.

Report Reviewed and Approved By:



Peter Hayes, P.Geo.
Senior Hydrogeologist
WSP Canada Inc.



Sergiy Tchernikov, M.Sc., P.Geo., QP-ESA
Senior Contamination/Waste Management Specialist, Hydrogeologist
AECOM



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Table A-3 East Section Geotechnical Details

Acronyms

CAMC..... Conservation Authorities Moraine Coalition

CH..... Conservation Halton

CVC..... Credit Valley Conservation

CVSPA..... Credit Valley Source Protection Area
ESA..... Environmentally Sensitive Areas
ETR Express Toll Route
GAR Groundwater Assessment Report
ha Hectares
HVA..... Highly Vulnerable Aquifers
km Kilometres
L/min Litres per Minute
LSW Locally Significant Wetland
m Metres
masl..... Metres Above Sea Level
mbgs Metres Below Ground Surface
MECP Ministry of the Environment, Conservation and Parks
MNR Ministry of Natural Resources
MTO Ministry of Transportation
ORM..... Oak Ridges Moraine
PSW Provincially Significant Wetland
PTTW Permit to Take Water
SGRA..... Significant Groundwater Recharge Areas
TRCA Toronto and Region Conservation Authority
WHPA Wellhead Protection Areas
WWA..... Water Well Assessment
WWIS Water Well Information System



1. Introduction

1.1 Project Overview

The Ontario Ministry of Transportation (MTO) has retained WSP Canada Inc. (WSP) and AECOM Canada ULC (AECOM) in collaboration with various sub-consultant and technical firms to undertake the Highway 413 Preliminary Design and Assessment of Environmental Impacts, hereafter referred to as “the Project”.

The Project is following the requirements of the *Highway 413 Act, 2024*.

The Project includes the 52-kilometre (km) Highway 413 Corridor, a 4 km extension to Highway 410, and a 3 km extension to Highway 427 (both facilitating connections to the Highway 413 Corridor), for a total of 59 km of new infrastructure (**Figure 1**). The highway will have 11 interchanges at municipal roads. Features such as stormwater management ponds, carpool lots, Commercial Vehicle Inspection Facilities, maintenance facilities, and the potential for electric vehicle charging stations, have been explored as part of Preliminary Design.

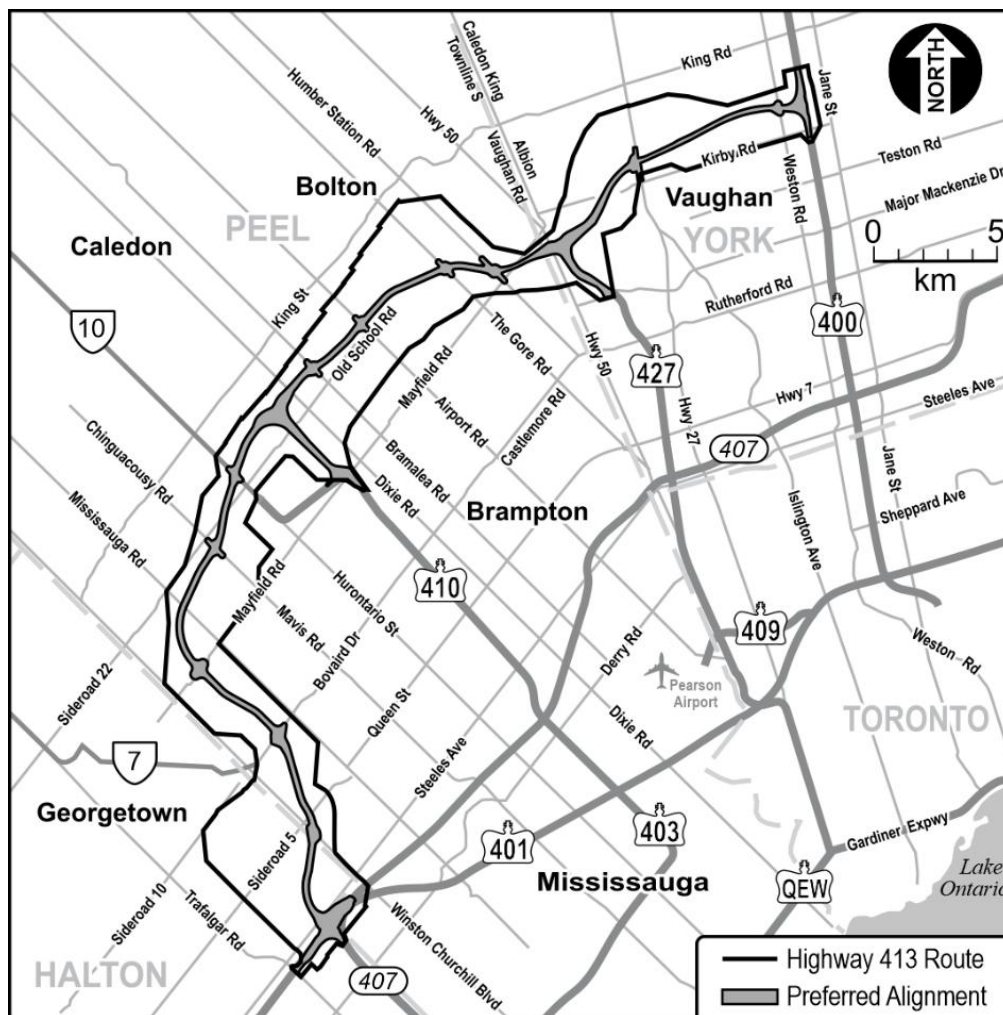
Highway 413 will connect Highway 401 and Highway 407 Express Toll Route (or, 407 ETR) in the Regional Municipality of Halton and the Regional Municipality of Peel with Highway 400 in the Regional Municipality of York.

The typical right-of-way (ROW) will be 170 metres (m) which includes 110 m for the typical mainline highway and 60 m for a proposed transitway. A multi-use trail (MUT) parallel to Highway 413 may be accommodated within the proposed transitway ROW. The right-of-way is expanded at interchanges and high fills areas to accommodate ramps to/ from the crossing roads, as well as in locations with ancillary highway facilities as mentioned above. The Preliminary Design consists of a typical 6-lane cross-section (3 lanes in each direction) with a grassed median. The right-of-way has been designed to accommodate up to 10-lanes (5 lanes in each direction) should future traffic conditions warrant additional capacity. These additional lanes would be provided by widening the highway towards the median.

The proposed transitway will be a separate corridor running alongside the highway, dedicated for public transit, including stations to facilitate passenger access at key locations. The proposed transitway and stations will be subject to a separate future assessment of environmental impacts.

Highway 413 is a 400-series highway, which is a network of controlled-access highways throughout the Province of Ontario. Their primary function is to accommodate through traffic and provide links between urban centres. 400-series highways feature full grade separations (such as bridges) at most intersecting roads and railway lines. Interchanges are provided along the 400-series highways to connect to other highways and municipal roads. These highways have design standards to accommodate high speeds and various collision avoidance and traffic management systems. Highway 413 is proposed to have a posted speed limit of 110 km/h.

Figure 1: Highway 413 Route



The future Highway 413 is expected to:

- Relieve traffic on local roads and parallel highways;
- Help accommodate travel demand;
- Reduce travel times for commuters and goods movement;
- Reduce the social, environmental, and economic costs of congestion;
- Provide greater connectivity between urban growth centres;
- Provide better connections to residential and employment lands; and
- Provide an alternate route in the event of an incident or road closure on local and regional roads.

1.2 Purpose of Report

This report documents the hydrogeological investigations conducted during the Preliminary Design phase of the Highway 413 Project and summarizes the hydrogeological conditions evaluated up to September 2025. The report includes:

- Key background information from the Planning Phase Groundwater Assessment Report (GAR; WSP, 2024).
- Results of the Water Well Assessment (WWA; WSP & AECOM, 2024).
- Interpretations of groundwater conditions observed during geotechnical drilling, including identification of areas where an Environmental Activity and Sector Registry (EASR) will be required for construction.

In addition, this report provides recommendations for advancing more detailed hydrogeological studies during the Detail Design phase.

1.3 Study Area

A 500 m evaluation zone was added to either side of the centreline of the Preliminary Design (herein 'Analysis Area') to characterize the local hydrogeological conditions. Further hydrogeological assessments may be undertaken during Detail Design as necessary. The entire Analysis Area includes approximately 13,135 ha of land within the same general geographic limits as noted above (Figure 2). The Analysis Area has been

divided into nine Sections, and grouped into the West Section (Sections 1, 2, and 3), Central Section (Sections 4, 5, and 6), and the East Section (Sections 7, 8, and 9) for this report.

The West Section includes Sections 1, 2, and 3, and extends from the Highway 401 and Trafalgar Road interchange easterly to the Highway 401 and 407 ETR junction, and then northerly / northeasterly to Mississauga Road and Old School Road. The majority of the West Section is located within the Town of Halton Hills (Regional Municipality of Halton (Halton Region)), the City of Brampton and the Town of Caledon (Regional Municipality of Peel (Peel Region)), while very limited areas at the southern / southeastern end are located within the Town of Milton (Halton Region) and the City of Mississauga (Peel Region).

The Central Section includes Sections 4, 5, and 6, and is bound by Mississauga Road to the west, Highway 50 to the east and consists of land between Mayfield Road to the south and King Street to the north. The Central Section is located within Peel Region, with the majority of the Analysis Area located within the Town of Caledon, and the most eastern portion of the Central Section is located in the City of Brampton.

The East Section includes Sections 7, 8, and 9. The East Section extends from Highway 50 to the eastern edge of the Analysis Area at Highway 400. The East Section is bound by Major MacKenzie Drive to the south, and King Road to the north. The East Section is primarily within the City of Vaughan and the Regional Municipality of York (York Region).

2. Methodology

2.1 Background Information Review

2.1.1 Groundwater Assessment Report

The Planning Phase GAR discusses potential impacts within the Analysis Area in the context of the following:

- Potential impacts to private water wells;
- Existing source water protection areas;
- Likelihood of release of contaminants; and
- Impacts to groundwater and surface water from construction activities.

The Scope of Work undertaken in the GAR included the following tasks.

- Review of Records. This review included geological and hydrogeological maps and reports, Official Plans and studies from local municipalities and conservation authorities, source water protection assessment reports, Ministry of the Environment, Conservation and Parks (MECP) water well records, and MECP Permit to Take Water (PTTW) records.
- Windshield Visual Inspection. This inspection attempted to observe local groundwater characteristics (e.g., springs and seeps), flow in culverts and streams, serviced areas and presence of private water wells, which are readily visible from the public ROW.

Key findings related to the hydrogeological aspect of the Highway 413 Project are provided in Section 3.1, and a more detailed review can be found in the GAR (WSP, 2024).

2.1.2 Water Well Assessments

A WWA was conducted by WSP and AECOM in 2023 and 2024 (WSP & AECOM, 2024). The WWA consisted of soliciting water well owners to participate in the WWA work and conducting interviews with water well owners within the proposed Highway 413 Project Analysis Area. Virtual interviews were scheduled with participating water

well owners to collect information of the water supply well on their property, including but not limited to the number, depth, and type of private wells, well construction details, and historical water quantity and quality issues. This data allows hydrogeologists to evaluate existing conditions and assess potential impacts to water supply as a result of the proposed Highway 413 Project, so that the negative impacts can be mitigated or avoided.

Properties included in the WWA were located within the Analysis Area and were split into the West, Central, and East Sections (Figure 3). Key findings from the completed virtual well surveys are present in Section 3.2 of this report, and additional details of the are provided in the WWA Report (WSP & AECOM, 2024). It is important to note that WSP and AECOM relied upon the information obtained from each property owner as being accurate.

2.1.3 Geotechnical Drilling Observations

Preliminary geotechnical investigations were performed at proposed structure locations (i.e. overpass, underpass, ramp, culvert, and bridge) throughout the West, Central, and East sections of the proposed Highway 413 Corridor (Figure 3). The geotechnical investigations included the advancement of boreholes, installation of monitoring wells, and grain size distribution analyses. The investigations documented subsurface conditions and groundwater conditions and provided construction considerations with respect to groundwater / surface water control. A summary of key findings for the West, Central, and East Sections are provided in Section 3.3, and additional information can be found in the individual geotechnical investigation reports.

3. Existing Conditions

3.1 Groundwater Assessment Report Key Findings

3.1.1 Watershed and Conservation Authority Information

The entire Analysis Area falls under the jurisdiction of Conservation Halton (CH), Credit Valley Conservation (CVC), and the Toronto and Region Conservation Authority (TRCA) as shown in Figure 3.

The West Section is primarily located within the Sixteen Mile Creek Watershed in the southern / southwestern portion, and the Credit River Watershed in the northern / northeastern area. A very limited area of the West Section (north of Mayfield Road in the vicinity of Mississauga Road), the entire Central Section, and the entire East Section lie within the Etobicoke Creek Watershed and the Humber River Watershed. A small portion of the Central Section and the East Section is located within the Main Humber subwatershed. The remainder of the East Section lies within the East Humber River subwatershed. This subwatershed divide is present in the east portion of the Analysis Area between Huntington Road and Highway 27.

3.1.2 Topography

The topography within the West Section is undulating in nature, with a general downward slope from the northwest to the southeast (Department of Energy, Mines and Resources, 1994).

The topography within the Central Section is flat to slightly undulating, with the exception of several deeply incised river valleys associated with West Humber River and Etobicoke Creek West Branch.

The topography within the East Section has ground surface elevations ranging from approximately 185 metres above sea level (masl) within the floodplain of the Humber River (north of Kleinburg) to a peak of 285 masl in the northeast end of the East Section, near Highway 400 (MNR, 2015).

3.1.3 Wetlands

Wetlands are observed along several streams within the Analysis Area. Based on the information obtained from the Ontario Ministry of Natural Resources (MNR), provincially significant or locally significant wetlands are present in the middle portion of the West Section along the Credit River (Churchville-Norval Wetland Complex) and Levi's Creek (Levi's Creek Wetland Complex). The wetlands in the Central Section include the Etobicoke Creek Headwater Provincially Significant Wetland (PSW) Complex, the Etobicoke Creek Headwaters II Locally Significant Wetland (LSW) Complex, and the Heart Lake PSW Complex. The wetland areas are also classified as Environmentally Sensitive Areas (ESAs). Within the Central Section, the Gooseville Moraine ANSI is present. The Tormore Wetland Complex is a locally significant wetland complex and is located near portions of the Main Humber River. The East Humber River Wetland Complex PSW surrounds portions of the East Humber River and its tributaries within the East Section. The King Creek Forest ESA and the East Humber River ESA are in the East Section (MNR, 2015).

3.1.4 Physiography

According to Chapman and Putnam's "The Physiography of Southern Ontario, Third Edition" (1984; 2007), the Analysis Area is located within two physiographic regions known as the South Slope and the Peel Plain (Figure 4).

The South Slope physiographic region is an area defined as the southern slope of the Oak Ridges Moraine. The soils within the South Slope are primarily comprised of drumlinized till plains of Halton Till deposits present at surface (Chapman and Putnam, 2007).

The Peel Plain is a slightly undulating to flat tract of clay soils sloping downward in a general southern direction toward Lake Ontario. The underlying geological material of the Peel Plain is till containing large amounts of shale and limestone. This has been modified by a veneer of clay, and when cut deep enough is seen to be varved (Chapman and Putnam, 1984).

3.1.5 Geology

The deeper overburden geology and hydrogeology was assessed using the conceptualization developed by the Conservation Authorities Moraine Coalition (CAMC) and their study partners, as part of the CAMC – York, Peel, Durham, and Toronto project (Kassenaar and Wexler, 2006; CAMC, 2006). The detailed CAMC

hydrostratigraphic model has particular emphasis on the ‘core area’, which includes the Toronto Conservation Authority watersheds, York Region and parts of Durham and Peel regions. The groundwater flow model for the core area is comprised of eight hydrostratigraphic layers. This model is used to provide a baseline understanding of the hydrogeological conditions on a regional scale. It was determined by Davies and Holysh (2007) that the stratigraphic framework developed by CAMC for the Oak Ridges Moraine area can be applied across the Credit River watershed with some minor modifications to local surficial geology. The following is a summary of the interpreted stratigraphy within the Analysis Area, in ascending order of age.

Surficial Deposits	Description
<ul style="list-style-type: none"> ▪ Recent Deposits 	Modern Alluvial deposits
<ul style="list-style-type: none"> ▪ Peel Pond / Halton Till 	Surficial clay to sand and till
Oak Ridges Moraine Complex	
<ul style="list-style-type: none"> ▪ Oak Ridges Moraine (ORM) Deposit 	Interbedded fine sands and silt, with subordinate coarse sands and heterogeneous gravels. Surficial exposures of coarse-textured sediments can be interpreted to be equivalent to ORM sediments.
Lower Sediments	
<ul style="list-style-type: none"> ▪ Newmarket Till 	Dense, sandy till underlying ORM sediments.
<ul style="list-style-type: none"> ▪ Thorncliffe Formation 	Glaciolacustrine deposits of silt, sand and clay. Occurs below the Niagara Escarpment in deeper bedrock valley settings. Not exposed at surface within the Study Area.
<ul style="list-style-type: none"> ▪ Sunnybrook Drift and Scarborough Formation 	Fluvio-deltaic deposits of silt and clay and upper sands. Not exposed at surface within the Study Area.
<ul style="list-style-type: none"> ▪ Bedrock (weathered and unweathered) 	Georgian Bay Formation and Queenston Formation

3.1.6 Water Well Records

The MECP water well information system (WWIS) is a compilation of records for water wells drilled in the Province of Ontario for the purpose of human, agricultural, commercial, and industrial consumption. A search of the MECP WWIS (April 2020) identified a total of 311 water well records (including 285 water supply wells) in the West Section, 438 water well records (including 405 water supply wells) in the Central Section, and 253 water well records present within the East Section of the Analysis Area. A summary is provided in Table 1 below.

Table 1: Summary of MECP Water Well Records in Analysis Area

Criteria	West Section	Central Section	East Section	Total
Well Depth (mbgs)				
< 10	92	71	35	198
10 to 15	92	110	9	211
15 to 20	35	80	11	126
20 to 30	47	92	20	159
30 to 40	26	26	34	86
40 to 50	11	30	21	62
50 to 100	8	26	92	126
> 100	0	2	25	27
No Depth Information	0	1	6	20
Screened Formation				
Bedrock	112	139	29	280
Overburden	157	252	158	567
Unknown / Not Provided	42	47	66	155
Primary Water Use				
Commercial	10	0	3	13
Domestic	221	347	156	724
Industrial	10	0	2	12
Irrigation	20	0	3	23
Livestock	15	54	23	92
Monitoring	17	27	41	85
Not Used	6	2	8	16
Public	7	2	5	14
Unknown	5	6	12	23
Water Quality				
Fresh	254	314	167	735
Mineral	3	1	0	4
Salty	2	5	5	12
Unknown / Not Stated / Not Tested	51	118	81	250
Gas	1	0	0	1

3.1.7 Permit to Take Water Records

3.1.7.1 Active Permit to Take Water Records

A review of the MECP PTTW database identified no active PTTWs within the Preliminary Design as of September 2025.

3.1.7.2 Inactive Permit to Take Water Records

A review of the MECP PTTW database identified 37 inactive PTTWs within the Preliminary Design as of September 2025.

There are 24 inactive PTTW locations within the West Section (MECP, 2025). The purposes of the inactive PTTWs included dewatering construction, dewatering, and miscellaneous (pumping test). The sources of water included both groundwater and surface water. The most recent expiry date was May 2024.

There are two inactive PTTWs located within the Central Section (MECP, 2025). The purposes of the inactive PTTWs included construction. The sources of water included surface water. The most recent expiry date was September 2022.

There are 11 inactive PTTWs located within the East Section (MECP, 2025). The purposes for water takings included commercial, dewatering construction, and construction. The sources of water included both surface and groundwater. The most recent expiry dates were September 2019.

3.1.8 Hydrogeological Setting - Overburden Aquifers

3.1.8.1 Surficial / Unconfined Aquifer

Surficial or unconfined aquifer units within the Analysis Area are limited to the isolated glaciolacustrine deposits located within Sections 1, 2, 5, 7, and 8 of the Analysis Area, as well as modern alluvial deposits found within the river valleys that transect the Analysis Area.

The following defines the local surficial sediments into hydrostratigraphic units:

- Halton Till (clay to silt till) – Aquitard.
- Newmarket Till (sandy silt till) – Aquitard.
- Fine-Textured Glaciolacustrine Deposits (silt and clay, laminated) – Aquitard.

- Modern Alluvial Deposits (clay, silt, sand, gravel, may contain organics) – Unconfined Aquifer or Aquitard.
- Coarse-Textured Glaciolacustrine Deposits (sand, gravel, minor silt and clay) – Unconfined Aquifer.

3.1.8.2 Overburden Aquifers

There are three aquifers that have been historically documented within the Analysis Area, including the Lower Chinguacousy Aquifer, the Kleinburg Aquifer, and the Woodbridge Aquifer (Singer et al., 2003).

The Lower Chinguacousy Aquifer is located within the Municipalities of Brampton and Caledon. The area where the aquifer occurs is covered mostly by Halton Till, with a few small areas covered by glaciofluvial and glaciolacustrine deposits.

The Kleinburg Aquifer is located in the vicinity of Kleinburg. This local aquifer consists of sand and gravel deposits.

The Woodbridge Aquifer is located in the Woodbridge area, south of Kleinburg. This confined aquifer is covered by glaciolacustrine clay deposits and consists of sand and gravel deposits.

A review of local MECP water well records and the CAMC hydrostratigraphic model was completed for the purpose of characterizing the hydrostratigraphy of the Analysis Area beneath the surficial sediments. A summary of the CAMC hydrostratigraphic model is as follows.

- Recent Deposits (including weathered till) – Unconfined Aquifer
- Halton Till – Aquitard
- Oak Ridges Moraine Complex – Confined Aquifer
- Newmarket Till – Aquitard
- Thorncliffe – Confined Aquifer
- Sunnybrook – Aquitard
- Scarborough – Confined Aquifer
- Weathered Bedrock – Confined Aquifer
- Un-weathered Bedrock – Aquitard

According to the MECP WWIS, the static groundwater levels in the overburden wells in the West Section range from approximately 3 m above ground surface to 47.0 m below ground surface (mbgs). Approximately 60% of the overburden wells have static groundwater levels within 5 mbgs. Four flowing overburden wells (i.e., under artesian pressure and static groundwater level was at or above ground surface), were identified within the Analysis Area. According to the MECP WWIS, there are 27 overburden wells located in the West Region on and within 50 m of the Preferred Route.

Within the Central Section, the wells completed in overburden material range in depth between about 3.7 and 64 m (MECP, 2020). The static groundwater levels in the overburden wells in the Central Section range from artesian conditions, approximately 1.5 m above ground surface to 26.8 mbgs. Approximately 37% of the overburden wells have a static groundwater level within 5 mbgs. Two flowing wells (i.e., under artesian pressure) were identified within the Analysis Area. According to the MECP WWIS, there are 32 overburden wells located in the Central Region on and within 50 m of the preferred route.

The static water levels in the overburden throughout the East Section range from 0 mbgs to 73.2 mbgs. There are ten water wells with a static water level less than 3 mbgs in the East Section. These wells are 3.4 to 61.9 m deep (MECP, 2020). According to the MECP WWIS, there are 4 overburden wells located in the East Region on and within 50 m of the Preferred Route.

3.1.9 Hydrogeological Setting – Bedrock Aquifers

The primary bedrock units within the Analysis Area are known as the Queenston Formation and the Georgian Bay Formation.

The West Analysis Area is primarily underlain by red Queenston shale (with limestone interbeds) from approximately 0 m to greater than 67 mbgs. Bedrock is overlain by silt to silty clay till of considerable thickness in the majority of the West Section and, therefore, the bedrock aquifer could be considered as regionally confined. According to Singer et al. (2003), the Queenston Formation is relatively compact and dense, and often has a low fracture density and limited porosity. These hydrogeological properties define the bedrock unit as a poor aquifer. Only the top 3 to 5 m of the Queenston Formation is weathered and may provide sufficient quantities of water to meet domestic water requirements. Specific capacity values range from 0.5 to 20 L/min (Singer et al., 1997; 2003).

The Georgian Bay Formation consists of greenish to bluish-green shale interbedded with limestone, siltstone, and sandstone. The Blue Mountain and Georgian Bay Aquifers were treated as one hydrogeologic unit in Singer et al. (2003). Singer et al. indicated that the groundwater occurs in the upper 3 to 5 m of the Georgian Bay Formation, which was described as a poor aquifer with poor water-yielding capability (Singer et al., 2003). The Georgian Bay Formation, which underlies the Queenston Formation, is not considered to be a significant source of water.

One hundred twelve (36%) MECP water wells are reported to be completed in bedrock in the West Section. The static groundwater levels in the bedrock wells range from approximately 3 m above ground surface to 27.4 mbgs in the West Section, indicating artesian groundwater conditions (under pressure) at some well locations (MECP, 2020). There are two flowing bedrock wells identified. According to the MECP WWIS, there are 15 bedrock wells located in the West Region on and within 50 m of the Preferred Route. One hundred thirty-nine (32%) MECP water wells are reported to be completed in bedrock in the Central Section and range in depth between about 7.3 mbgs and 126.5 mbgs. Many of these wells are completed in the upper 10 m of the bedrock unit, which is interpreted to be 'weathered' bedrock. Wells completed in bedrock in the Central Section are fairly evenly distributed between these two formations, with 44% of bedrock wells completed in Georgian Bay Formation and 55% of bedrock wells completed in Queenston Formation. The static water levels in these bedrock wells range from artesian conditions of 0 mbgs to 33.5 mbgs. In addition, one flowing well (i.e., under artesian pressure), was identified within the Analysis Area. According to the MECP WWIS, there are 10 bedrock wells located in the Central Region on and within 50 m of the Preferred Route. According to the MECP WWIS, there are 25 wells drilled in the bedrock aquifer with depths ranging from 18 to 118.6 mbgs in the East Section. The static water levels in the 25 bedrock wells range from 11.0 mbgs to 61.0 mbgs (MECP, 2020). According to the MECP WWIS, there are no bedrock wells located in the East Region on and within 50 m of the Preferred Route.

3.1.10 Wellhead Protection Area

There are two separate areas that represent Wellhead Protection Areas (WHPA) within the Analysis Area in the East Section. The WHPAs for the municipal water supply for the municipalities within the Study Area are shown on Figures 5a, 5b, and 5c, based on available information from York Region (2009). There is a single set of WHPAs overlapping with the Analysis area at Kleinburg.

3.1.11 Groundwater Flow in Analysis Area

Groundwater flow within the three primary aquifer complexes, the Oak Ridges Aquifer Complex, the Thorncliffe Formation, and the Scarborough Formation is generally south and southeast towards Lake Ontario and flow is controlled on a regional scale by changes in bedrock topography, changes in stratigraphy and differences in groundwater elevation expressed as a potentiometric surface (TRCA, 2015c).

The groundwater flow of the Thorncliffe formation shows local deviation toward the major river systems, and then flows to Lake Ontario.

There are deep channels cut within the Newmarket Till (where it is present) that cause some level of hydrogeological connectivity between shallow and deep overburden aquifers.

3.1.12 Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas

Highly Vulnerable Aquifers (HVA) are aquifers which can be easily changed or affected by contamination from both human and natural processes (TRCA, 2015c). If an aquifer is considered highly vulnerable, then a vulnerability score of 6 (out of a maximum of 6) is assigned to this aquifer (TRCA, 2015c). Only the HVAs having vulnerability score of 6, representing more sensitive environments, are shown on Figures 5a, 5b, and 5c (note, layers are clipped to the approximate areas of the analysis area).

Significant Groundwater Recharge Areas (SGRA) are delineated by Conservation Authorities using the Water Budget prepared for the watershed of interest. The SGRAs are given a vulnerability score of 6 (high), 4 (medium) or 2 (low) based on where the estimated average annual groundwater recharge rates are greater than the threshold recharge rate (TRCA, 2015b). The SGRAs that are shown on Figures 5a, 5b, and 5c include only those with a vulnerability score of 6 and over, representing more sensitive environments.

3.1.13 Surface Water Intake

According to the Source Protection Assessment Reports, there are no Intake Protection Zones (IPZ) located within the Analysis Area. The IPZ is an area around a surface water intake that is identified for protection.

3.2 Water Well Assessment Report Key Findings

3.2.1 Water Well Surveys – West and Central Sections

Requests to participate in a virtual well survey were sent to 790 commercial / residential properties and 79 properties owned by provincial and municipal government agencies / entities with potential groundwater wells in use within the Analysis Area. A virtual well survey was conducted at 51 commercial / residential properties and 27 properties owned by provincial and municipal government agencies / entities. A total of 46 water wells were identified by the property owners (Figures 7a, 7b, and 7c).

A general summary of the completed virtual well surveys is provided below. An updated water well survey will be completed during Detail Design to capture all properties within 500 m of the Preliminary Design.

- A majority of property owners (72%) had dug wells, that were primarily used for residential water use, and secondary use was livestock / irrigation.
- Limited property owners (4) had historical issues with water quantity or quality. Those owners had issues due to drought or nearby infrastructure construction. Water quality issues were identified by public health testing and wells were shocked or additional treatment systems installed.
- All properties, except for one, have water softeners and / or some form of water treatment (chlorination, reverse osmosis or ultraviolet lights).
- Surface water features included intermittent streams, rivers, ponds fed by surficial runoff and stormwater ponds.

3.2.2 Water Well Surveys – East Section

Requests to participate in a virtual well survey were sent to 354 commercial / residential properties and 48 properties owned by provincial and municipal government agencies / entities with potential groundwater wells in use within the Analysis Area. A virtual well survey was conducted at 9 commercial / residential properties and 23 properties owned by provincial and municipal government agencies / entities. A total of 5 water wells were identified by the property owners (Figure 6).

A general summary of the completed virtual well surveys is provided below. An updated water well survey will be completed during Detail Design to capture all properties within 500 m of the Preliminary Design.

- Most property owners had drilled wells that were primarily used for residential water use, and the secondary use was irrigation.
- All properties have water softeners and / or some form of water treatment (chlorination, reverse osmosis or ultraviolet lights).
- Surface water features include a river and pond.

3.3 Geotechnical Investigations Key Findings

3.3.1 Geotechnical Investigations – West Section

As of August 2024, geotechnical investigations have been conducted at 12 structure locations within the West Section of the Analysis Area (Appendix A; WSP 2022-2024). The locations of the geotechnical investigations are shown in figures A-1 and A-2 in Appendix A. A detailed summary of the geotechnical investigations undertaken is also provided in summary Table A-1 in Appendix A.

The general stratigraphy encountered during the investigations included silty clay till, sandy silt, clayey silt, and sand and gravel. Bedrock was encountered at 6 structure locations and was classified as the Queenston Formation (Shale). Bedrock was initially encountered at elevations ranging from 169.8 masl to 246.3 masl.

During borehole advancement, groundwater elevations were inferred from the soil conditions. According to the borehole logs, groundwater elevations ranged from 200.9 masl and 260.4 masl. Groundwater monitoring wells were installed at only two (2) structure (W-18 and W-23) locations in the West portion of the Analysis Area. The groundwater elevations in the 2 monitoring wells ranged from 190.3 masl and 260.4 masl.

Based on the geotechnical investigation findings, construction considerations were provided for groundwater / surface water control. In general, considering the consistency and relatively low permeability of the near surface soils, it was recommended that dewatering should be feasible by pumping from properly filtered sumps from within the excavation and that surface water should be directed away from excavations.

Any remaining geotechnical investigations will be included in the hydrogeological analysis during Detail Design.

3.3.2 Geotechnical Investigations – Central Section

As of August 2024, geotechnical investigations have been conducted at 21 structure locations within the Central Section of the Analysis Area (Appendix A; Peto McCallum Ltd. 2023). The locations of the geotechnical investigations are shown in figures A-1 and A-3 in Appendix A. A detailed summary of the geotechnical investigations undertaken is also provided in summary Table A-2 in Appendix A.

The general stratigraphy encountered during the investigations included silty clay till, sandy silt, silt, silty clay and sand till. Bedrock was encountered at 5 structure locations and was classified as the Queenston Formation (Shale). Bedrock was initially encountered at elevations ranging from 193 masl to 257 masl.

During borehole advancement, groundwater elevations were inferred from the soil conditions. According to the borehole logs, groundwater elevations ranged from 225.8 masl and 277.9 masl. Groundwater monitoring wells were installed at various structure locations throughout the Central portion of the Analysis Area. Artesian conditions were encountered near the Healey Road Bridge.

Based on the geotechnical investigation findings, construction considerations were provided for groundwater / surface water control. In general, considering the consistency and relatively low permeability of the near surface soils, it was recommended that dewatering should be feasible by pumping from properly filtered sumps from within the excavation and that surface water should be directed away from excavations.

Any remaining geotechnical investigations will be included in the hydrogeological analysis during Detail Design.

3.3.3 Geotechnical Investigations – East Section

As of August 2024, geotechnical investigations have been conducted at 27 structure locations within the East Section of the Analysis Area (Appendix A; Thurber, 2022-2024). The locations of the geotechnical investigations are shown in figures A-1 and A-3 in Appendix A. A detailed summary of the geotechnical investigations undertaken is provided in summary Table A-3 in Appendix A.

The general stratigraphy encountered during the investigations included silty clay till, sandy silt, silt, and silty clay. Bedrock was encountered at 9 structure locations and was classified as the Georgian Bay Formation. Bedrock was initially encountered at elevations ranging from 168.3 masl to 186.3 masl.

During borehole advancement, groundwater elevations were inferred from the soil conditions. According to the borehole logs, groundwater elevations ranged from 208.8 masl and 323.7 masl. Groundwater monitoring wells were installed at various structure locations throughout the East portion of the Analysis Area. The groundwater elevations in the monitoring wells ranged from 193.4 masl and 262.2 masl.

Based on the geotechnical investigation findings, construction considerations were provided for groundwater / surface water control.

In general, considering the consistency and relatively low permeability of the near surface soils, it was recommended that dewatering should be feasible by pumping from properly filtered sumps from within the excavation and that surface water should be directed away from excavations.

In addition, several structure locations (E-20, E-W17, E-W23, and E-W25) may require additional pumps if zones of perched water or concentrated seepage are encountered in localized non-cohesive layers within the cohesive soils. At structure location E-W13, located near Robinson Creek, it was recommended that if water levels from the creek impact the proposed construction method, consideration can be given to using a cofferdam or flow diversion of the creek.

Any remaining geotechnical investigations will be included in the hydrogeological analysis during Detail Design.

4. Potential Groundwater Impacts and Mitigation

4.1 Potential Impacts to Drinking Water

There are 21 potential impacts for which the Source Protection Committees must write policies in areas where a threat of impact could be significant. For the scope of this Project, the following prescribed threats will be discussed as they relate to the construction and operation of a roadway / highway:

- Application of road salt;
- Application of commercial fertilizer; and
- Handling and storage of fuel.

These three construction and operation activities are considered to pose a low-risk threat to the drinking water systems in the area, with the exception of application of commercial fertilizer in the areas where managed land is present within the Credit Valley Source Protection Area (CVSPA). Based on the Assessment Report for CVSPA, the application of commercial fertilizer is considered as a moderate threat in the areas where managed land is present. The source protection plans do not provide prescriptive policies for low-risk threats. The MTO will apply current best management practices to minimize threats from these activities by way of adherence to MTO plans and policies, the use of special contract provisions, and contract oversight and monitoring.

4.2 Temporary and Permanent Construction Impacts

MTO identified construction activities that may be associated with the Highway 413 Corridor. Any adverse impacts may be more significant where PSWs were identified or where geological formations have high permeability (i.e., sands and gravels).

4.2.1 Clearing and Grubbing

The removal of trees and stumps, and other vegetation may result in increased surface water runoff and a decrease in water infiltration into the subsurface. This can affect groundwater quantity and quality. Watercourses may also be affected due to an increase in the amount of suspended particles carried by surface water runoff.

4.2.2 Grading

The use of heavy equipment to “cut” or “fill” the original topography within the Analysis Area (to grades specified in future Detail Design) can have a significant effect on groundwater. Excavations made into the shallow aquifer system can result in temporary or permanent changes in groundwater flow patterns and could result in the need for dewatering. Dewatering activities (e.g., discharging to an alternate location) may change the water supply to private water users; lead to settlement of the ground surface; and / or change the quality of groundwater.

4.2.3 Bridges / Interchanges

Embankments, foundations, footings, abutments, and piers may be required for the construction of bridges, the interchanges, on-ramps, off-ramps and integration with existing road infrastructure. This may result in obstruction and / or interception of groundwater as baseflow to surface watercourses.

4.2.4 Preparation of the Road Bed

Compaction of the land prior to road surfacing activities can reduce groundwater recharge to the overburden and bedrock aquifer systems. Obstruction to groundwater recharge will have the greatest impact in upland (elevated) areas where permeable deposits are removed, compacted, or paved over. Obstruction to groundwater discharge may occur if compaction takes place adjacent to surface water features and seepage zones. Compaction can also increase surface water runoff to nearby watercourses.

4.2.5 Road Surfacing

The installation of concrete and / or asphalt roadway surfaces, installation of ramp terminals, etc. for the construction of the Highway 413 Corridor can increase imperviousness and result in the entrainment or wash-off of residual material such as lime, cement, oil and grease, and asphalt into surface water runoff. Runoff can flow to

nearby watercourses or adjacent areas where infiltration into the aquifer system may result in groundwater contamination if residuals are not appropriately managed.

4.2.6 Well Decommissioning

Based on the final design of the Highway 413 Corridor, private water wells for residences and commercially-dependent enterprises may need to be decommissioned to facilitate the construction of the Highway 413 Corridor. All well decommissionings, as needed, will be carried out in accordance with Ontario Regulation 903.

4.2.7 Overall Change in Groundwater Recharge and Discharge

Effects on groundwater recharge could reduce infiltration capacity to the aquifer system and result in an alteration of groundwater storage and flow patterns. Road construction activities might also disrupt groundwater discharge or result in the formation of new discharge areas, which could impact groundwater quantity and flow; change water table levels; and / or result in a change in the distribution of wetlands.

Changes in surface water flow are generally reflected in a corresponding alteration of the groundwater flow pattern, specifically, flow rate, water level, and direction of flow. Some components of road construction might cause changes in the amount of surface water runoff, drainage patterns, water levels, and flow volumes. In general, changes in groundwater quantity or flow in response to changes in surface water recharge are expected to be attenuated (i.e., more subdued in magnitude and potentially of longer duration).

4.2.8 Overall Likelihood of Release of Contaminants

During any phase of any roadway construction activities, due care should be exercised to avoid fuel, lubricant and fluid spills. Spill and contamination prevention practices should be implemented to avoid potential environmental hazards and cleanups. Where practical, activities such as refueling should not be undertaken in areas with high susceptibility to groundwater contamination, shown in Figures 5a, 5b, and 5c. Small spills and leaks during construction activities have the potential to affect areas of shallow groundwater in high permeability soils. When future Detail Design information is available it should be compared to bedrock elevation, and overburden thickness mapping to determine the potential for excavations to encounter bedrock and bedrock aquifers.

Road salting activities during the winter season are currently present within the Analysis Area and will increase upon the completion of the Highway 413 Corridor.

Concentrations of sodium and chloride will continue to be present in the runoff along roadside drainage ditches and through roadside infiltration, which may impact surface water features. MTO employs and recognizes the importance of salt best management practices and has developed a Salt Management Plan in accordance with Environment Canada's Code of Practice for the Environmental Management of Road Salts (Environment Canada, 2004).

5. Recommendations and Conclusions

The recommendations and conclusions presented in this section should be revisited during Detail Design to confirm their continued validity and applicability.

5.1 Groundwater Well Users

Since the Analysis Area is partially reliant on private groundwater well use, it is recommended to provide advance notice to well owners residing along the Preferred Route in advance of any upcoming construction activities. The Detail Design will review if additional measures are needed, such as developing a construction contingency plan. An updated water well survey will be completed during Detail Design to capture all properties within 500 m of the Preliminary Design.

5.2 Environmental Activity and Sector Registry

The *Ontario Water Resources Act* states that the diversion of surface water or the extraction of groundwater in excess of 50,000 litres per day requires EASR registration with the MECP. Construction activities for proposed construction of the Highway 413 Corridor may result in localized water takings, depending on the nature of the construction work (e.g., ditching, trenching, footing excavation). Based on the preliminary geotechnical investigations, dewatering will be required for at least 12 structures in the West Region, 21 structures in the Central Region, and 27 structures in the East Region. Once the Detail Design for each structure is determined, the need for dewatering and an EASR will be assessed on a case-by-case basis.

Water taking permits may be required for some sections of the project due to presence of permeable soils and groundwater sensitivity, shallow water table, groundwater discharge areas and presence of wetlands.

If it is determined during Detail Design that an EASR is required for surface water and / or groundwater control, wetlands and areas with the groundwater discharge or shallow water levels should be evaluated in detail to support an EASR application. A new water taking permit search for current and expired permits will need to be performed to characterize stresses on the aquifers within the Study Area during Detail Design.

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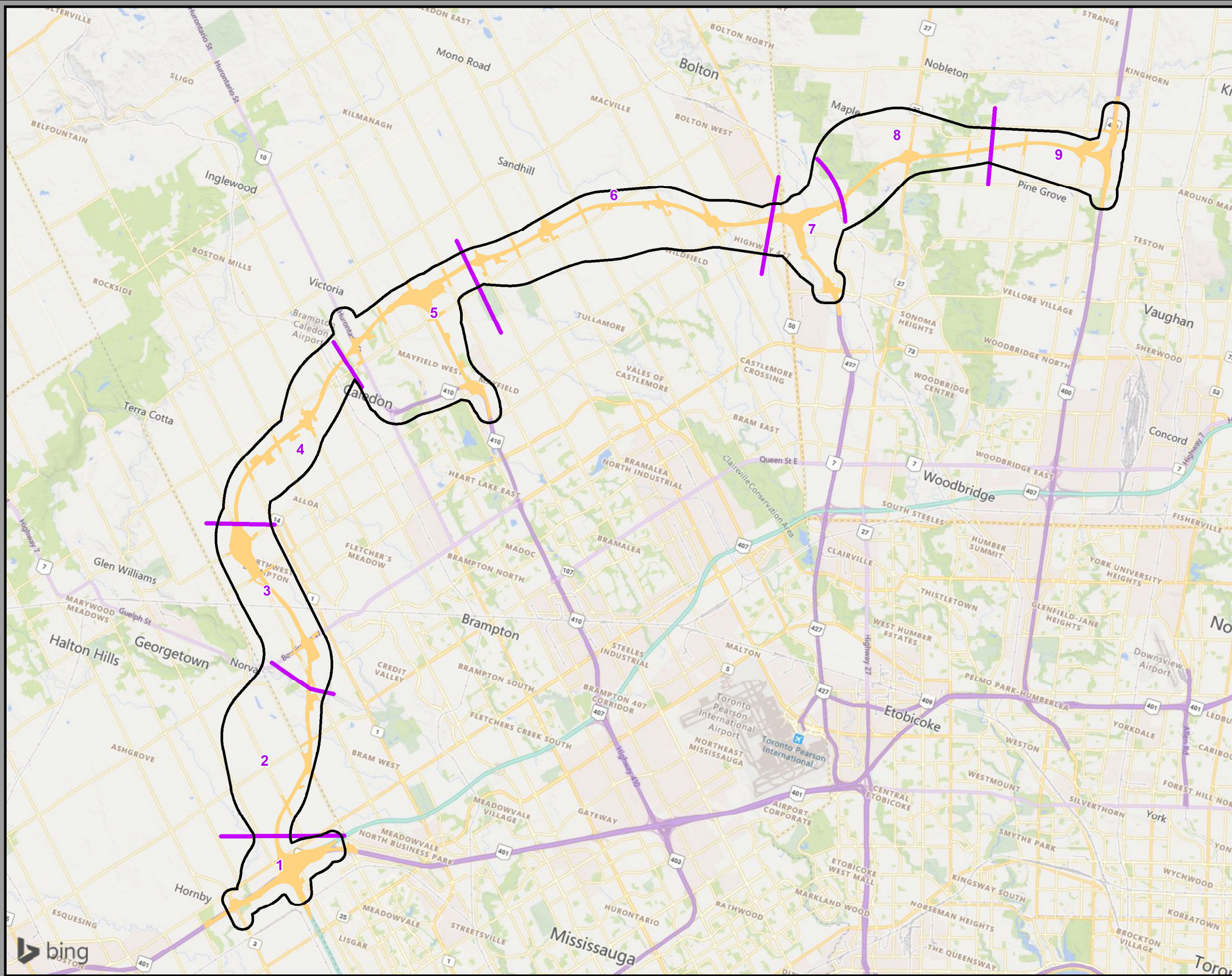
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Figures





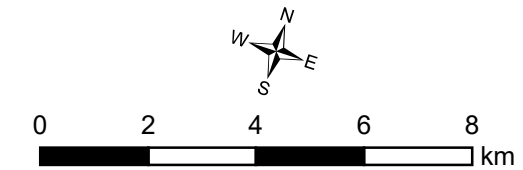
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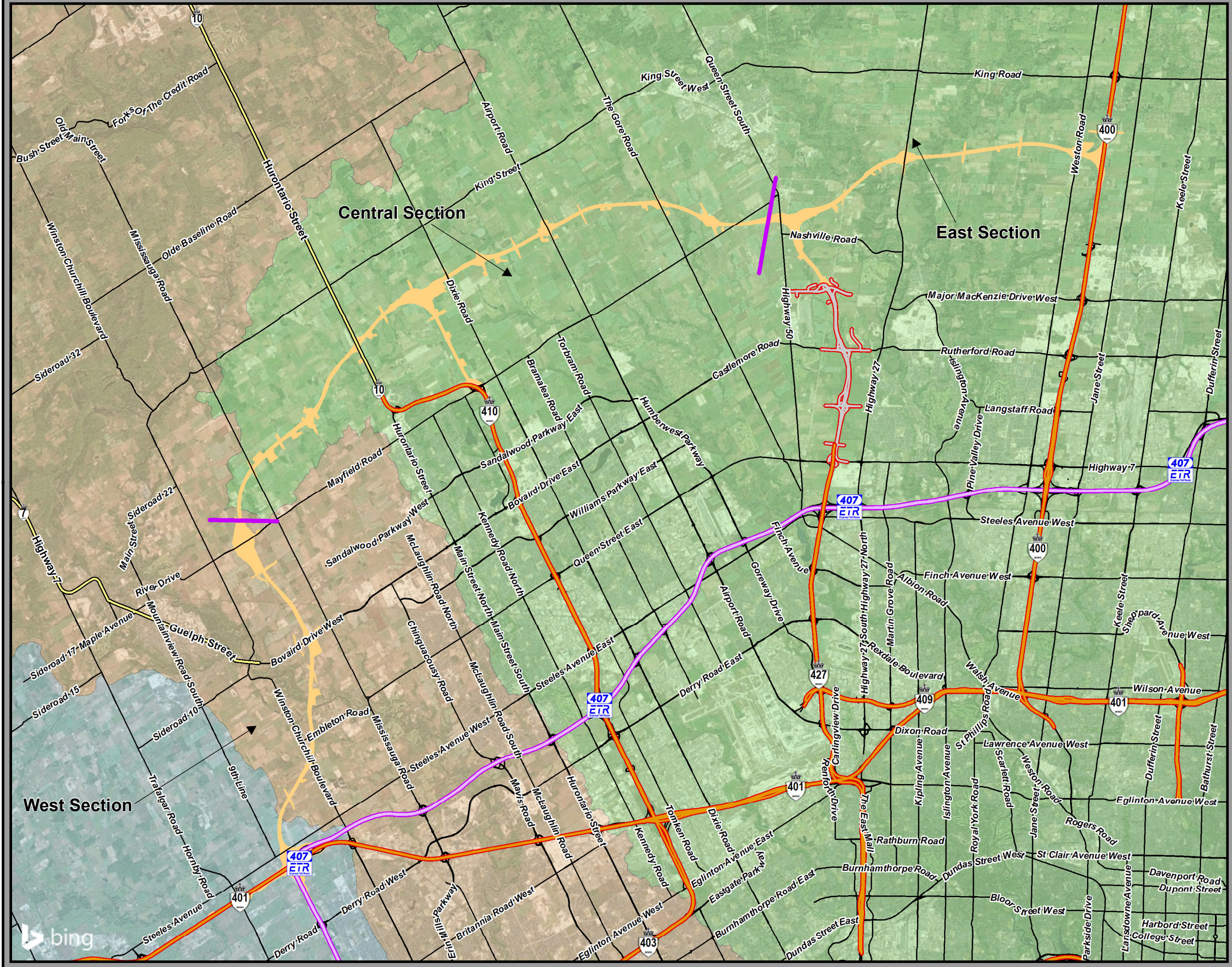
- Analysis Area
- Preliminary Design ROW
- Route Alternative Alignment Sections

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**Study Area Plan
 Figure 2**

October, 2025





Legend

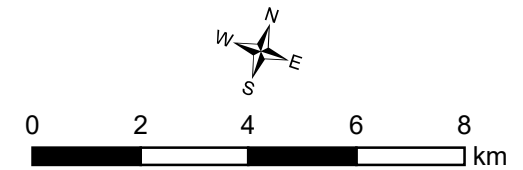
- Section Limits
- Preliminary Design ROW
- Conservation Authority Jurisdictions**
 - Credit Valley
 - Halton Region
 - Toronto and Region
- Roads**
 - Freeway
 - 407 ETR Freeway
 - Future 427 Alignment
 - Provincial Highway
 - Arterial Road

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Conservation Authority Jurisdictions

Figure 3

October, 2025



West Section

Central Section

East Section



Legend

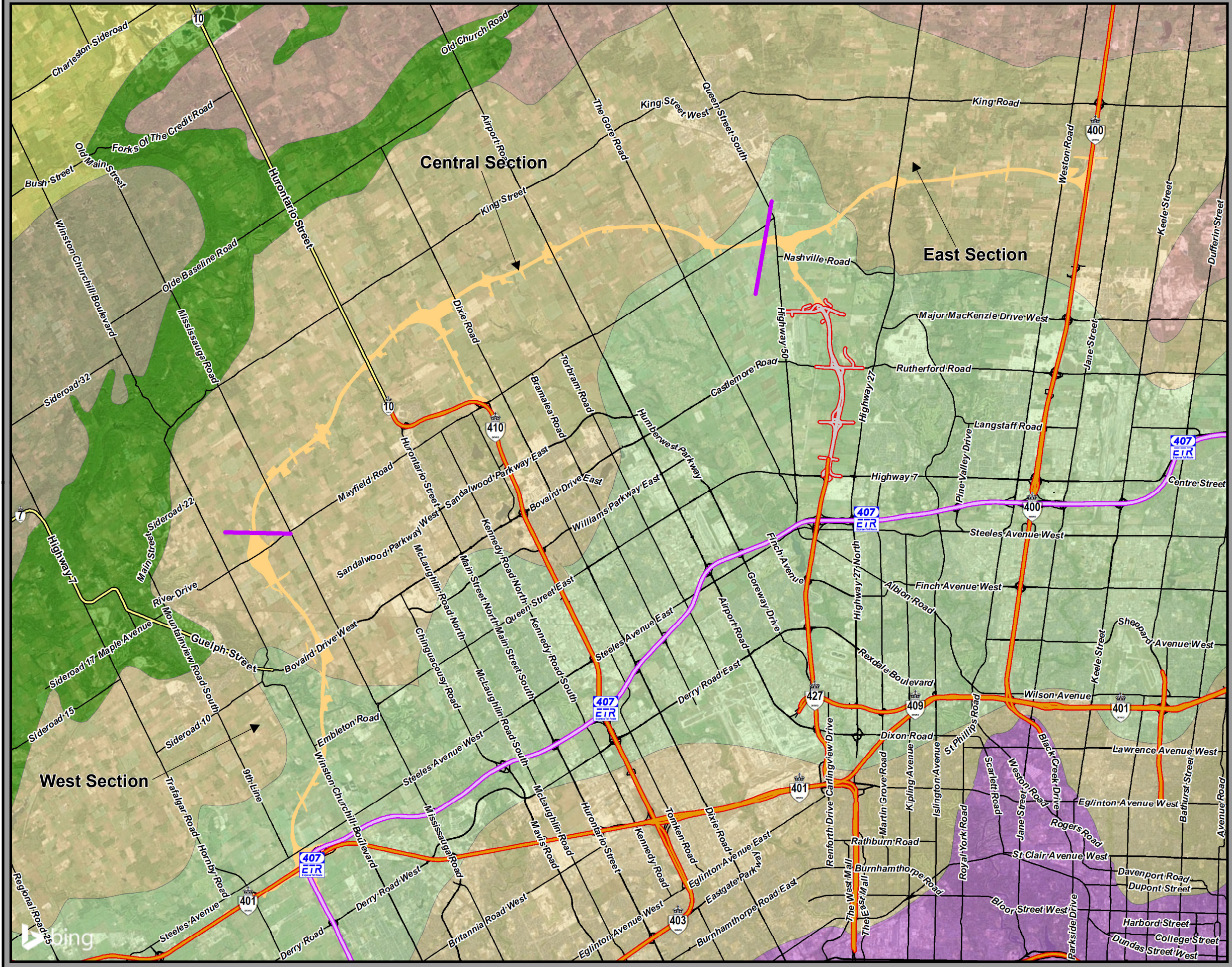
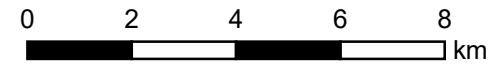
- Section Limits
 - Preliminary Design ROW
- Physiographic Region**
- Guelph Drumlin Field
 - Horseshoe Moraines
 - Iroquois Plain
 - Niagara Escarpment
 - Oak Ridges Moraine
 - Peel Plain
 - South Slope

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Physiographic Regions

Figure 4

October, 2025

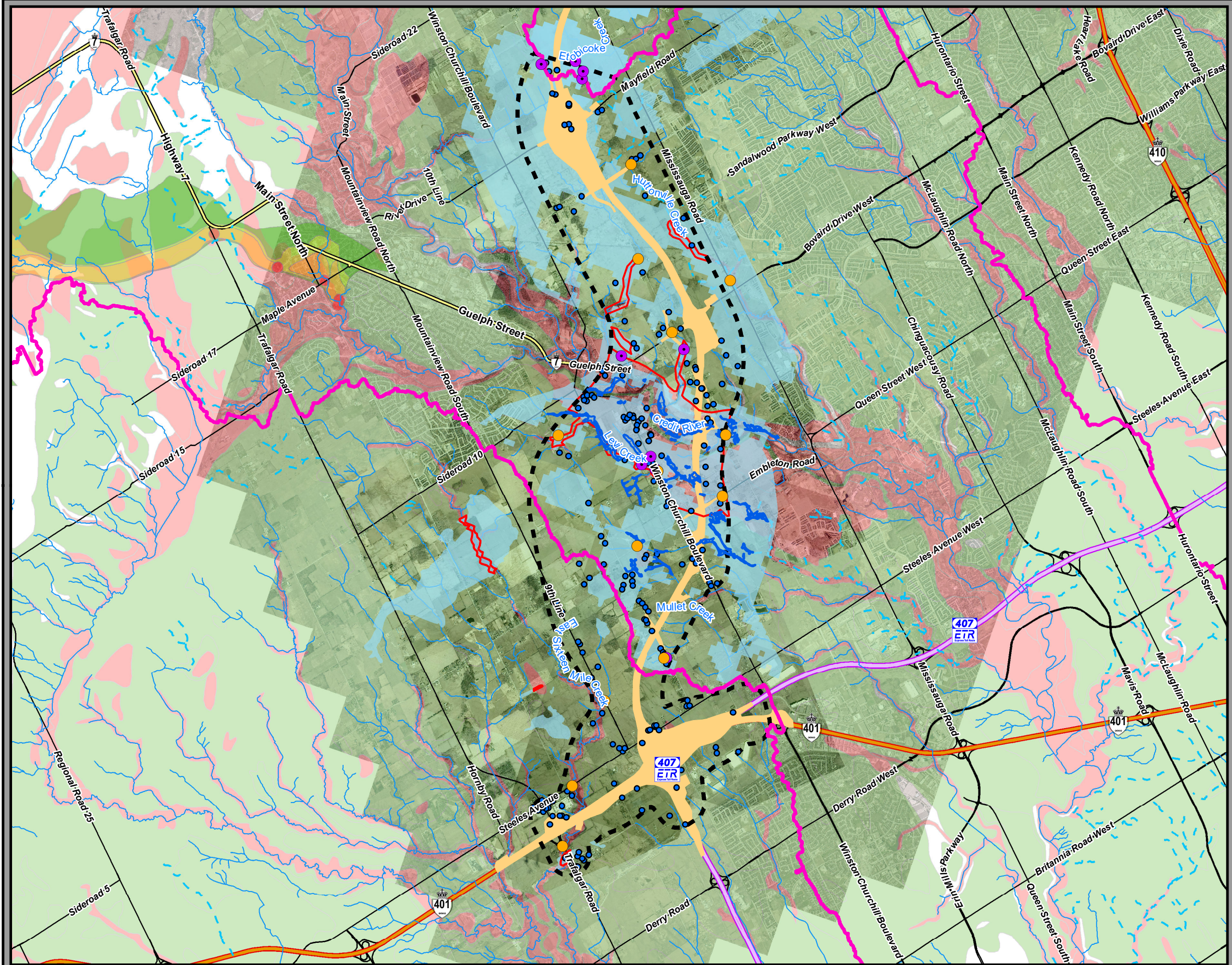


West Section

Central Section

East Section





Legend

- Analysis Area
- Water Well Records with Depth <= 15 mbs
- Preliminary Design ROW

Groundwater Discharge Locations

- Groundwater Discharge Observed by Hydrogeologists
- Groundwater Discharge Observed by Ecologists

Significant Groundwater Recharge Areas

- Credit Valley SPA, no IPZ
- HVA
- Provincially Significant Wetlands

Surficial Geology

- High Permeability Deposit
- Low Permeability Deposit

Watercourses

- Intermittent
- Permanent

Wellhead Protection Area

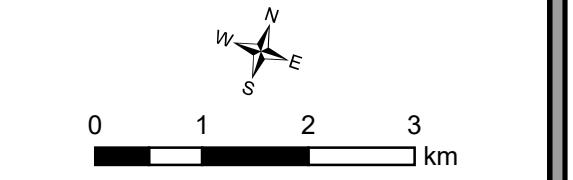
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D

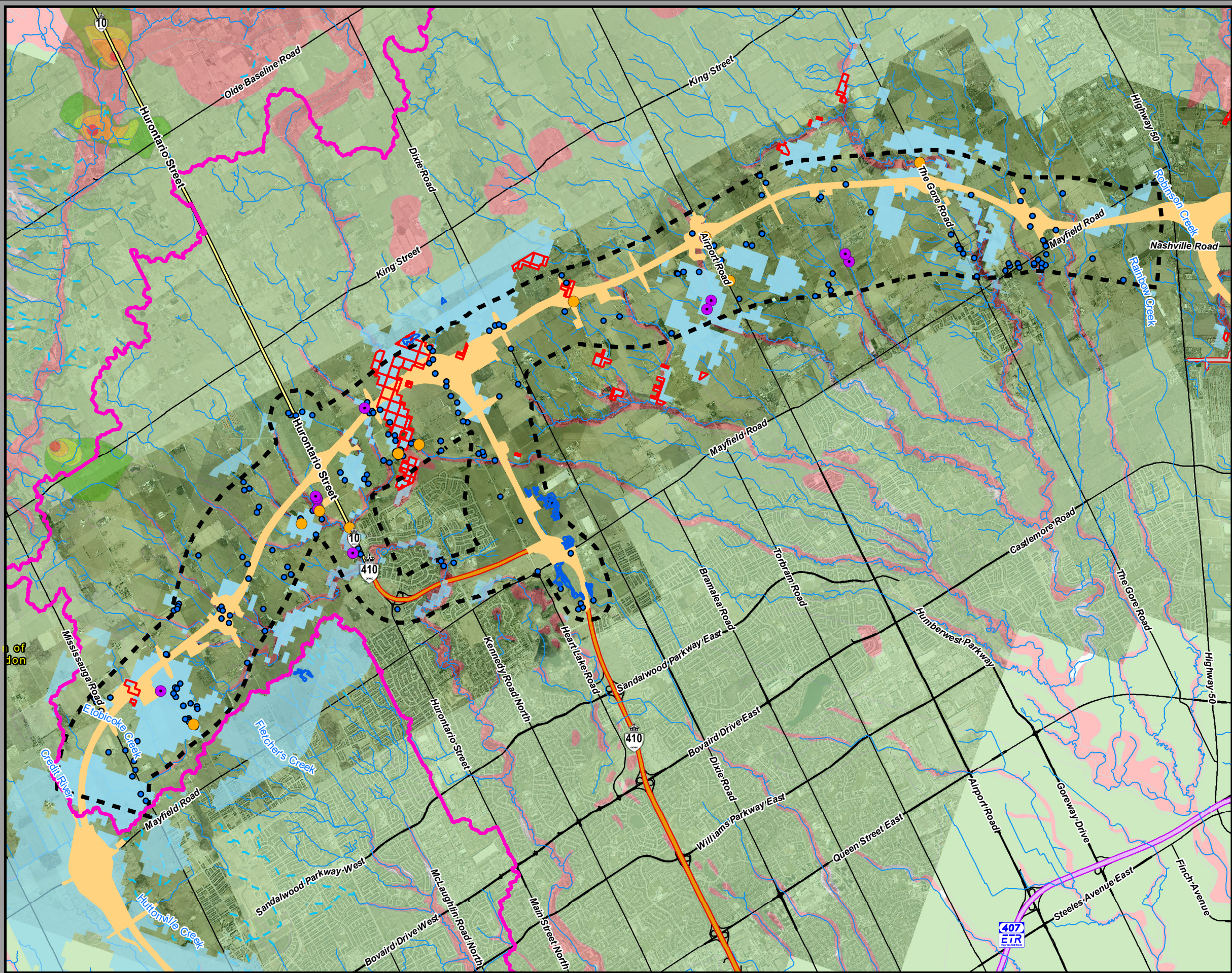
Roads

- Freeway
- 407 ETR Freeway
- Provincial Highway
- Arterial Road

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Groundwater Susceptibility to Contamination - West Section
Figure 5A
October, 2025





Legend

- Analysis Area
- Water Well Records with Depth <= 15 mbgs
- Preliminary Design ROW
- Groundwater Discharge Locations**
- Groundwater Discharge Observed by Hydrogeologists
- Groundwater Discharge Observed by Ecologists
- Significant Groundwater Recharge Areas
- Credit Valley SPA, no IPZ
- HVA
- Provincially Significant Wetlands
- Surficial Geology**
- High Permeability Deposit
- Low Permeability Deposit
- Watercourses**
- Intermittent
- Permanent
- Wellhead Protection Area**
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Roads**
- Freeway
- 407 ETR Freeway
- Future 427 Alignment
- Provincial Highway
- Arterial Road

Sources:

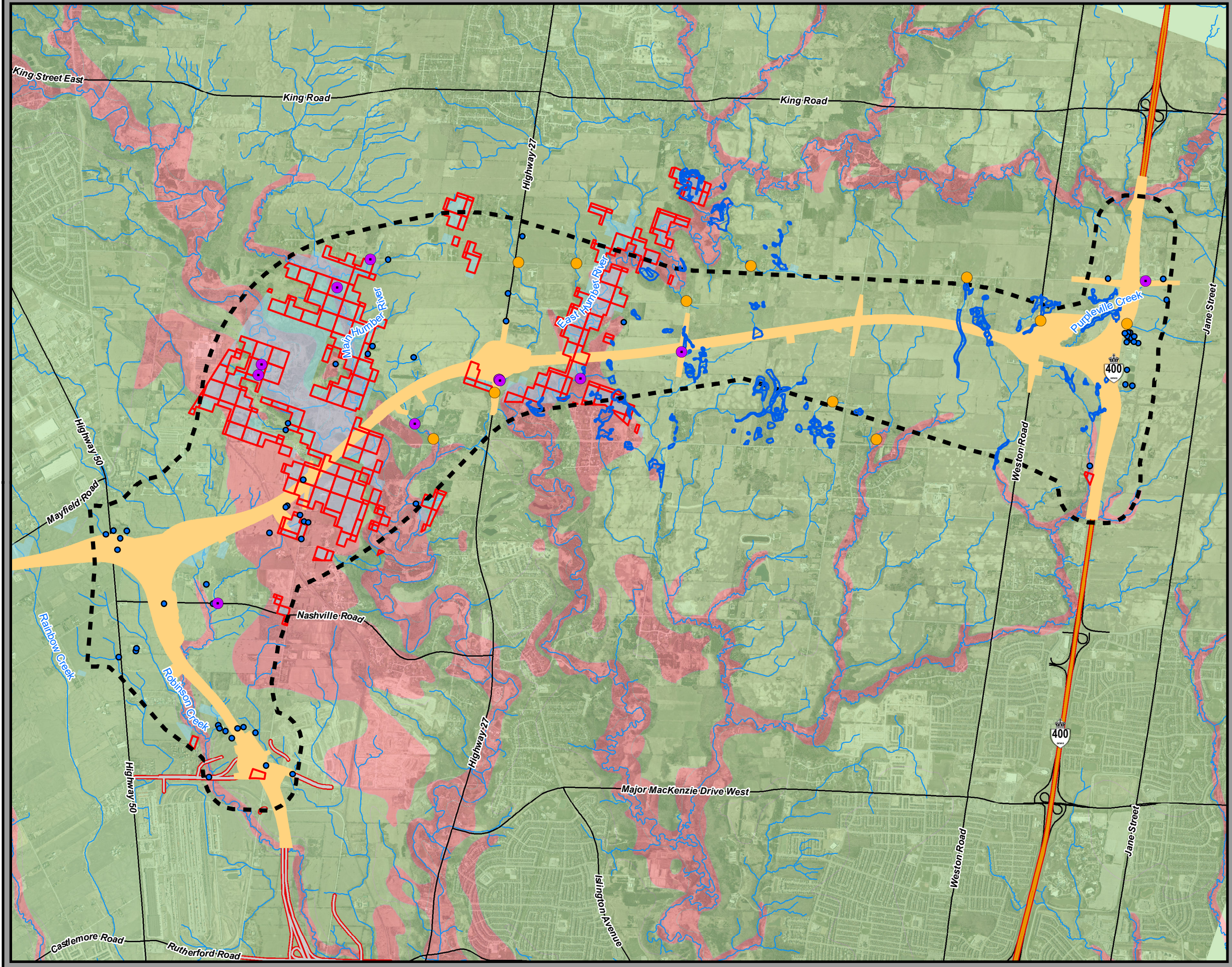
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Groundwater Susceptibility to Contamination - Central Section

Figure 5B

October, 2025





Legend

- Analysis Area
- MECEP Water Well Records with Depth <= 15 mbgs
- Preliminary Design ROW
- Groundwater Discharge Locations**
- Groundwater Discharge Observed by Hydrogeologists
- Groundwater Discharge Observed by Ecologists
- Significant Groundwater Recharge Areas
- HVA
- Provincially Significant Wetlands
- Surficial Geology**
- High Permeability Deposit
- Low Permeability Deposit
- Wellhead Protection Area**
- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- Watercourses**
- Intermittent
- Permanent
- Roads**
- Freeway
- Future 427 Alignment
- Arterial Road

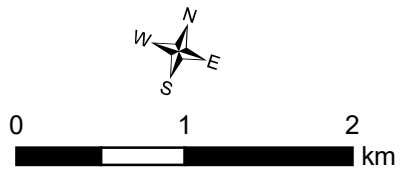
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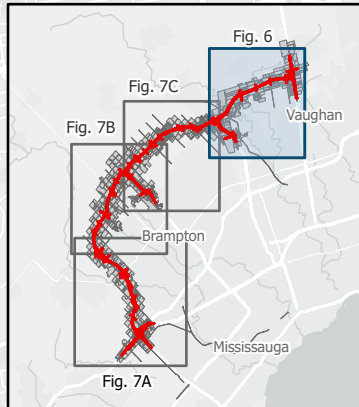
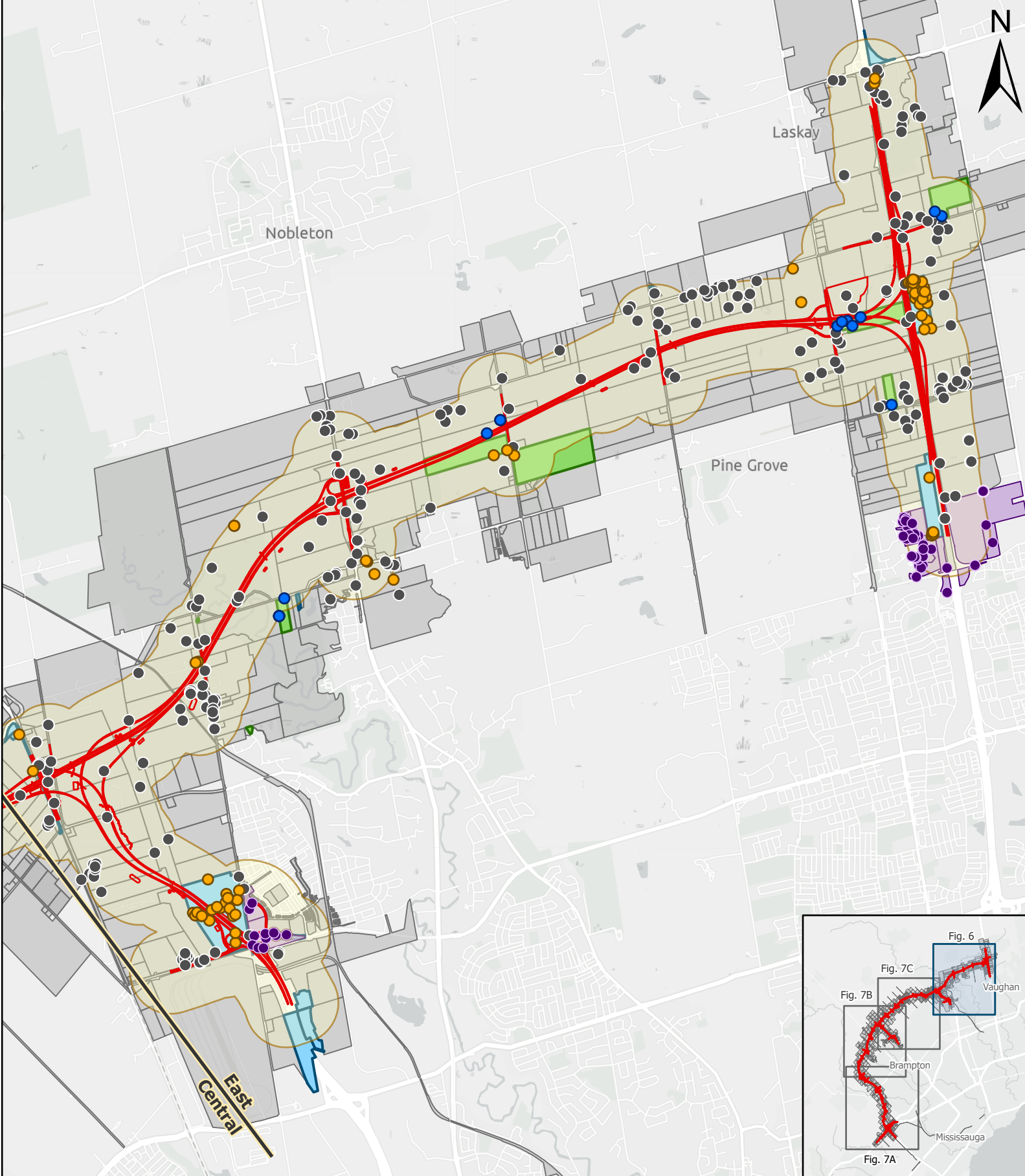
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Groundwater Susceptibility to Contamination - East Section

Figure 5C

October, 2025



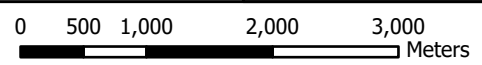


Well Surveys - East Section

Legend	
● Water Well Survey to be Completed during Detail Design	— Preliminary Design
● No Response	 500m Buffer
● Well Not In Use	 Residential/Commercial Water Well Surveys Completed
● Well In Use	 Agency Water Well Survey Completed
 Delineation Line	 Water Well Survey to be Completed during Detail Design

Scale: 1:60,000

Prepared By: GeoVerra



Project Number: 14M-00321-00

Figure No. 6

Date: 2025-10-09



Central
West

Brampton

Georgetown

Norval

Crediton

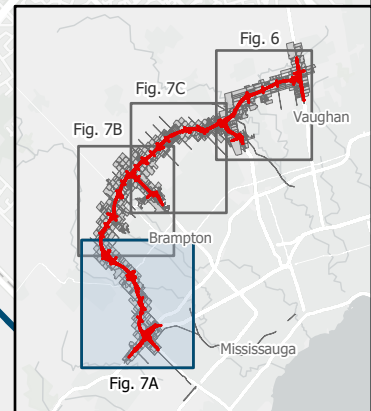
Ashgrove

Whaley's
Corner

Hornby

Agerton

Mansewood



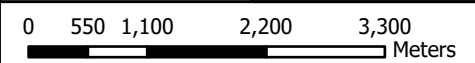
Well Surveys - West Section

Scale: 1:70,000

Prepared By: GeoVerra

Legend

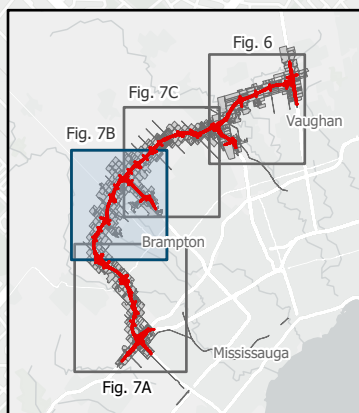
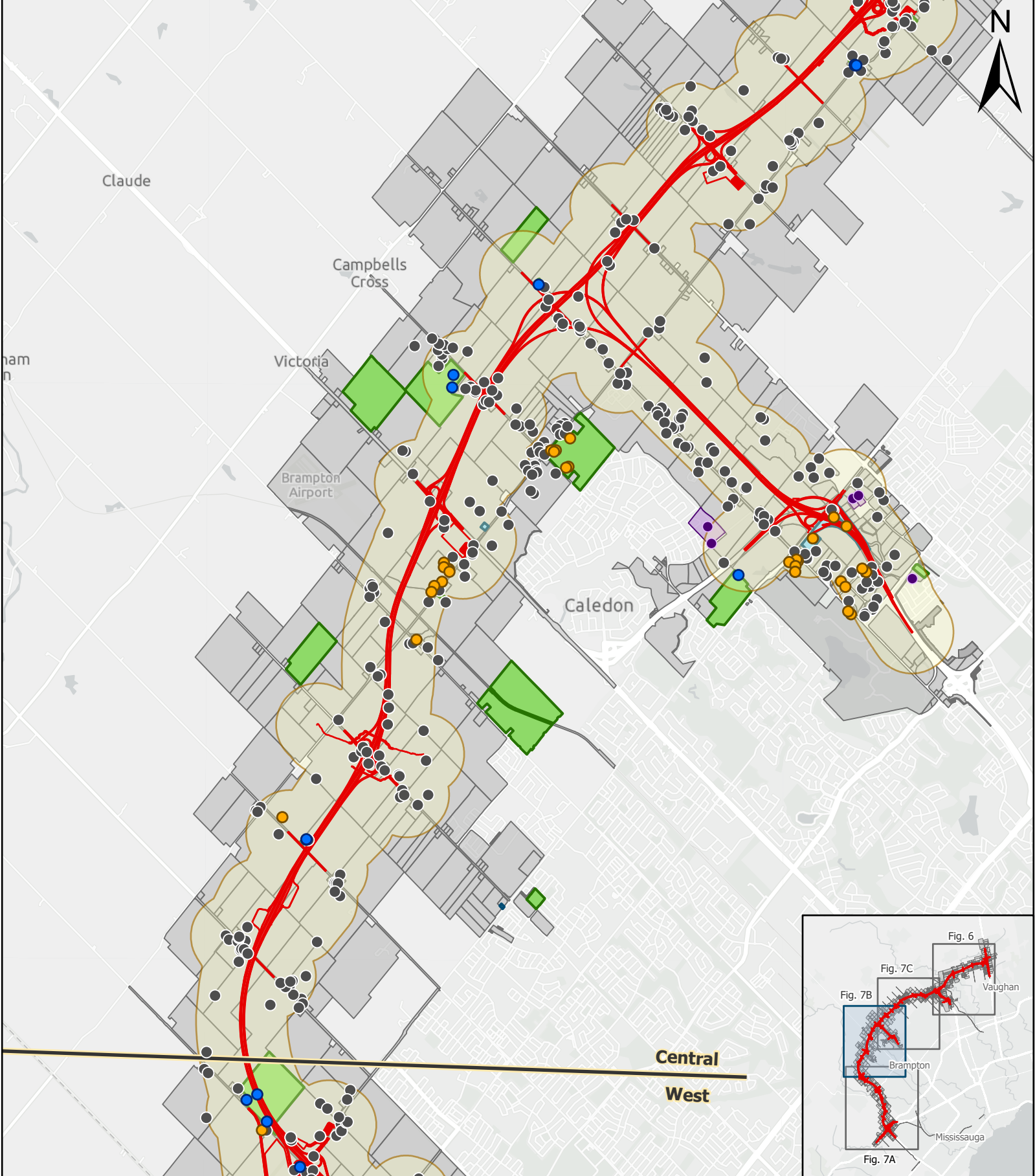
- Water Well Survey to be Completed during Detail Design
- No Response
- Well Not In Use
- Well In Use
- Delineation Line
- Preliminary Design
- 500m Buffer
- Residential/Commercial Water Well Surveys Completed
- Agency Water Well Survey Completed
- Water Well Survey to be Completed during Detail Design



Project Number: 14M-00321-00

Figure No. 7A

Date: 2025-10-09

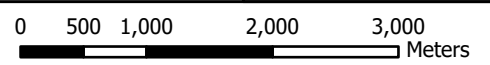


Well Surveys - Central West Section

Scale: 1:60,000

Prepared By: GeoVerra

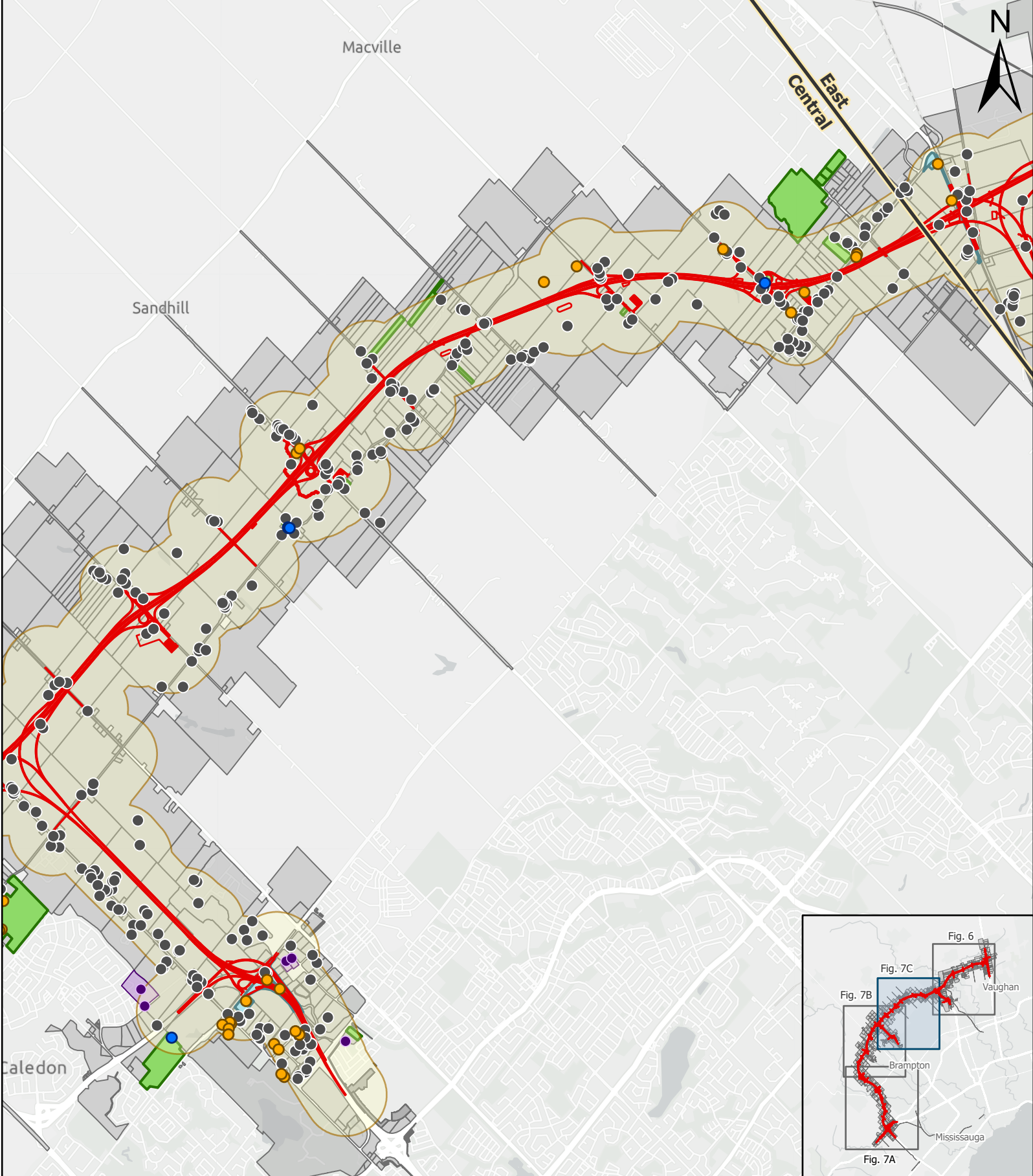
Legend	
	Water Well Survey to be Completed during Detail Design
	No Response
	Well Not In Use
	Well In Use
	Agency Water Well Survey Completed
	Residential/Commercial Water Well Surveys Completed
	Agency Water Well Survey Completed
	Water Well Survey to be Completed during Detail Design
	Preliminary Design
	Delineation Line
	500m Buffer



Project Number: 14M-00321-00

Figure No. 7B

Date: 2025-10-09



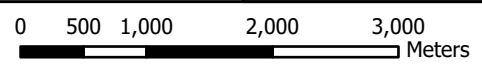
Well Surveys - Central East Section

Scale: 1:60,000

Prepared By: GeoVerra

Legend

- Water Well Survey to be Completed during Detail Design
- No Response
- Well Not In Use
- Well In Use
- Delineation Line
- Preliminary Design
- 500m Buffer
- Residential/Commercial Water Well Surveys Completed
- Agency Water Well Survey Completed
- Water Well Survey to be Completed during Detail Design



Project Number: 14M-00321-00

Figure No. 7C

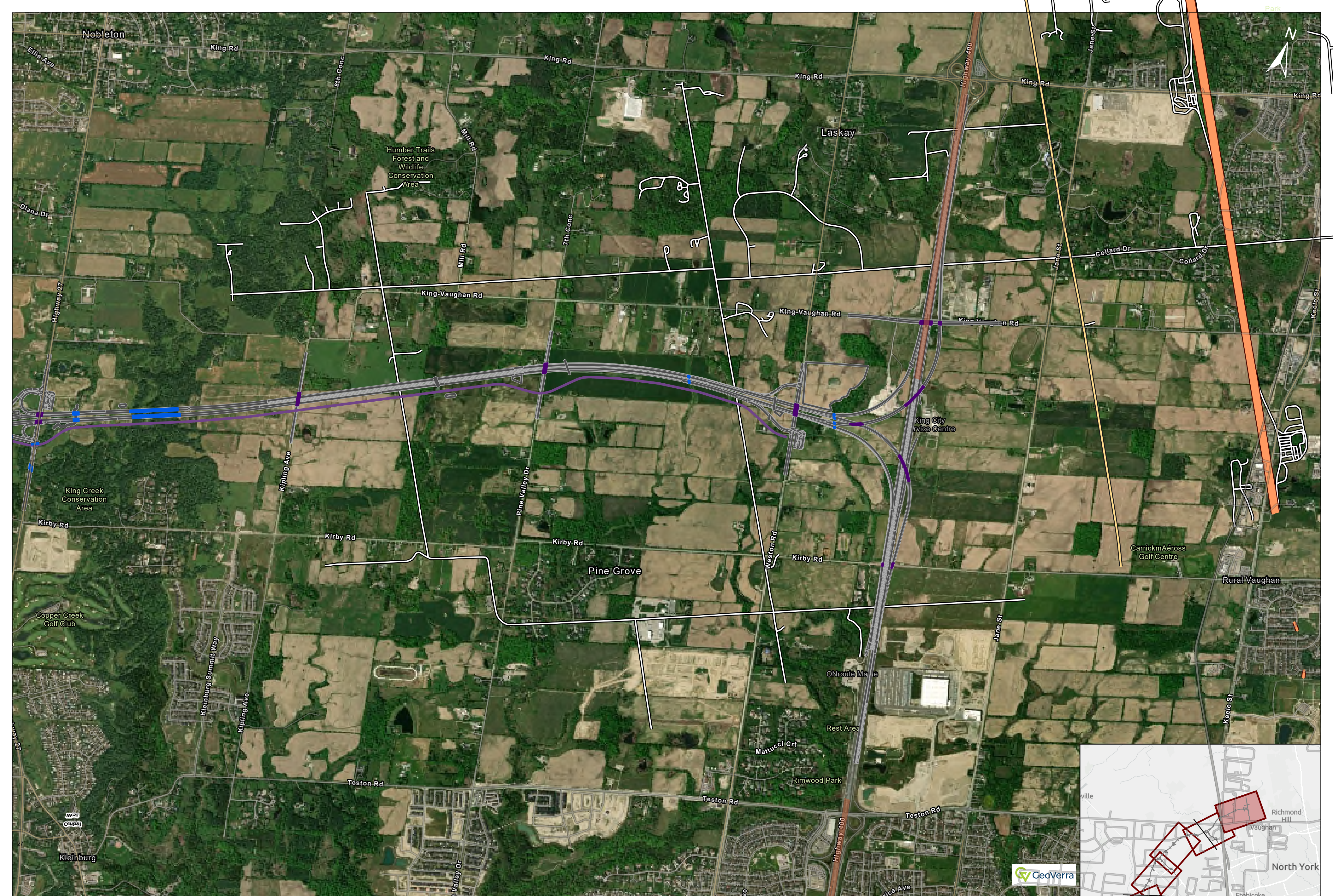
Date: 2025-10-09

A

Geotechnical Investigation Summary

- West, Central, and East Regions



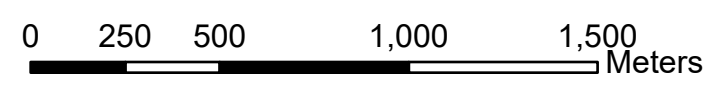


Bridge Structure Locations Overview Map

- Legend**
- Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:20,000

Prepared By:

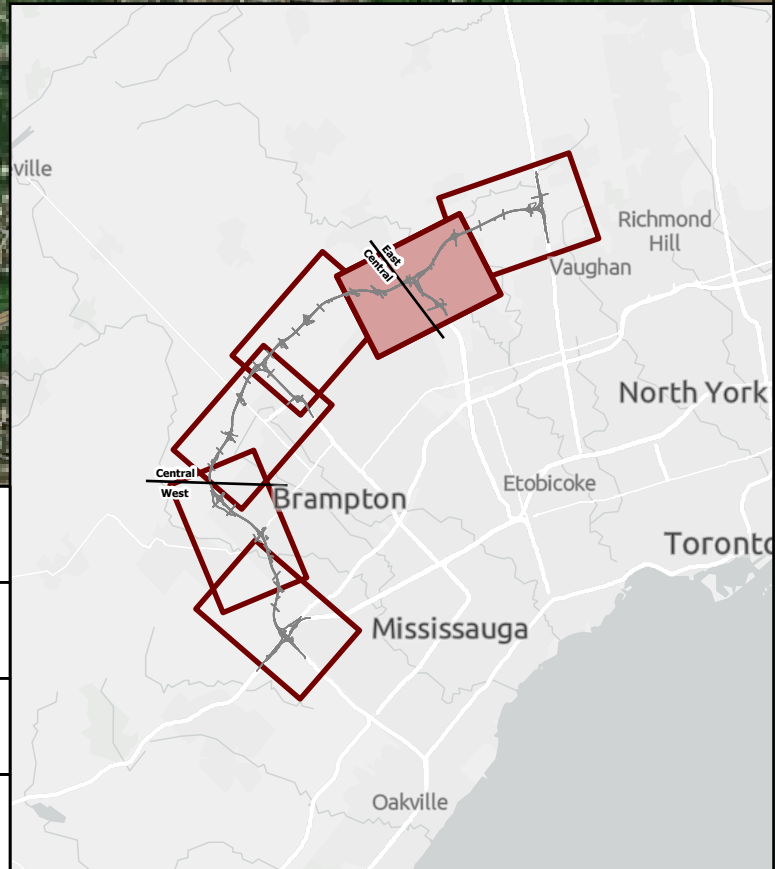
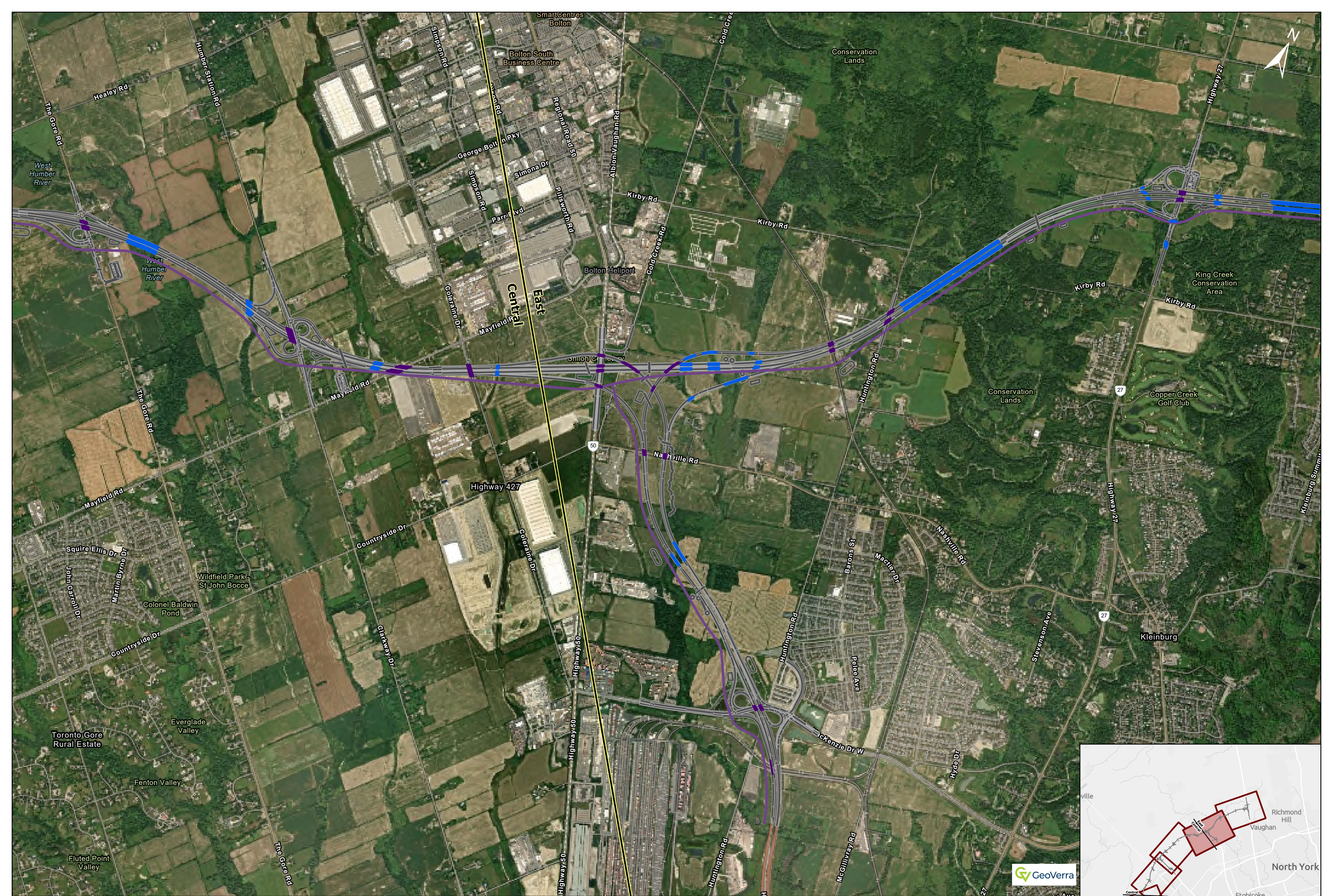


Project Number: 14M-00321-00

Figure No. A-1.1

Date: 2025-10-09



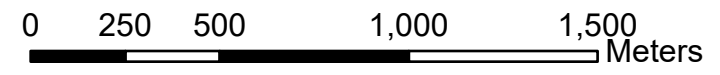


**Bridge Structure Locations
 Overview Map**

- Legend**
- Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:20,000

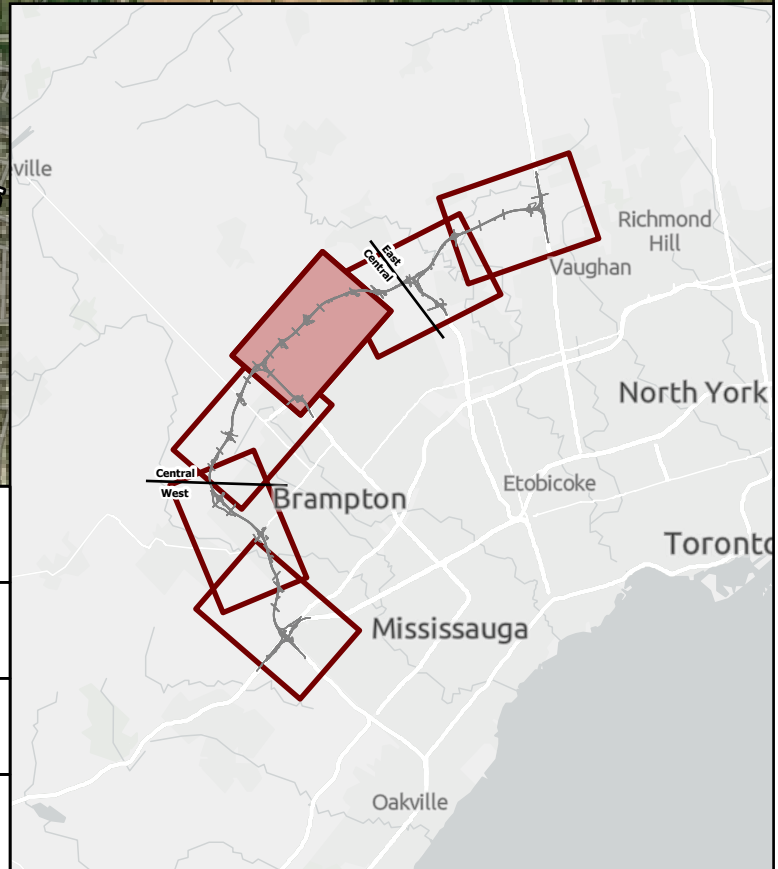
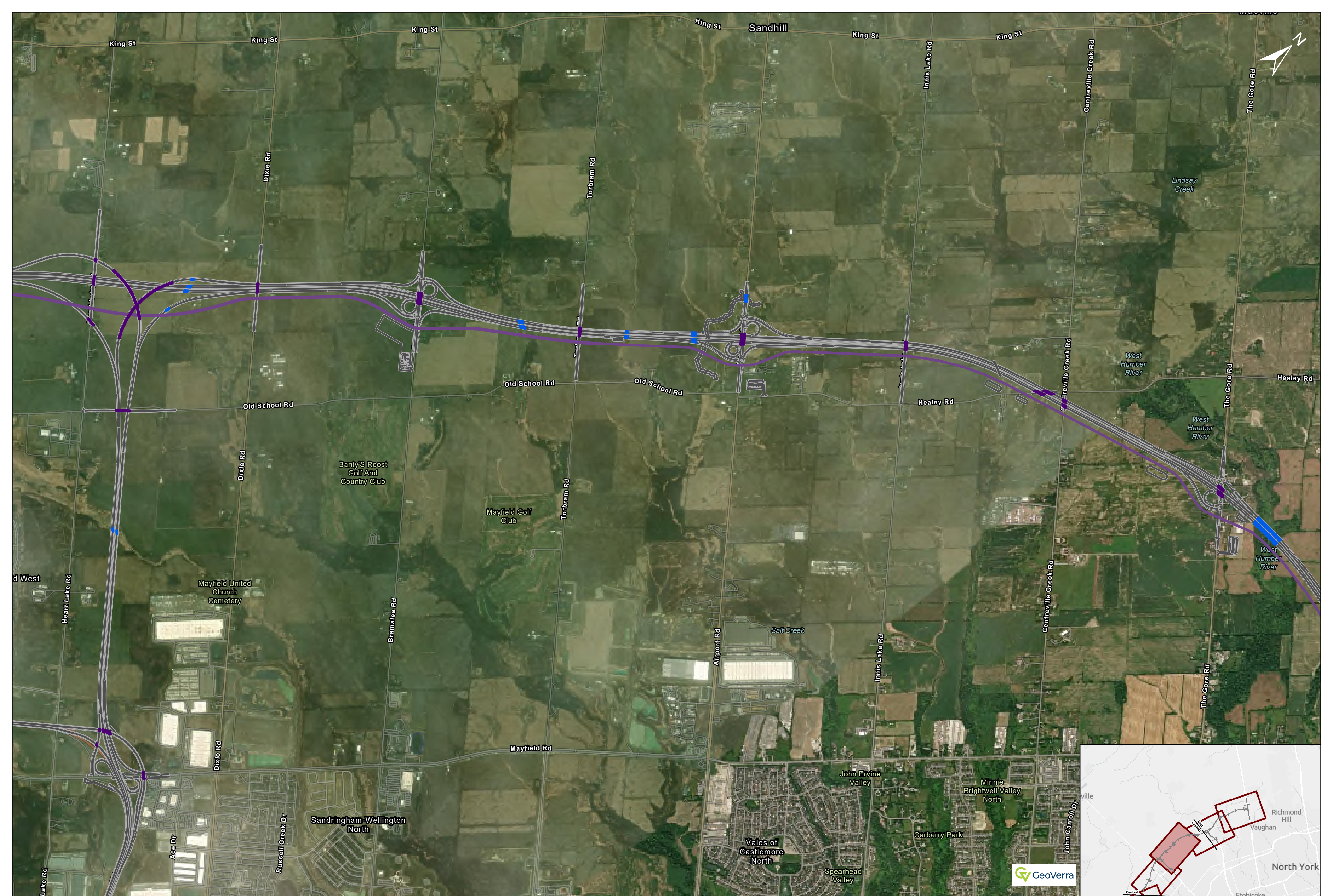
Prepared By:



Project Number: 14M-00321-00

Figure No. A-1.2

Date: 2025-10-09



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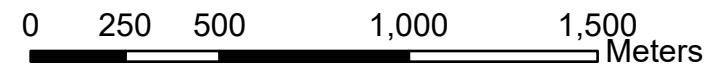
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Bridge Structure Locations Overview Map

- Legend**
- Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:20,000

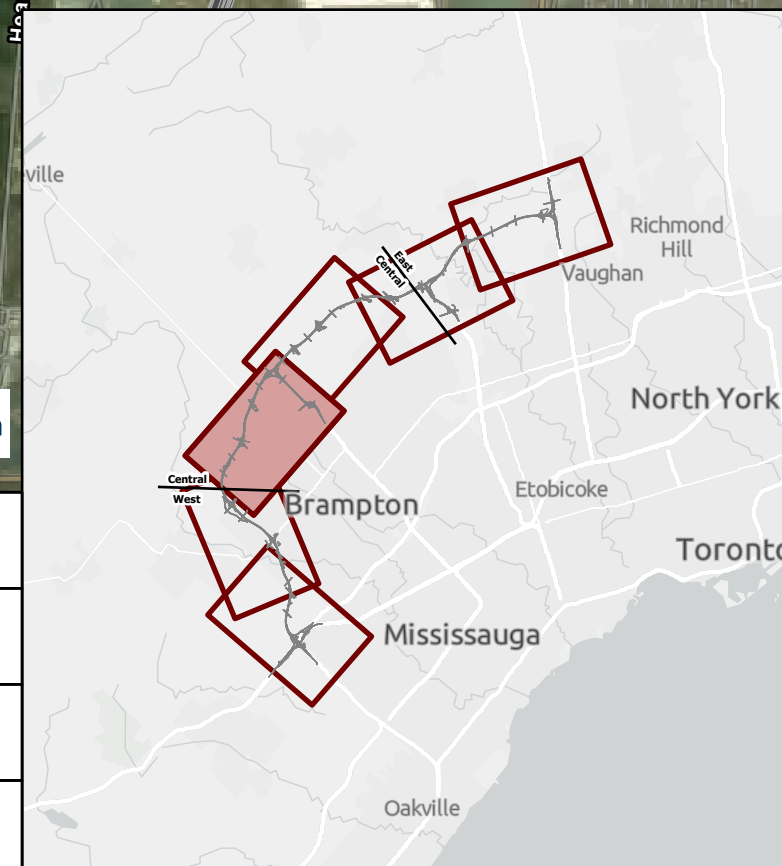
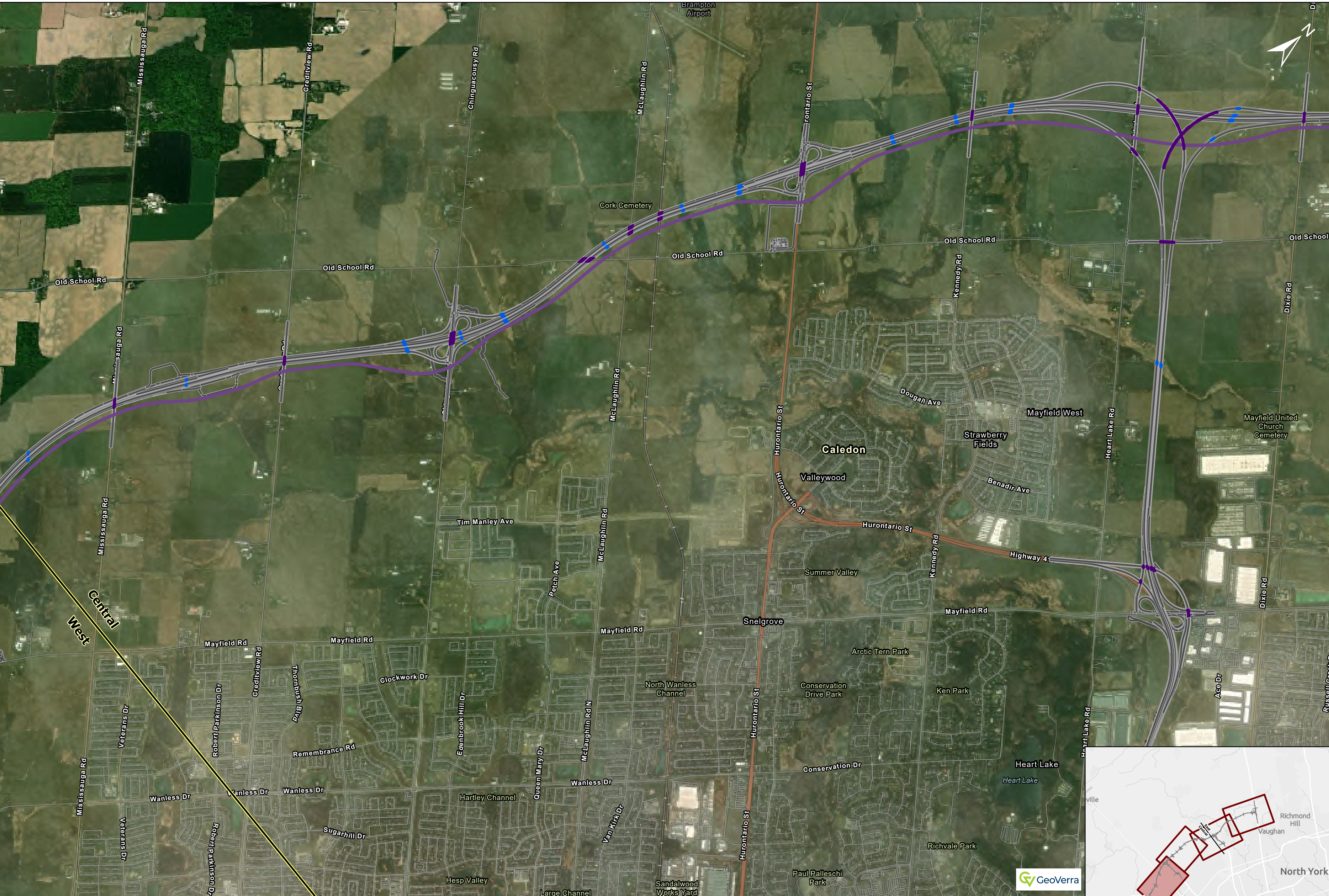
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Project Number: 14M-00321-00

Figure No. A-1.3

Date: 2025-10-09

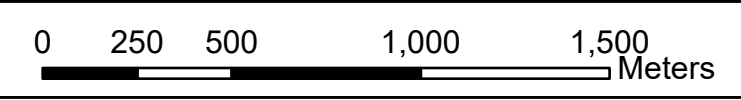


Bridge Structure Locations Overview Map

- Legend**
- Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:20,000

Prepared By:



Project Number: 14M-00321-00

Figure No. A-1.4

Date: 2025-10-09



Bridge Structure Locations Overview Map

- Legend**
- Delineation Line
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design
 - Transitway

Scale: 1:20,000

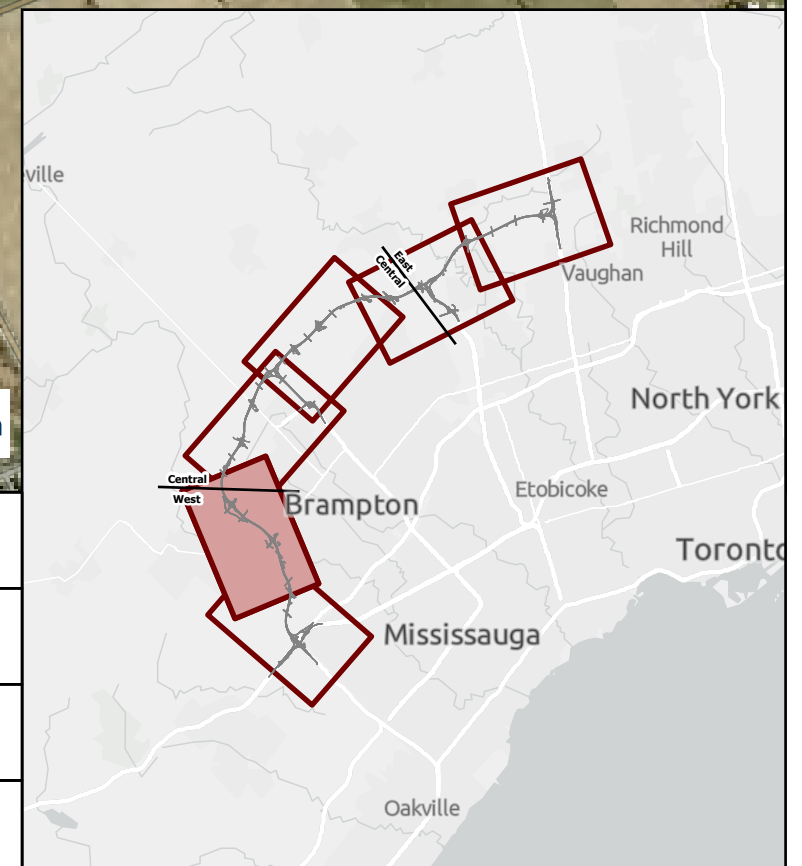
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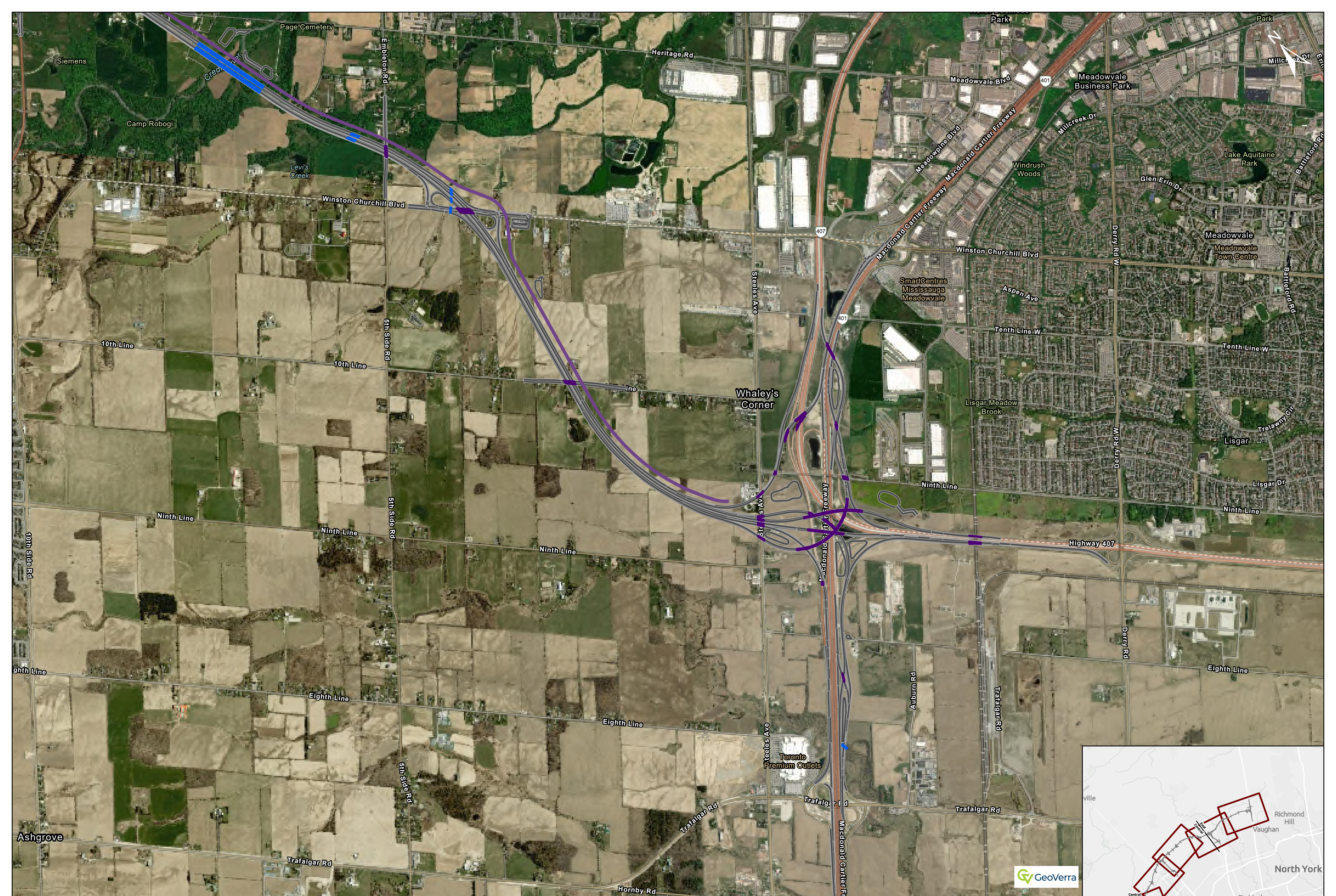
Project Number: 14M-00321-00

Figure No. A-1.5

Prepared By:

Date: 2025-10-09





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Bridge Structure Locations Overview Map

- Legend**
- Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:20,000

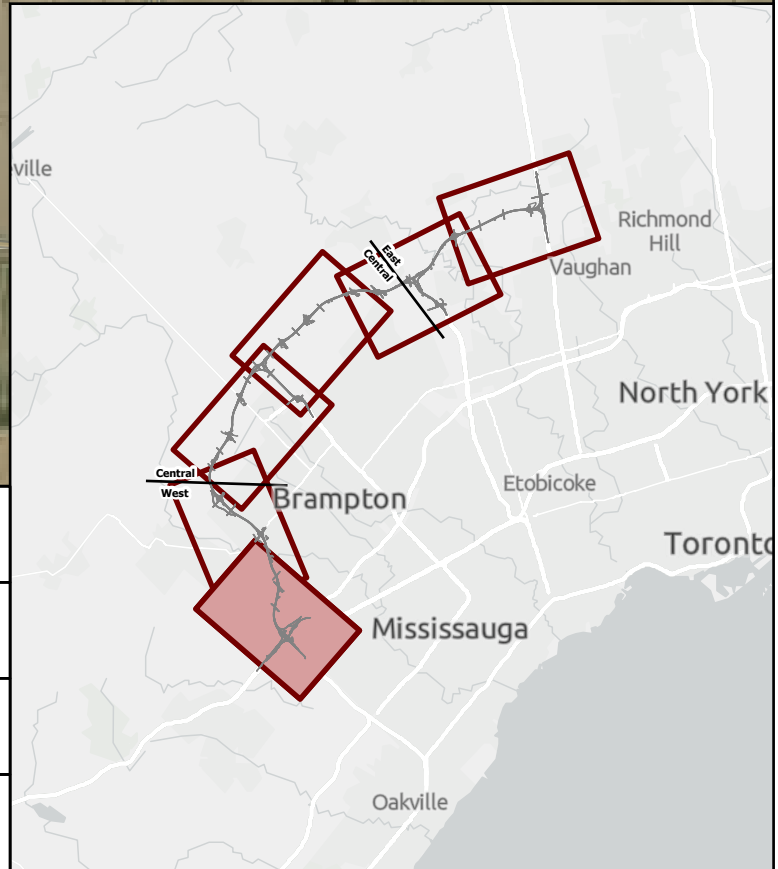
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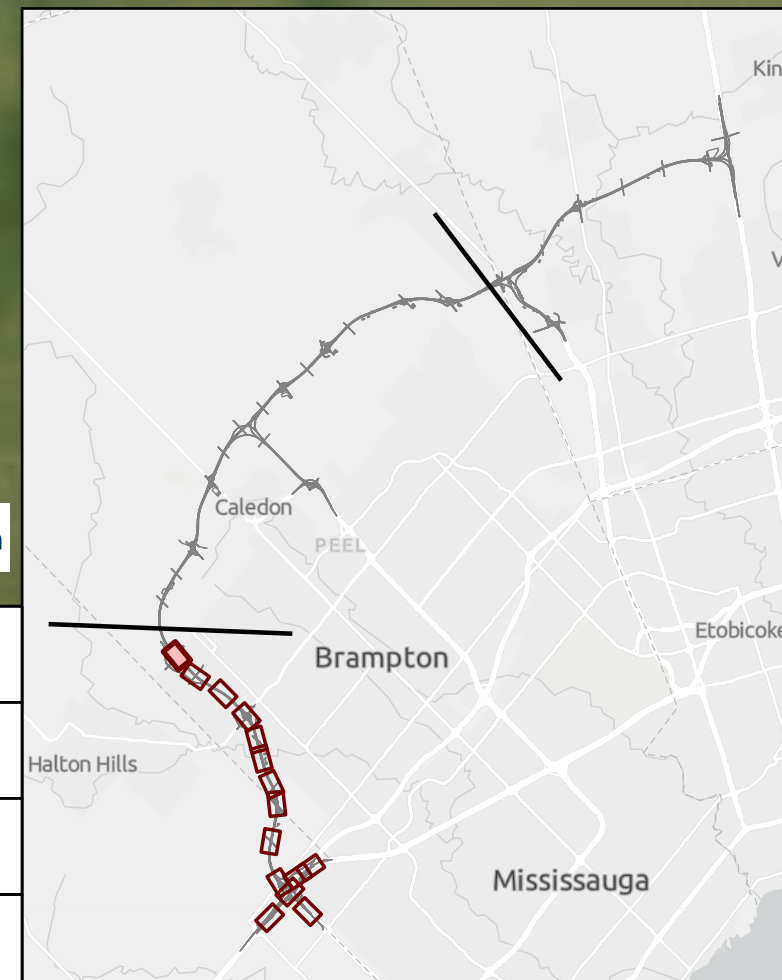


Project Number: 14M-00321-00

Figure No. A-1.6

Date: 2025-10-09











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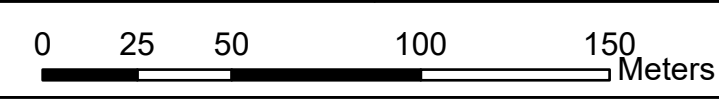
AECOM

**Bridge Structures Locations
 West Section Detail Map**

- Legend**
-  Proposed Foundation Boreholes
 -  Road Over Road Bridges
 -  Delineation Line
 -  Watercourse Bridges
 -  Preliminary Design
 -  Transitway

Scale: 1:2,000

Prepared By:



Project Number: 14M-00321-00

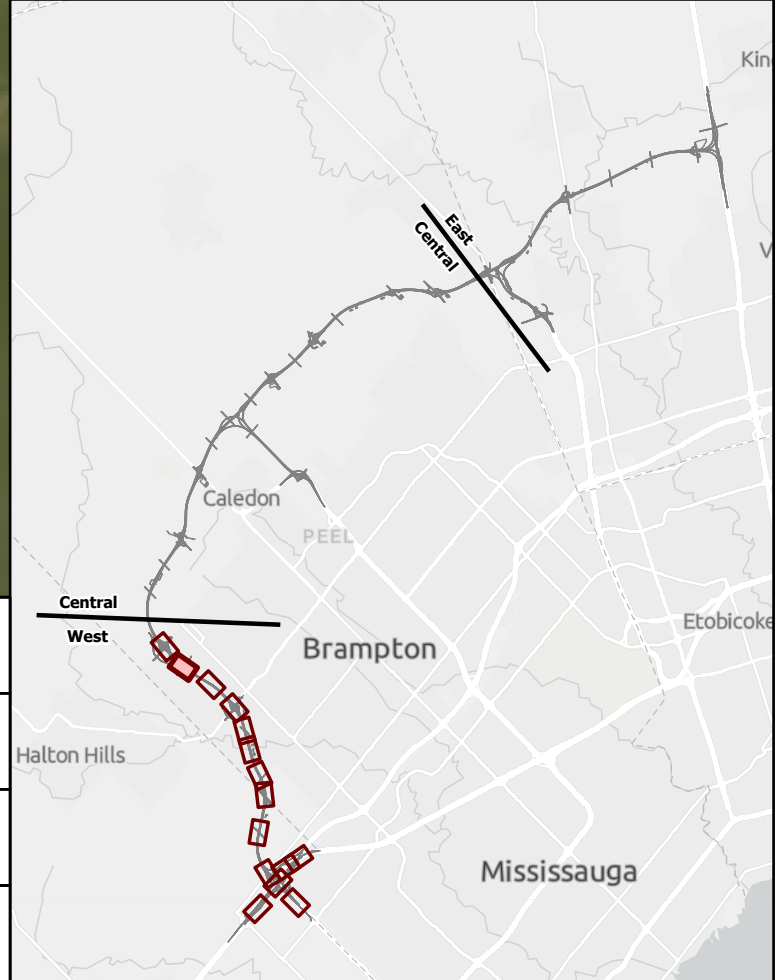
Figure No. A-2.1

Date: 2025-10-09



Northwest
Brampton

W-22



HIGHWAY 413
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AECOM

**Bridge Structures Locations
West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Watercourse Bridges
 - Delineation Line
 - Preliminary Design
 - Transitway

Scale: 1:2,000

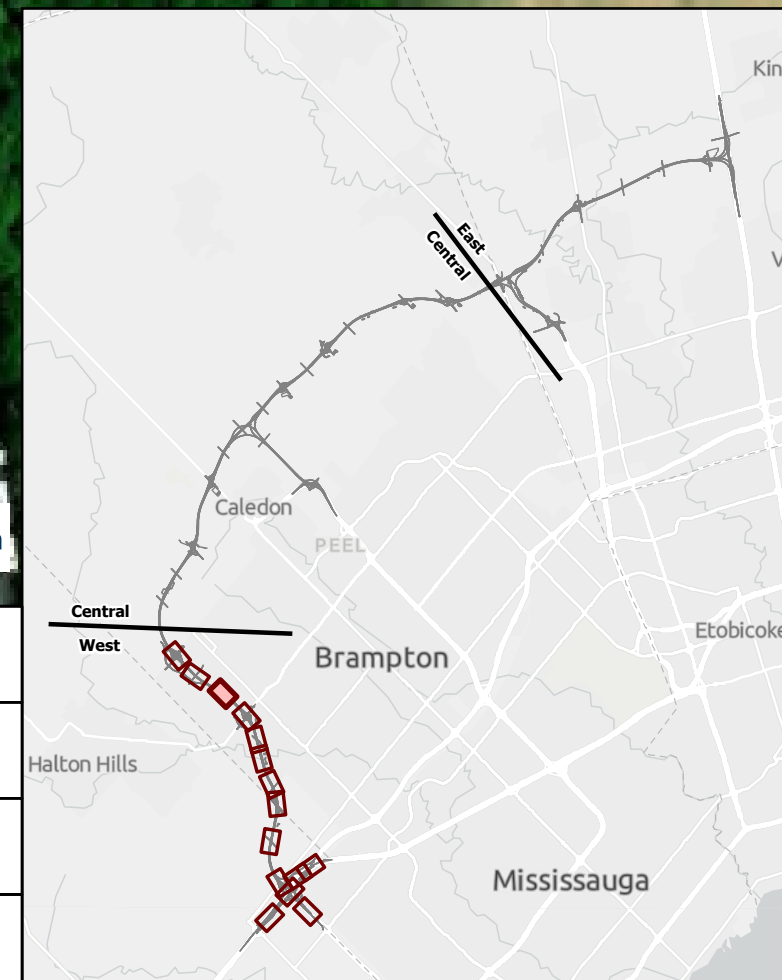
Prepared By:



Project Number: 14M-00321-00

Figure No. A-2.2

Date: 2025-10-09



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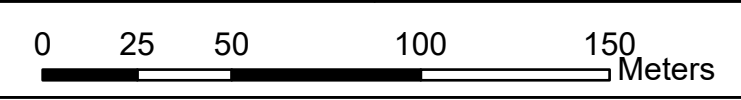
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Bridge Structures Locations West Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

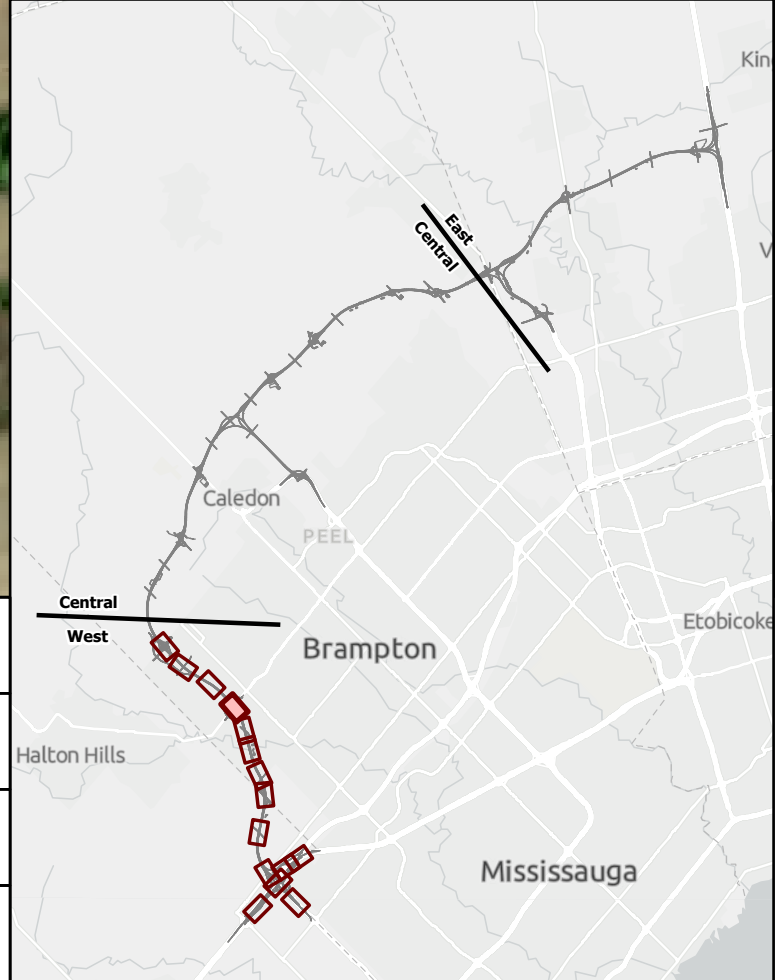
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Project Number: 14M-00321-00

Figure No. A-2.3

Date: 2025-10-09



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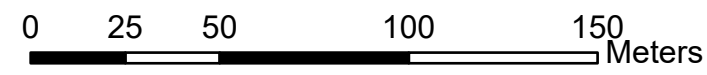
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**Bridge Structures Locations
 West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

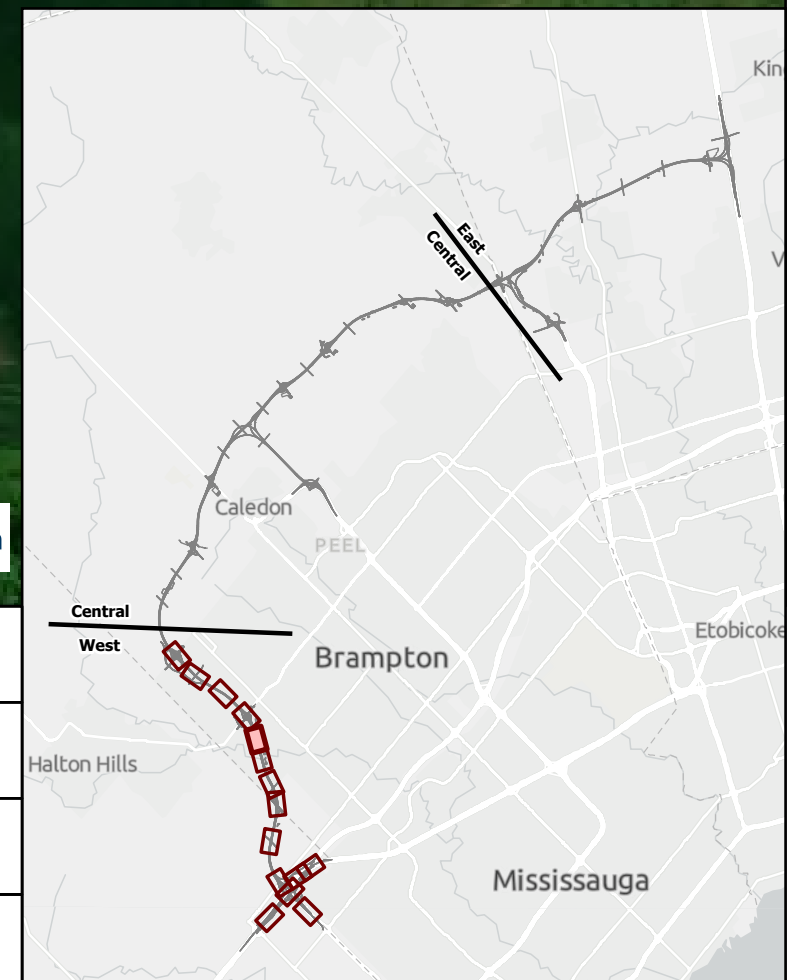
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Project Number: 14M-00321-00

Figure No. A-2.4

Date: 2025-10-09



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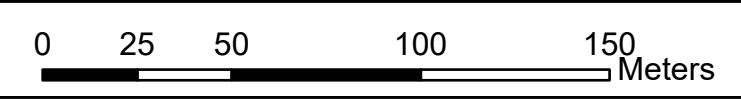
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**Bridge Structures Locations
 West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

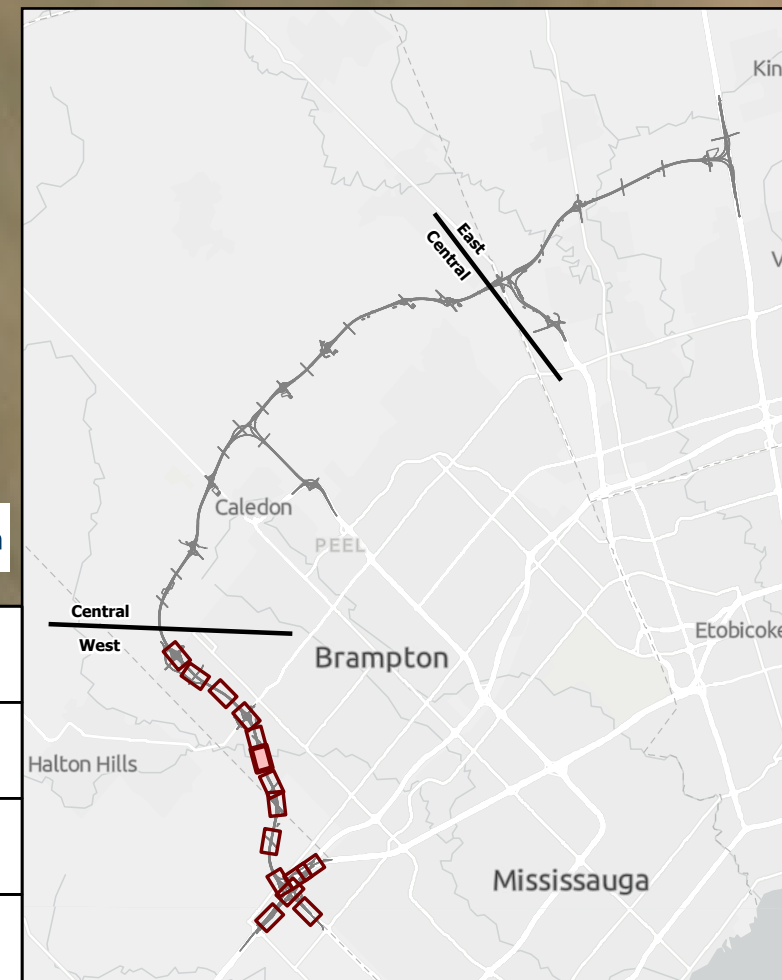
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Project Number: 14M-00321-00

Figure No. A-2.5

Date: 2025-10-09



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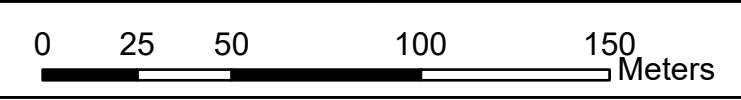
AECOM

**Bridge Structures Locations
 West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

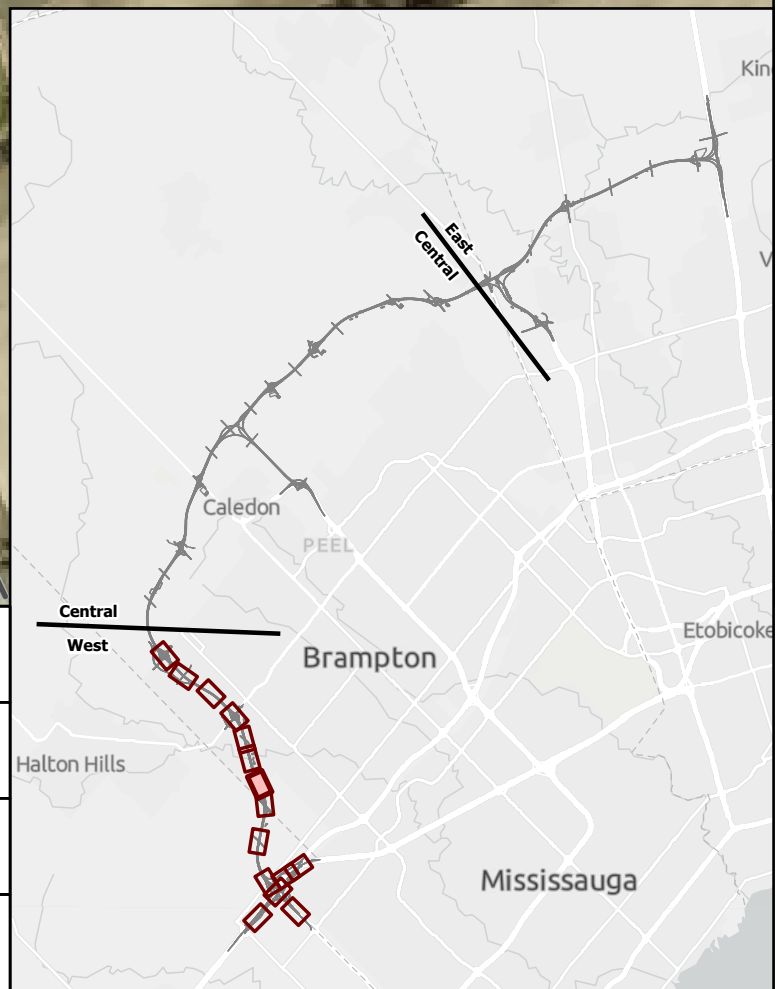
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Figure No. A-2.6

Date: 2025-10-09



**Bridge Structures Locations
 West Section Detail Map**

Legend	
	Proposed Foundation Boreholes
	Delineation Line
	Preliminary Design
	Transitway
	Road Over Road Bridges
	Watercourse Bridges

Scale: 1:2,000

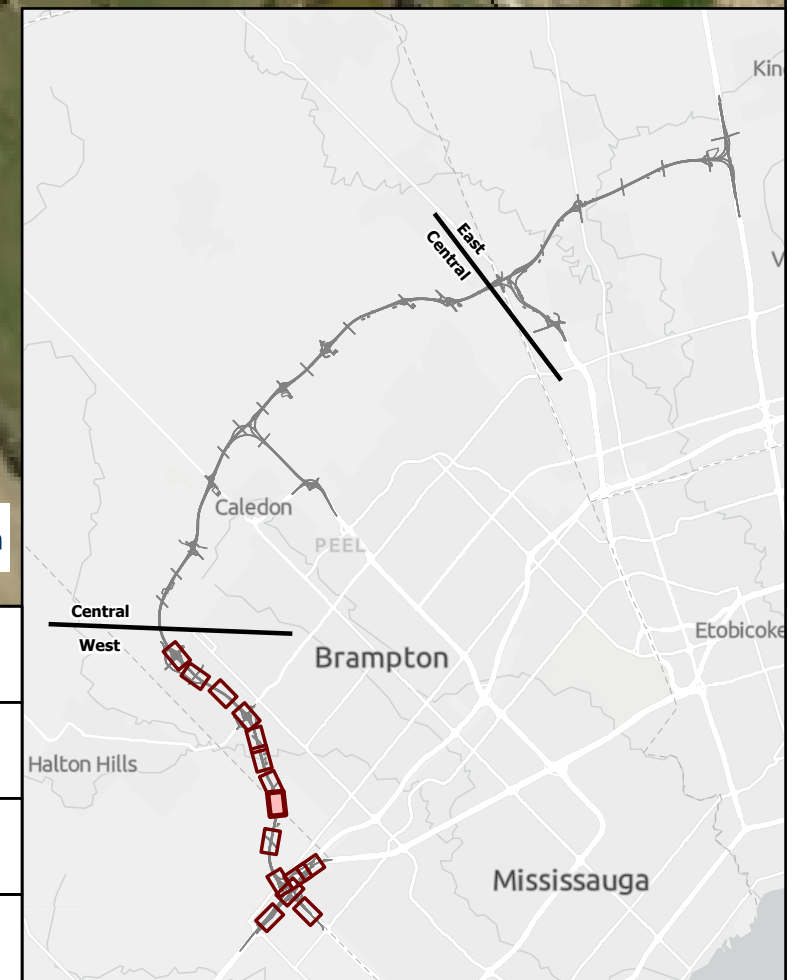
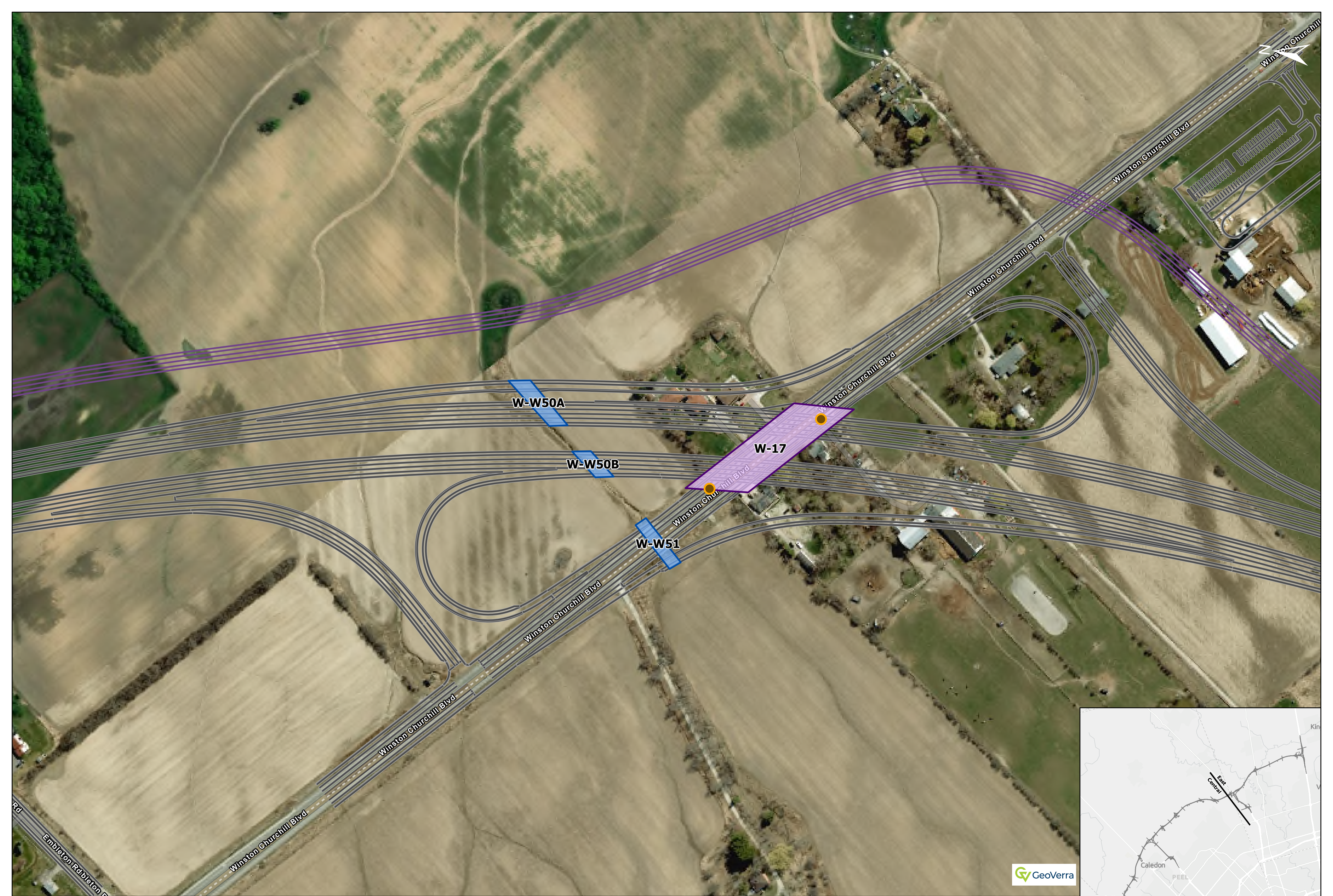
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Figure No. A-2.7

Date: 2025-10-09



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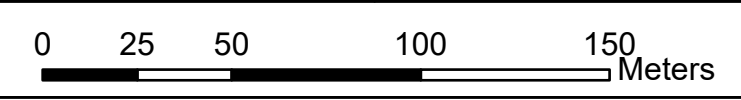
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Bridge Structures Locations West Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

Prepared By:



Project Number: 14M-00321-00

Figure No. A-2.8

Date: 2025-10-09









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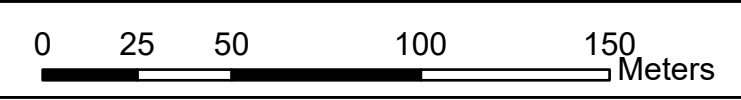
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**Bridge Structures Locations
 West Section Detail Map**

- Legend**
-  Proposed Foundation Boreholes
 -  Road Over Road Bridges
 -  Delineation Line
 -  Watercourse Bridges
 -  Preliminary Design
 -  Transitway

Scale: 1:2,000

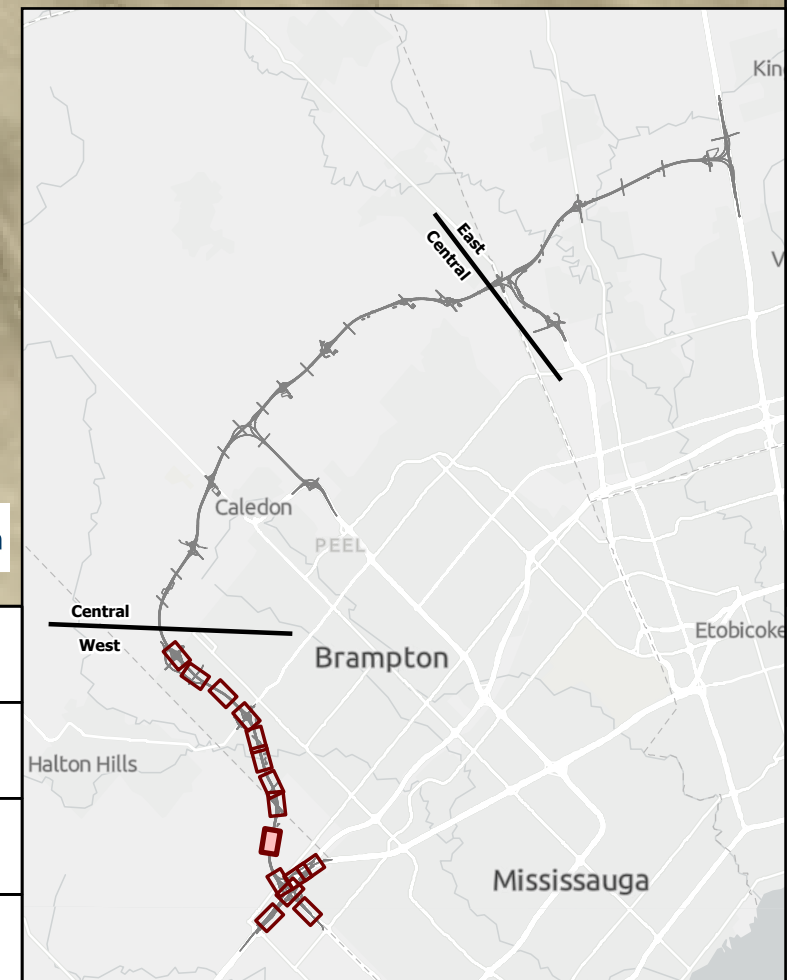
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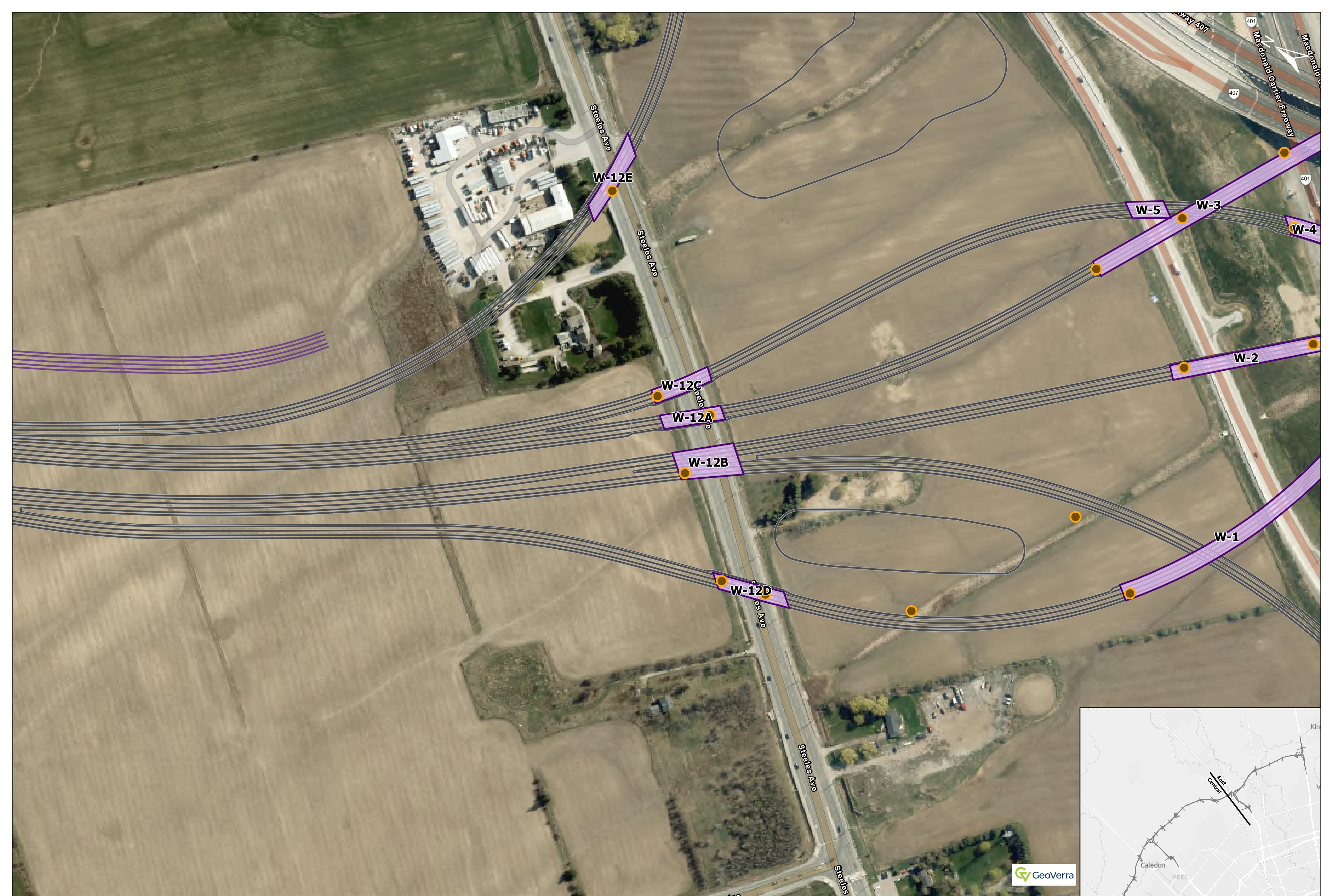


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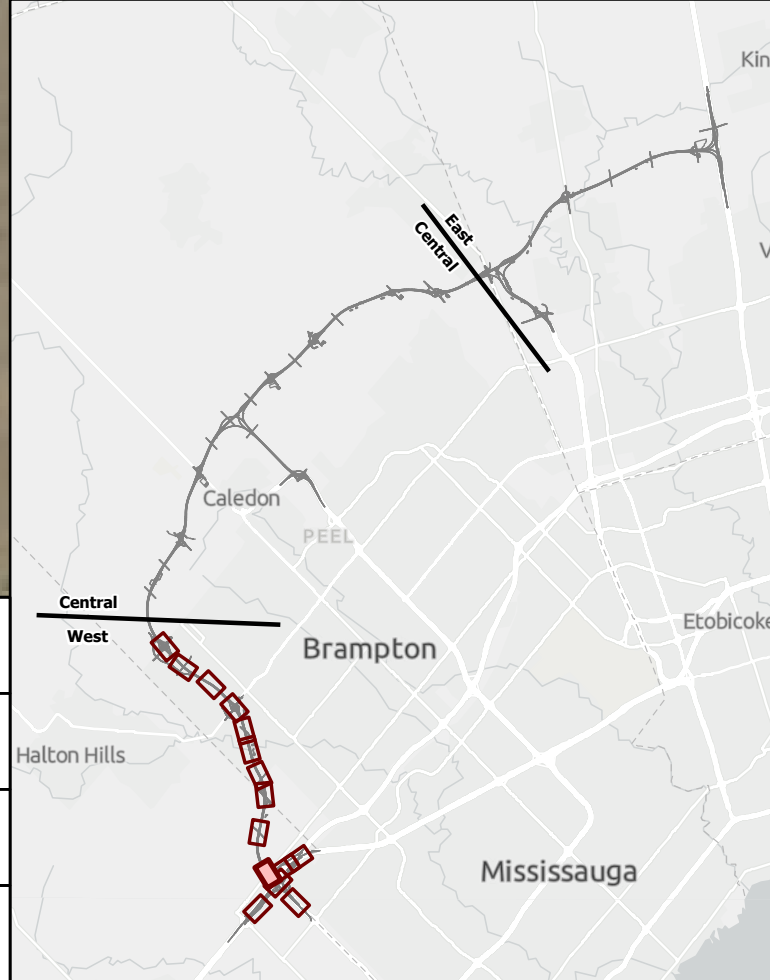
Figure No. A-2.9

Date: 2025-10-09





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**Bridge Structures Locations
 West Section Detail Map**

- Legend**
-  Proposed Foundation Boreholes
 -  Road Over Road Bridges
 -  Delineation Line
 -  Watercourse Bridges
 -  Preliminary Design
 -  Transitway

Scale: 1:2,000

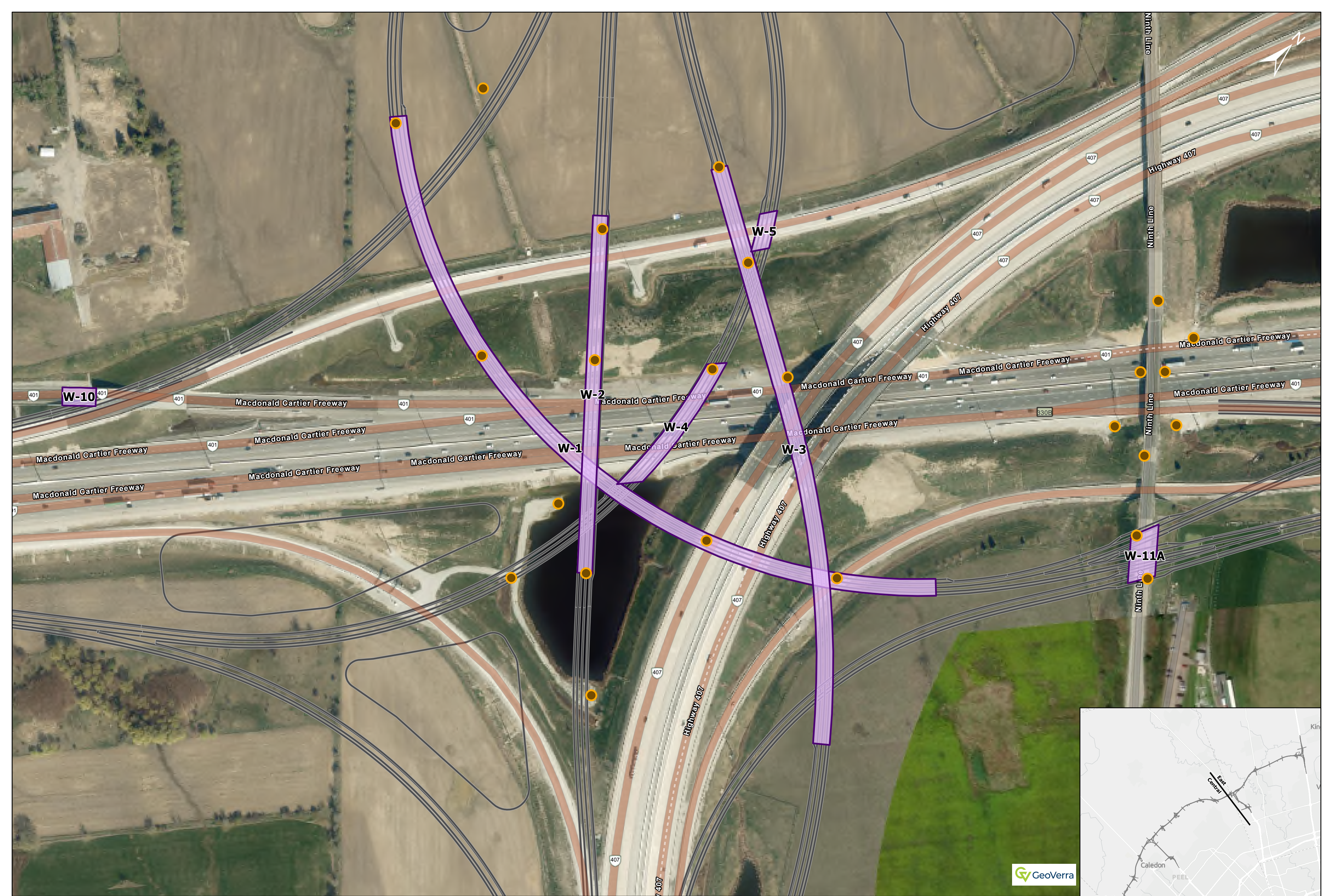
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Project Number: 14M-00321-00

Figure No. A-2.10

Date: 2025-10-09



**Bridge Structures Locations
 West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

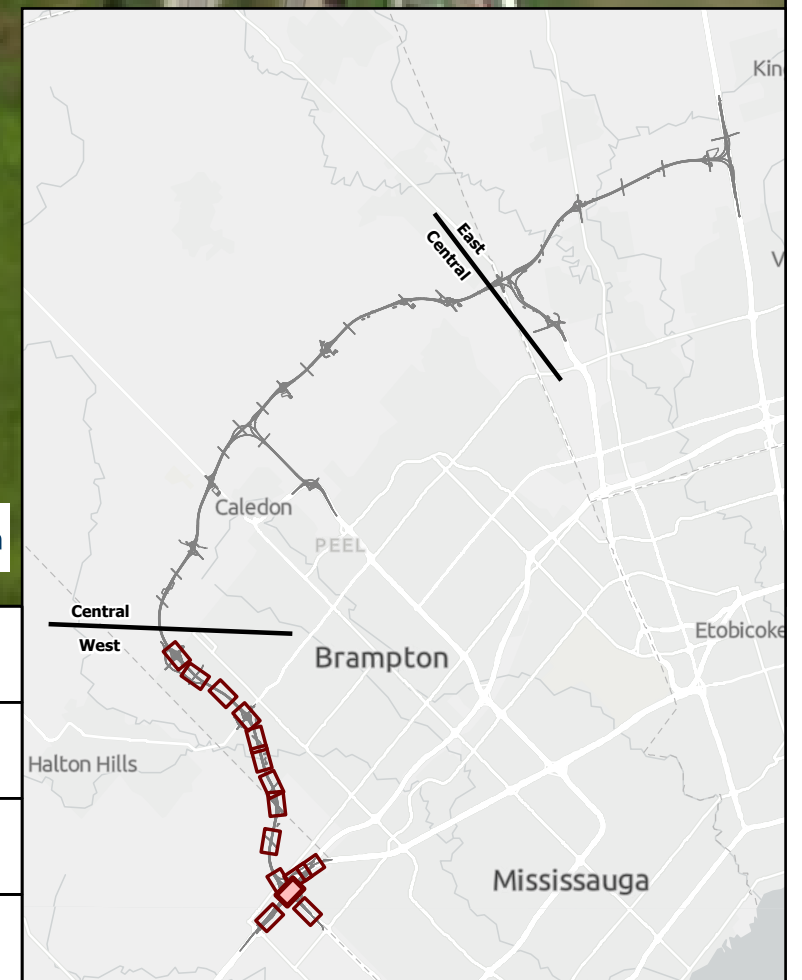
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Project Number: 14M-00321-00

Figure No. A-2.11

Prepared By:

Date: 2025-10-09





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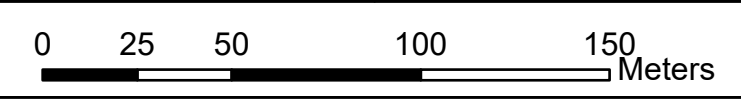
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**Bridge Structures Locations
 West Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

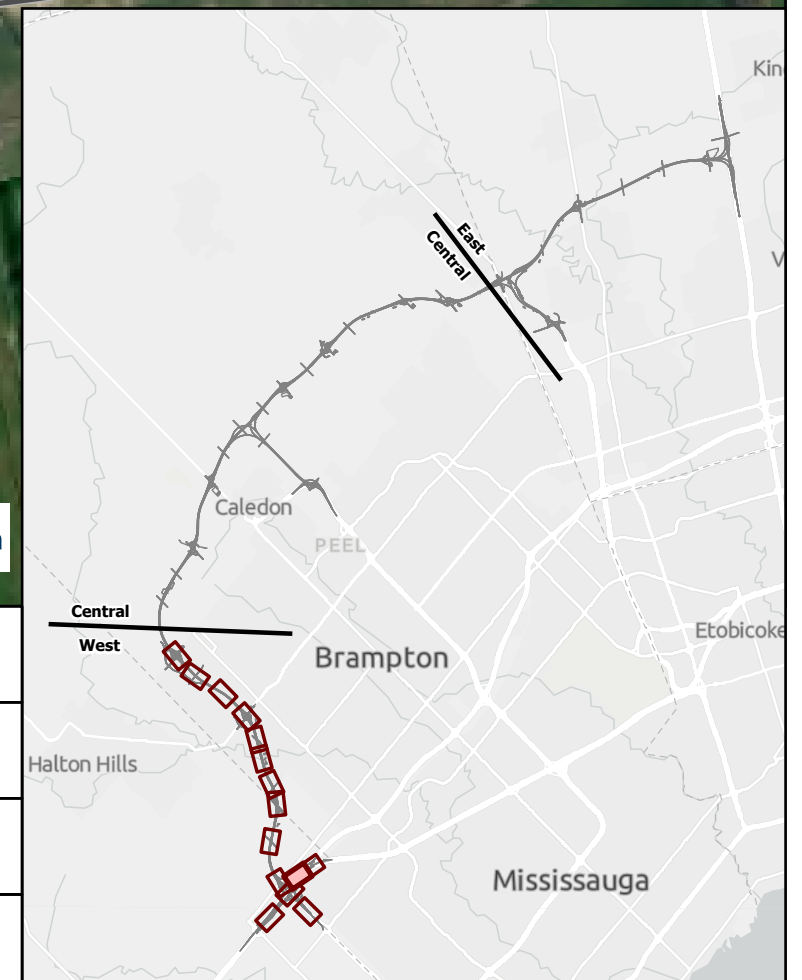
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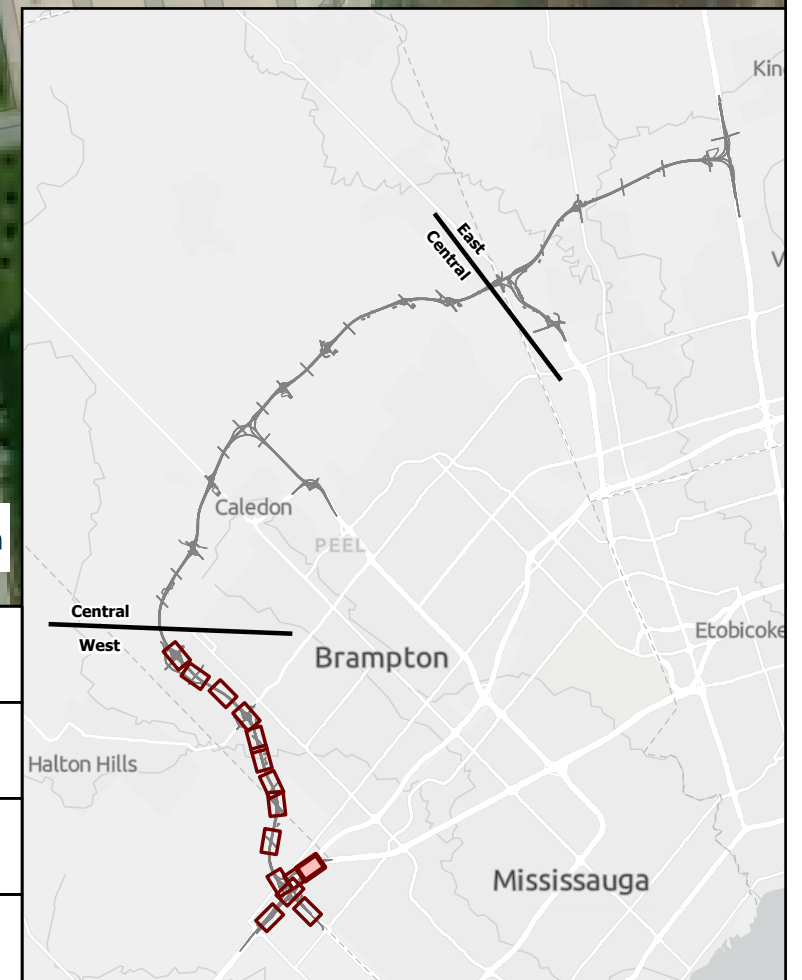


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Figure No. A-2.12

Date: 2025-10-09





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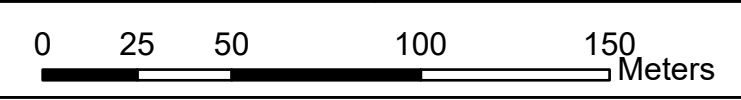
AECOM

Bridge Structures Locations West Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Preliminary Design
 - Transitway

Scale: 1:2,000

Prepared By:



Project Number: 14M-00321-00

Figure No. A-2.13

Date: 2025-10-09

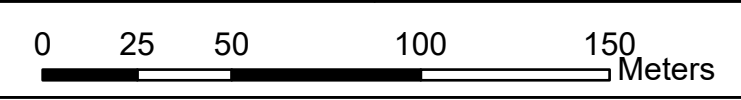


Bridge Structures Locations West Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

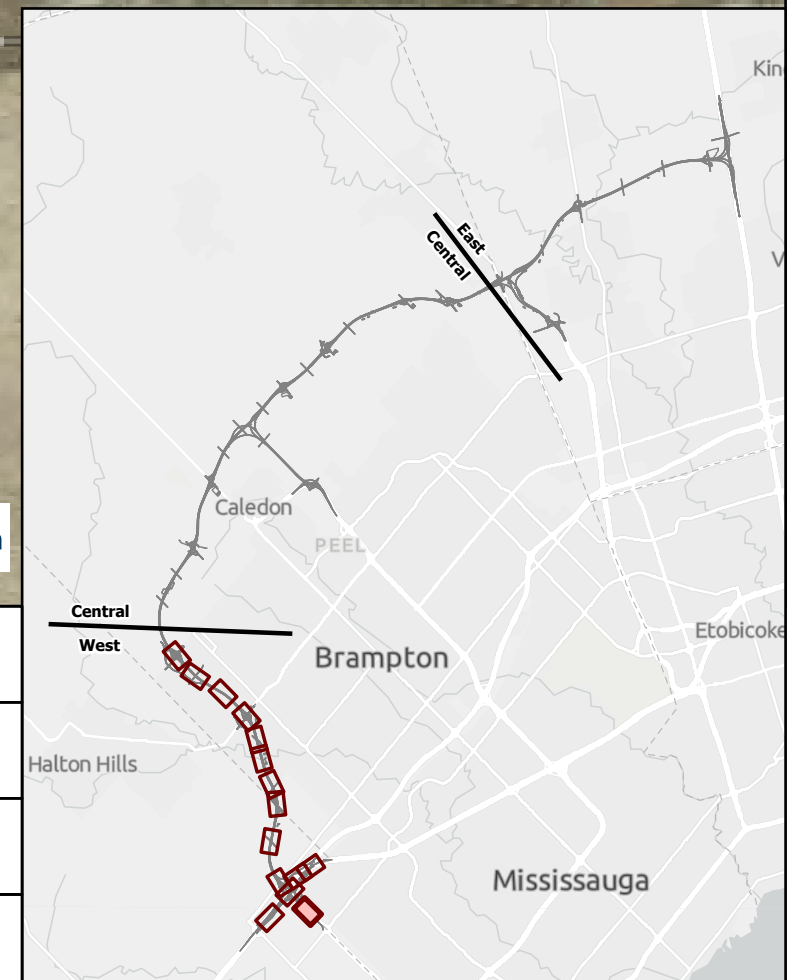
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Figure No. A-2.14

Date: 2025-10-09





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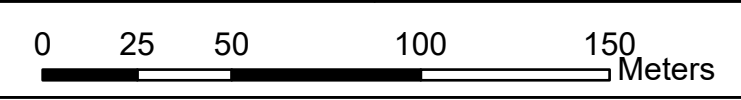
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Bridge Structures Locations West Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

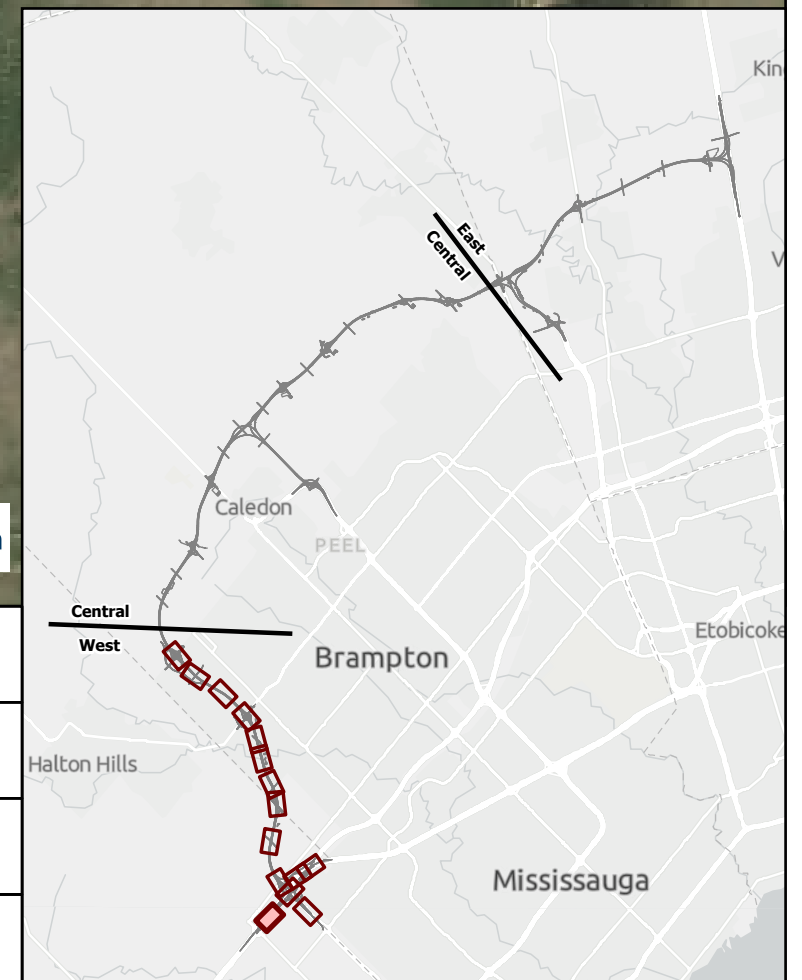
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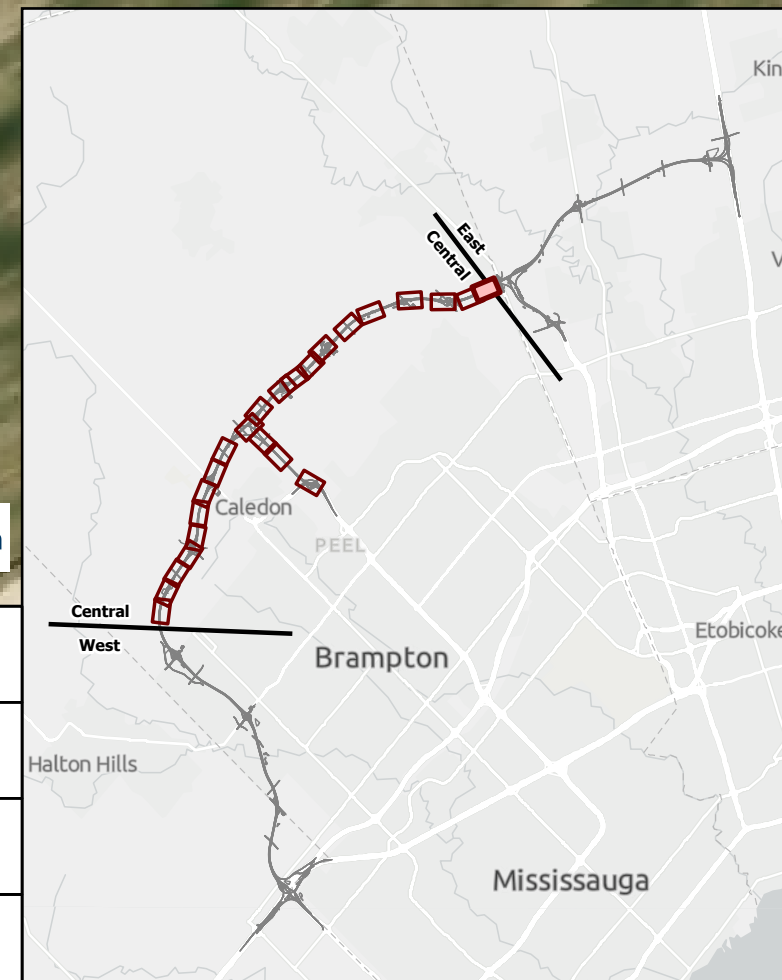


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Figure No. A-2.15

Date: 2025-10-09





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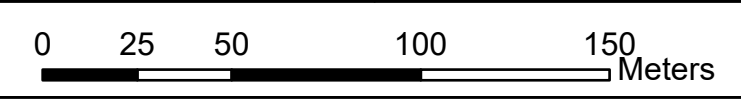
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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Transitway
 - Preliminary Design

Scale: 1:2,000

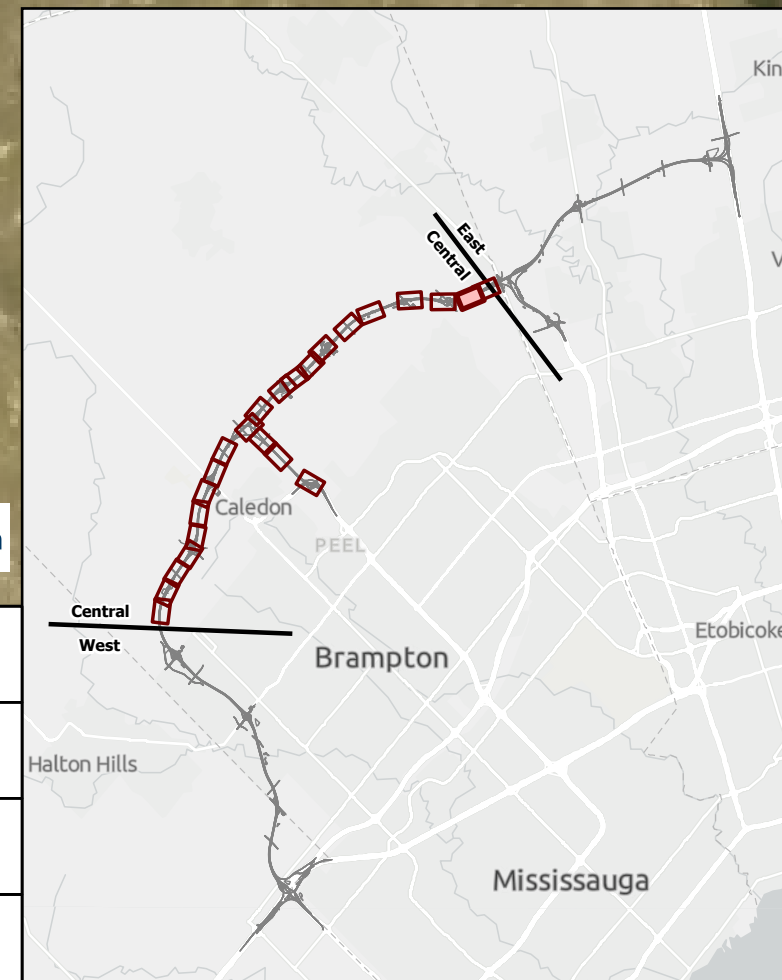
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Figure No. A-3.1

Date: 2025-10-09



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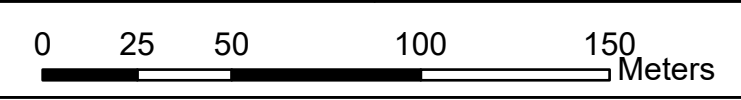
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

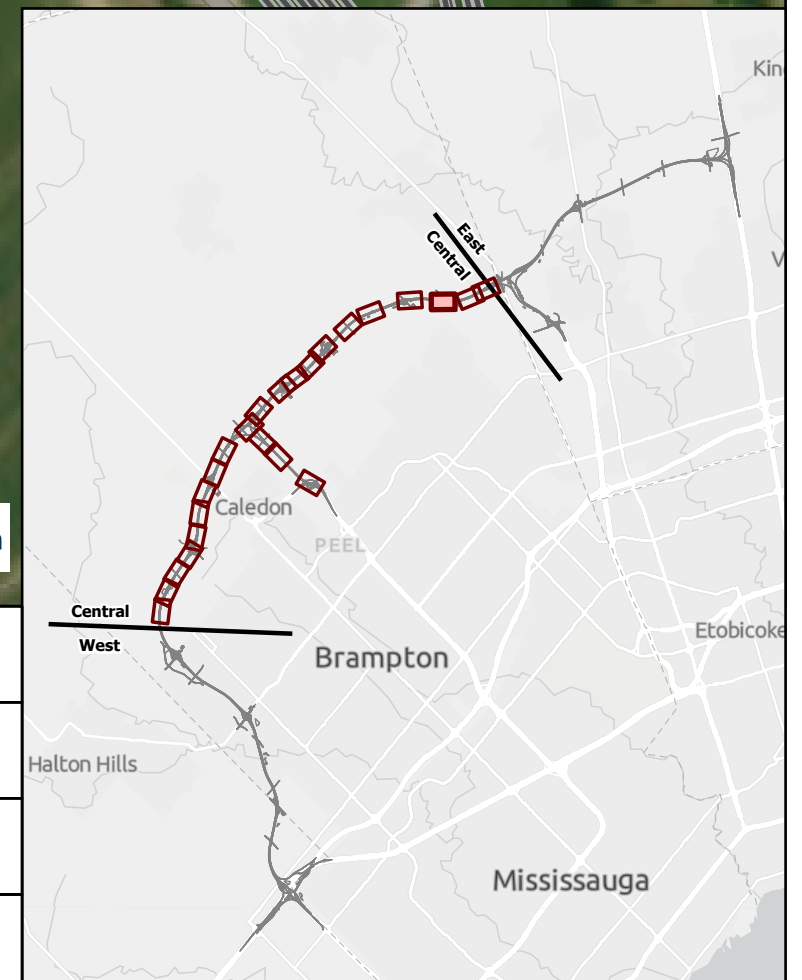
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Project Number: 14M-00321-00

Figure No. A-3.2

Date: 2025-10-09



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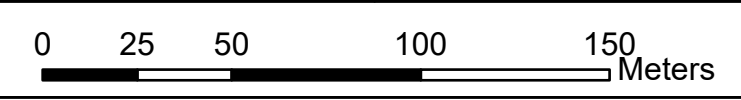
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

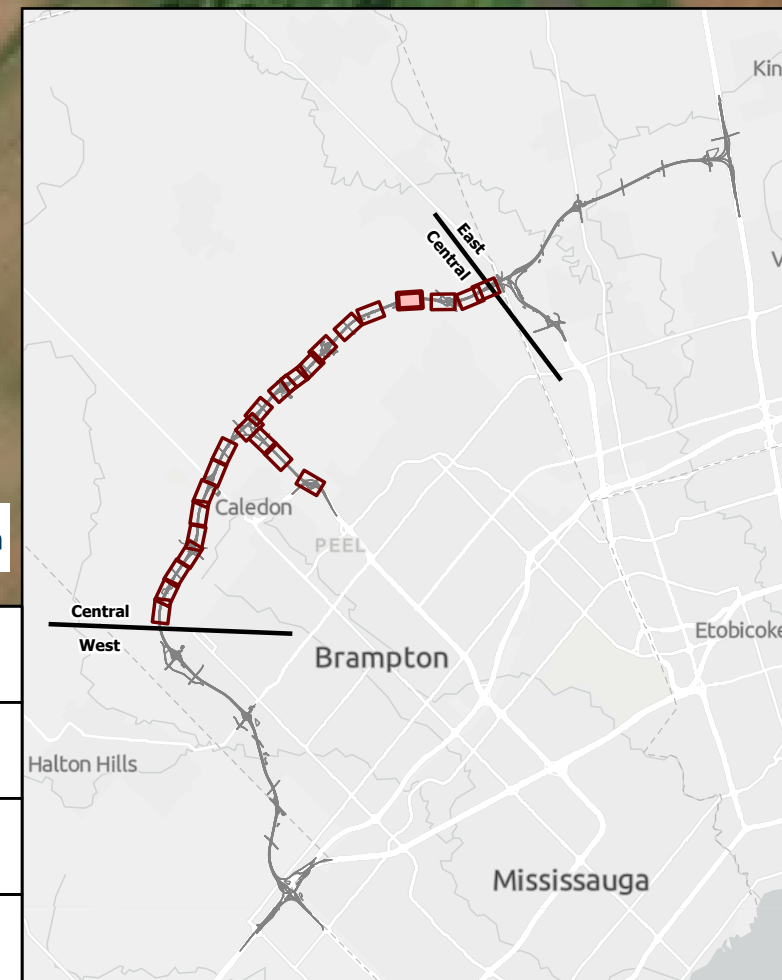
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Project Number: 14M-00321-00

Figure No. A-3.3

Date: 2025-10-09



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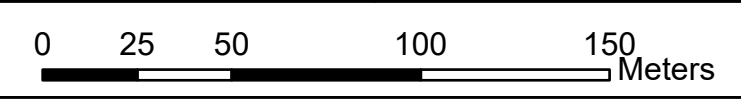
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

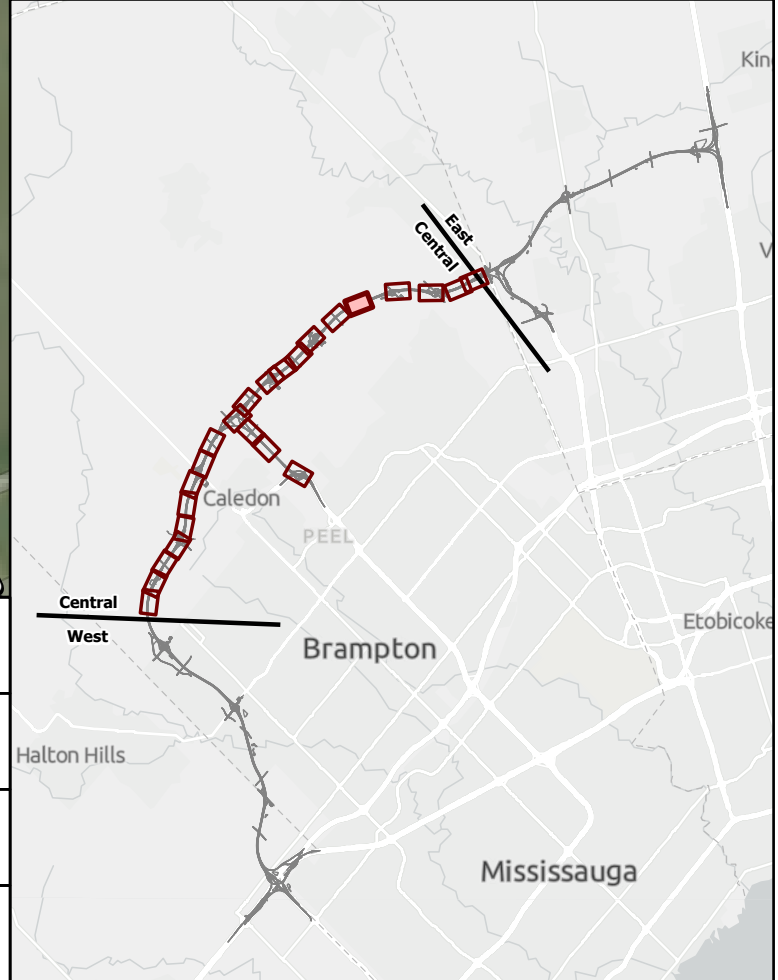
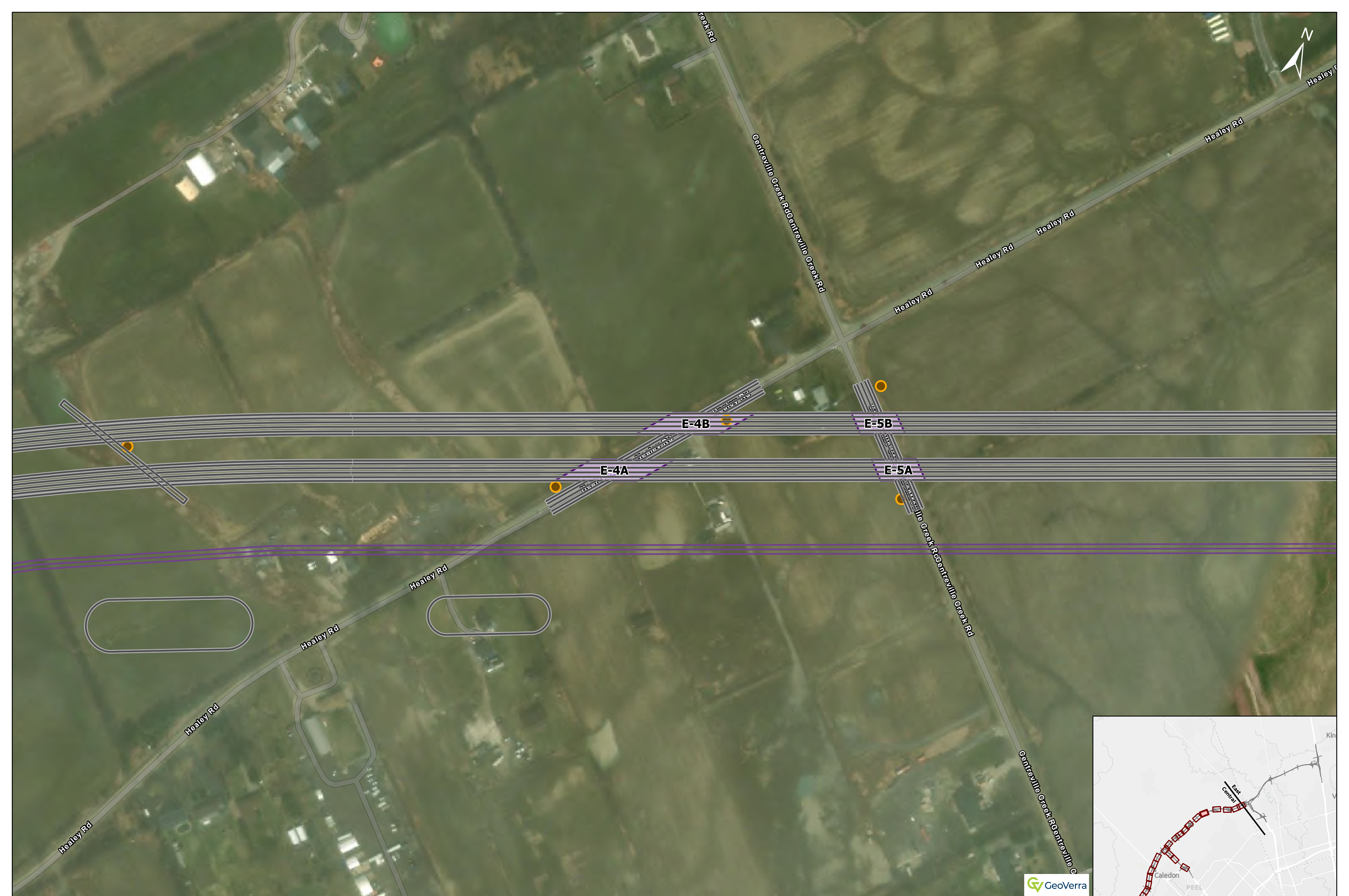
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Project Number: 14M-00321-00

Figure No. A-3.4

Date: 2025-10-09



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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

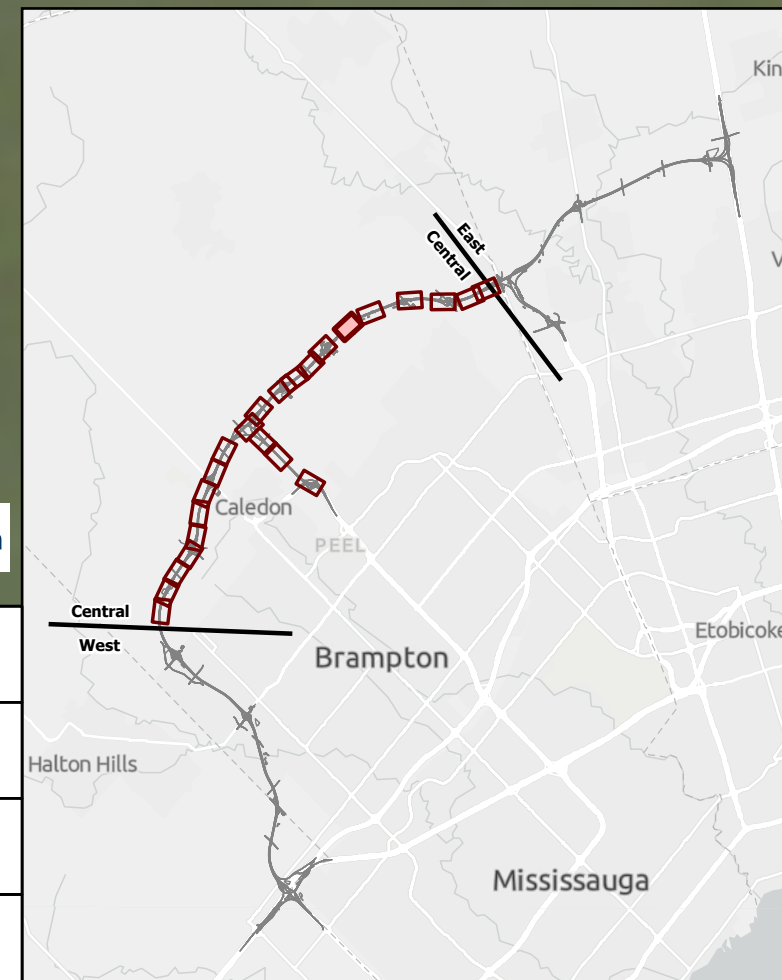
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Project Number: 14M-00321-00

Figure No. A-3.5

Date: 2025-10-09



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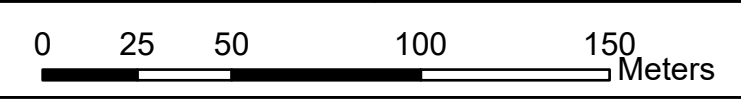
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

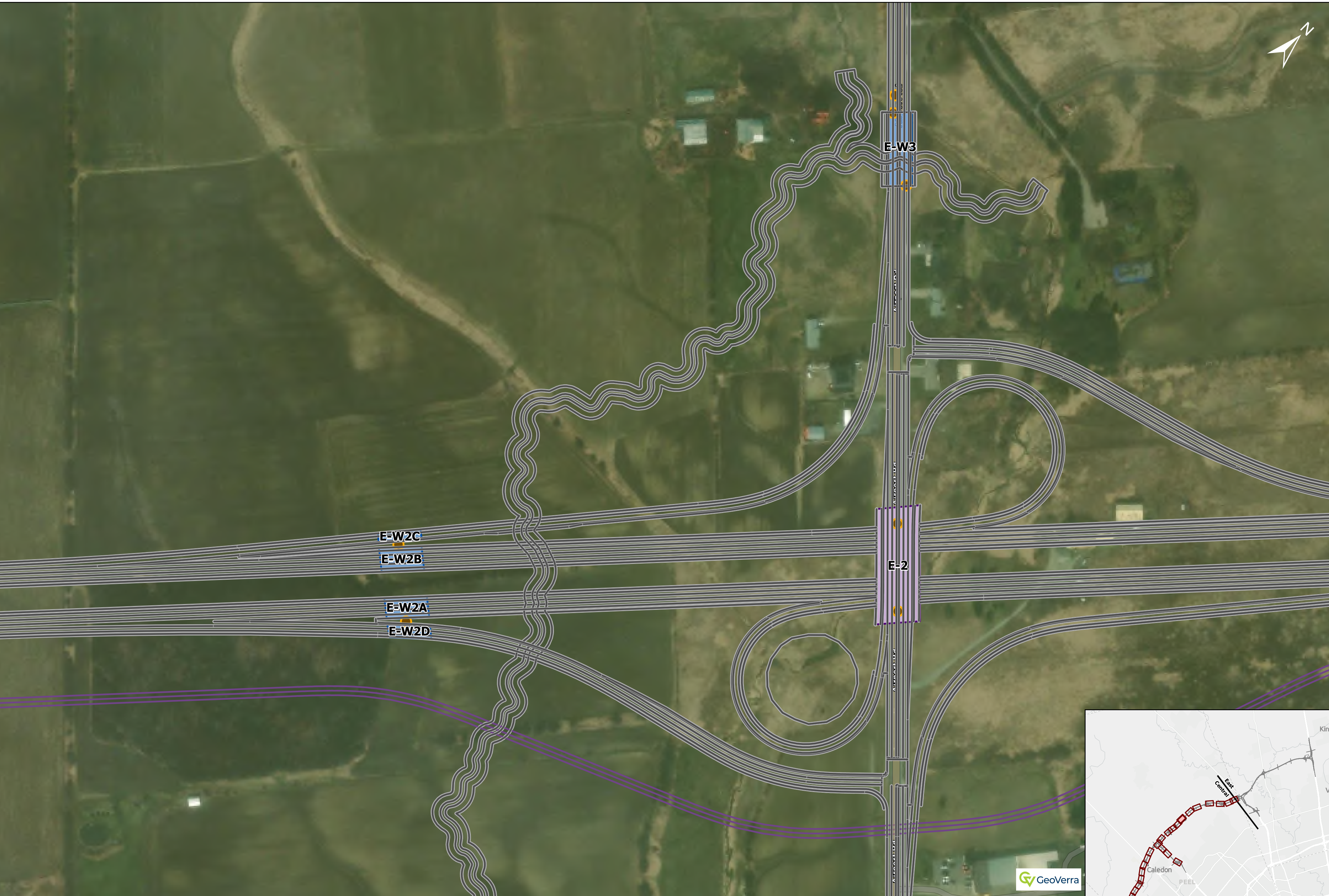
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Project Number: 14M-00321-00

Figure No. A-3.6

Date: 2025-10-09

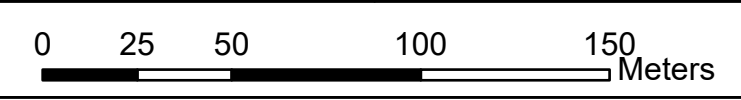


**Bridge Structures Locations
 Central Section Detail Map**

Legend	
Proposed Foundation Boreholes	Road Over Road Bridges
Delineation Line	Watercourse Bridges
Transitway	Preliminary Design
Preliminary Design	

Scale: 1:2,000

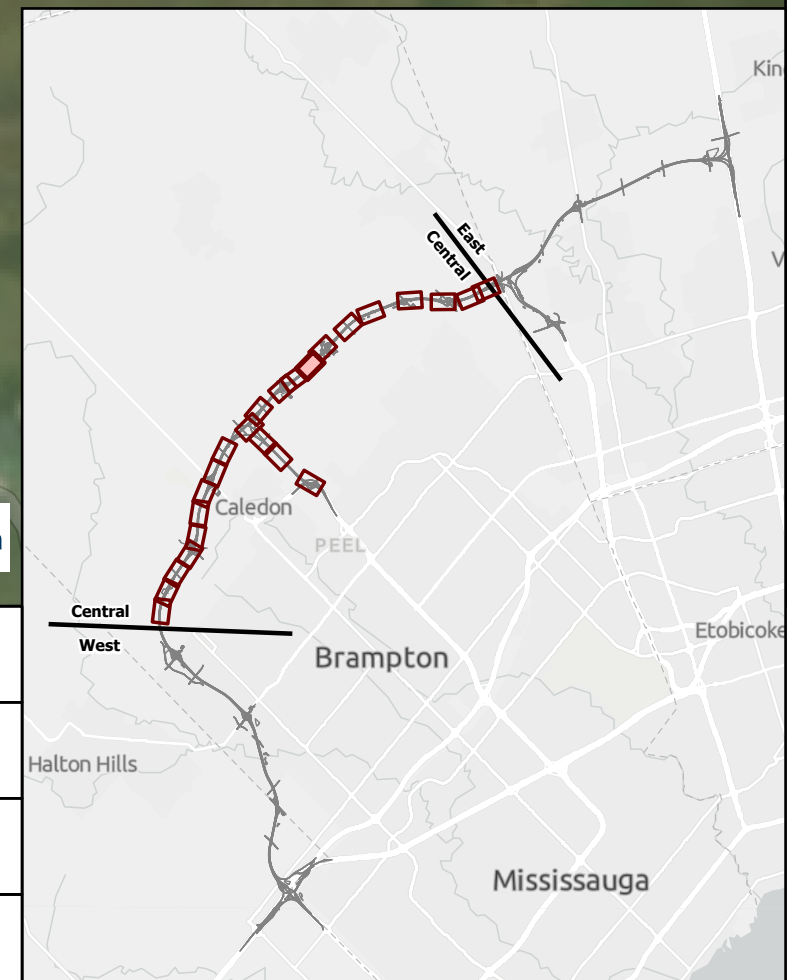
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Project Number: 14M-00321-00

Figure No. A-3.7

Date: 2025-10-09

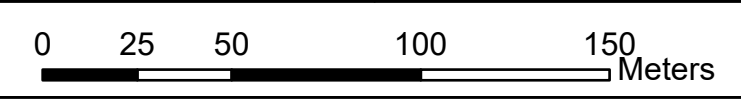


Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Transitway
 - Preliminary Design

Scale: 1:2,000

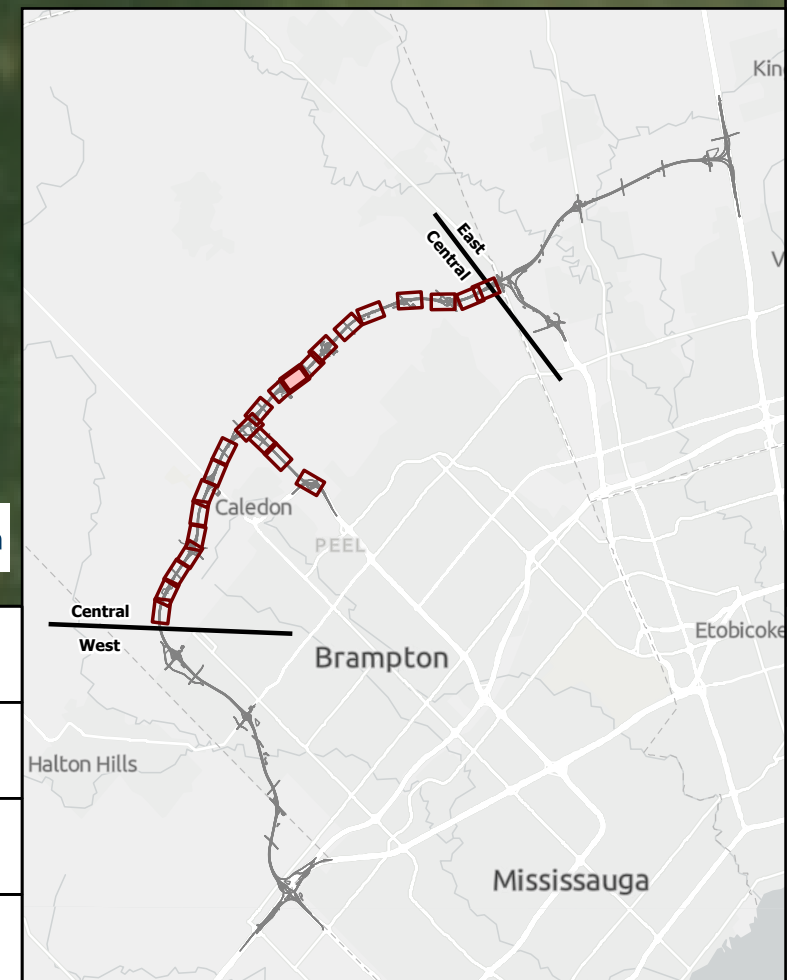
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Project Number: 14M-00321-00

Figure No. A-3.8

Date: 2025-10-09



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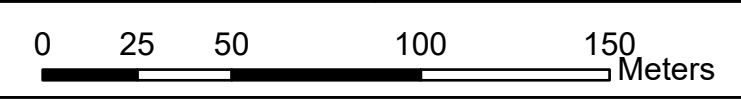
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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

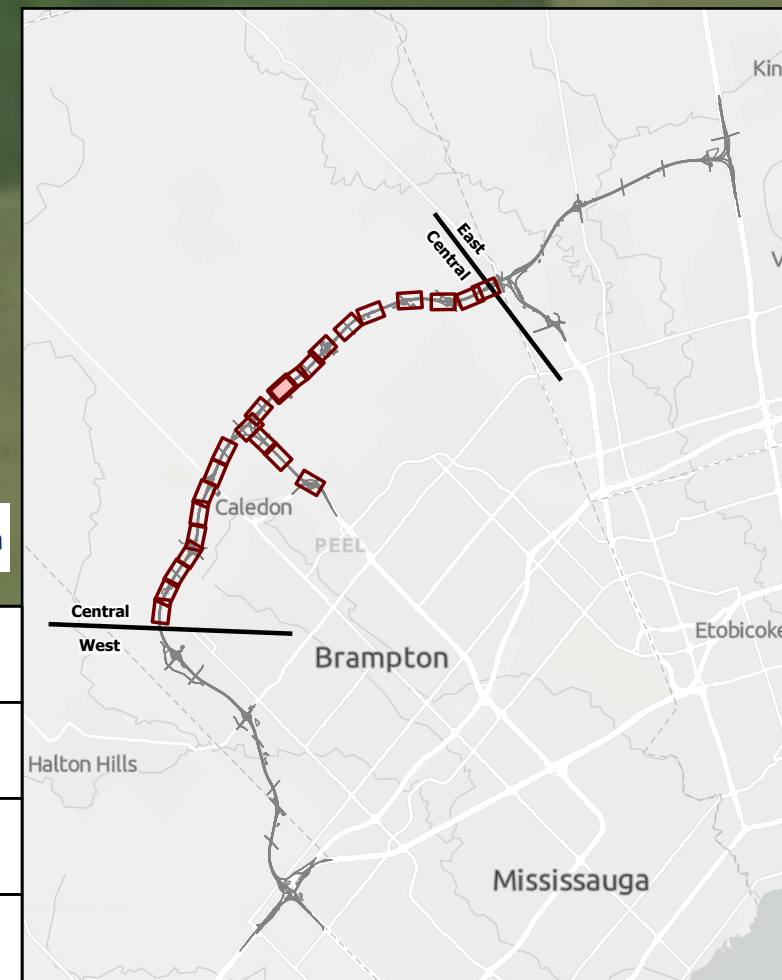
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Project Number: 14M-00321-00

Figure No. A-3.9

Date: 2025-10-09

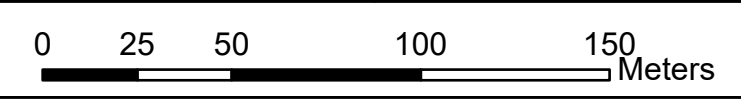


Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

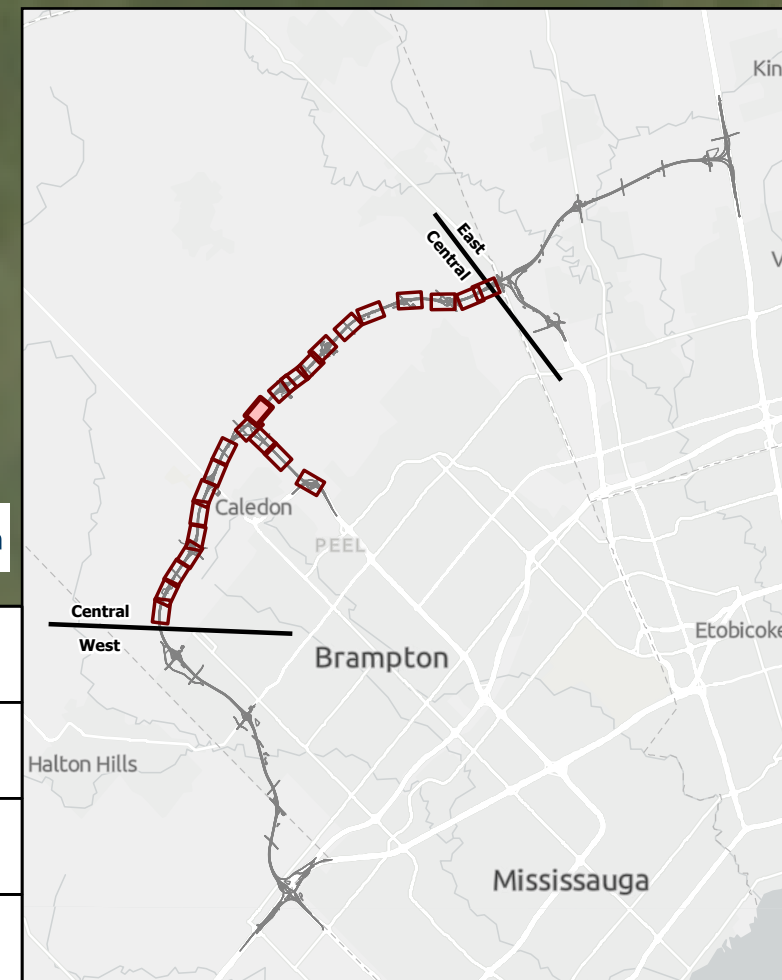
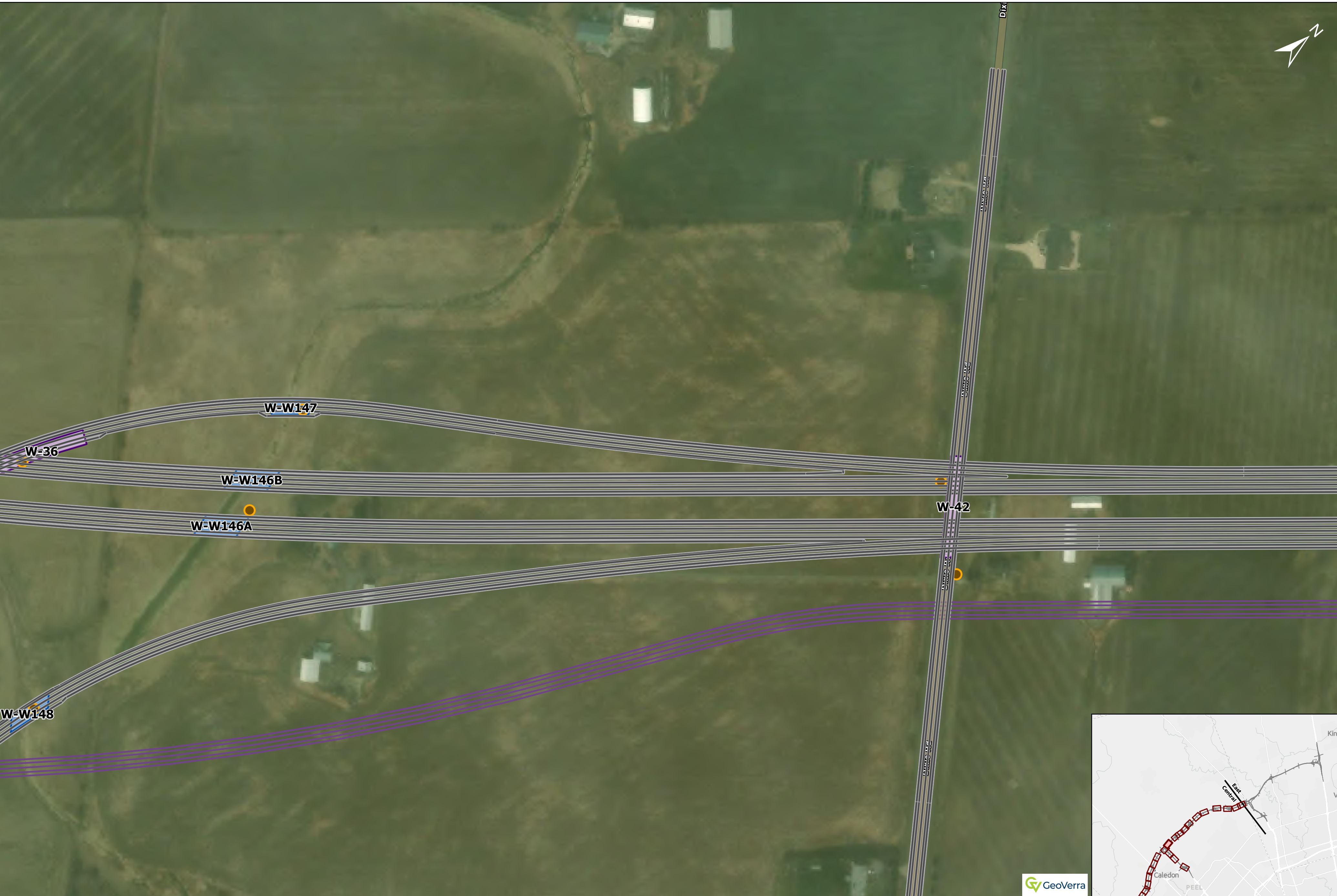
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Project Number: 14M-00321-00

Figure No. A-3.10

Date: 2025-10-09



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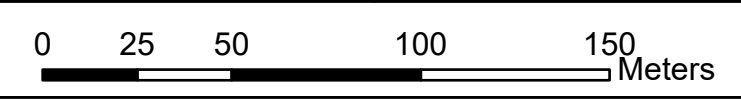
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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

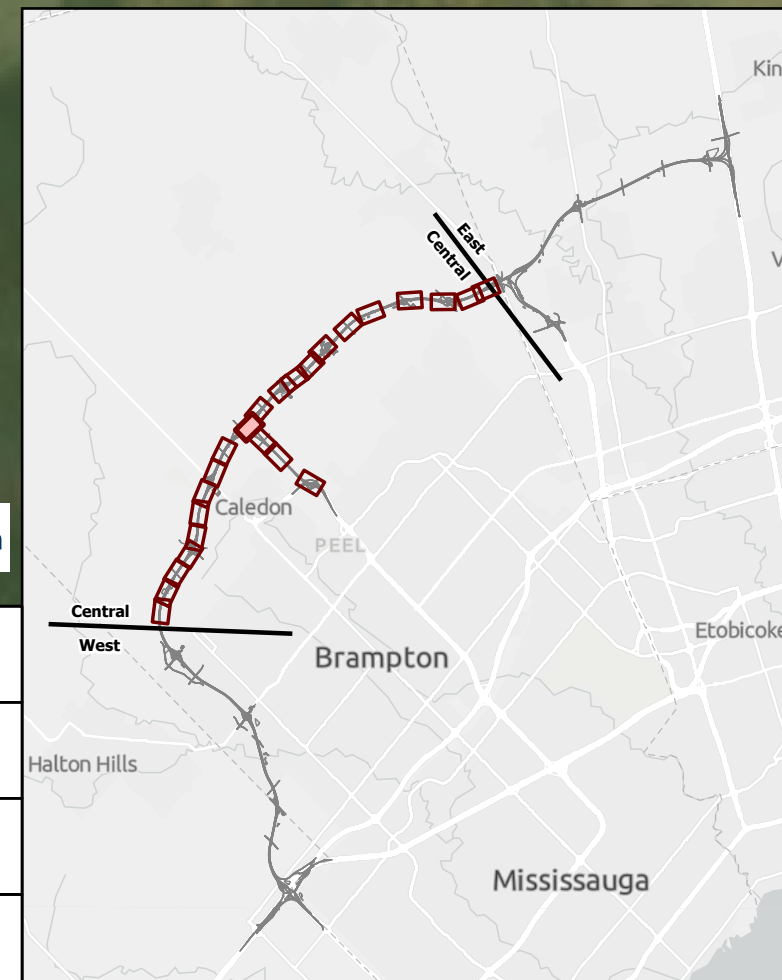
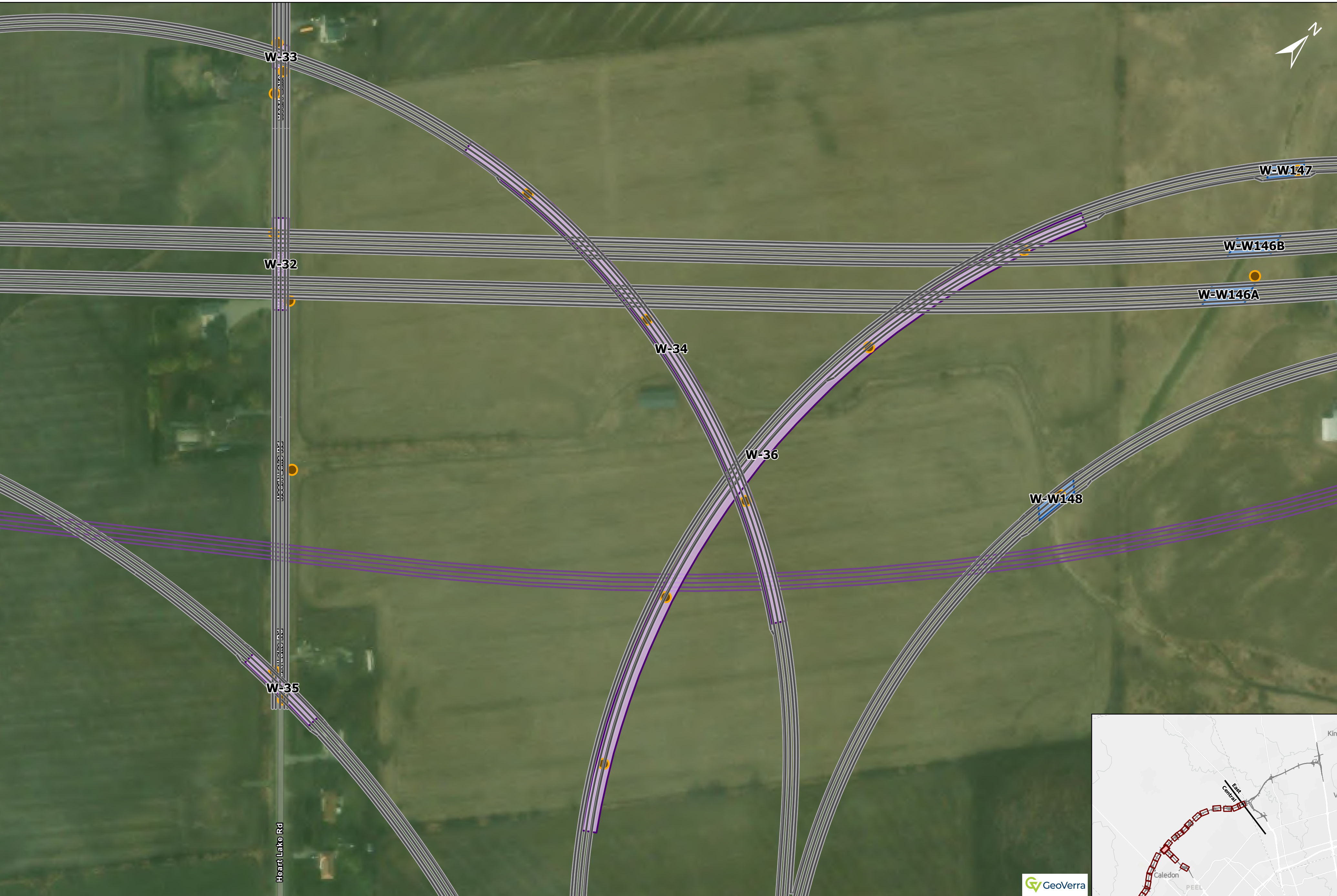
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Project Number: 14M-00321-00

Figure No. A-3.11

Date: 2025-10-09

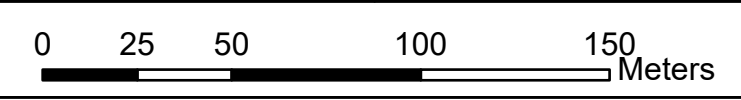


Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Transitway
 - Preliminary Design

Scale: 1:2,000

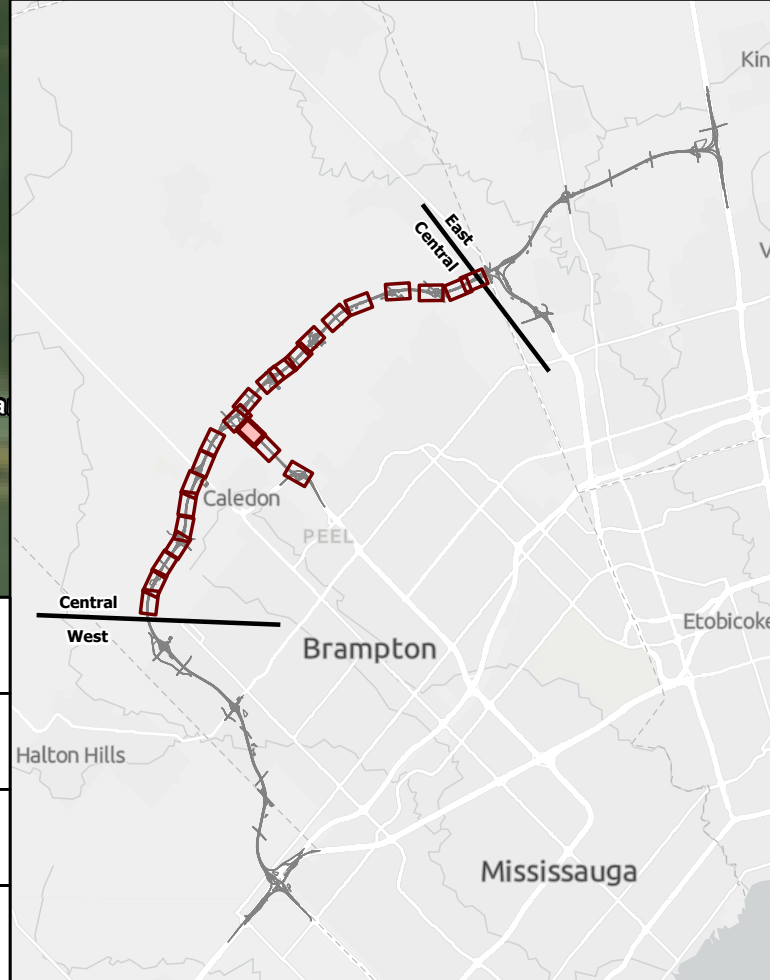
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Project Number: 14M-00321-00

Figure No. A-3.12

Date: 2025-10-09



Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

0 25 50 100 150 Meters

Project Number: 14M-00321-00

Figure No. A-3.13

Prepared By:

Date: 2025-10-09



W-W142A

W-W142B

Heart Lake Rd

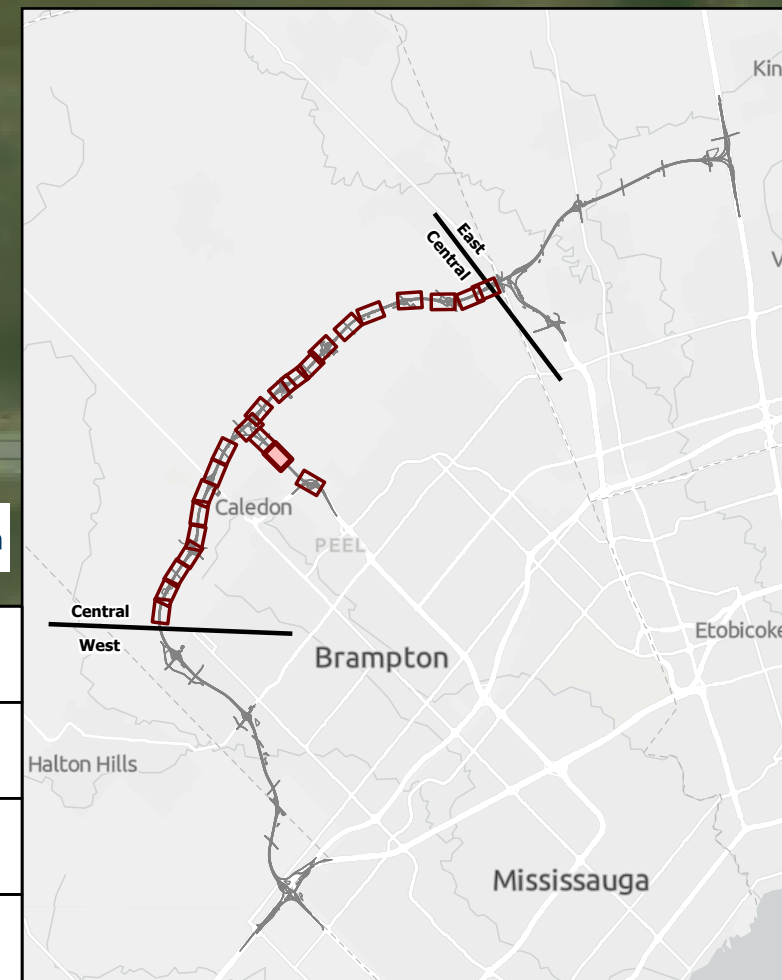
Heart Lake Rd

Heart Lake Rd

Heart Lake Rd

Heart Lake Rd

Heart Lake Rd



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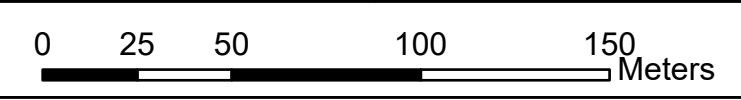
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

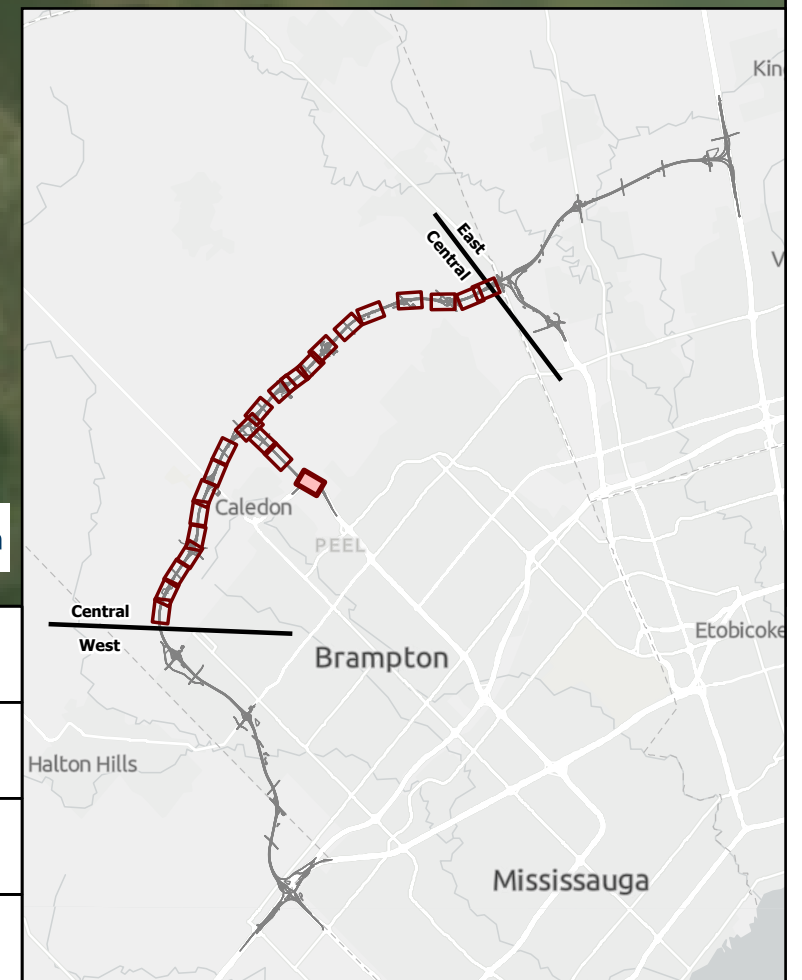
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Project Number: 14M-00321-00

Figure No. A-3.14

Date: 2025-10-09



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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

0 25 50 100 150 Meters

Project Number: 14M-00321-00

Figure No. A-3.15

Prepared By:

Date: 2025-10-09



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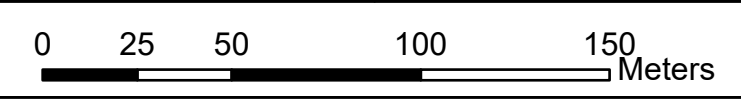
AECOM

Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

Prepared By:



Project Number: 14M-00321-00

Figure No. A-3.16

Date: 2025-10-09





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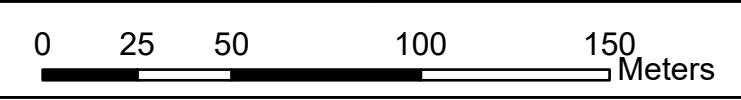
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

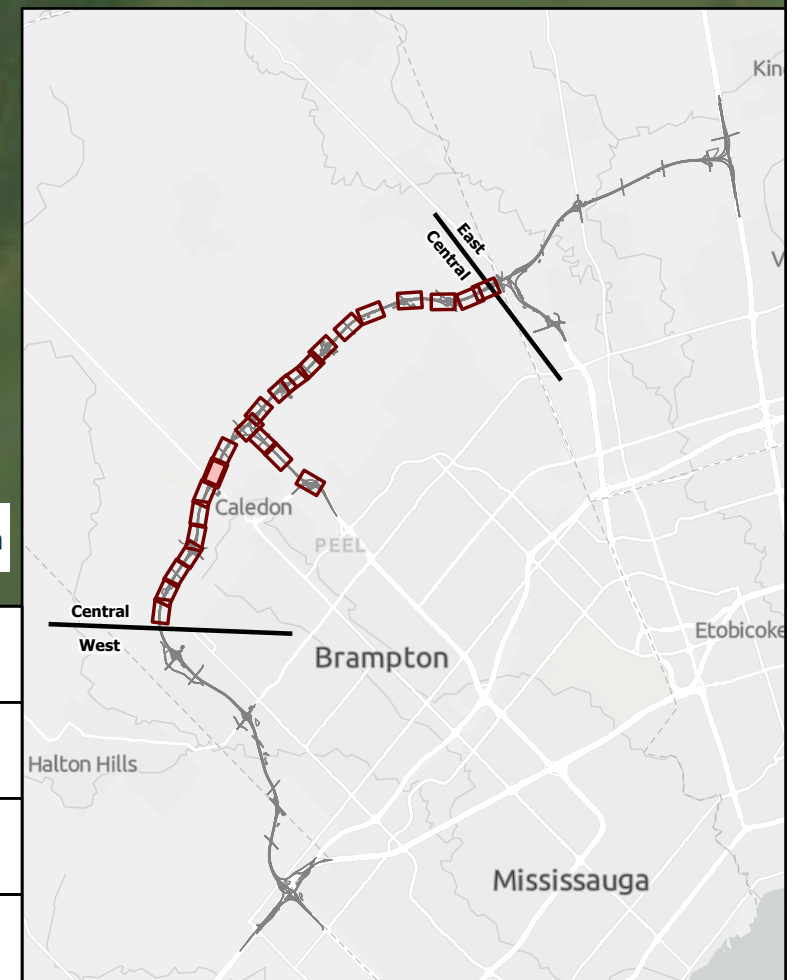
Prepared By:



Project Number: 14M-00321-00

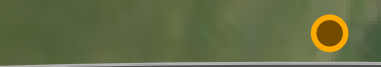
Figure No. A-3.17

Date: 2025-10-09





Orangeville-Brampton Railway



W-W119B

W-W121B



W-W119A

W-W121A










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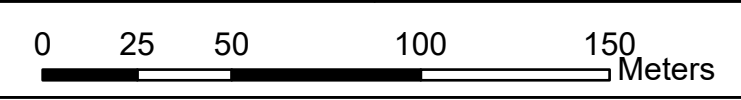
AECOM

Bridge Structures Locations Central Section Detail Map

- Legend**
-  Proposed Foundation Boreholes
 -  Delineation Line
 -  Transitway
 -  Preliminary Design
 -  Road Over Road Bridges
 -  Watercourse Bridges
 -  Preliminary Design

Scale: 1:2,000

Prepared By:

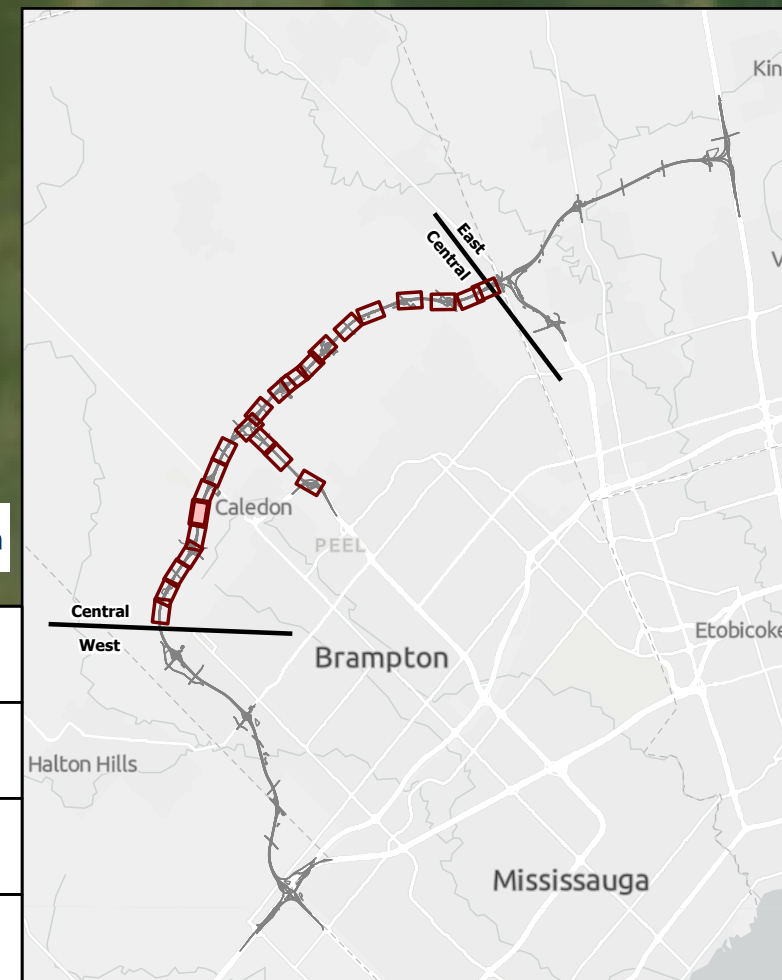


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Figure No. A-3.18

Date: 2025-10-09





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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

0 25 50 100 150 Meters

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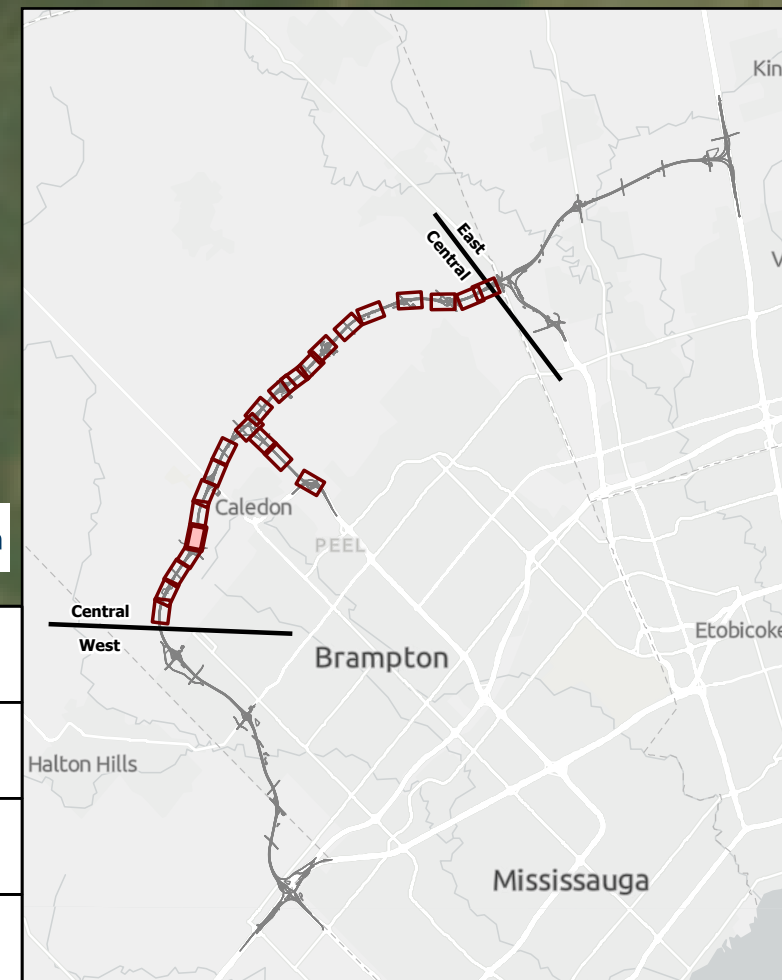
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Old School Rd
Old School Rd
Old School Rd
Old Sch



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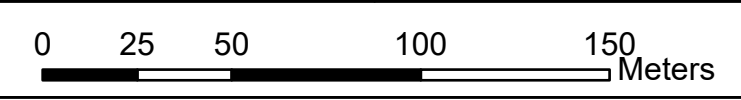
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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

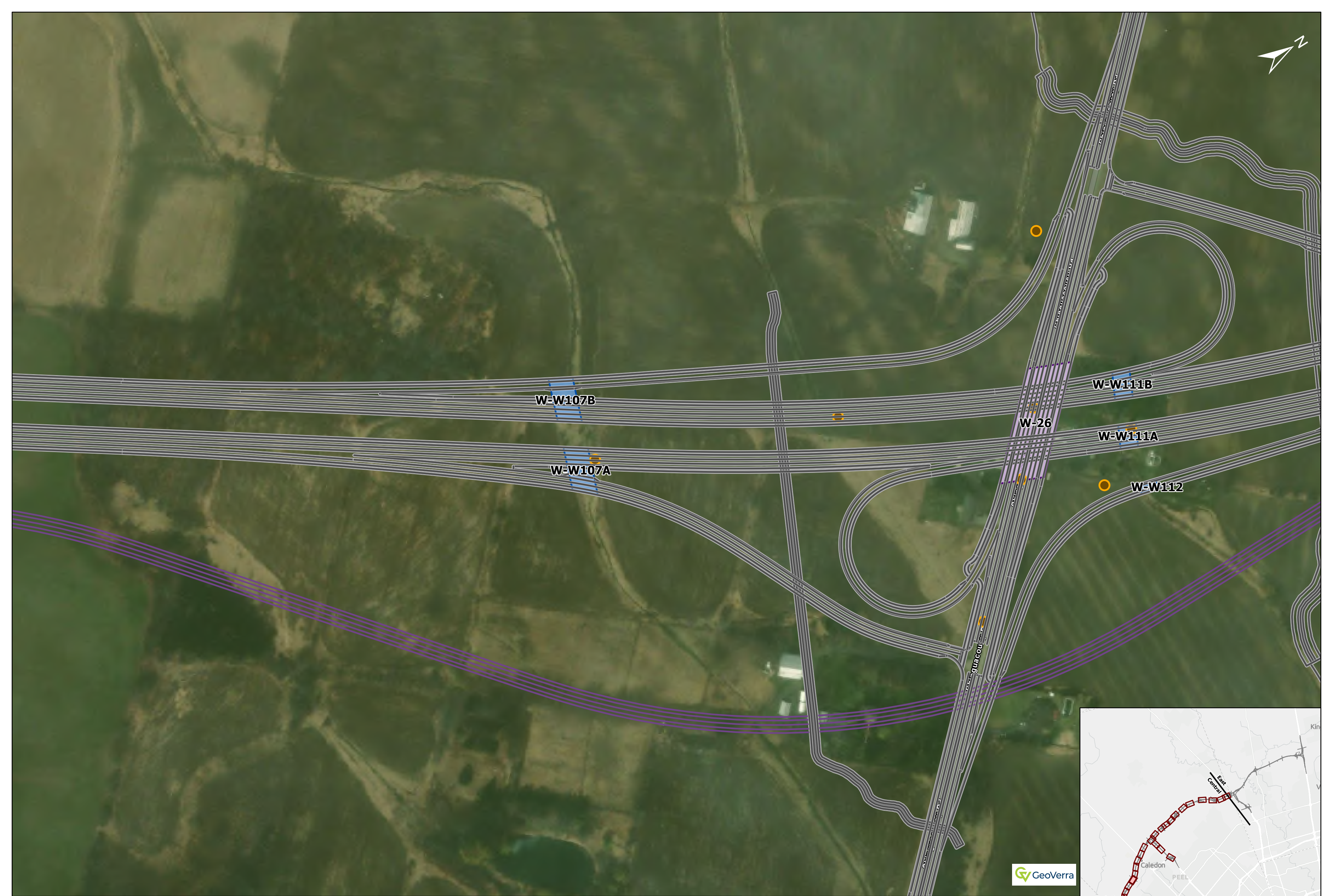
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Figure No. A-3.20

Date: 2025-10-09



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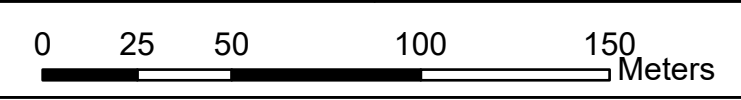
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Transitway
 - Preliminary Design
 - Preliminary Design

Scale: 1:2,000

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Project Number: 14M-00321-00

Figure No. A-3.21

Date: 2025-10-09

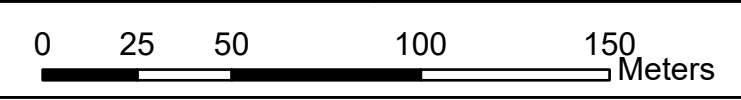


Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Transitway
 - Preliminary Design
 - Road Over Road Bridges
 - Watercourse Bridges
 - Preliminary Design

Scale: 1:2,000

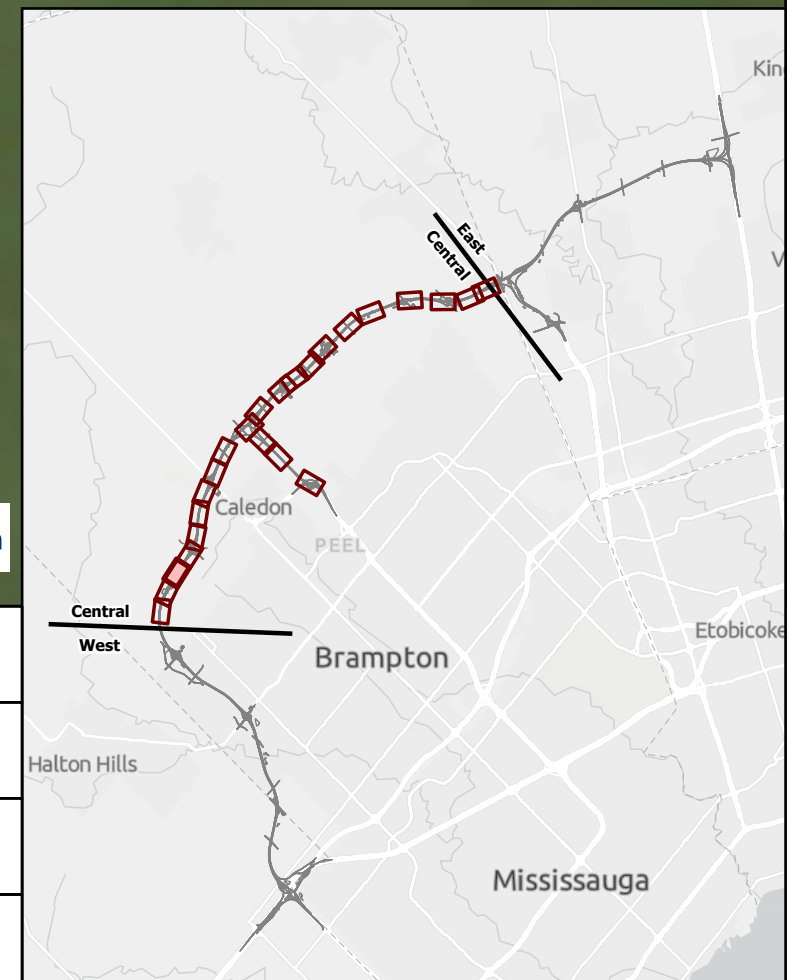
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Figure No. A-3.22

Date: 2025-10-09





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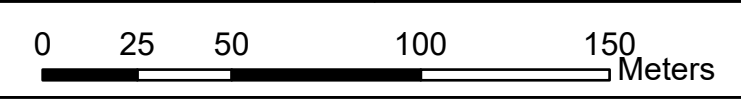
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Bridge Structures Locations Central Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Transitway
 - Preliminary Design

Scale: 1:2,000

Prepared By:

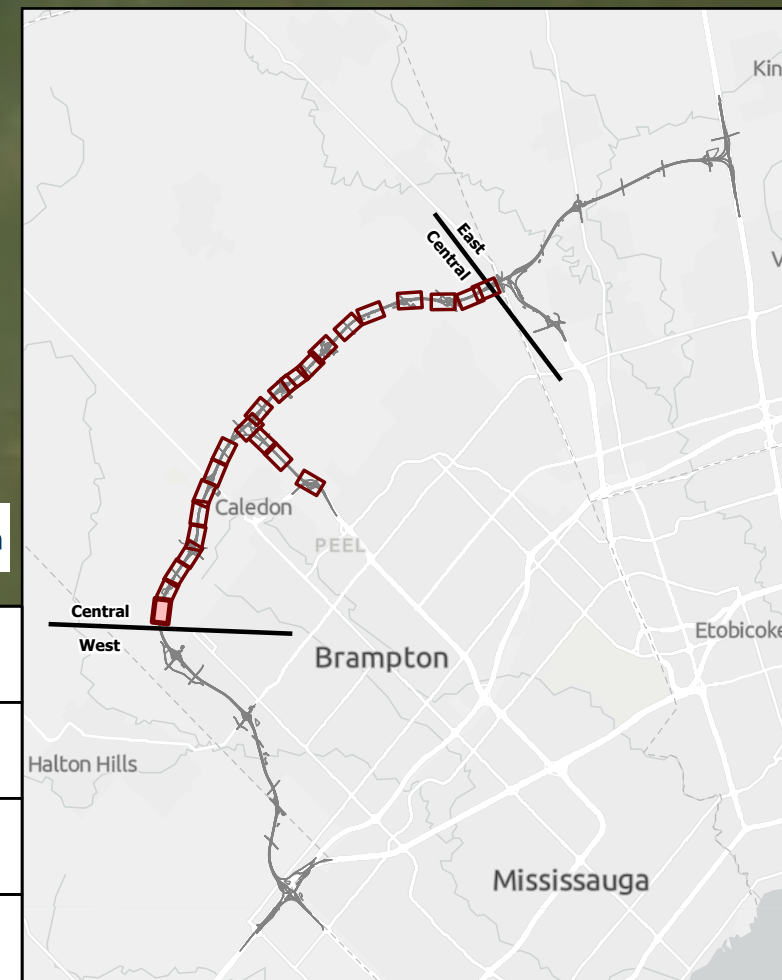


Project Number: 14M-00321-00

Figure No. A-3.23

Date: 2025-10-09





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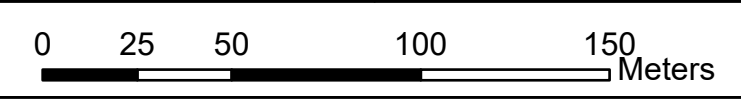
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**Bridge Structures Locations
 Central Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Watercourse Bridges
 - Transitway
 - Preliminary Design
 - Delineation Line
 - Preliminary Design

Scale: 1:2,000

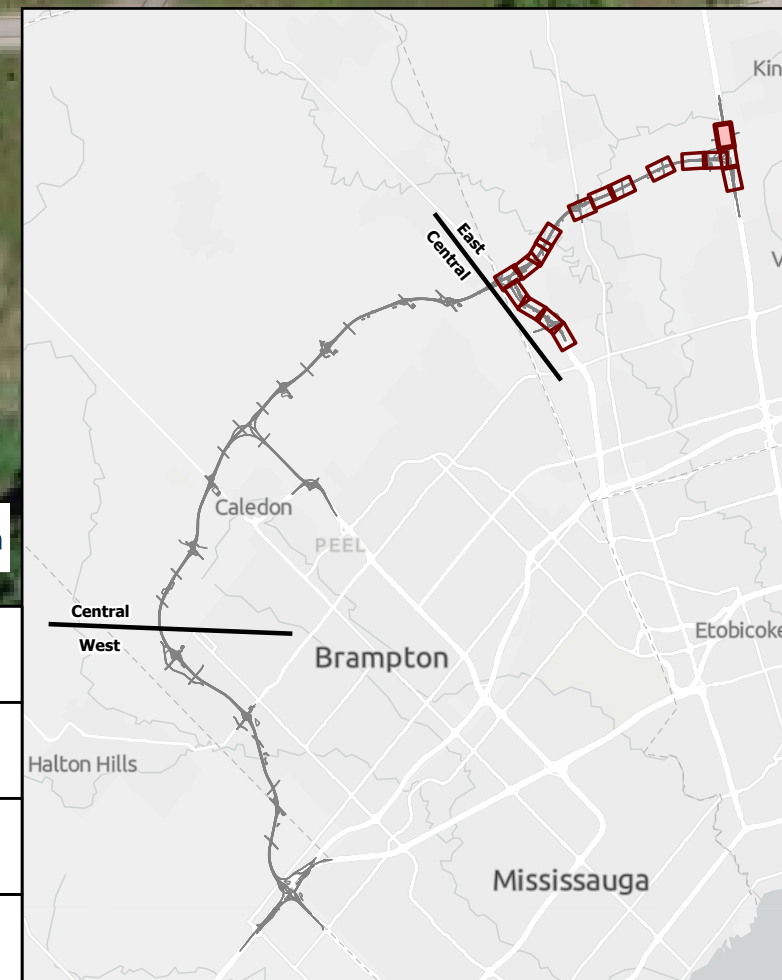
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Project Number: 14M-00321-00

Figure No. A-3.24

Date: 2025-10-09



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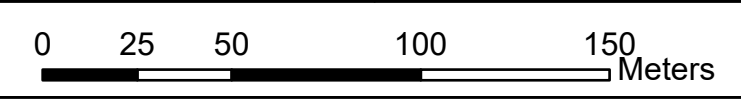
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Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

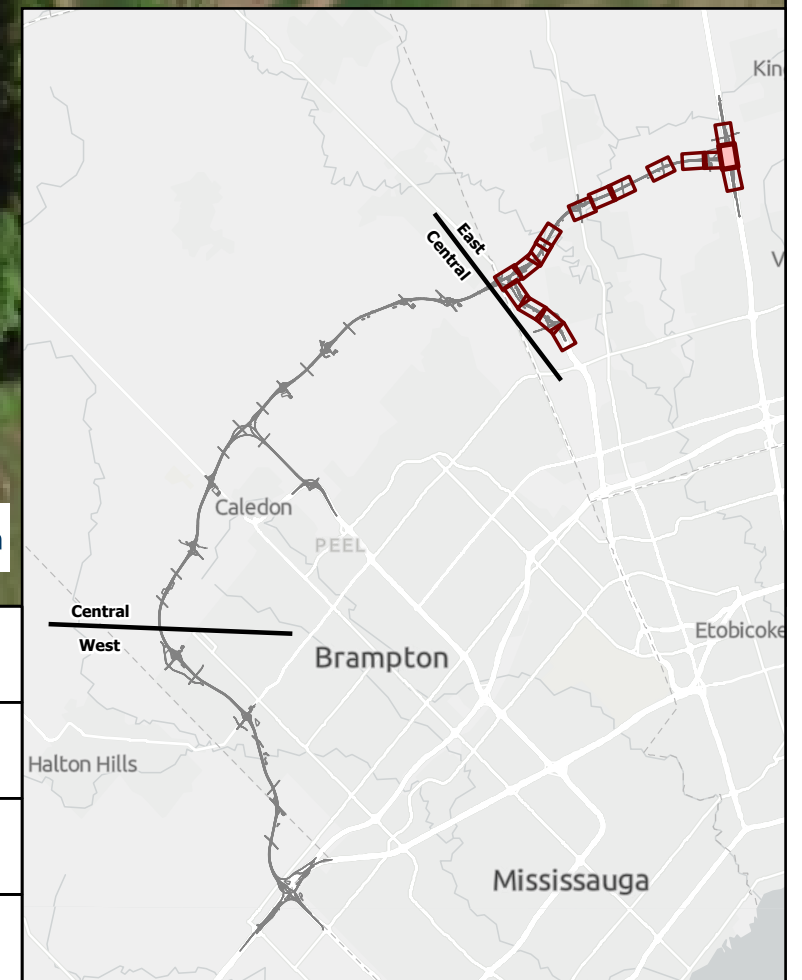
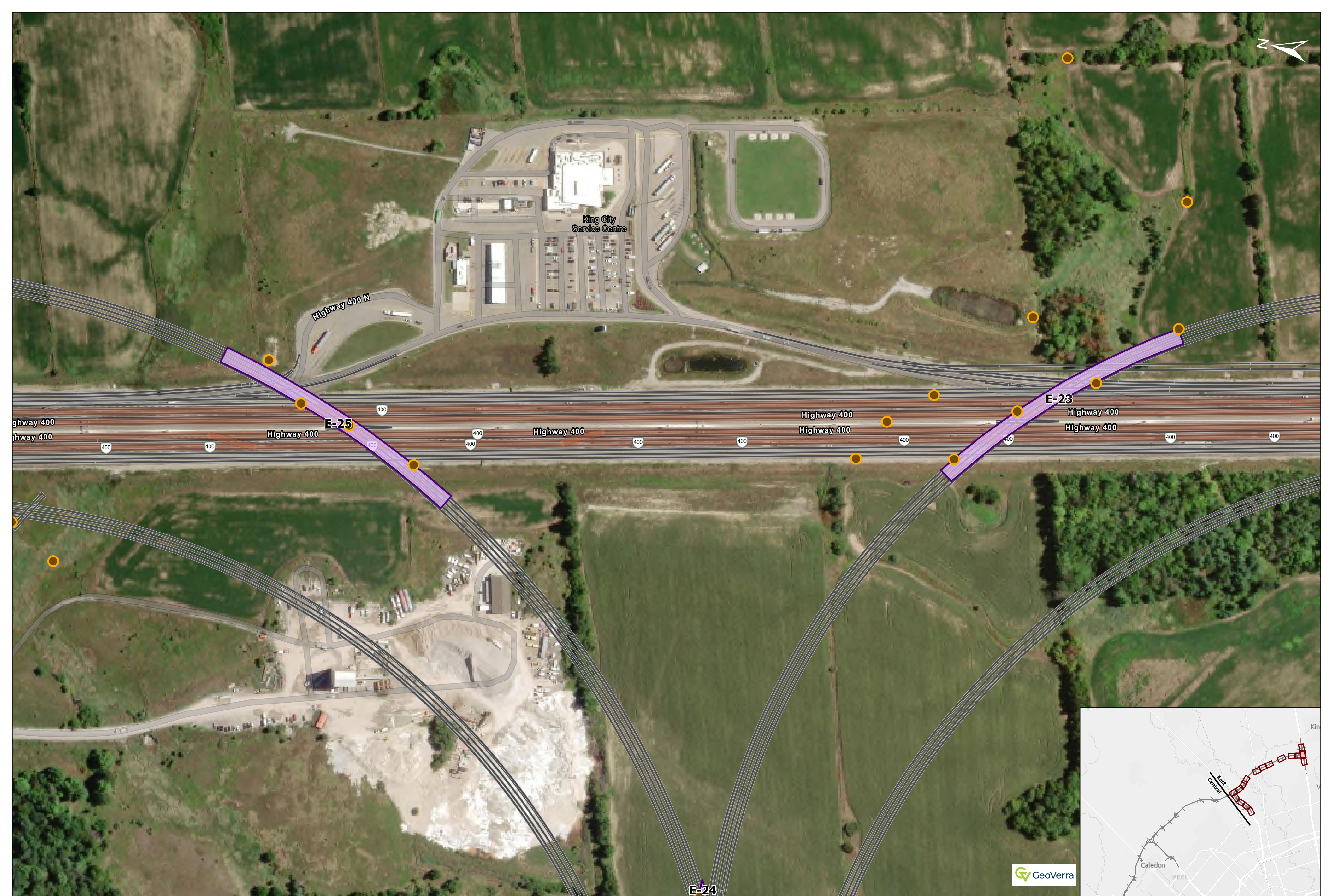
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Figure No. A-4.1

Date: 2025-10-09



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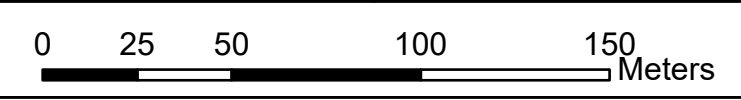
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Preliminary Design
 - Transitway

Scale: 1:2,000

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Figure No. A-4.2

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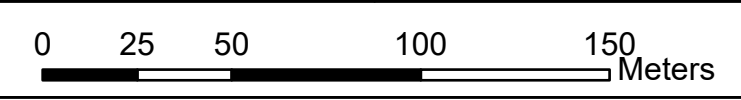
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

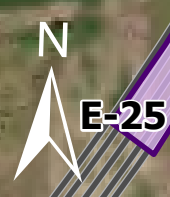
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Figure No. A-4.3

Date: 2025-10-09



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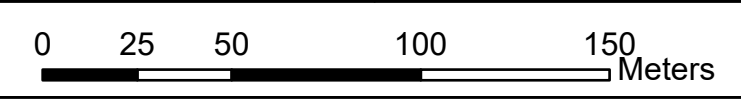
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

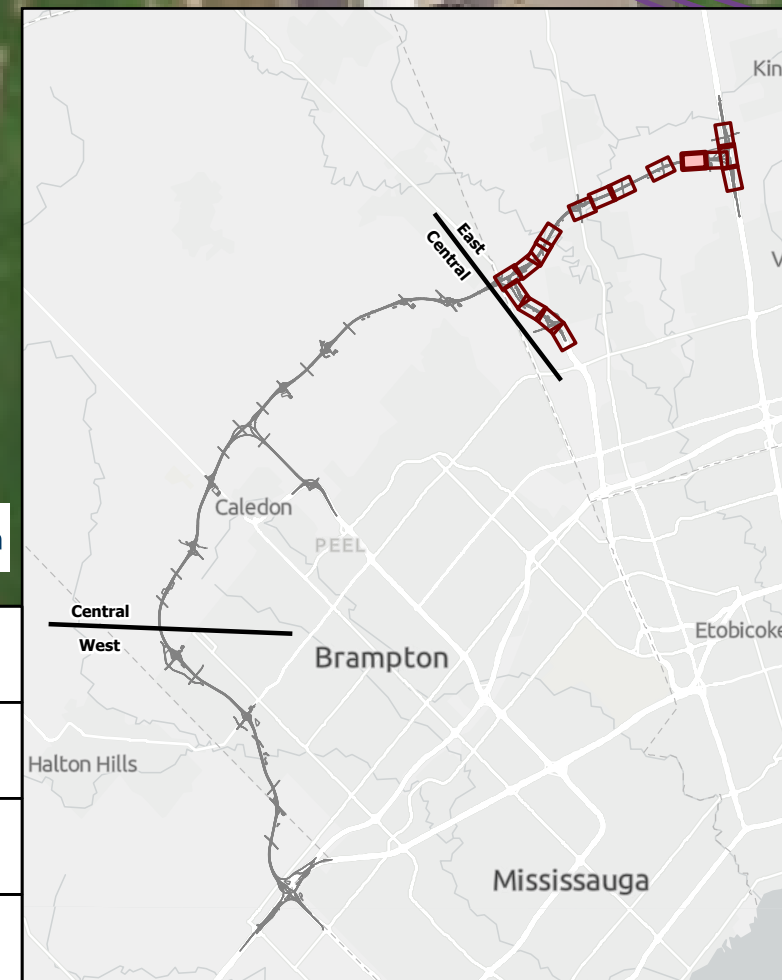
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Figure No. A-4.4

Date: 2025-10-09

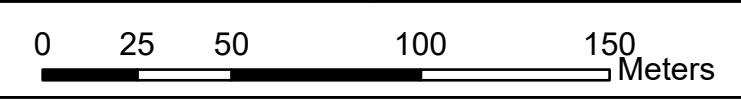


Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

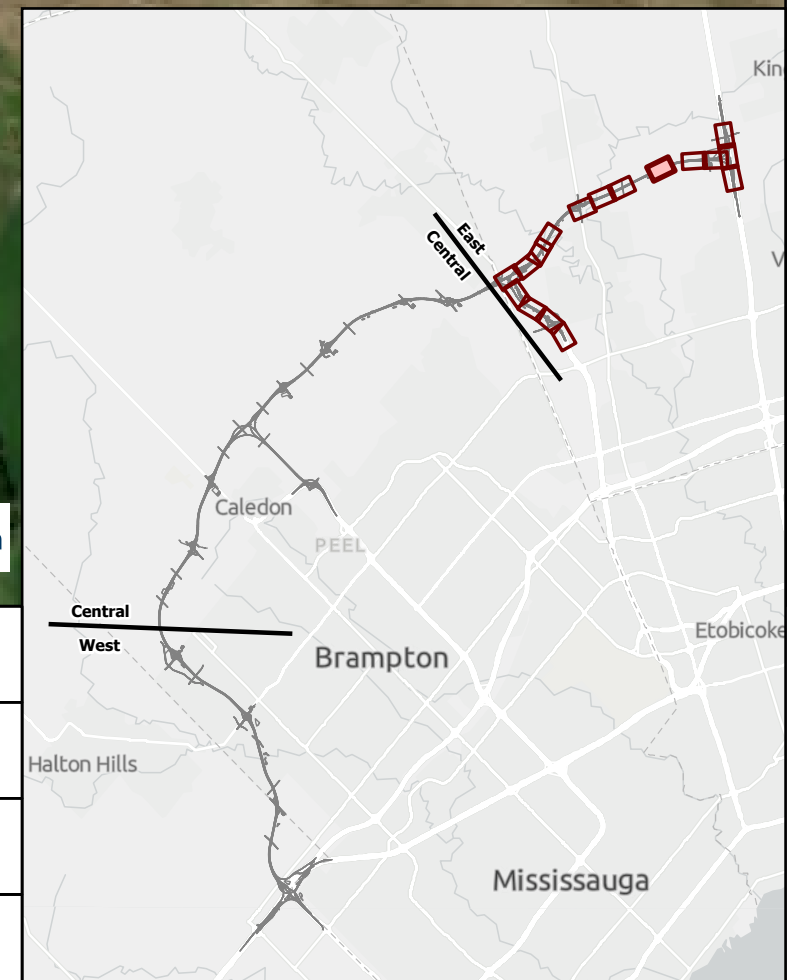
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Figure No. A-4.5

Date: 2025-10-09



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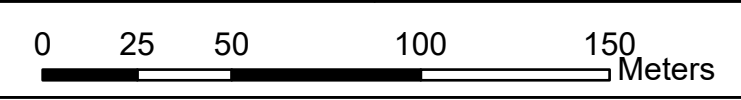
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Preliminary Design
 - Transitway

Scale: 1:2,000

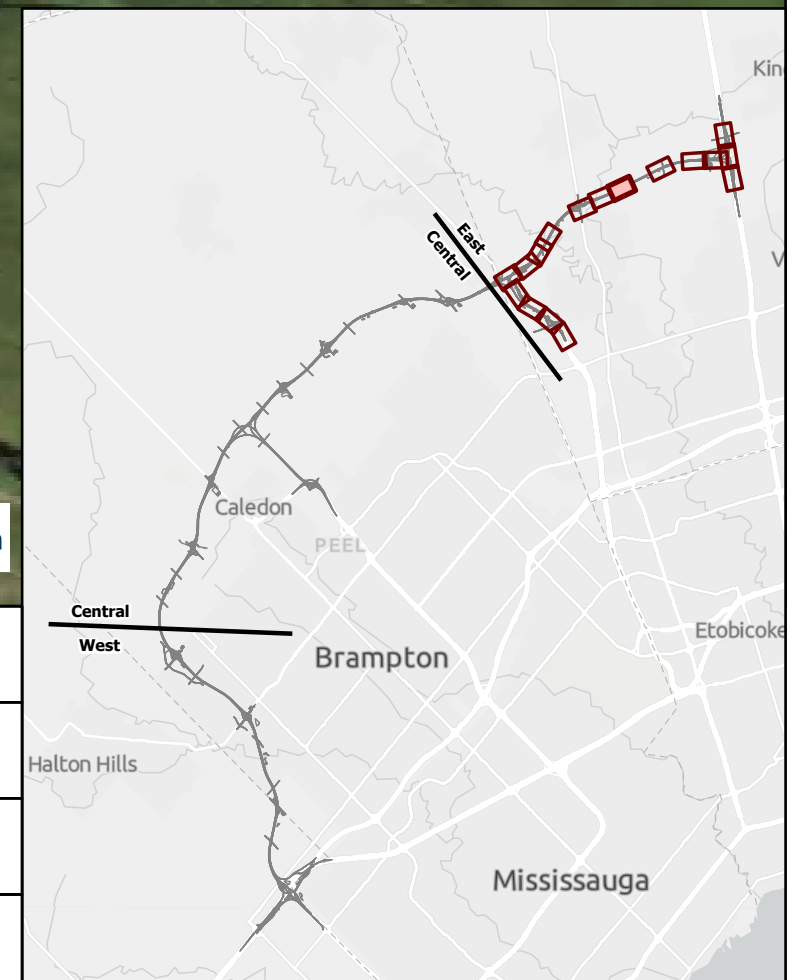
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Project Number: 14M-00321-00

Figure No. A-4.6

Date: 2025-10-09

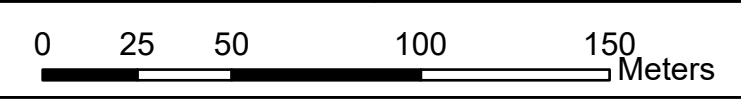


Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Delineation Line
 - Watercourse Bridges
 - Preliminary Design
 - Transitway

Scale: 1:2,000

Prepared By: GeoVerra



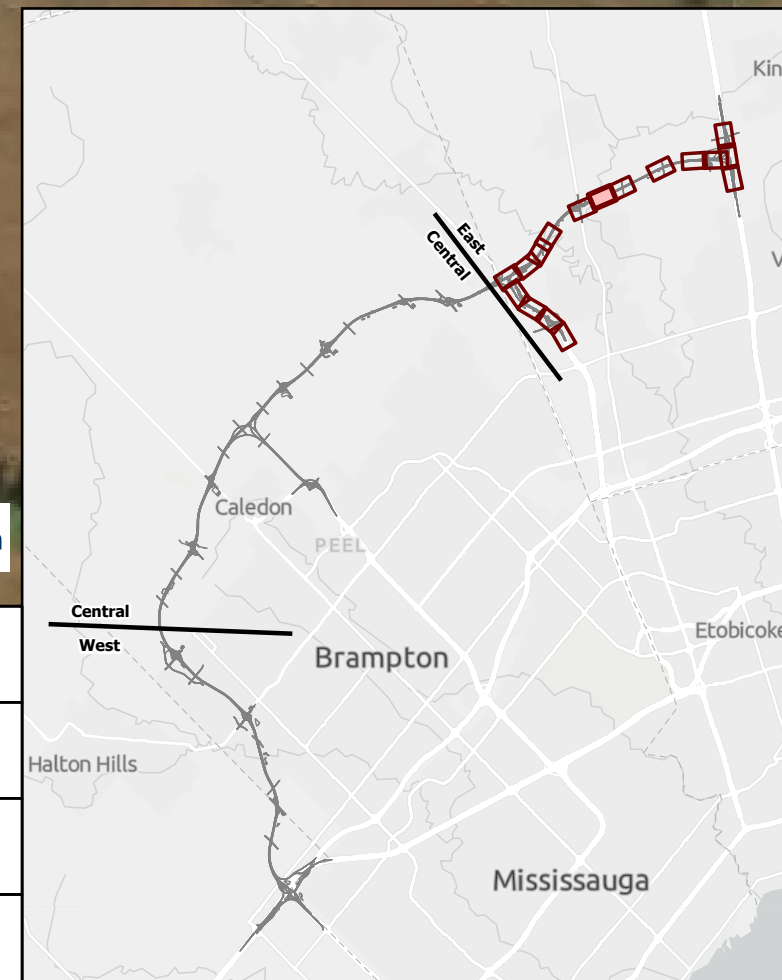
Project Number: 14M-00321-00

Figure No. A-4.7

Date: 2025-10-09



East Humber River



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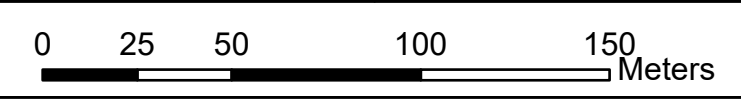
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

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Figure No. A-4.8

Date: 2025-10-09



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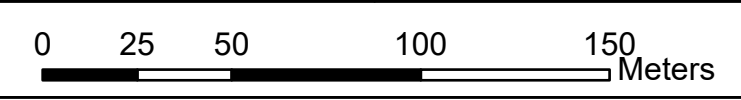


Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - ▭ Road Over Road Bridges
 - ▭ Watercourse Bridges
 - Delineation Line
 - Preliminary Design
 - Transitway

Scale: 1:2,000

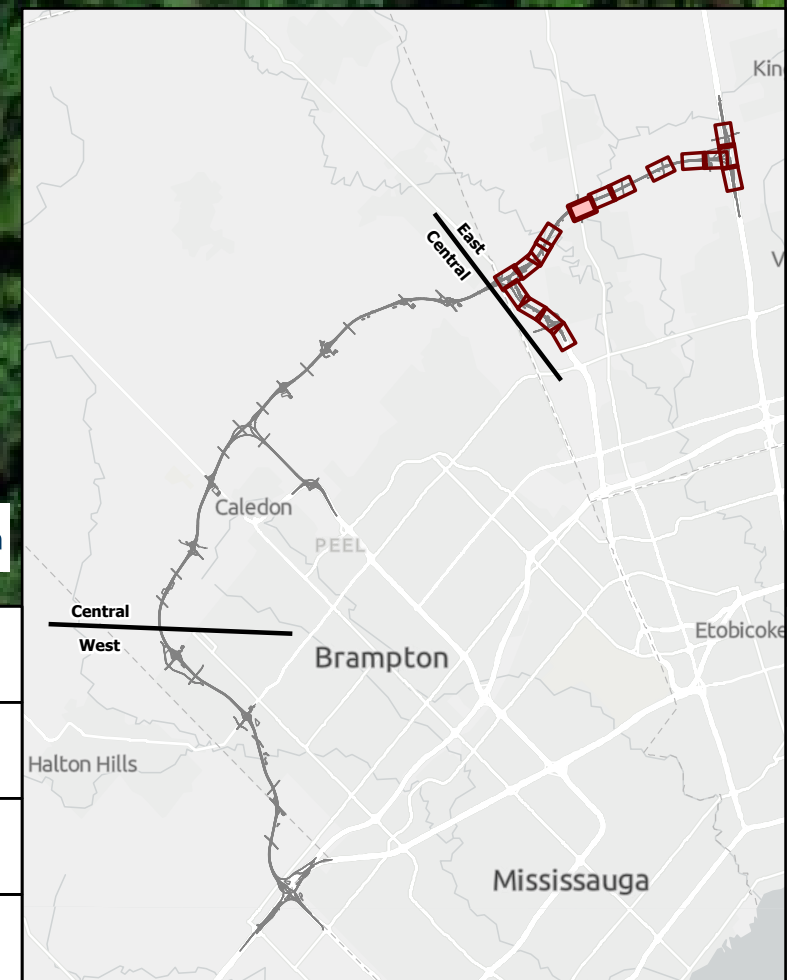
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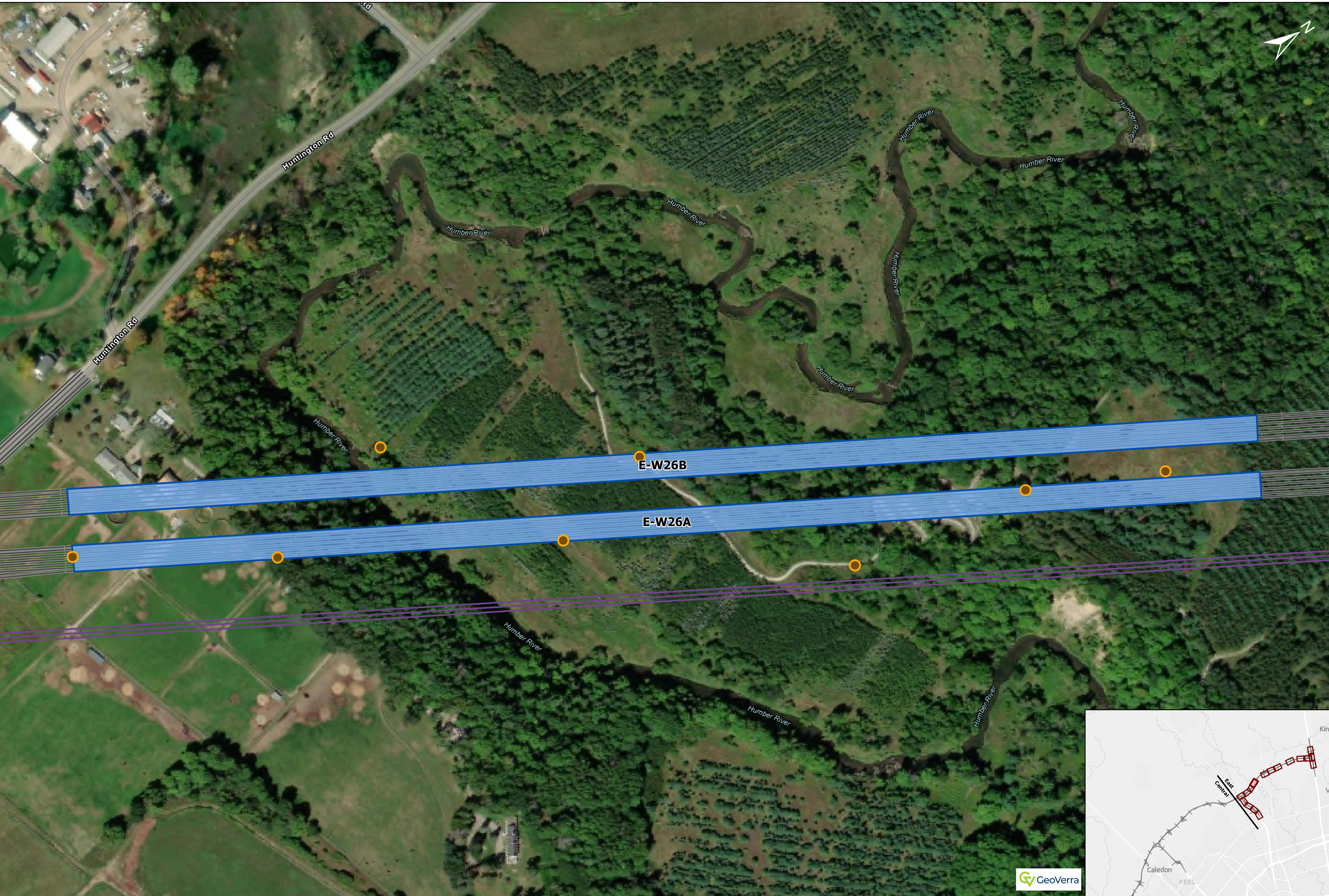


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Figure No. A-4.9

Date: 2025-10-09





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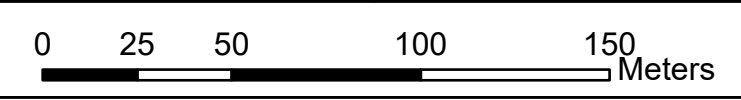
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

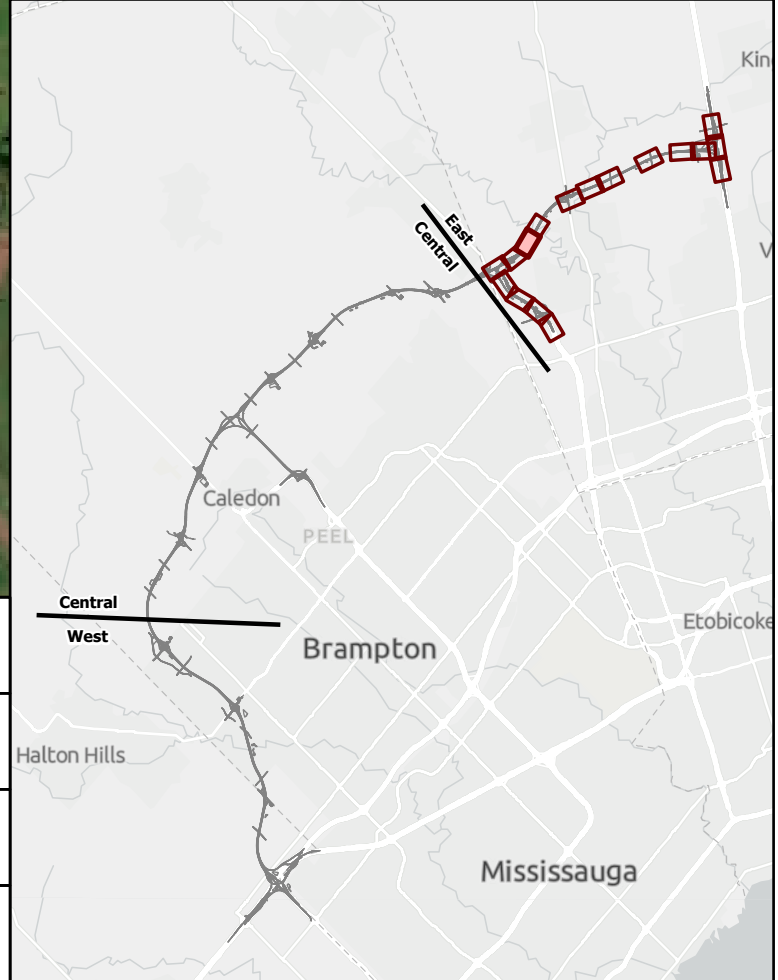
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Figure No. A-4.10

Date: 2025-10-09



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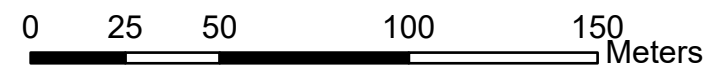
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Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - E-16A Road Over Road Bridges
 - E-W26A Watercourse Bridges

Scale: 1:2,000

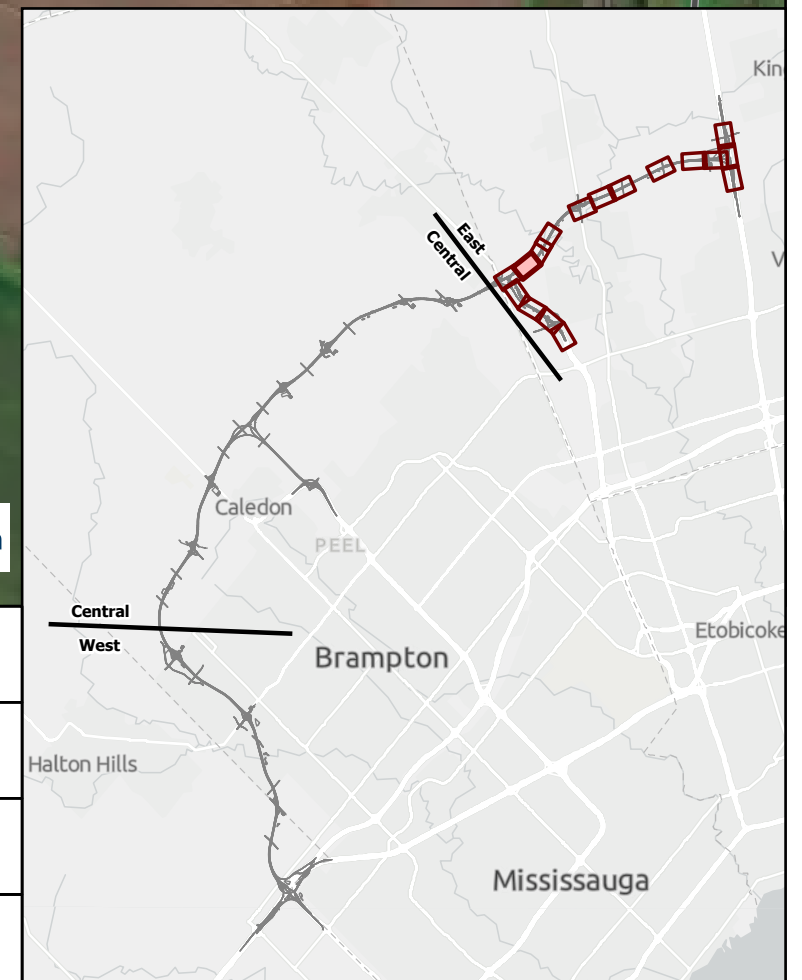
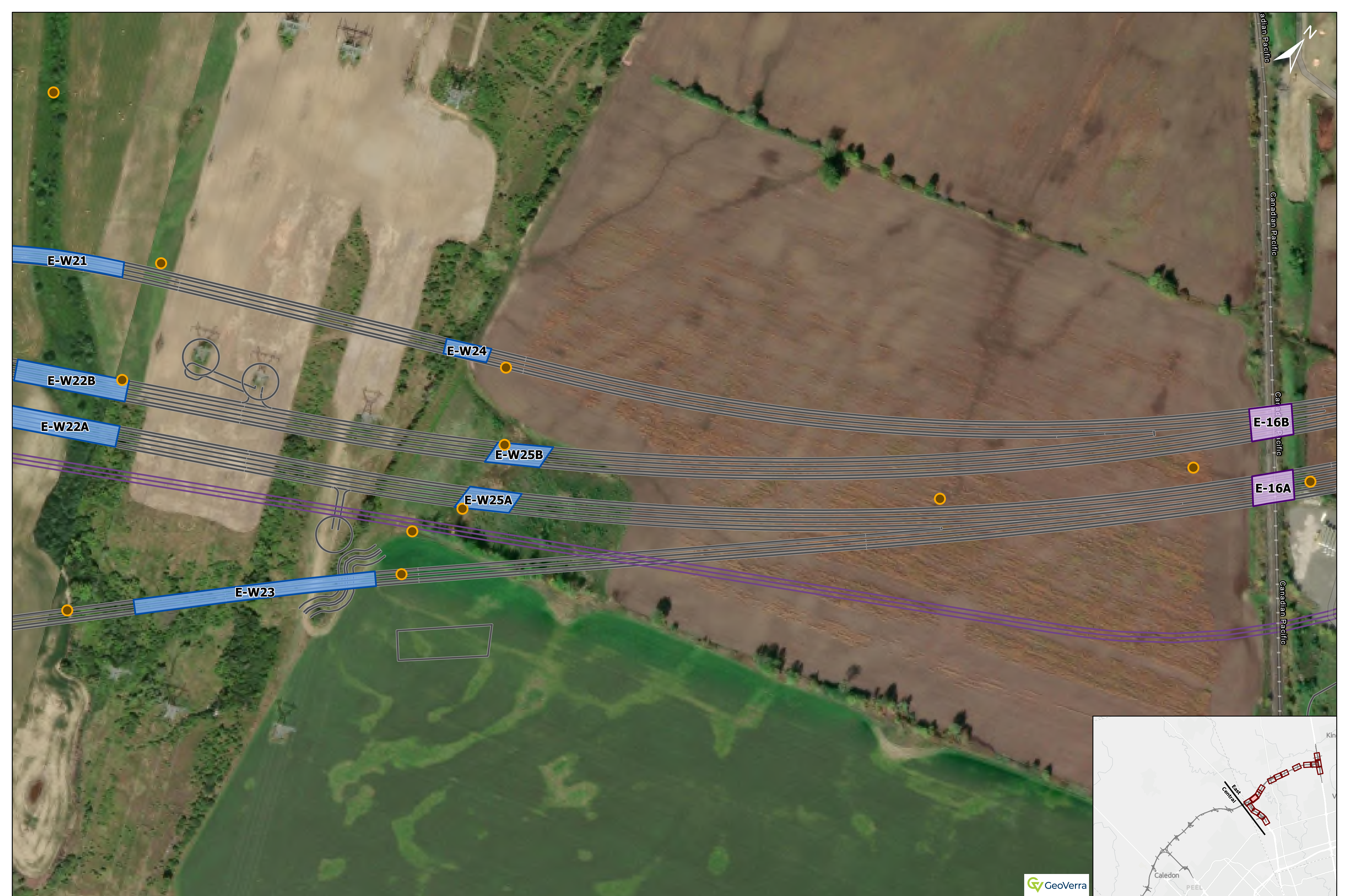
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Project Number: 14M-00321-00

Figure No. A-4.11

Date: 2025-10-09

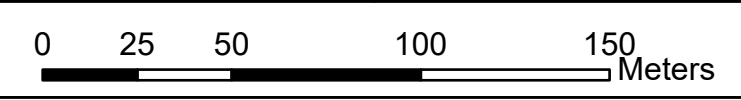


Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

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Project Number: 14M-00321-00

Figure No. A-4.12

Date: 2025-10-09



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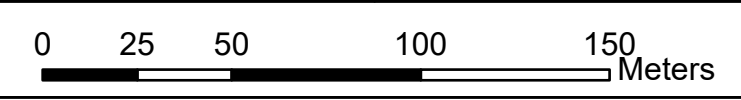
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Road Over Road Bridges
 - Watercourse Bridges
 - Delineation Line
 - Preliminary Design
 - Transitway

Scale: 1:2,000

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Project Number: 14M-00321-00

Figure No. A-4.13

Date: 2025-10-09

E-W20



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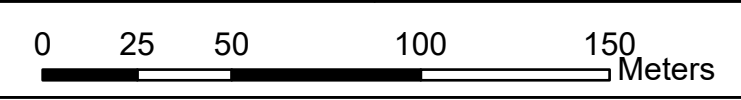
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

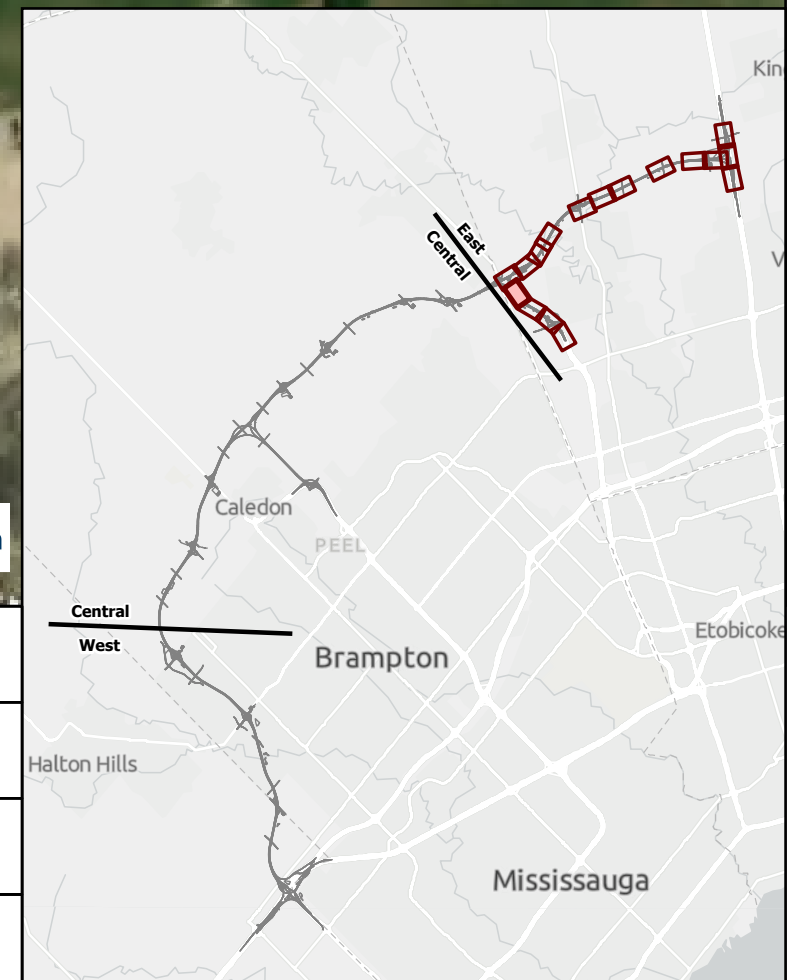
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Project Number: 14M-00321-00

Figure No. A-4.14

Date: 2025-10-09





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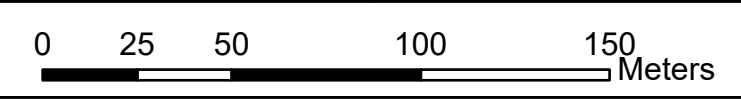
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**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

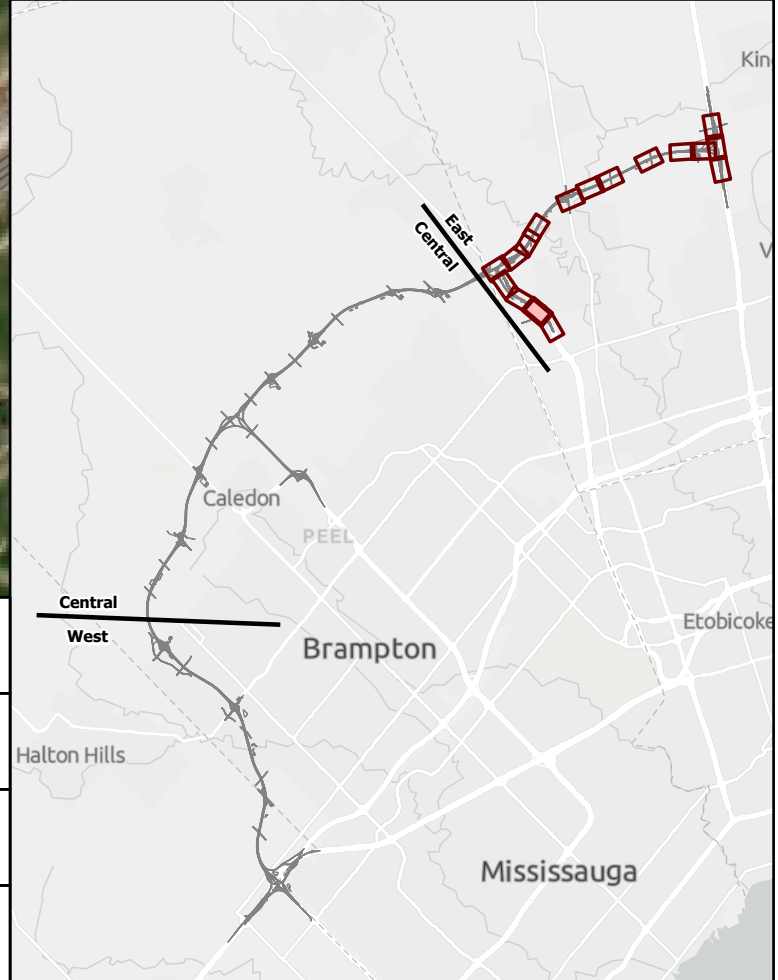
Prepared By: GeoVerra



Project Number: 14M-00321-00

Figure No. A-4.15

Date: 2025-10-09



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Bridge Structures Locations East Section Detail Map

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

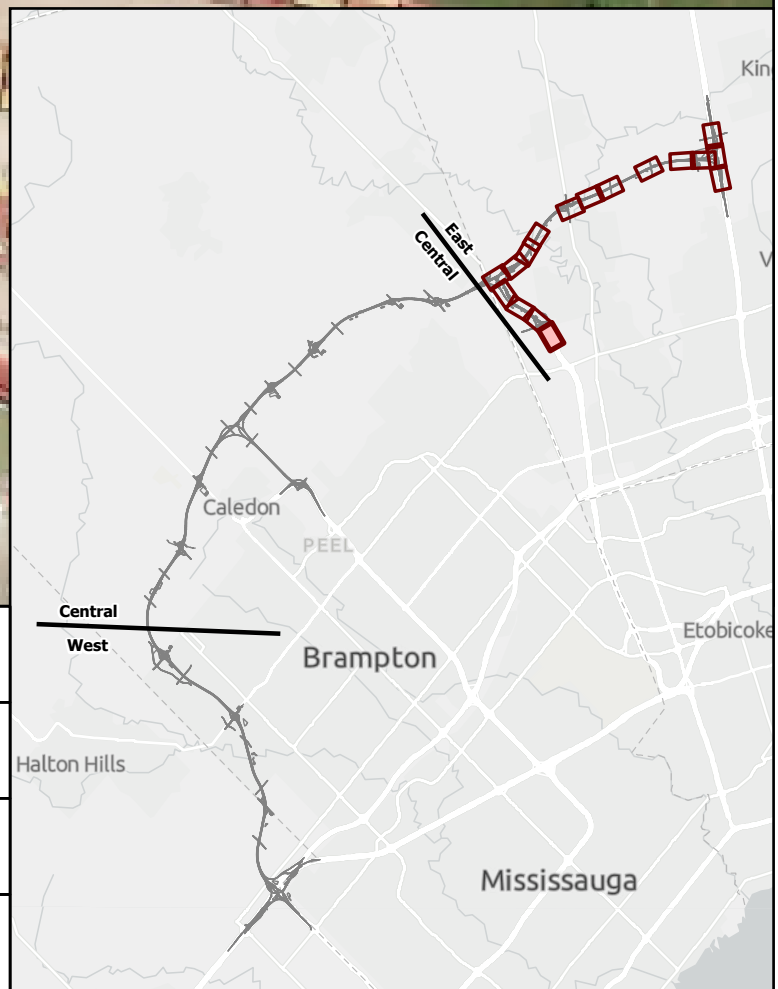
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Project Number: 14M-00321-00

Figure No. A-4.16

Date: 2025-10-09



**Bridge Structures Locations
 East Section Detail Map**

- Legend**
- Proposed Foundation Boreholes
 - Delineation Line
 - Preliminary Design
 - Transitway
 - Road Over Road Bridges
 - Watercourse Bridges

Scale: 1:2,000

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Project Number: 14M-00321-00

Figure No. A-4.17

Date: 2025-10-09



Highway 413 Hydrogeological Report
Table A-1: West Section Geotechnical Details

Structure Number	Structure Type	Location	Approximate Station	General Stratigraphy	Number of Samples Sent for Grain Size Analysis	Number of Boreholes	Total Depth of Investigation (mbgs)	Elevation of Bottom of Borehole (masl)	Bedrock Depth - If Encountered (mbgs)	Bedrock Elevation (masl)
W-14	Three-span Structure	Hwy 407 over CPKC Rail on NBL (east side) and SBL (west side)	2+300 (Hwy 407 NBL), and 0+900 (Hwy 407 SBL)	Concrete/Gravelly Sand (Fill)/Clayey Silt (Fill)/Sandy Silt to Silty Sand Interlayer (Fill)/Clayey Silt-Silt to Clayey Silt/Sand and Silt to Silt and Sand (Till)	13	4	71	195.7	-	-
W-11A	Bridge	30 m long single span bridge to carry Hwy 413 to Hwy 407 N-E Ramp, Hwy 413 to Hwy 401 N-E Ramp, and Hwy 407 to Hwy 401 S-E Ramp over Ninth Line	10+060	Asphalt/Gravelly Sand (Fill)/Sandy Clayey Silt to Clayey Silt and Sand (Fill)/Silty Clay to Clayey Silt (Till)/Silty Sand to Silt and Sand (Till)/Silty Clay to Clayey Silt-Silt/Silty Sand to Silt/Clayey Silt (Residual Soil)/Shale (Bedrock)	10	2	55.4	188.2	24.4 Shale (Queenston Formation)	191.7
W-13	Multi-span Bridge	Approximately 135 m long multi-span bridge replacement/realignment to carry Hwy 401 to Hwy 407 E-S Ramp over Hwy 407	10+100 (Ramp)	Concrete and Asphalt/Sand and Gravel (Fill)/Clayey Silt (Fill)/Silty Sand to Silt and Sand (Till)/Sandy Clayey Silt-Silt (Till)/Silty Sand/Clayey Sand-Silty Sand (Till)	7	3	38.7	193.2	-	-
W-8	Bridge	Approximately 105 m long two-span bridge to carry Hwy 401 E to Hwy 413 N Ramp over Hwy 407	10+400 (Ramp)	Concrete/Sand and Gravel (Fill)/Sandy Clayey Silt to Clayey Silt (Fill)/Sandy Clayey Silt-Silt (Till)/Silty Sand (Till)	6	3	29.7	202.1	-	-
W-11B	Single span Bridge	30 m long single span bridge to carry Hwy 401 E / Hwy 407 E to Hwy 413 N Ramps over Ninth Line	10+925 (Hwy 401 E to Hwy 413 N Ramp)	Gravelly Sand (Fill)/Silty Sand (Fill)/Silty Sand (Till)/Silt (Till)	3	1	9.4	213	NA	NA
W-7	Bridge	Approximately 140 m long multi-span bridge carrying realigned Hwy 401 W to Hwy 407 E Ramp over Hwy 401	11+000 (Ramp)	Topsoil/Clayey Silt (Fill)/Sandy Silt/Clayey Silt/Clayey Silt to Clayey Silt-Silt (Till)/Silty Sand (Till)/Sandy Clayey Silt-Silt (Till)/Silty Sandy to Sand/Clayey Silt/Silt and Sand/Clayey Sand (Residual Soil)/Shale Bedrock	4	2	33.7	187.2	25.9 Shale (Queenston Formation)	187.2
W-15	Bridge	Approximately 56 m long bridge to carry Hwy 401 W and Trafalgar Road N/S to Hwy 407 S Ramp over CPKC Railway	11+200	Concrete/Gravelly Sand (Fill)/Clayey Silt (Fill)/Sandy Silt Interlayer (Fill)/Clayey Silt-Silt to Clayey Silt/Sand and Silt to Silt and Sand (Till)	6	2	35.6	197	-	-
W-5	Bridge	Approximately 30 m long bridge to carry Hwy 401 to Hwy 413 W-N Ramp over Hwy 407 to Hwy 401 E-W Ramp	11+765 (Ramp)	Clayey Silt (Fill)/Silty Sand (Till)/Clay/Sand/Silt/Clayey Silt/Clayey Silt (Residual Soil)/Shale Bedrock	3	1	23.1	189.2	19.8 Shale (Queenston Formation)	192.5
W-17	Bridge	Interchange-Approximately 110 m long bridge to carry Winston Churchill Boulevard over Hwy 413 Mainline	210+000	Asphalt/Gravelly Sand to Gravelly Silty Sand (Fill)/Clayey Silt (Fill)/Sandy Clayey Gravel to Clayey Silt (Till)/Clayey Sand, Sandy Clayey Silt-Silt to Sandy Silt (Till)/Clayey Silt (Residual Soil)/Shale (Bedrock)	7	2	33	189.9	15.5 Shale (Queenston Formation)	193.6
W-18	Bridge	Underpass - approximate 85 m long bridge to carry realigned Embleton Road over Hwy 413 Mainline	210+825	Gravelly Sand (Fill)/Clayey Silt (Fill)/Clayey Silt to Clayey Silt-Silt (Till)/Clayey Silt/Clayey Sand and Gravel/Silty Sand to Silt/Clayey Silt (Residual Soil)/Shale (Bedrock)	11	2	73	166.7	36.7 Shale (Queenston Formation)	169.8
W-22	Bridge	Underpass – approximate 70 m long bridge to carry Wanless Drive over HWY 413 Mainline	217+440	Asphalt/Gravelly Sand (Fill)/Clayey Silt (Fill)/Clayey Silt-Silt to Silt (Till)/Silt (Till)	8	2	20.7	240.4	-	-
W-23	Bridge	About 86 m long bridge to carry Mayfield Road over Hwy 413, east of existing Heritage Road	218+700	Gravelly Sand (Fill)/Sandy Clayey Silt to Clayey Silt (Fill)/Clayey Silt-Silt to Clayey Silt (Till)/Silt and Sand to Silty Gravel (Till)/Clayey Silt (Residual Soil)/Shale (Bedrock)	7	2	39.7	241.7	15.8 & 16.9 - Shale (Queenston Formation)	246.3 & 245

Highway 413 Hydrogeological Report
Table A-1: West Section Geotechnical Details

Structure Number	Depth to Water (mbgs)	Water Elevation (masl)	Water Elevation Notes	Number of Monitoring Wells	Geotechnical Recommendation
W-14	> 3.0 - 13.6	> 212.6 - 202.0	W-14-2: (WL less than 3.0 m), Borehole dry prior to switching to casing advancement at 3 m depth (EL. 212.6 m). W-15-2: (WL 13.6 m), Measured in HW-casing. W-14-1: (WL 3.6 - 10.4 m), Measured in HW-casing at the end of the drilling on June 24, 2022, and prior to starting drilling on June 26, 2022.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-11A	4.6 - 13.7	211.5 - 203.9	W-11-2: Water level (13.7 m) measured inside hollow stem augers during drilling. W-11-3: (WL 4.6 m), water/mud level measured at start of day (prior to rock coring).	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-13	Dry to 7.8	Dry to 206.1	W-13-1: Measured inside Hollow Stem Augers (HSA) during drilling. W-13-3: Borehole was dry upon completion of drilling.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-8	6.9 - 7.9	207.0 - 206.3	W-8-1: Measured inside hollow stem augers (HSA) upon completion of drilling. W-8-2: Measured inside HSA upon completion of drilling. W-8-3: Measured inside HSA upon completion of drilling.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-11B	6.4	216	Measured inside HSA upon completion.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-7	Dry	Dry	W-7-1: The borehole was dry upon completion of the drilling. W-7-3: Inside HSA, prior to switching to casing advancement at a depth of 9.1 m.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-15	5.9 - 13.6	209.7 - 202.0	W-15-1: Measured in open borehole. W-15-2: Measured in HW-size casing.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-5	Dry to 2.6	Dry to 209.7	W-5-1: Dry, inside HSA, prior to switching to casing at 3 m depth and introducing water. (WL: 2.6 m): After water introduced to advance casing.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-17	Dry to 2.3	Dry to 206.5	W-17-1: Dry before switching to casing advance at 3.0 m (elev.205.4 m). W-17-2: Measured in HSA prior to rock coring.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-18	6.0 - 16.2	200.9 - 190.3	W-18-1: Piezometer: WL: 16.2 m. Dry: Measured inside HSA advanced to 21 mbgs.	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-22	9.0 - 9.2	243.8 - 242.5	Measured in HSA.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
W-23	1.7 - 4.5	260.4 - 257.4	W-23-1: (WL 1.7 m), Measured in Piezometer. W-23-2: (WL 4.5 m), Measured inside HSA prior to rock coring.	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.

**Highway 413 Hydrogeological Report
Table A-2: Central Section Geotechnical Details**

Structure Number	Structure Type	Location	Approximate Station	General Stratigraphy	Number of Samples Sent for Grain Size Analysis	Number of Boreholes	Total Depth of Investigation (mbgs)	Elevation of Bottom of Borehole (masl)	Bedrock Depth - If Encountered (mbgs)	Bedrock Elevation (masl)	Depth to Water (mbgs)	Water Elevation (masl)
W-37	Overpass	Old School Road over Highway 410 NBL and SBL, approximately 0.3 km East of Heart Lake Road.	-	Pavement Structure/Sandy Clayey Silt Till/Silty Sand to Sandy Silt Till/Clayey Silt Till/Silt Till	11	2	60.7	237.5	-	-	2	277.9
W-38	Overpass	On Mayfield Road, at the end of Highway 410 North exit ramp to Mayfield Road	-	Pavement Structure/Silty Clayey Sand to Sandy Clayey Silt Till/Silty Sand to Sandy Silt Till/Sand Till	10	2	65.7	224.7	-	-	8.5	251.3
W-41	Overpass	On Mayfield/Highway 410 N-W ramp, approximately 330 m east of Heart Lake	-	Pavement Structure/Sandy Clayey Silt Till/Silty Sand to Sandy Silt Till/Clayey Silt Till/Silt Till/Sand and Silt to Sandy Silt Till/Sand/Gravelly Sand (Till)	5	1	28	231.4	-	-	7.5	251.9
W-42	Overpass	On Dixie Road, approximately 1.0 km north of Old School Road	-	Pavement Structure/Fill/Clayey Silt Till/Interbedded Sandy Silt to Silty Sand Till/Sand Till/Bedrock	8	2	41.6	254.2	19.8, unweathered reddish brown Queenston shale	257.3	2.2	274.5
W-43	Bridge	On Bramalea Road, approximately 800 m north of Old School Road	-	Pavement Structure/Sandy Clayey Silt Till/Sandy Silt to Silty Sand Till/Sand Till	11	2	59.8	243	-	-	6	267.8
W-W148, W-34, and W-36	1 Culvert and 2 Multi-span Ramp	At proposed Hwy 410/Hwy 413 interchange, approximately 0.5 km north of Old School Road, East of Heart Lake Road	-	Topsoil / Clayey Silt Till / Silt Till / Sand/Sandy Silt/Silty Sand Till / Clayey Silt Till	39	8	201.1	245.9	-	-	-1	269.6
W-24	Bridge	Mississauga Road over GTA West mainline, approximately 1.0 km southeast of the intersection of Old School Road and Mississauga Road.	221+525	Asphaltic Concrete over Granular Fill/Fill/Sandy Clayey Silt (Till)/Sand and Silt (Till)/Silty Sand/Silty Clay	6	2	14	255.4	-	-	1.1	268.3
W-25	Bridge	Over GTA West Mainline, approximately 2.35 km northwest of Mayfield Road	222+950	Pavement Structure: Asphaltic Concrete over Granular Fill/Fill/Sandy Clayey Silt (Till)/Sandy Silt/Silt to Sandy Silt/Sandy Silt to Silty Sand (Till)/Sand/Sandy Silt to Silty Sand/Gravelly Sand/Silty Clay (Till)/Silty Clay to Clayey Silt/Shale Bedrock	9	2	61.1	237.8	26.9, Queenston Formation, Shale	242	2	266.4
W-30	Bridge	Interchange structure to carry Hurontario Street over GTA West Mainline, approximately 0.7 km North of Old School Road	227+600	Granular Fill/Silty Clay to Clayey Silt/Sand and Silt/Silty Sand/Clayey Silt/Clayey Silt Till/Silty Sand to Sandy Silt/Sand/Silt/Gravelly Sand/Sandy Silt	12	2	85.2	232.1	-	-	7.18	267.52
W-31	Overpass	Highway 413 GTA West Mainline over Kennedy Road, approximately 1 km North of Old School Road intersection	227+600	Pavement Structure/Clayey Silt Sand to Sandy Clayey Silt Till/Sandy Silty Clay Till/Sand/Silt to Clayey Silt/Silt/Silty Sand Till/Silty Sand	10	2	44.8	255.8	-	-	3.4	277
W-32, W-33 and W-34	Bridges	W-32: GTA-West W-33 & W-34: Hwy 410 Interchange ramps, 0.95 km North of the intersection of Old School Road and Heart Lake Road	230+450	Asphaltic Concrete over Granular Fill/Clayey Silt to Silty Clay (Till)/Gravelly Sand to Sand/Silt/Sand/Clayey Silt to Silty Clay	31	5	227.3	218.4	-	-	3.75	273.85
E-1	Bridge	620 m north of the intersection of Old School Road (Regional Rad 14) and Torbram Road	234+560	Asphaltic Concrete over Granular Fill/Fill/Silty Clay to Clayey Silt (Till)/Sandy Clayey Silt (Till)/Silt (Till)/Sandy Silt (Till)	9	3	39.1	246.1	-	-	0.8	265.1
W-26	Bridge	Structure over GTA West Mainline, approximately 3.1 km northwest of the intersection of Mayfield Road and Chinguacousy Road	244+350	Pavement Structure/Fill/Sandy Clayey Silt Till/Silty Clay Till/Clay/Clayey Silt/Silt/Silt and Sand/Sandy Gravel to Gravel/Silty Sand/Clayey Silt to Silt/Sandy Silt	8	2	42.5	239.2	-	-	0.2	263.7
E-2	Bridge	On Airport Road approximately 300 m northwest of the intersection of Old School Road and Airport Road	310+000	Asphaltic Concrete over Granular Fill/Fill/Sandy Clayey Silt (Till)/Silt (Till)/Silty Sand (Till)	6	2	12.3	242	-	-	5.1	249.4

**Highway 413 Hydrogeological Report
Table A-2: Central Section Geotechnical Details**

Structure Number	Water Elevation Notes	Number of Monitoring Wells	Geotechnical Recommendation
W-37	At W37-2: A 50 mm diameter monitoring well was installed.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-38	W-38-1: Borehole was charged with drilling water, thus groundwater level could not be established. W-38-2: monitoring well, WL:8.5 m.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-41	Groundwater was not encountered in the boreholes during drilling.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-42	-	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-43	-	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-W148, W-34, and W-36	Artesian conditions encountered at C-112-1, water levels ranged between 1.3 and 3.4 m in W34-2/W34-3, and 2.2 to 4.3 m in W36-1/W36-4.	5	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-24	Groundwater was encountered at depths between 6.1 and 6.4 m during drilling at BH/MW W24-2 and BH W24-1.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-25	Groundwater was encountered at depths ranging between 3.2 and 2.15 m during drilling at BH/MW W25-1 and BH W25-2, respectively.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-30	Groundwater was encountered in BH W30-2 at 3.1 m (Elev. 271.6 m) during drilling. Groundwater was not observed at BH/MW W30-1 during drilling.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-31	Groundwater was encountered in BH W31-1 at 1.71 m (Elev. 278.70 m) during drilling and at 3 m (Elev. 277.4 m) in BH W31-2.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
W-32, W-33 and W-34	-	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-1	-	1	It is expected that any groundwater inflow in the foundation excavations can be adequately controlled by pumping from filtered sumps. If the excavation operations are carried out in the wet season, the groundwater level could be higher and more extensive groundwater control measures may be required depending on the excavation requirements. This will need to be confirmed during the detail design or design-build stage.
W-26	Groundwater was encountered at a depth of 3.8 m during drilling in BH W26-1.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-2	-	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.

**Highway 413 Hydrogeological Report
Table A-2: Central Section Geotechnical Details**

Structure Number	Structure Type	Location	Approximate Station	General Stratigraphy	Number of Samples Sent for Grain Size Analysis	Number of Boreholes	Total Depth of Investigation (mbgs)	Elevation of Bottom of Borehole (masl)	Bedrock Depth - If Encountered (mbgs)	Bedrock Elevation (masl)	Depth to Water (mbgs)	Water Elevation (masl)
E-3	Bridge	On Innis Lake Road approximately 480 m northwest of the intersection of Healey Road and Innis Lake Road	311+365.00	Asphaltic Concrete over Granular Fill/Fill/Silty Clay / Silty Clay to Clayey Silt (Till)/Silt (Till)	7	2	24.9	249	-	-	5.1	256.4
E-4	Bridge	On Healey Road, approximately 100 m southwest of the intersection of Centreville Creek Road with Healey Road	312+600	Asphaltic Concrete over Granular Fill/Fill/Silty Clay to Clayey Silt (Till)/Shale (Bedrock)	6	4	38.7	239.1	7.6-10.9, Georgian Bay Formation, Shale bedrock	242.4-242	0	250
E-5	Bridge	On Centreville-Creek Road, approximately 40 m southeast of the intersection of Healey Road and Centreville Creek Road	312+800	Asphaltic Concrete over Granular Fill/Fill/Silty Clay to Clayey Silt (Till)/Clay to Clayey Silt (Till)/SANDY Clayey Silt (Till)/Shale (Bedrock)	6	2	29.4	237.7	BH E5-1: at 11, BH/MW E5-2: at 9.1, Georgian Bay Formation, Shale bedrock	240.4 and 241.6	5.3	247.7
E-6	Bridge	On The Gore Road (Regional Road 8) approximately 2.25 km northwest of the intersection of Mayfield Road and The Gore Road and about 250 m west of West Humber River valley	314+300	Sand (Fill)/Asphaltic Concrete/Silty Clay (Fill)/Silty Clay (Till)/Silty Clay to Clayey Silt (Till)/Silt/Silty Sand/Silt and Sand/Gravelly Silty Sand/Carbonated Cobbles and Clay/Shale (Bedrock)	9	2	98.8	190	44.3 to 47. Georgian Bay Formation, Shale	195.4 to 193.0	12.8	227.2
E-7	Bridge	On Humber Station Road, approximately 630 m north of Mayfield Road	316+280	Asphaltic Concrete over Granular Fill/Clayey Silt (Till)/Silt and Sand (Till)/Sandy Silt (Till)	6	2	18.9	219.7	-	-	1.23	228.5
E-8	Bridge	GTA West Mainline over Mayfield Road, approximately 0.6 km West of the intersection of Mayfield Road and Coleraine Drive	410+000	Asphaltic Concrete over Granular Fill/Fill/Silty Clay to Clayey Silt (Till)/Silt/Sandy Silt (Till)	9	2	40.5	206.8	-	-	2.9	225.8
E-9	Bridge	Over GTA West Mainline, approximately 0.3 km South of the intersection of Mayfield Road and Coleraine Drive	410+600	Asphaltic Concrete over Granular Fill/Fill/Sandy Clayey Silt (Till)/Silt/Sandy Silt (Till)	9	2	33.9	209.4	-	-	1.8	226.1-227

**Highway 413 Hydrogeological Report
Table A-2: Central Section Geotechnical Details**

Structure Number	Water Elevation Notes	Number of Monitoring Wells	Geotechnical Recommendation
E-3	Groundwater was neither encountered during drilling nor upon completion of drilling operations.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-4	On December 10, 2021 it was noticed that the water flowing from the MW under artesian water pressure, therefore, the MW was decommissioned.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-5	Groundwater was encountered during drilling a depth of approximately 9.2 m (Elev. 242.2 m) in BH E5-1. Groundwater was encountered upon completion drilling at a depth of 2.3 m (Elev. 250.7 m) in BH/MW E5-2.	1	The foundation excavations for the shallow foundations or pile caps are anticipated to be located above the groundwater elevation. However, additional assessment of groundwater conditions is required for detailed design.
E-6	Groundwater was not encountered during drilling at borehole (BH E6-1) but was recorded at a depth of about 12.8 m in BH/MW E6-2.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-7	Groundwater was encountered in BH/MW E7-1 and BH E7-2 during drilling at depths of 3.1 m and 2.3 m.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-8	Groundwater was encountered in BH/MW E8-1 and BH/MW E8-2, upon drilling completion, at depths of 8.8 m and 16.8 m.	2	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.
E-9	Groundwater was encountered at a depth of 10.7 m (Elev. 216.3 m) at BH E9-2 but was not encountered during drilling at BH/MW E9-1.	1	Excavation extending below the groundwater table will require provision for effective dewatering schemes or other means to ensure sidewall and basal stability. Additional assessment of groundwater conditions is required for detailed design purposes.

**Highway 413 Hydrogeological Report
Table A-3: East Section Geotechnical Details**

Structure Number	Structure Type	Location	Approximate Station	General Stratigraphy	Number of Samples Sent for Grain Size Analysis	Number of Boreholes	Total Depth of Investigation (mbgs)	Elevation of Bottom of Borehole (masl)	Bedrock Depth - If Encountered (mbgs)
E-10	Overpasses	Mainline over Highway 50	510+000	Silty Clay Till/Silty Clay/Silt	13	2	44.4	178.8	42.6 (Georgian Bay Formation)
E-11	Overpass	427 S-W Ramp over Highway 50	9+260	Silty Clay Till/Silty Clay/Silt	7	1	43.9	180.5	41.8 (Georgian Bay Formation)
E-12	Underpass	427 S-W Ramp over 413	8+850	Silty Clay/Silty Sand/Silty Clay to Clayey Silt	11	2	49.1	173.6	42.1 (Georgian Bay Formation)
E-13	Overpass	413 to 427 W-S Ramp over Highway 50	10+880	Sandy Silty Clay Till/Silty Clay/Silt	7	1	40.5	182.4	36.6 (Georgian Bay Formation)
E-14	Underpass	427 E-S Ramp over 413	11+280, 510+610	Silty Clay/Silty Clay to Clayey Silt	14	2	54.9	163	49.6 (Georgian Bay Formation)
E-14-1	Ramp	427 E-S Ramp over S-W Ramp	11+520, 8+580	Silty Clay/Silt and Sand/Silt	11	2	34.1	187.5	39.9 (Georgian Bay Formation)
E-16	2 Bridges	CP Rail Line	511+970	Silty Clay/Silty Sandy Clay Till	5	1	45.2	175.7	-
E-17	Overpasses	Huntington Road	512+540	Silty Clay Till, Silt, Sand	17	2	46.4	178.4	-
E-18	Overpasses	Highway 27	515+260	Silty Clay Till/Silt/Silty Sand	13	2	45.7	190	-
E-19	Overpasses	Kipling Avenue	517+450	Silty Clay Till/ Silt/Silty Sand to Sandy Silt	11	2	45.4	190.4	-
E-20	Underpass	Pine Valley Drive	519+540	Silty Clay Till/Silt to Sandy Silt	12	2	30.9	241.1	-
E-21	Underpass	Weston Road	521+675	Silty Clay Till/Sand and Silty to Sandy Silt	12	3	36.9	230.9	-
E-22	Overpasses	Kirby Road	10+180, 10+600	Sandy Silty Clay Till/Silt/Silty Sand	15	2	48.3	208.5	-
E-23	Underpass	400 to 413 S-W Ramp	11+180	Silty Clay Till/Sand/Silt/Silty Clay	30	4	46.3	221.2	-
E-25	Underpass	413 to 400 W-N Ramp	8+640	Silty Clay Till/Silt	29	4	47.7	228.7	-
E-28	Underpass	King-Vaughan Road	24+500, 10+000	Silty Clay Till/Silt/Silty Sand	16	2	47.2	229.9	-
E-30	Overpasses	Nashville Road	11+675/12+175, 8+050/8+450	Silty Clay Till/ Sandy Silt/Silty Clay	10	2	29.2	188.1	-

Notes:

1) * = Indicates that the groundwater elevation is inferred (i.e. inferred from soil logs or during drilling and not from a monitoring well measurement).

**Highway 413 Hydrogeological Report
Table A-3: East Section Geotechnical Details**

Structure Number	Bedrock Elevation (masl)	Depth to Water (mbgs)	Water Elevation (masl)	Water Elevation Notes	Number of Monitoring Wells	Geotechnical Recommendation
E-10	181.1	4.5	219.2*	Inferred from soil logs.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-11	182.5	14.1	210.3	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-12	180.6	21.9	201.3	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-13	186.3	14.1	208.8*	Soil logs transitioned from moist to wet at 3.8 mbgs.	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-14	168.3	21.9	196	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-14-1	181.5	2.3	219.3*	Taken upon completion of drilling. Water was introduced during drilling.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-16	-	3	217.9*	Inferred from drilling	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-17	-	1.5-2.3	223.3-222.3*	Inferred from soil logs.	0	Considering the permeability of the near surface sand to silt deposit, dewatering by pumping from properly filtered sumps from with the excavation will be required. Surface water should be directed away from excavation.
E-18	-	6.4	226.3	-	1	Considering the consistency and relatively low permeability of the clayey soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-19	-	0.8-1.5	235-234.1*	Recorded upon completion of drilling.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-20	-	22.7	249.3*	Soil logs transitioned from moist to wet around 3 mbgs.	1	Considering the consistency and relatively low permeability of the near clayey soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations. Additional pumps maybe required if zones of perched water or concentrated seepage are encountered in localized cohesionless layers.
E-21	-	2.1-3.8	264.5-264*	Inferred from soil logs.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-22	-	1.5	255.3	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-23	-	6.6	262.4*	Not believed to reflect stabilized conditions.	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-25	-	9.8	262.8*	Not believed to reflect stabilized conditions.	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-28	-	14.5	262.2	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-30	-	2.1-4.6	215.2-214.2*	Inferred from soil logs.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.

Notes:

1) * = Indicates that the groundwater elevation is inferred (i.e. inferred from soil logs or during drilling and not from a monitoring well measurement).

**Highway 413 Hydrogeological Report
Table A-3: East Section Geotechnical Details**

Structure Number	Structure Type	Location	Approximate Station	General Stratigraphy	Number of Samples Sent for Grain Size Analysis	Number of Boreholes	Total Depth of Investigation (mbgs)	Elevation of Bottom of Borehole (masl)	Bedrock Depth - If Encountered (mbgs)
E-W13	Culvert	413 over Robinson Creek	510+335	Clayey Silt Till/Silt	4	1	16.8	205.4	-
E-W17	2 Bridges	427 over West Robinson Creek	18+000	Silt & Sand/Silt/Silty Clay Till	7	1	42.8	167.5	39.8 (Georgian Bay Formation)
E-W18	1 Bridge	427 E-S Ramp over West Robinson Creek (2)	11+100	Silt Clay Till/Sandy Silt/Silty Clay	13	2	44.2	174.4	-
E-W19	2 Bridges	413 over W Robinson Creek	570+750	Clayey Silt to Silty Clay/Silty Sand	7	1	54.9	163	49.6 (Georgian Bay Formation)
E-W20	1 Bridge	427 S-E Ramp over West Robinson Creek	8+860	Silty Clay to Clayey Silt/Sandy Silt to Silt	7	1	47.4	167.4	45.3 (Georgian Bay Formation)
E-W21	1 Bridge	427 E-S Ramp over West Robinson Creek	10+940	Silty Clay/Silty Clay to Clayey Silt	7	1	43.8	176.1	-
E-W22	2 Bridges	413 over W Robinson Creek (2)	510+980	Silty Clay/Silty Clay to Clayey Silt	6	1	45	172.7	-
E-W23	1 Bridge	427 S-E Ramp over West Robinson Creek (2)	9+260	Silty Clay Till/Silt/Silty Sand	6	1	44.2	174.3	-
E-W25	2 Bridges	413 over Robinson Creek	511+330	Silty Clay/Silt/Silt and Sand	6	1	41.8	174.7	-

Notes:

1) * = Indicates that the groundwater elevation is inferred (i.e. inferred from soil logs or during drilling and not from a monitoring well measurement).

**Highway 413 Hydrogeological Report
Table A-3: East Section Geotechnical Details**

Structure Number	Bedrock Elevation (masl)	Depth to Water (mbgs)	Water Elevation (masl)	Water Elevation Notes	Number of Monitoring Wells	Geotechnical Recommendation
E-W13	-	Dry	Dry*	Dry upon completion of drilling.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations. If water levels from the creek impact the proposed construction method, consideration can be given to using a coferdam or flow diversion of the creek.
E-W17	170.5	8.2-8.5	201.8-202.1	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils and the anticipated shallow excavations, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations. Additional pumps maybe required if zones of perched water or concentrated seepage are encountered in localized non-cohesive layers within the cohesive soils.
E-W18	-	23.6	195.2	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-W19	168.3	21.9	196	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-W20	169.5	2.2	323.7*	Inferred from soil samples (mud rotary drilling)	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-W21	-	6.1	213.8*	Inferred from soil samples (mud rotary drilling)	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-W22	-	24.3	193.4	-	1	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations.
E-W23	-	4	214.5*	Inferred from soil logs.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations. Additional pumps and/or perimeter wells maybe required if zones of perched water or concentrated seepage are encountered in localized non-cohesive layers within the cohesive soils.
E-W25	-	3	213.5*	Inferred from soil logs.	0	Considering the consistency and relatively low permeability of the near surface cohesive soils and the anticipated shallow excavations, dewatering should be feasible by pumping from properly filtered sumps from within the excavation. Surface water should be directed away from excavations. Additional pumps and/or perimeter wells maybe required if zones of perched water or concentrated seepage are encountered in localized non-cohesive layers within the cohesive soils.

Notes:

1) * = Indicates that the groundwater elevation is inferred (i.e. inferred from soil logs or during drilling and not from a monitoring well measurement).

