Appendix N

Erosion and Sediment Control Overview and Risk Assessment

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Project name:
GWP 4024-20-00
Highway 401 from 1 km East of Highway 16 to 3.3 km West of Maitland Road

From:
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Date:
May 23, 2024

To:
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CC:
Amanda Dickson, MTO
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Memorandum

Subject: (G.W.P. 4024-20-00) Highway 401 Maitland West of Maitland Road, PD & EA – Preliminary Erosion and Sediment Overview Risk Assessment (ESORA) Technical Memorandum

1. Introduction

The Ontario Ministry of Transportation (MTO) retained the services of AECOM Canada Limited (AECOM) to complete a Class Environmental Assessment (EA) and Preliminary Design for Highway 401 from 1 km east of Highway 16 to 3.3 km west of Maitland Road for a total length of approximately 20.75 km, located within the Township of Augusta, Town of Prescott, and the Township of Edwardsburg Cardinal. The primary focus of this study was to address current and future transportation needs by developing a plan for the rehabilitation and/or replacement of 14 structures, determining the long-term plans for the Maitland Road, Edward Street and Highway 16 interchanges, and to establish the future footprint for interim six lanes and ultimate eight lanes of Highway 401.

The study includes developing the rehabilitation or replacement plans for ten bridges and four structural culverts. The drainage scope of work includes the analyses and recommendations for the four structural culverts as well as all the other drainage culverts within the study area to accommodate the proposed design. Storm sewer design and stormwater management will also be addressed. This project has been completed following the approved environmental planning process for Group 'B' projects in accordance with the Class Environmental Assessment for Provincial Transportation Facilities (2000).

This memorandum summarizes the existing topographic and environmental characteristics of the study area, analyzes the erosion and sediment risk of the proposed design and recommends mitigation measures required to address any erosion concerns for the study area. The assessment has been completed following the requirements and guidelines provided by the MTO *Environmental Guide for Erosion and Sediment Control During Construction for Highway Projects* (Sept. 2015).

Figures and drawings are provided at the end of the memorandum.

2. Background Information

Several documents and resources were referenced to complete the ESORA requirements, per MTO, summarized here:

- MTO *Environmental Guide for Erosion and Sediment Control During Construction for Highway Projects* (Sept. 2015). (EROSA Guide);
  - MTO Documents
    - Culvert General Arrangement Drawings

  - Culvert As-built drawings
  - Culvert OSIM Inspection Forms
  - Contract drawings for previous projects along the study area
  - KML file – Hwy401_Active_Culverts (Google Earth)
- Final Culvert Condition Report - Hwy 401 from Maitland Road to Highway 416 (Ainley, 2014)
- Natural Science Existing Conditions and Impact Assessment – Terrestrial Ecosystem Report (AECOM, September 2023);
- Fish and Fish Habitat Existing Conditions Report (AECOM, June 2022);
- Land Information Ontario (LIO), OntGeoHub GIS database (*Contains information licensed under the Open Government License – Ontario*), used for watercourses, wetlands and waterbodies.
- OMAFRA's soil survey complex (Contains information licensed under the Open Government License – Ontario), used for soil type.
- MNR's Ontario Watershed Information Tool (OWIT) (*Contains information licensed under the Open Government License – Ontario*), for drainage catchment boundaries.
- Contours with 0.5m and 5m intervals
- Aerial photos and Google Earth
- LIDAR data

The Terrestrial and Fisheries reports were referenced to determine the existing characteristics of the study area in terms of fish, fish habitat, wildlife, species at risk, vegetation, ecological communities and sensitive environmental features within the study area that may impact or be impacted by erosion concerns.

3. ESORA Purpose

The purpose of the Erosion and Sediment Overview Risk Assessment (ESORA) is to assess the risk of erosion and sedimentation of the proposed works, and to identify the steps and recommended mitigation measures necessary to achieve effective erosion and sediment control and the protection of environmentally sensitive areas and receiving water bodies within the project limits. Based on the ESORA requirements, the erosion potential and sedimentation risk assessment are intended for projects with a route selection component or where information about erosion and sedimentation risk will assist in preliminary design decisions. The assessment is not intended for projects with a more limited scope such as single water crossings, local widening, or interchange / intersection improvements.

Based on the preliminary level of design for the current assignment and considering the proposed highway works and the environmental and topographic characteristics of the study area, a preliminary ESORA was completed. The assessment included consideration of the topographic characteristics of external drainage areas to the watercourse and culvert highway crossings within the project limits. Erosion best management practices have been referenced to address potential impacts for consideration during future design and construction stages and to recommend appropriate mitigation measures to minimize impacts at these locations (i.e. Best Management Practises (BMP's) and good housekeeping). It is understood that the overall study area assessed as part of this project will be broken up into a number of individual detailed design assignments and smaller contracts, the details of which will be confirmed at a later stage. The recommendations from this assessment and best management practices will be confirmed during future design stages, and are discussed in the following sections.

4. Existing Site Characteristics

As shown in **Figure 1**, the study area is located within the Township of Augusta, Township of Edwardsburg Cardinal and Town of Prescott near the City of Brockville, Ontario and within the jurisdiction of Cataraqui Region Conservation Authority (CRCA) and South Nation Conservation (SNC).

The relevant drainage features that cross Highway 401 within the study area are Lemon's Creek, Bradley's Creek, Smades Creek and Johnstown Creek, as well as some unnamed watercourses. The existing highway drainage system includes culverts, side ditches, median ditches and storm sewers.

The land use within the study area is primarily rural residential, agricultural, forest and/or wetland. The key sensitive environmental features associated with this project include several water crossings and wetlands (some of which are Provincially sensitive), as well as some species at risk.

a. Soils and Topography

As shown in **Figure 2**, the predominant soils within the adjacent areas to Highway 401 are Loam and Sand.

Slope Gradient and Slope Length were acquired from the Land Information Ontario (LIO) open access website (https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home) via their Soil Survey Complex layer. The data was compiled by the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) and Agri-Food Canada, in cooperation with the Ministry of Natural Resources and Forestry (MNRF), from a collection of southern Ontario soil survey data previously mapped between 1920 and 1990. A digital elevation model (DEM) was also acquired from the LIO open access website to later calculate flow length and based on flow length; slope length was estimated. This information is preliminary and should be confirmed during the detailed design phase.

As shown on **Figure 3**, the predominant soil slopes upstream of the study area are between 0.5% - 2% (Nearly level) with some areas 0.0% - 0.5% (Level) and 2% to 5% (Very Gentle Slope).

Figure 4 depicts the slope lengths that were estimated. According to the results from the GIS model, the slope length upstream of the crossing culverts is over 70m for all crossings.

b. Terrestrial Features

There are several designated natural areas adjacent to the Hwy 401 corridor. The area has many wetlands, some of which are provincially significant. The South Augusta Wetland Complex is on the north side of the highway near the west end of the study area. There are woodlands along the majority of the study area, many of which are considered significant.

There are several Threatened/Endangered terrestrial Species at Risk (SAR) that have the potential to be within the study area given the habitat present. These include several species of bats, whip-poor-will, Eastern meadowlark, barn swallow and bobolink. The Eastern meadowlark and barn swallow were observed within the study area during field surveys undertaken in 2021. Based on the proposed highway works, no direct impacts are anticipated to Designated Natural Areas and this project requires relatively minimal amount of vegetation removal. The potential for this project to impact area vegetation and wildlife is expected to be low provided appropriate mitigation measures are implemented.

c. Fish and Fish Habitat

There are six watercourses that cross the highway, some of which have multiple tributaries that cross the highway, and/or the main watercourse curves and crosses more than once. The main watercourses are Lemon's Creek, Smades Creek, Bradley's Creek, Johnstown Creek and two unnamed watercourses.

Based on the Fish Report, all of the six permanent watercourses have direct fish habitat along the study area. Background information on fish species was limited, however, some species information was obtained for some of the crossing locations. Based on the several sources available (DFO, MECP, Cas), no aquatic Species at Risk (SAR) are known to inhabit the watercourses identified in the study area based on the available background information.

The fish report anticipates that serious harm to the fish can be avoided by implementing proper environmental protection and mitigation measures (BMP's) for the duration of construction at the many fish habitat locations along the study area. Refer to the Fish Report for additional information about the fish habitat, potential impacts and mitigation measures recommended at the watercourse crossing culverts.

5. Project Scope of Work

This project involves widening of Highway 401 to an interim 6-lane and ultimate 8-lane configuration, bridge and culvert replacements, and modifications to the Maitland Road, Edward Street and Highway 16 interchanges. It is expected that the recommended improvements will be implemented through a series of construction contracts over the next 5 to 25 years. Vegetation removal will be limited to the areas of the interchange reconfigurations and select locations along the Highway 401 right-of-way. In-water work is required at the Lemon's Creek culvert to accommodate the replacement of the culvert In-water works will also be required at several other culverts to facilitate either culvert rehabilitations or extension. The scope of the ESORA is focused on designated watercourses that cross the study area, as opposed to smaller culverts that convey only local drainage.

6. ESORA and Site Characteristics

Based on the characteristics of the study area and considering the preliminary design nature of the study, a more general approach was undertaken for the project at this time. Instead of discretizing upstream catchment areas into polygons based on topography, watercourse crossings (designated watercourses and culverts conveying external drainage upstream of the ROW) were assessed based on overall upstream catchments. This approach was selected based on the level of detail available for the assignment and was found to be the most beneficial and efficient way to complete the analysis since the entire study area drains to one of these watercourses. The main environmental and erosion/sedimentation concerns have been highlighted for the study area. Smaller culvert crossings along the study area were not included in this assessment, as with small ROW drainage areas and flows, the risks are also significantly less than those of watercourse crossings.

The topographic characteristics of the study area have been assessed to identify the erosion potential within the limits of the project and to identify erosion and sediment control requirements. The assessment is generally based on the requirements presented in **Table 1 (Table 5.1** -Hierarchy of Soil Erodibility of the ESORA Guide) and **Table 2 (Table 5.2** - Erosion Potential Associated with Slope Length, Slope Gradient, and Soil Erodibility Rating of the ESORA Guide), shown below.

a. Soil Erodibility

Soil erodibility is the soil's inherent susceptibility to erosion by runoff and the impact of rainfall drops on the soil surface. The soil erodibility is dependent primarily on soil type. As shown in **Figure 2**, the predominant soils within the study area are Loam and Sand. **Table 1** provides the hierarchy of soil erodibility rating for various soil types. As noted in this table, sand has a low erosion potential rating, while loam soils have a high erosion potential rating. The site contains sandy loam, which has a medium rating, clay loam, which has a low rating, and loamy fine sand, which has a low rating.

Table 1: ESORA Hierarchy of Soil Erodibility

Erodibility Classification	Soil Type	Soil Erodibility Rating
Most	Silt	High
	Silty Loam	High
	Loam	High
	Silty Sand	High
	Sandy Loam	Medium
	Silty Clay Loam	Medium
	Sandy Clay Loam	Medium
	Silty Clay	Medium
	Sandy Clay	Low
	Clay	Low
	Heavy Clay	Low
	Loamy Sand	Low
	Sand	Low
	Poorly Graded Gravel	Low
Least	Well-Graded Gravel	Low

b. Slope Gradient and Slope Length

As shown in **Figure 3**, the soil slopes within the study area range between 0% to 10% which represents a low erosion potential rating. The ESORA Guide states that steeper slopes increase erosion potential because they allow water to flow faster. Consequently, the soil slopes within the limits of the proposed highway works do not represent a risk of erosion potential and sedimentation.

Figure 4 presents the slope lengths within the study area. The slope lengths are all over 70m. This slope length is identified in the ESORA Guide (**Table 5.2**) with a moderate to high erosion potential rating, depending on the soil type. The ESORA Guide states that the longer the slope the greater the erosion potential because they collect larger quantities of water and offer more potential for flow concentration. However, since for this analysis the entire upstream drainage catchments are considered, this criterion is less applicable. The lengths discussed in **Table 2** are for the polygons meant to make up the drainage area, which would therefore be much smaller producing shorter slope lengths. The length of an entire flow path upstream of a watercourse crossing would be much longer than 70m but would also have other crossings upstream and possibly wetlands and other features that would slow down flow and minimize erosion potential. Because of the different methodology, the erosion potential rating summarized in **Table 3** is a more general rating than defined in **Table 2**.

Table 2: ESORA Erosion Potential Associated with Slope Length, Slope Gradient and Soil Erodibility

Slope Gradient	Soil Erodibility (Table 5-1)	Slope Length	
		< 70 m	> 70 m
0-10%	Low	Low	Low
	Medium	Low	Moderate
	High	Moderate	High
10-20%	Low	Low	Moderate
	Medium	Moderate	High
	High	High	High
>20%	Low	Moderate	Moderate
	Medium	High	High
	High	High	High

c. Erosion and Sediment Risk

Table 3 below summarizes the factors included in determining the overall erosion and sedimentation risk at the crossing culverts along the study area. The table below is based on the assessment of topographic characteristics of the culvert catchments and the sensitivity of any environmental areas within each catchment at the preliminary design stage.

Table 3: Erosion and Sedimentation Risk Summary

Culvert Name	Soil Type	Soil Erodibility Rating (Table 5.1)	Slope Gradient (%)	Erosion Potential	Rationale for Erosion Potential based on Topography	Consequence Rating	Rationale for Consequence Rating based on Environmental Sensitivities of Receiving Waterbody	Overall Erosion and Sediment Risk Rating
WC1-M-01	Loam	High	<10	Moderate	High risk for surface soil, but low risk for slope, as slopes are low and 25% of upstream area is wetland	Moderate	Wetlands downstream, and direct fish habitat	**Moderate**
LC1-M-06	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and upstream 59% of upstream area is wetland	Moderate	Provincially significant wetland downstream, direct fish habitat	**Moderate**
LC2-M-11	Loam	High	<10	Moderate	High risk for surface soil, but low risk for slope, as slopes are low and 27% of upstream area is wetland.	Moderate	Provincially significant wetland downstream, direct fish habitat	**Moderate**
WC2-M-15	Loam	High	<10	Moderate	High risk for surface soil, , but low risk for slope as slopes are low and upstream area is relatively small.	Low	Wetlands downstream	**Low**
SC1-M-17	Loam	High	<10	Moderate	High risk for surface soil, but low risk for slope, as slopes are low and 14% of upstream area is wetland.	Moderate	Direct fish habitat for Smades Creek, wetlands downstream	**Moderate**
Drn-M-19	Loam	High	<10	Moderate	High risk for surface soil, low risk for slope, as slopes are low and upstream area is relatively small	Low	Wetlands downstream	**Low**
Drn-M-20	Loam	High	<10	Moderate	High risk for surface soil, low risk for slope	Low	Wetlands downstream	**Low**
Drn-M-21	Clay Loam	Low	<10	Low	Low risk for surface soil, low risk for slope	Low		**Low**
Drn-M-23	Clay Loam	Low	<10	Low	Low risk for surface soil, low risk for slope	Low		**Low**
WC3-M-24	Sand	Low	<10	Low	Low risk for surface soil, low risk for slope	Low	Wetlands downstream	**Low**
Drn-M-25	Clay Loam	Low	<10	Low	Low risk for surface soil, but low risk for slope as slopes are low and upstream area is relatively small.	Low		**Low**

Culvert Name	Soil Type	Soil Erodibility Rating (Table 5.1)	Slope Gradient (%)	Erosion Potential	Rationale for Erosion Potential based on Topography	Consequence Rating	Rationale for Consequence Rating based on Environmental Sensitivities of Receiving Waterbody	Overall Erosion and Sediment Risk Rating
WC4-M-26	Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 23% of the upstream area is wetland	Low		**Low**
Drn-M-27	Loam	High	<10	Moderate	High risk for surface soil, but low for slope.	Moderate	Direct fish habitat (seasonally)	**Moderate**
Drn-M-29	Loam	High	<10	Moderate	High risk for surface soil, but low for slope	Low		**Low**
Drn-M-30	Loam	High	<10	Moderate	High risk for surface soil, but low risk for slope as slopes are low and upstream area is relatively small	Low		**Low**
Drn-M-31	Loam	High	<10	Moderate	High risk for surface soil, but low for slope	Low		**Low**
Drn-M-32	Loam	High	<10	Moderate	High risk for surface soil, but low risk for slope as slopes are low and upstream area is relatively small	Low	Wetlands downstream	**Low**
BC1-M-34	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 14% of the upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat (seasonally)	**Moderate**
BC1-M-35	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 35% of the upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat	**Moderate**
Drn-M-39	Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and upstream area is relatively small	Moderate	Direct fish habitat (seasonal)	**Moderate**
Drn-M-43	Sand	Low	<10	Low	Low risk for surface soil and slope	Moderate	Wetlands downstream, direct fish habitat	**Moderate**
JC1-M-45	Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 38% of upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat	**Moderate**
JC2-M-46	Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 31% of upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat	**Moderate**
JC3-M-52	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 84% of upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat	**Moderate**

Culvert Name	Soil Type	Soil Erodibility Rating (Table 5.1)	Slope Gradient (%)	Erosion Potential	Rationale for Erosion Potential based on Topography	Consequence Rating	Rationale for Consequence Rating based on Environmental Sensitivities of Receiving Waterbody	Overall Erosion and Sediment Risk Rating
Drn-M-55	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope	Moderate	Wetlands downstream, direct fish habitat	**Moderate**
JC4-M-58	Loamy Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 30% of upstream area is wetland	Moderate	Direct fish habitat	**Moderate**
JC4-M-62/63	Fine Sand	Low	<10	Low	Low risk for surface soil and slope, as slopes are low and 30% of upstream area is wetland	Moderate	Direct fish habitat, potential spawning habitat for bluntnose minnow	**Moderate**
JC6-M-66	Sand Loam	Medium	<10	Low	Moderate risk for surface soil, low risk for slope, as slopes are low and 15% of upstream area is wetland	Moderate	Direct fish habitat to Johnston's Creek	**Moderate**
JC7-M-72	Loam	High	<10	Moderate	High risk for surface soil, but low for slope, as slopes are low and 53% of upstream area is wetland	Moderate	Wetlands downstream, direct fish habitat	**Moderate**

In addition to works at the crossing culverts, grading works associated with the interchange modifications and highway widening will introduce additional erosion and sedimentation risk. Based on the topographic and soil characteristics of the study area, the extent of proposed work and environmental sensitivities, it is concluded that appropriate procedural BMP's will provide the required erosion and sediment protection within the study area. For crossings with moderate overall ratings, the need for ESCP and additional BMPs (i.e. structural BMPs) will be confirmed at detailed design phase.

7. Preliminary ESC Recommendations

Based on an assessment of the existing conditions of the project and the proposed highway works, the following Ontario Provincial Standard Specifications (OPSS) for erosion and sediment control during construction are recommended. If revised and/or additional provisions/specifications are developed in the future, ESC recommendations should be assessed and considered during the detail design phase.

- **Ontario Provincial Standard Specifications (OPSSs):**
  - OPSS Prov. 100: MTO General Conditions of Contract
  - OPSS Prov. 180: Management of Excess Materials
  - OPSS Prov. 801: Protection of Trees
  - OPSS Muni. 802: Topsoil
  - OPSS Prov. 803: Vegetative Cover
  - OPSS Prov. 804: Temporary Erosion Control
  - OPSS Prov. 805: Temporary Sediment Control
  - OPSS Prov. 517: Dewatering, and
  - Special Provision No. 100S19 Amendment to MTO General Conditions of Contract, April 2022.
- **Working Area Perimeter - Sediment Control BMPs:**
  - OPSD 219.110 Light Duty Straw Bale Barrier
  - OPSD 219.130 Heavy Duty Straw Bale Barrier
  - MTOD 219.110 Sediment Fence Barrier
  - MTOD 219.120 Fibre Roll Barrier
  - MTOD 219.131 Wire-Backed Sediment Fence Barrier
  - OPSD 219.150 Sandbag Barrier, and
  - OPSD 219.160 Fibre Roll Grade Breaks.
- **Drainage, Check Dams and Sedimentation Basin BMPs:**
  - OPSD 219.180: Straw Bale Flow Check Dam (OPSD 219.191, 219.200, 219.210 and 219.211 are favored options over 219.180)
  - OPSD 219.191 Fibre Roll Flow Check Dam
  - OPSD 219.200 Sandbag Flow Check
  - MTOD 219.210 Rock Flow Check Dam V-Ditch
  - MTOD 219.211 Rock Flow Check Dam Flat Bottom Ditch
  - OPSD 219.220 Sediment Trap in Ditch
  - MTOD 219.230 Slope Drain for Sediment Trap
  - MTOD 219.231 Berm Barrier for Slope Drain, and
  - OPSD 219.240 Sediment Trap for Dewatering.
- **In-Water and Near-Water Works BMPs:**
  - OPSD 219.260 Turbidity Curtain
  - OPSD 219.261 Turbidity Curtain, Seam Detail
  - OPSD 221.010 Temporary Water Passage System – Culvert in Watercourse
  - OPSD 221.020 Temporary Water Passage System – Pumping and Piping, and
  - Specific in-water works will need to be designed, which are not depicted through standard mitigation.

8. BMP Selection

In addition to the above-mentioned specifications, the types of Best Management Practices (BMP) that should be implemented as part of the project are described below:

- ***Project Planning and Design BMPs*** – these BMP were discussed during the design process to consider erosion potential along the Highway 401 corridor, to avoid areas with higher risk of erosion and higher adverse impacts along the highway (wetlands), and waterbody crossings.
- ***Procedural BMPs*** – these measures are considered good housekeeping, and include site management, and scheduling practices, such as, minimize exposed soils, perimeter control, site access management, stockpile management as required, dust management, optimize construction sequence, and install BMPs early and restore early (see ESORA Guide **Table 8.1**).
- ***Water Management BMP's*** – these BMPs are recommended to minimize watercourse disturbance, keep clean water clean, and anticipate and manage groundwater where possible. (see ESORA Guide **Table 8.2**).
- ***Erosion Control BMP's*** – these BMPs are recommended to reduce potential for erosion due to wind, rain splash, and flowing water. Cover is the single most effective erosion control practice. (see ESORA Guide **Table 8.3**).

See **Table 8.1**, **Table 8.2** and **Table 8.3** obtained from the ESORA Guide at the end of this memorandum for a list of these BMPs.

a. General Mitigation Measures

Implementation of the following standard mitigation will assist in addressing erosion and sediment control for this project:

- OPSS-180: General Specification for the Management of Excess Materials
- OPSS-201: Construction Specification for the Clearing, Close Cut Clearing, Grubbing and Removal of Surface and Piled Boulders
- OPSS-804: Construction Specification for the Seed and Cover
- Any woody vegetation removed during the proposed works will be replaced with a similar native species
- Areas of herbaceous vegetation disturbed during proposed works will be seeded with MTO's Custom Roadside Pollinator Mix
- Temporary Flow Diversions shall be conducted in accordance with OPSS182 and OPSS 517
- Dewatering and the Use of Pumps shall be conducted in accordance with OPSS 182 and OPSS 518 (combined with OPSS 185 and replaced by a revised OPSS 517 in 2017)
- Fish Protection shall be conducted in accordance with OPSS 182
- Preservation of Riparian Vegetation shall be in accordance with OPSS 182
- Erosion and Sediment Controls shall be in accordance with OPSS 182 and OPSS 805, and
- Restoration of Disturbed Areas shall be in accordance with OPSS 182 and OPSS 804.
- Construction Specification for Placement of Aggregates in waterbodies in accordance with OPSS 825 and 1005

During future design and construction stages the following general recommendations should be reviewed further to determine what is applicable during the construction period:

- Sediment fencing should be installed along the construction limits to prevent contamination of watercourses, waterbodies and wetlands
- Sediment fencing should be installed around potentially suitable habitats, which should protect it from degradation by sediment deposition or other contaminants

- The extent and duration that disturbed soils are exposed to the elements shall be minimized
- Seed mix and / or mulch, and topsoil shall be placed in areas of soil disturbance to provide adequate slope protection and long-term slope stabilization
- Rock-check dams (or equivalent flow checks) will be placed as necessary at appropriate intervals in roadside ditches down gradient from areas of soil disturbance to trap suspended sediments and reduce the erosive force of runoff
- Delineate storage, stockpiling and staging areas prior to construction and inspect them in accordance with the Ontario Ministry of Transportation Construction Administration and Inspection Task Manual
- Assure that material generated during maintenance of sediment control measures (i.e., silt fence, flow checks dams, etc.) will be taken off-site for disposal, and
- Following construction, once disturbed areas have stabilized, all temporary erosion and sedimentation controls shall be removed.

Erosion and sediment control structures shall be routinely inspected as well as checked after storms and repaired as required. The structures will be cleaned out when accumulated sediment reaches half the design height.

9. Conclusion and Recommendations

Based on the environmentally sensitive areas within the study area and the topographic characteristics of the drainage areas to the culverts, this preliminary Erosion and Sedimentation Overview Risk Assessments (ESORA) was completed to identify the Erosion and Sediment (ES) risk rating (i.e., low, moderate, high) for each evaluated area. The preliminary ESORA results show that the erosion potential risk is low to moderate. It is understood that the overall study area assessed as part of this project will be broken up into a number of individual detailed design assignments and smaller contracts, the details of which will be confirmed at a later date. Due to environmentally sensitive areas along the study area and as the scope of the individual detailed design assignments is uncertain at this time, it is recommended that Erosion and Sediment Control Plan (ESCP) Approach 3: Two Part ESCP should be implemented during the future detail design stage. The ESCP Approach 3 requirements as well as the recommendations from this assessment and best management practices will be further investigated and confirmed in future design stages.

HWY 401

401

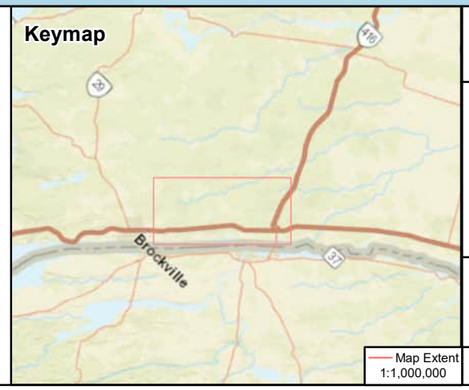
416

16

Legend

- Project Limits
- King's Highway
- Secondary Highway
- Tertiary Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

Source: Contains information licensed under the Open Government Licence Ontario. Base imagery provided by ESRI.

0 1 2

Km

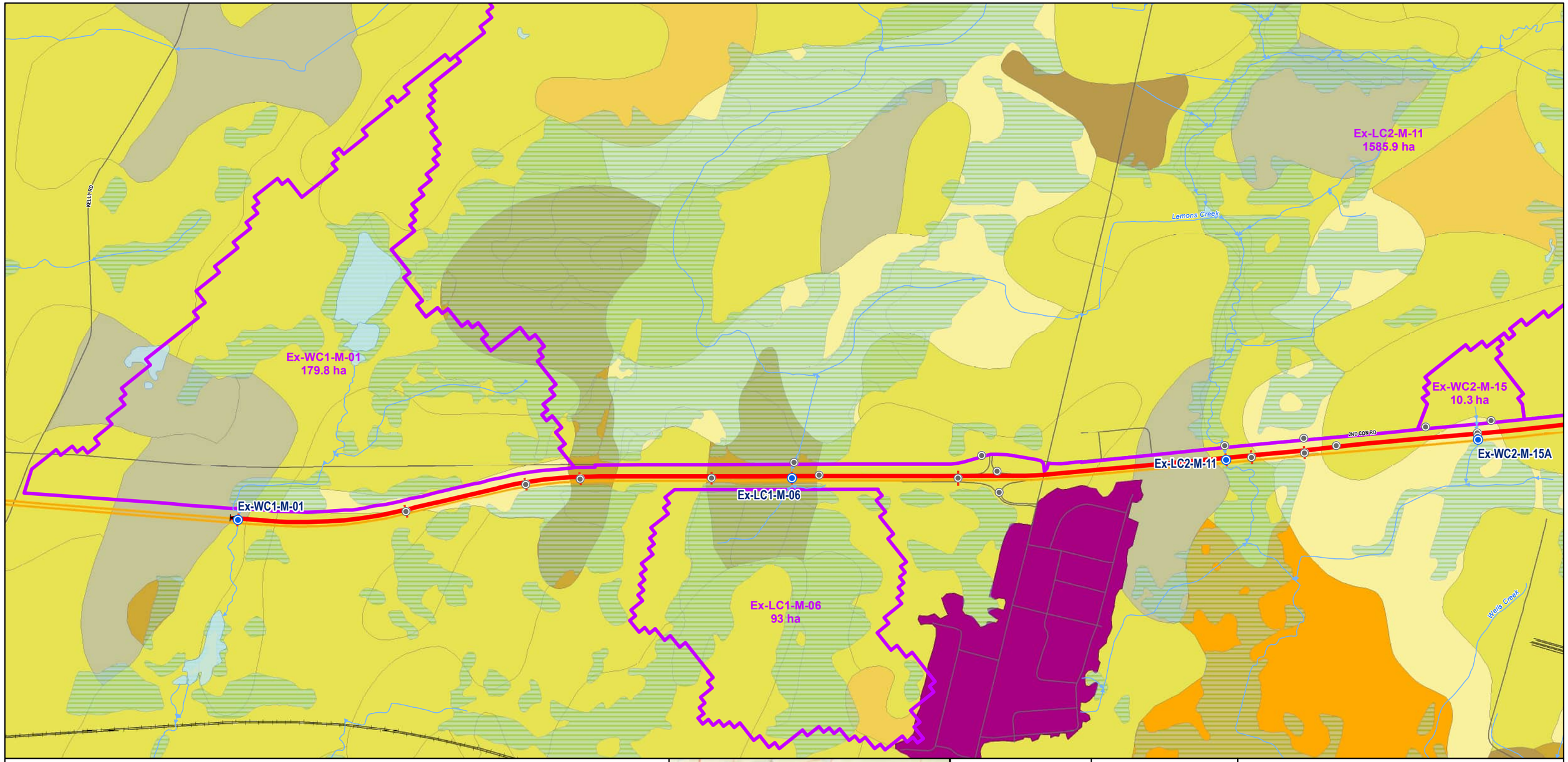
November 2023

Scale: 1:55,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 1: Study Area



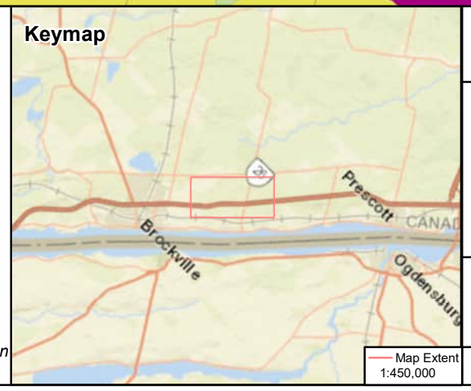
Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
- R - Rockland
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.



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Datum: NAD 1983 CSRS MTM 9

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0 150 300 450 600

Meters

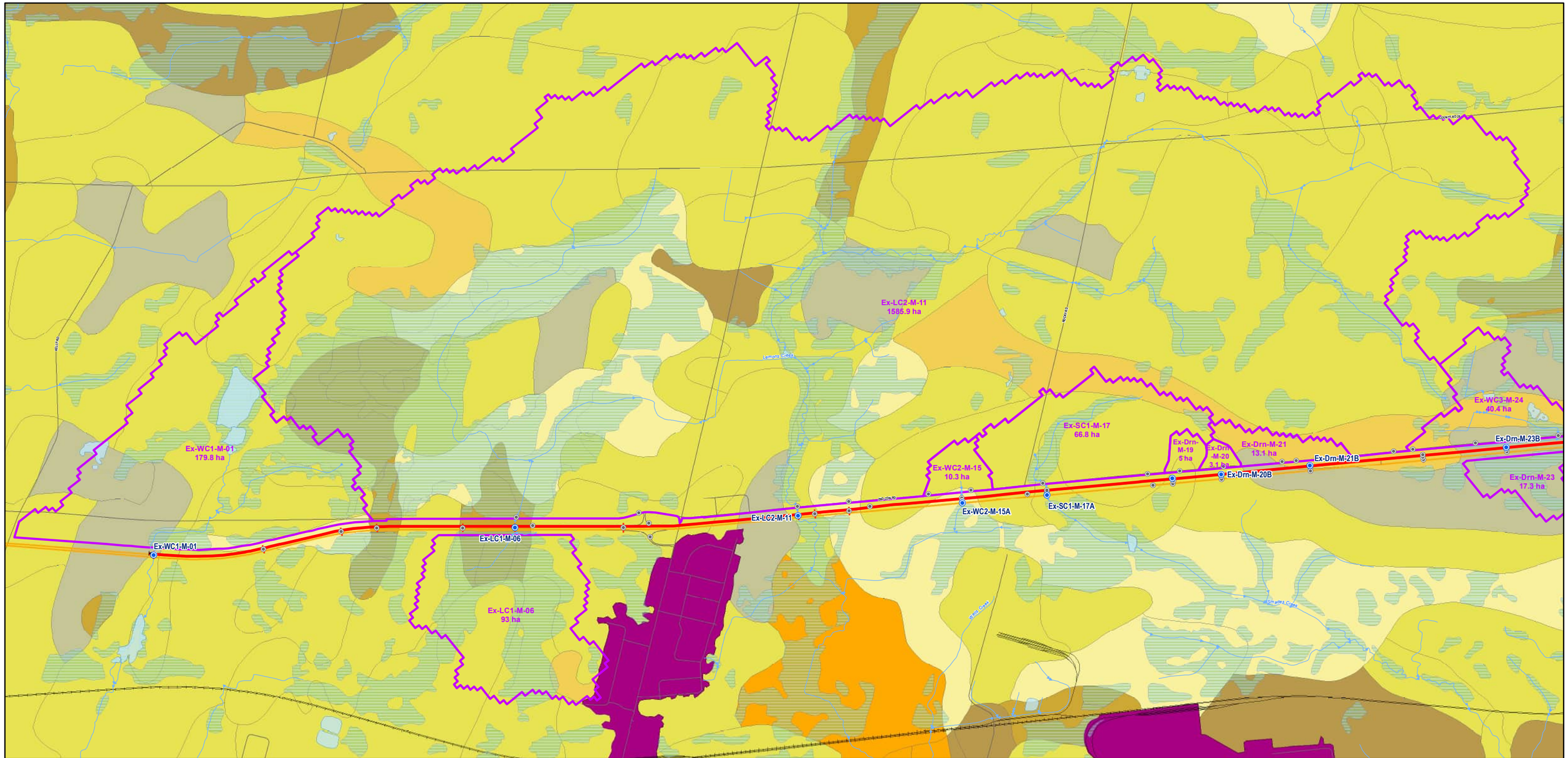
October 2023

Scale: 1:15,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-1: Surficial Soils



Legend

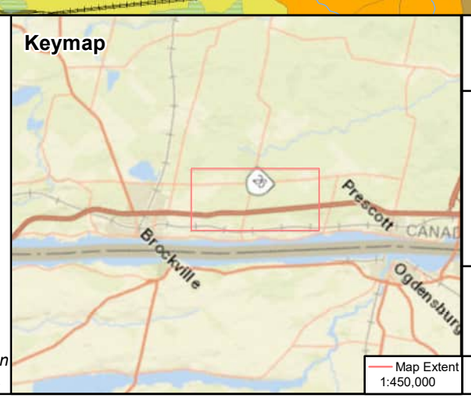
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
- R - Rockland
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 225 450 675 900

Meters

October 2023

Scale: 1:23,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-2: Surficial Soils

Ex-LC2-M-11
1585.9 ha

Ex-SC1-M-17
66.8 ha

Ex-WC3-M-24
40.4 ha

Ex-Drn-M-19
5 ha

Ex-Drn-M-20
3.1 ha

Ex-Drn-M-21
13.1 ha

Ex-Drn-M-23B

Ex-Drn-M-21B

Ex-Drn-M-20B

Ex-Drn-M-23
17.3 ha

Ex-WC2-M-15
10.3 ha

Ex-WC2-M-15A

Ex-SC1-M-17A

Ex-LC2-M-11

ROCKY RD

2ND CON RD

Wells Creek

Smades Creek

401

Legend

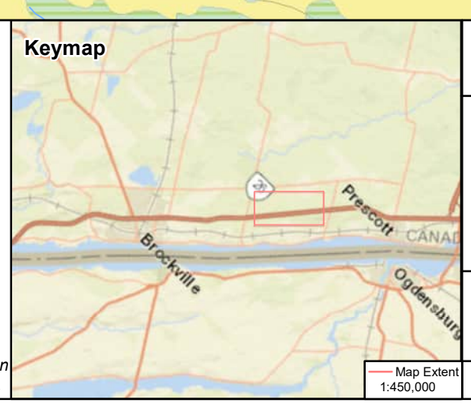
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
- R - Rockland
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

0 125 250 375 500

Meters

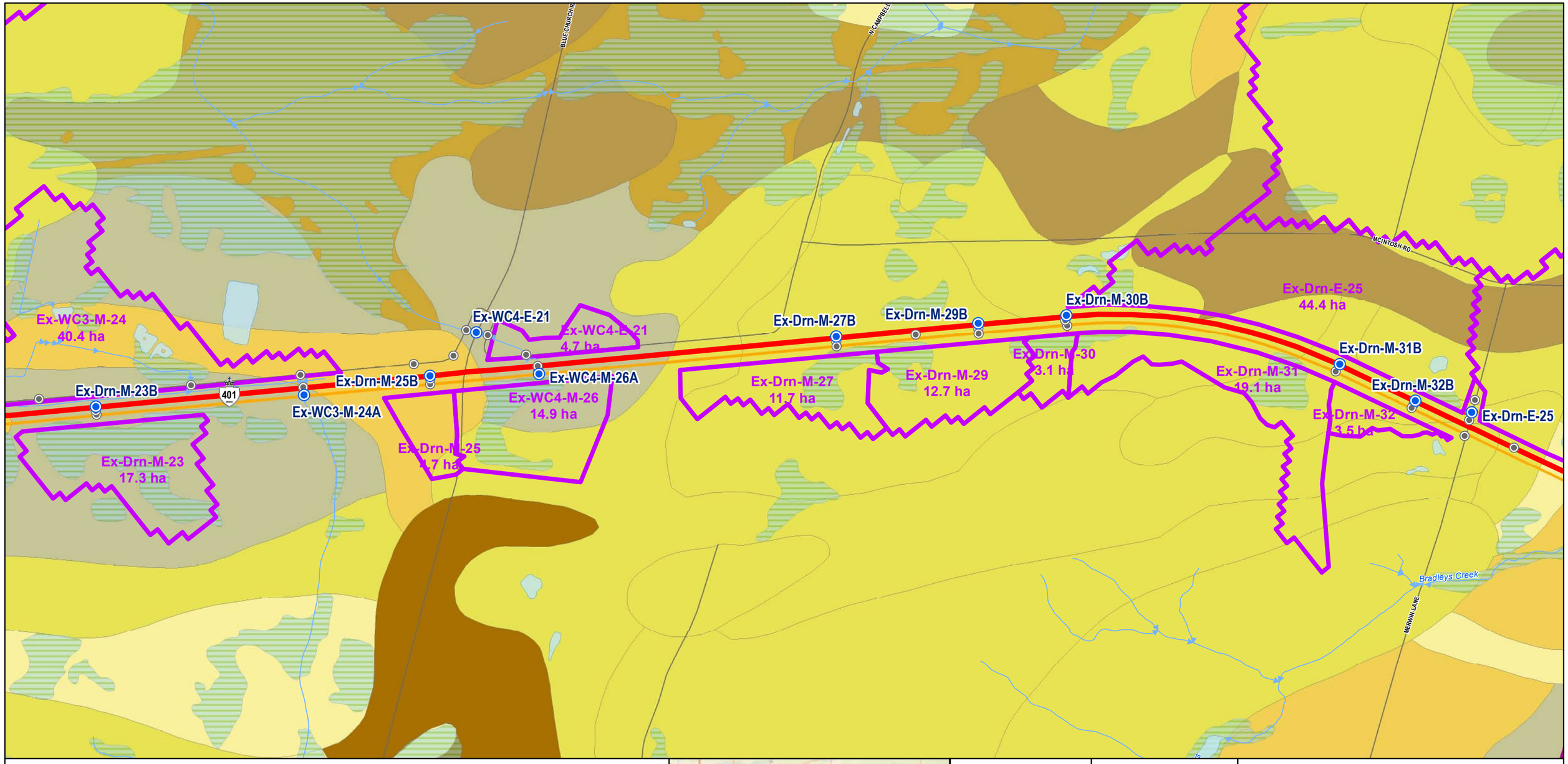
October 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-3: Surficial Soils



Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
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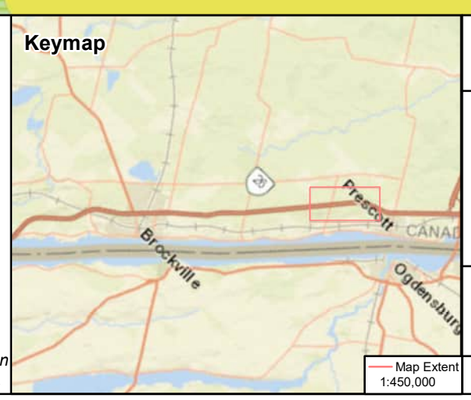
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.



AECOM

Ontario Ministry of Transportation

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0 125 250 375 500

Meters

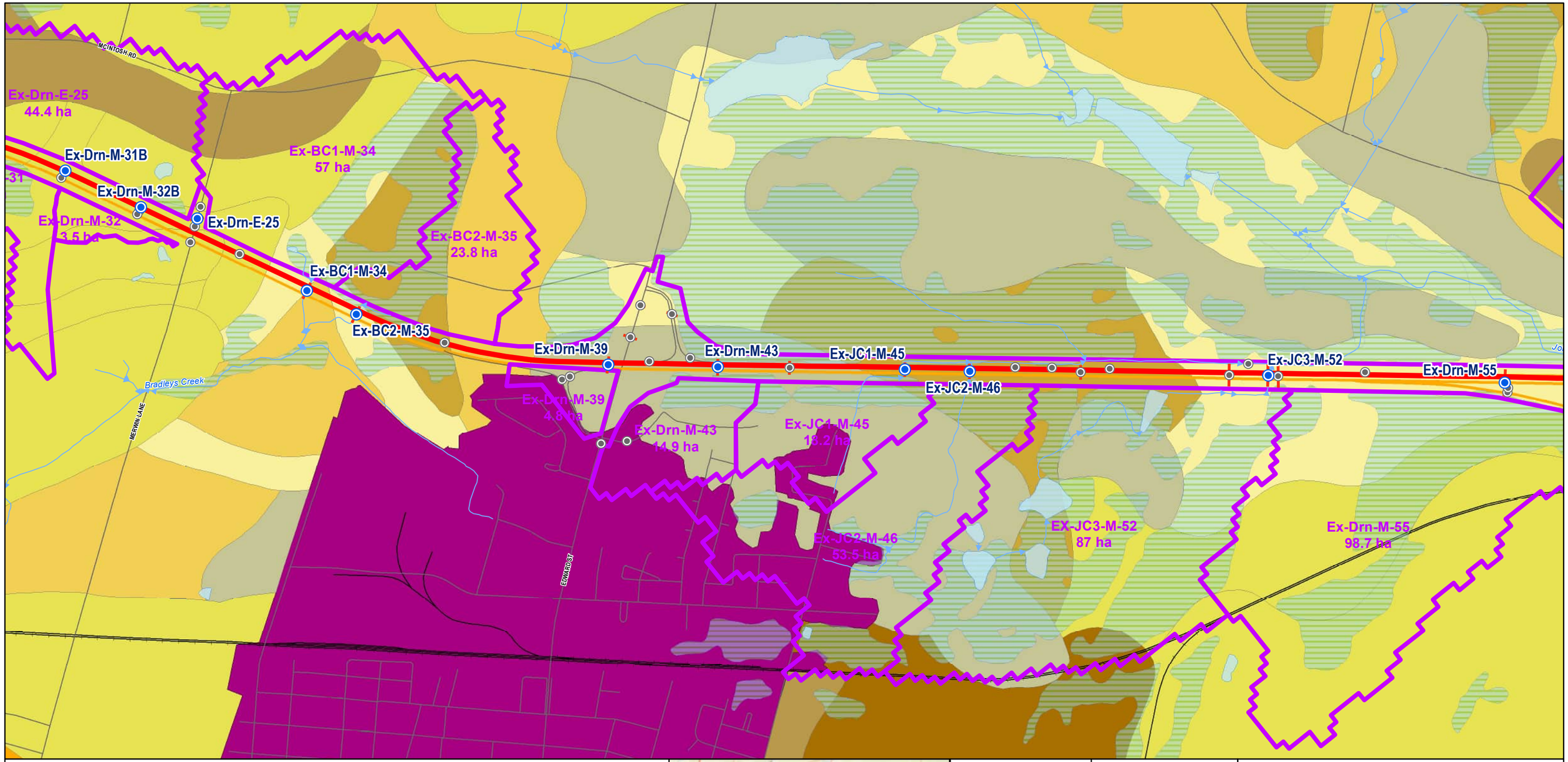
October 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-4: Surficial Soils



Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
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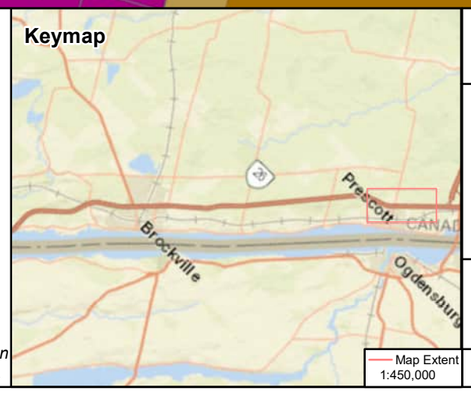
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

Meters

October 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-5: Surficial Soils

Ex-JC5-E-34
221.3 ha

Ex-Drn-M-65
26.1 ha

Ex-JC6-M-66
64.9 ha

Ex-JC7-M-73
217.8 ha

CEDAR GROVE RD

Ex-Drn-M-65

Ex-JC5-E-34

Johnstown Creek

Ex-JC4-M-58

Ex-JC3-M-52

Ex-Drn-M-55

Ex-JC6-M-66

Ex-JC7-M-73

16

Legend

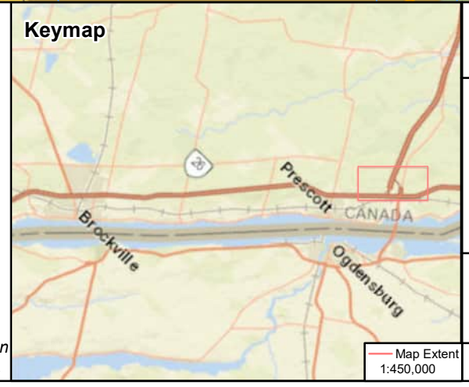
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
- R - Rockland
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500
Meters

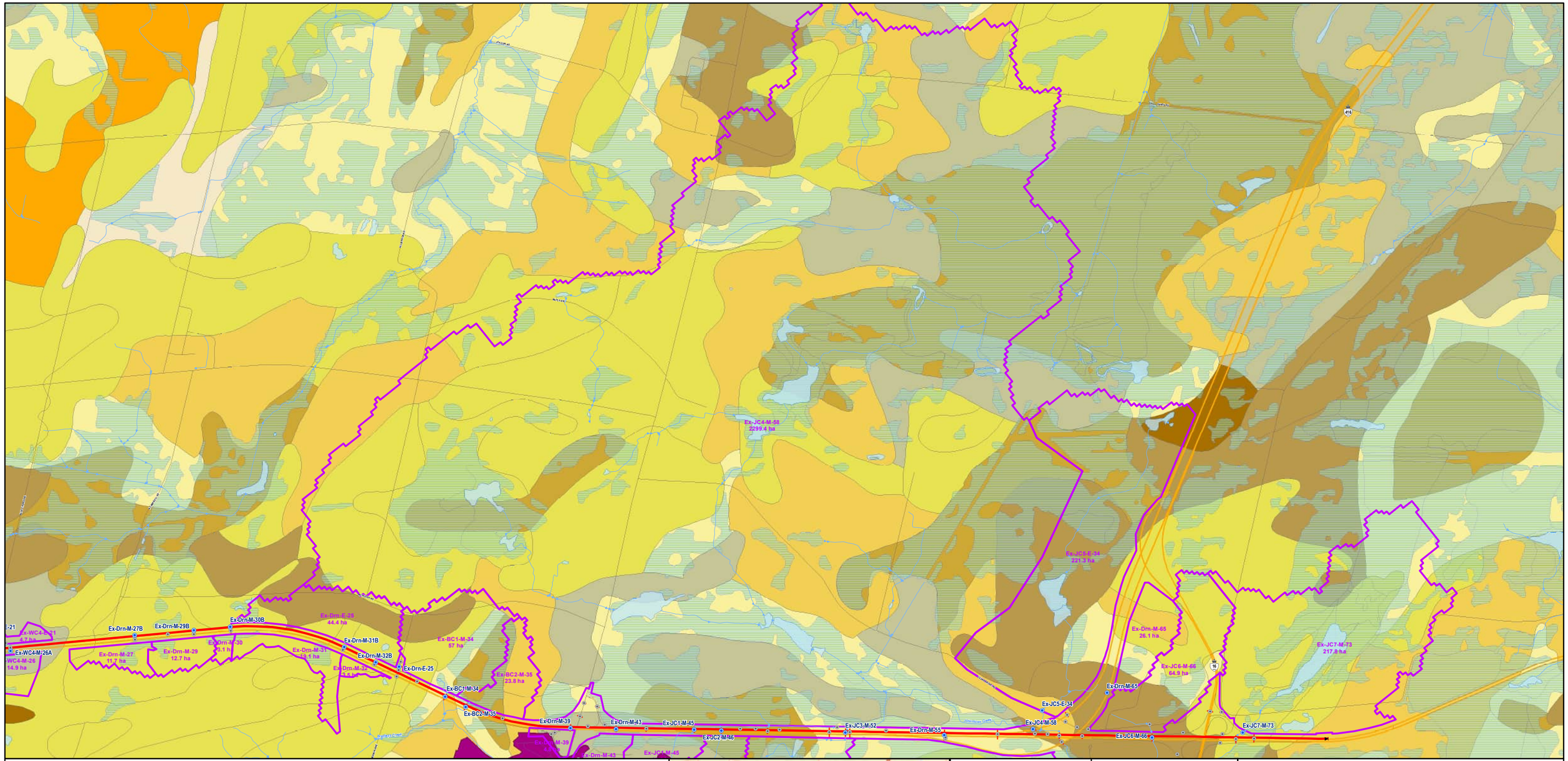
October 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-6: Surficial Soils



Legend

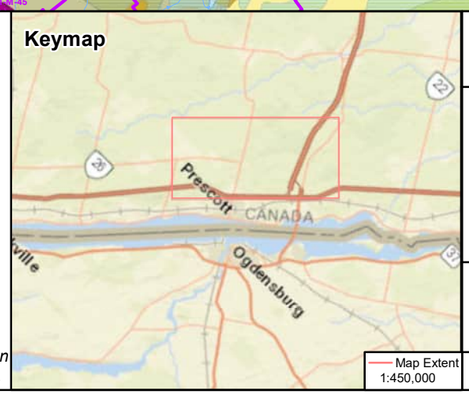
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Texture

- C - Clay
- CL - Clay Loam
- FS - Fine Sand
- FSL - Fine Sand Loam
- GSL - Gravelly Sandy Loam
- L - Loam
- LFS - Loamy Fine Sand
- NA/Urban
- ORG - Organic
- R - Rockland
- S - Sand
- SIL - Silt Loam
- SL - Sandy Loam
- VA - Variable
- VAR - Variable

Note: Soil texture information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

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0 300 600 900 1,200

Meters

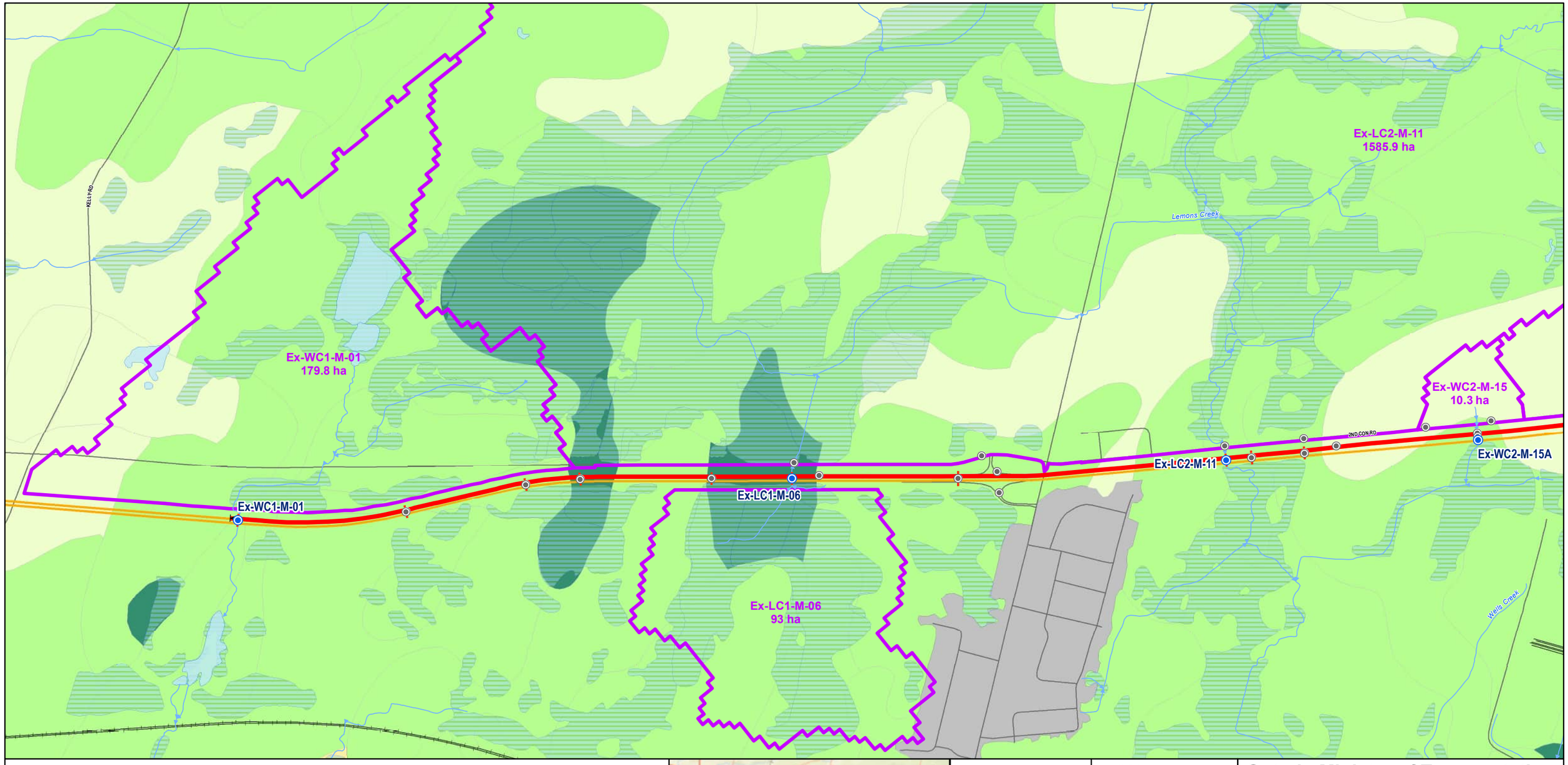
October 2023

Scale: 1:30,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 2-7: Surficial Soils



Legend

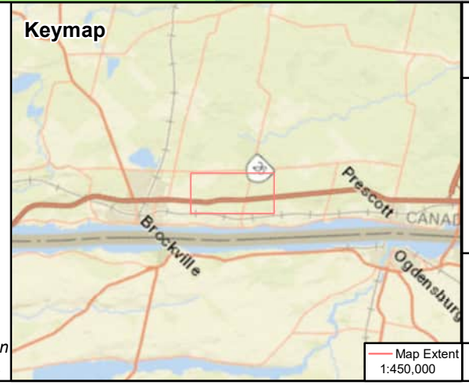
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 150 300 450 600

Meters

November 2023

Scale: 1:15,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-1: Soil Slopes

Ex-LC2-M-11
1585.9 ha

Ex-WC1-M-01
179.8 ha

Ex-WC2-M-15
10.3 ha

Ex-SC1-M-17
66.8 ha

Ex-Drn-M-19
5 ha

Ex-Drn-M-20
3.1 ha

Ex-Drn-M-21
13.1 ha

Ex-WC3-M-24
40.4 ha

Ex-Drn-M-23B

Ex-Drn-M-21B

Ex-Drn-M-20B

Ex-Drn-M-23
17.3 ha

Ex-WC2-M-15A

Ex-SC1-M-17A

Ex-LC2-M-11

Ex-WC1-M-01

Ex-LC1-M-06

Ex-LC1-M-06
93 ha

Lemons Creek

Wilkie Creek

Schades Creek

Legend

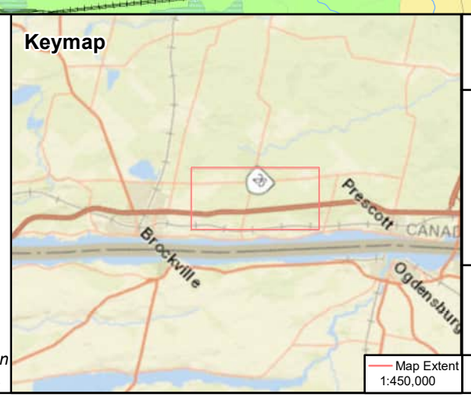
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 225 450 675 900

Meters

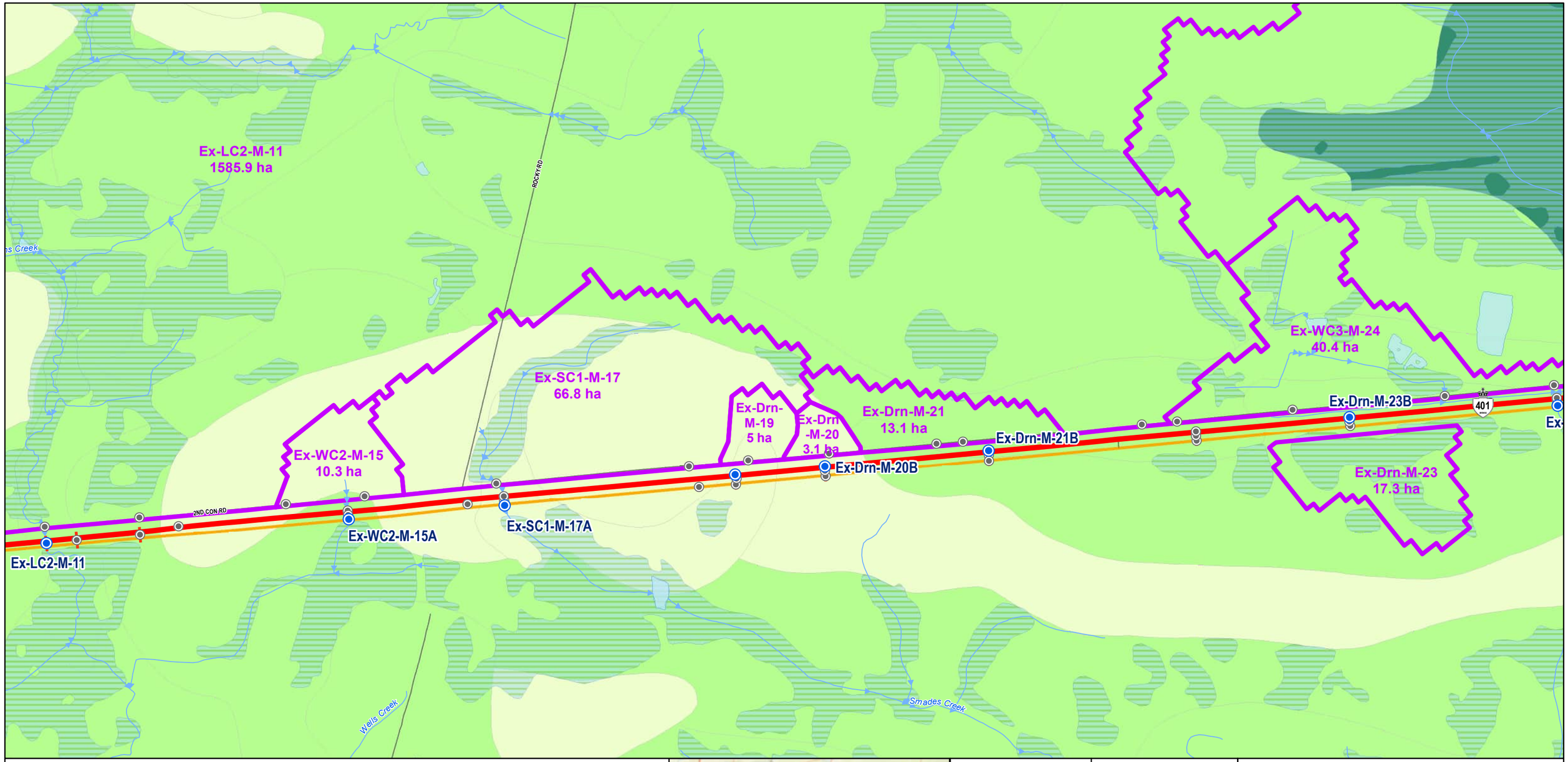
November 2023

Scale: 1:23,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-2: Soil Slopes



Legend

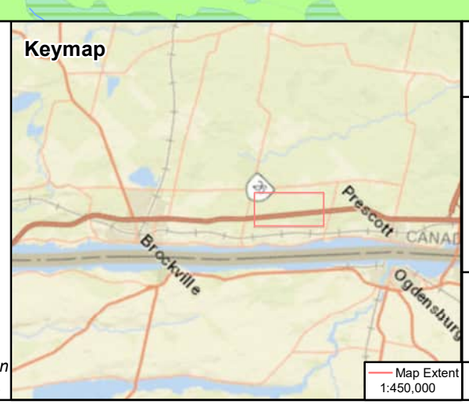
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

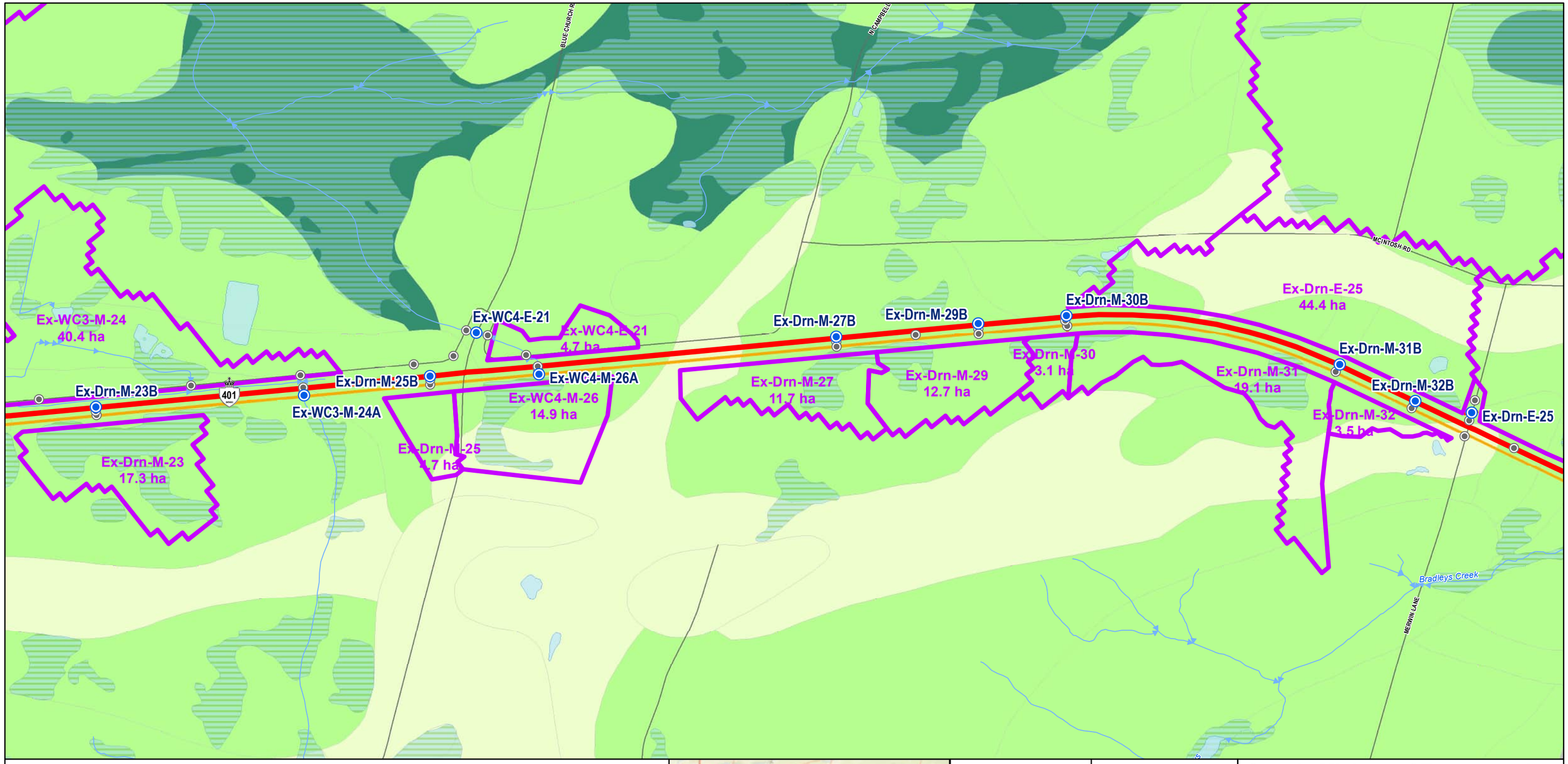
Meters

November 2023 | Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-3: Soil Slopes



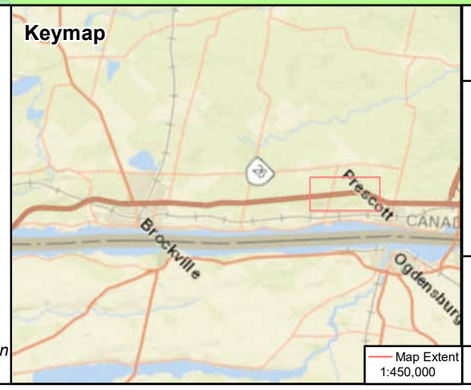
Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

Meters

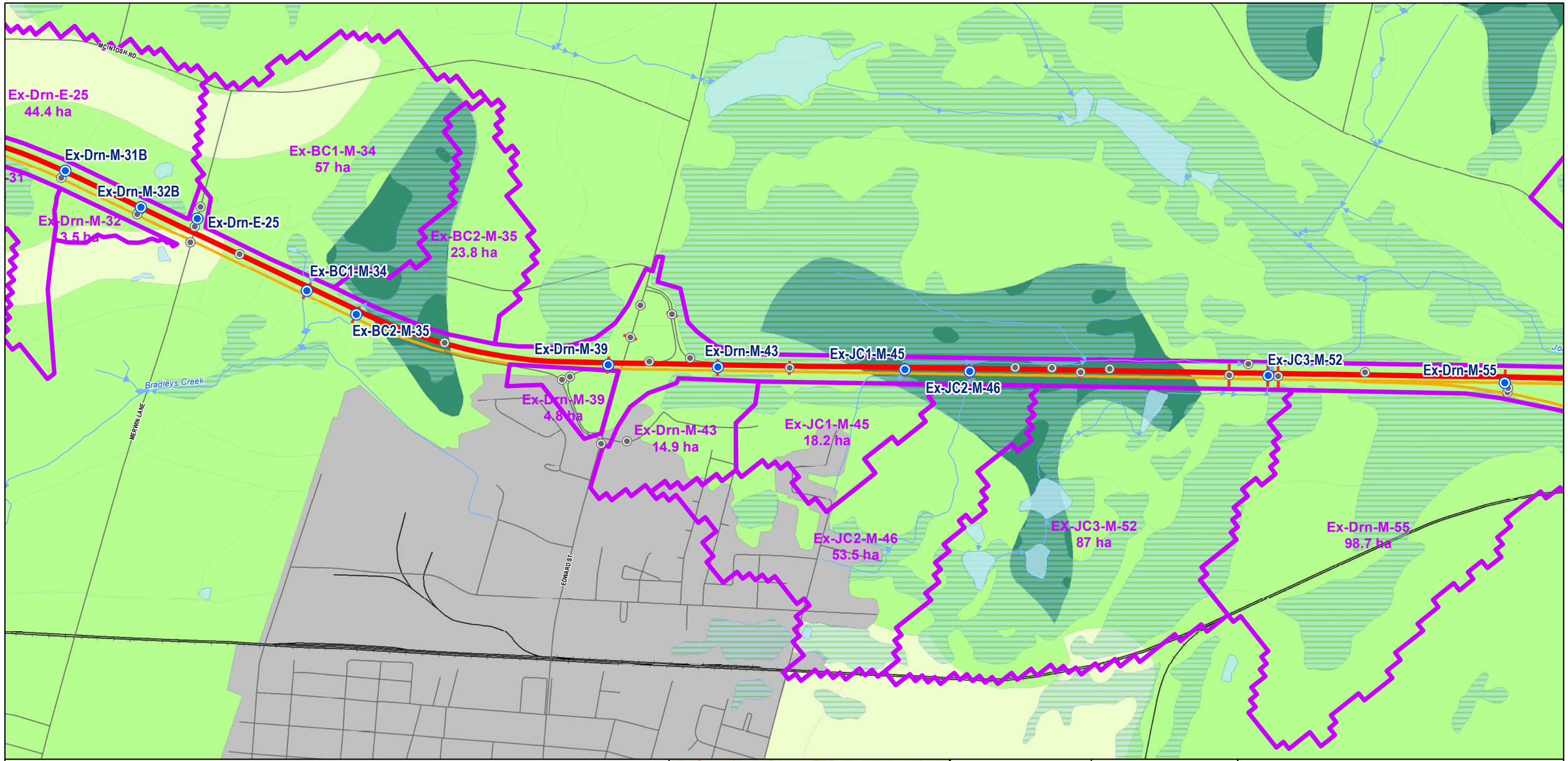
November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-4: Soil Slopes



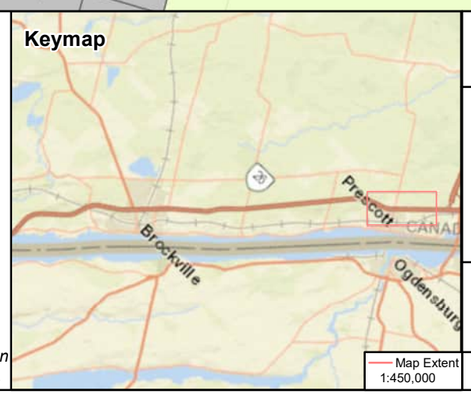
Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

Meters

November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-5: Soil Slopes

Ex-JC5-E-34
221.3 ha

Ex-Drn-M-65
26.1 ha

Ex-JC6-M-66
64.9 ha

Ex-JC7-M-73
217.8 ha

CEDAR GROVE RD

Johnstown Creek

Ex-JC3-M-52

Ex-Drn-M-55

Ex-Drn-M-65

Ex-JC5-E-34

Ex-JC4-M-58

Ex-JC6-M-66

Ex-JC7-M-73

16

Legend

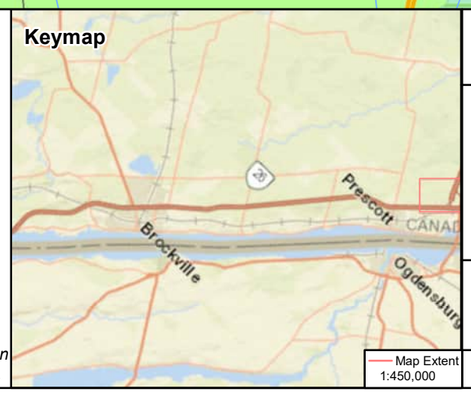
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

0 125 250 375 500

Meters

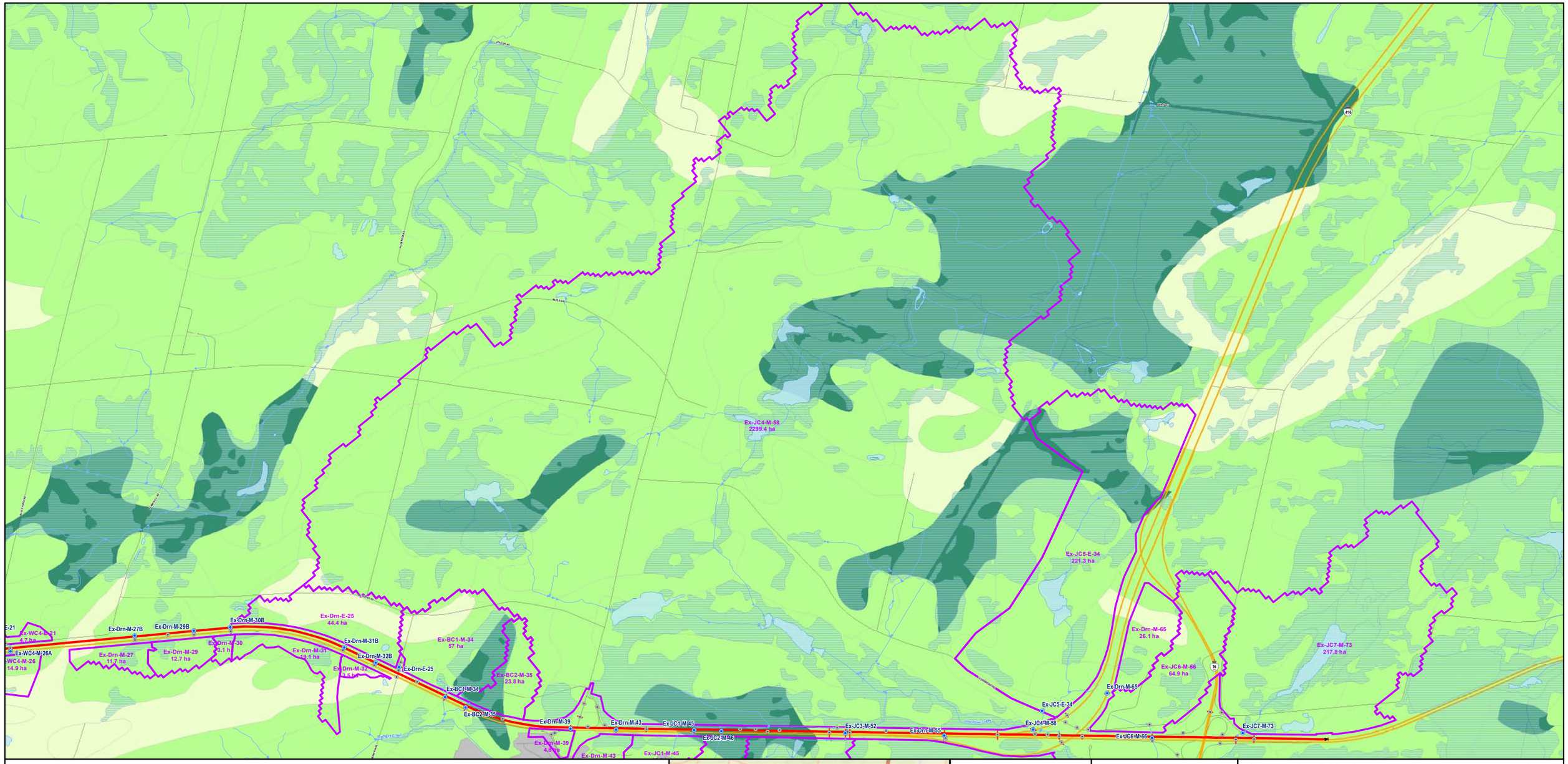
November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-6: Soil Slopes



Legend

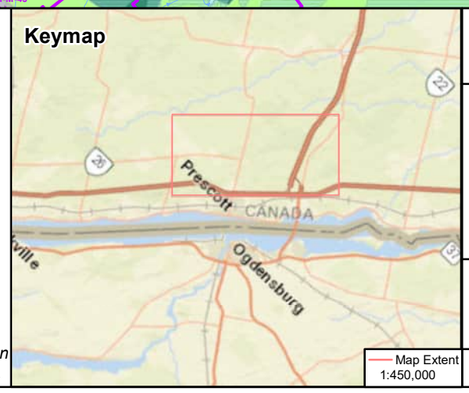
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Soil Slopes

- A - 0 - 0.5% (Level)
- B - 0.5 - 2% (Nearly Level)
- C - 2 - 5% (Very Gentle Slopes)
- D - 5 - 9% (Gentle Slopes)
- E - 9 - 15% (Moderate Slopes)
- N - 2 - 5% (Very Gentle Slopes)

Note: Soil gradient information provided in this drawings is based on Land Information Ontario Data Description, Soil Survey Complex, 2019.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 300 600 900 1,200

Meters

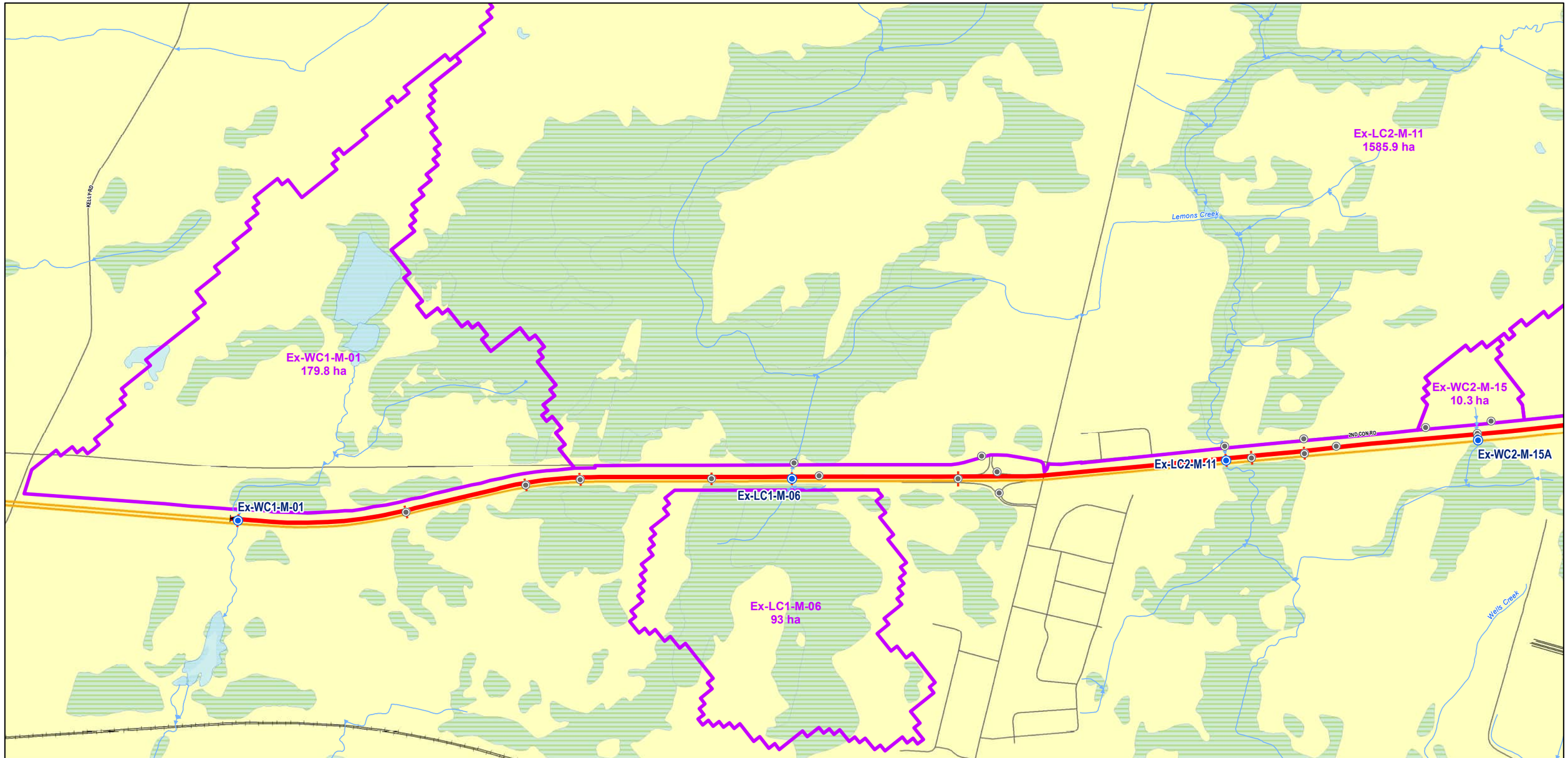
November 2023

Scale: 1:30,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 3-7: Soil Slopes



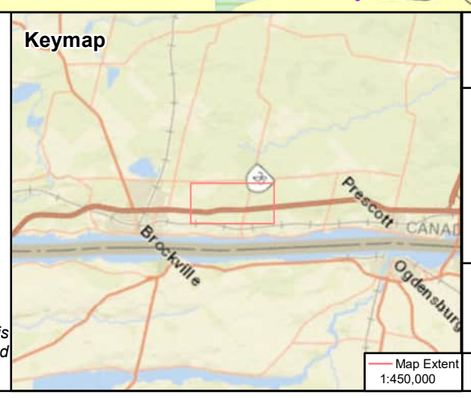
Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

Source: Contains information licensed under the Open Government Licence Ontario. Base imagery provided by ESRI.

0 150 300 450 600

Meters

November 2023

Scale: 1:15,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-1: Soil Slopes Length

Ex-LC2-M-11
1585.9 ha

Ex-WC1-M-01
179.8 ha

Ex-WC2-M-15
10.3 ha

Ex-SC1-M-17
66.8 ha

Ex-Drn-M-19
5 ha

Ex-Drn-M-20
3.1 ha

Ex-Drn-M-21
13.1 ha

Ex-WC3-M-24
40.4 ha

Ex-Drn-M-23
17.3 ha

Ex-WC1-M-01

Ex-LC2-M-11

Ex-LC1-M-06

Ex-WC2-M-15A

Ex-SC1-M-17A

Ex-Drn-M-20B

Ex-Drn-M-21B

Ex-Drn-M-23B

Ex-LC1-M-06
93 ha

Lemons Creek

Spades Creek

Legend

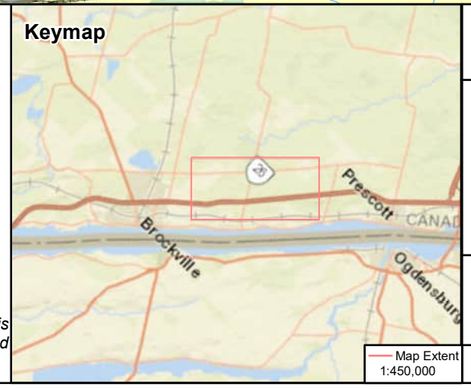
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 225 450 675 900
Meters

November 2023

Scale: 1:23,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-2: Soil Slopes Length

Ex-LC2-M-11
1585.9 ha

Ex-SC1-M-17
66.8 ha

Ex-Drn-
M-19
5 ha

Ex-Drn
-M-20
3.1 ha

Ex-Drn-M-21
13.1 ha

Ex-WC3-M-24
40.4 ha

Ex-WC2-M-15
10.3 ha

Ex-Drn-M-21B

Ex-Drn-M-20B

Ex-Drn-M-23B

Ex-Drn-M-23
17.3 ha

Ex-WC2-M-15A

Ex-SC1-M-17A

Ex-LC2-M-11

ROCKY RD

2ND CON RD

Wells Creek

Smades Creek

401

Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length
<VALUE>
- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.

Keymap

Prescott
Brockville
Ogdensburg
Map Extent
1:450,000

AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500
Meters

November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-3: Soil Slopes Length

Ex-WC3-M-24
40.4 ha
Ex-Drn-M-23B
Ex-Drn-M-23
17.3 ha
401
Ex-WC3-M-24A
Ex-Drn-M-25B
Ex-WC4-E-21
Ex-WC4-E-21
4.7 ha
Ex-WC4-M-26A
Ex-WC4-M-26
14.9 ha
Ex-Drn-M-25
1.7 ha
Ex-Drn-M-27B
Ex-Drn-M-27
11.7 ha
Ex-Drn-M-29B
Ex-Drn-M-29
12.7 ha
Ex-Drn-M-30B
Ex-Drn-M-30
3.1 ha
Ex-Drn-E-25
44.4 ha
Ex-Drn-M-31B
Ex-Drn-M-31
19.1 ha
Ex-Drn-M-32B
Ex-Drn-M-32
3.5 ha
Ex-Drn-E-25
MCINTOSH RD
BLUE CHURCH R
N CAMPBELL
Bradleys Creek
MERWIN LANE

Legend

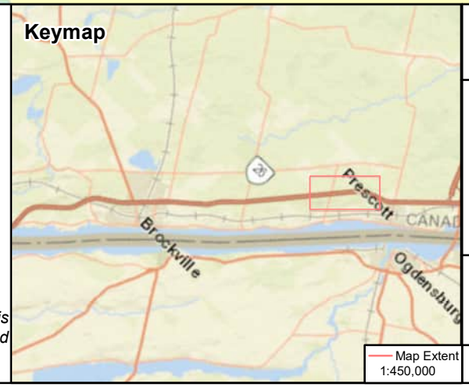
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500
Meters

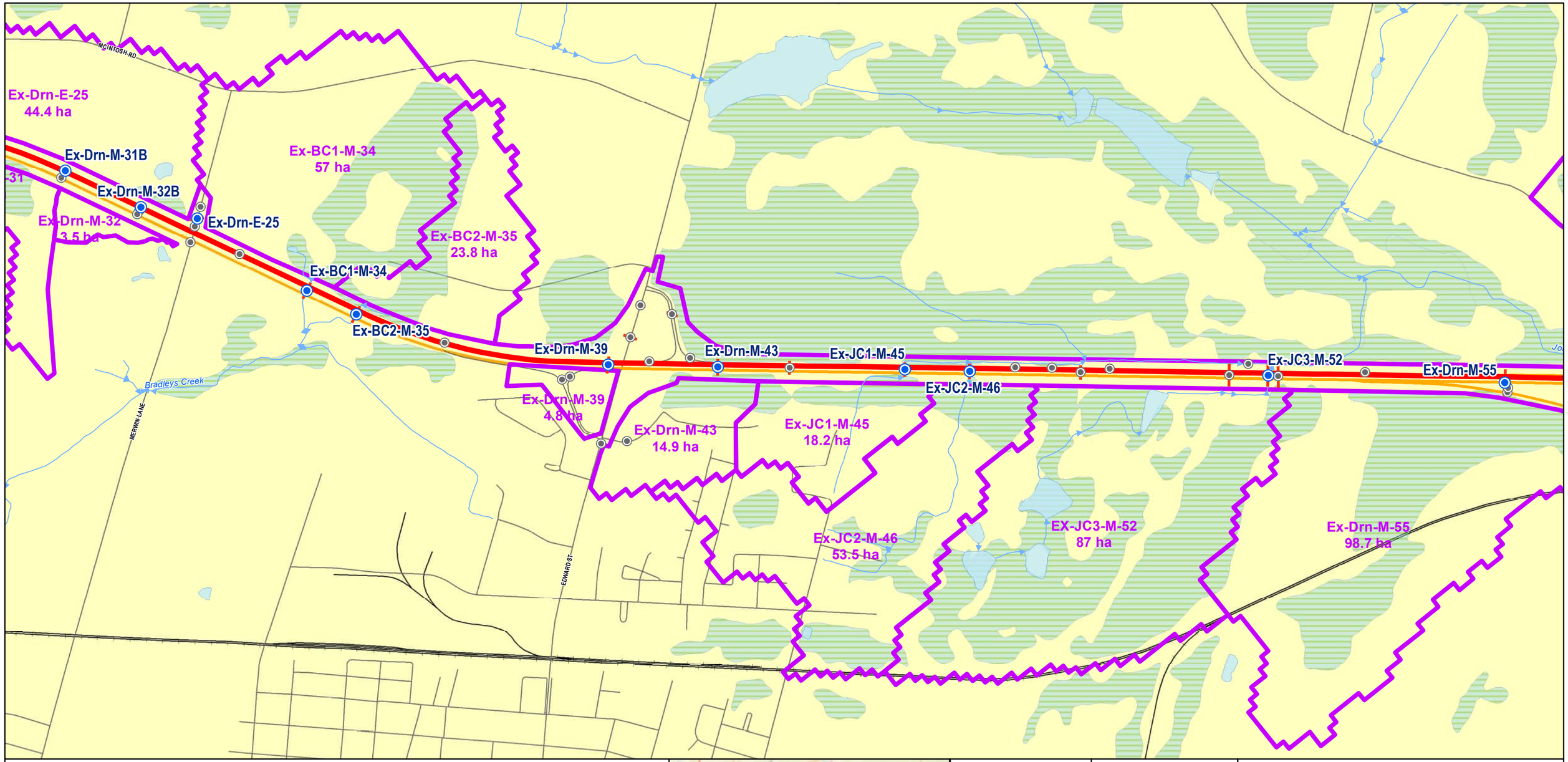
November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-4: Soil Slopes Length



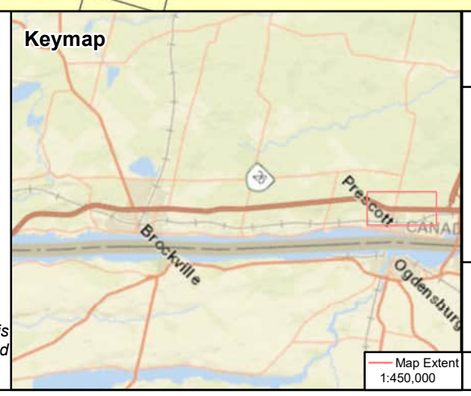
Legend

- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

Meters

November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-5: Soil Slopes Length

Ex-JC5-E-34
221.3 ha

Ex-Drn-M-65
26.1 ha

Ex-JC6-M-66
64.9 ha

Ex-JC7-M-73
217.8 ha

CEDAR GROVE RD

Johnstown Creek

Ex-JC3-M-52

Ex-Drn-M-55

Ex-JC4-M-58

Ex-JC5-E-34

Ex-Drn-M-65

Ex-JC6-M-66

Ex-JC7-M-73

16

Legend

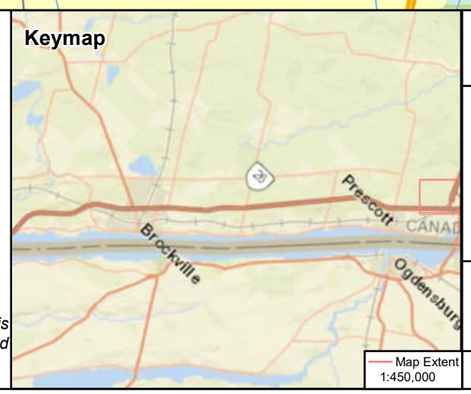
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Railway
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 125 250 375 500

Meters

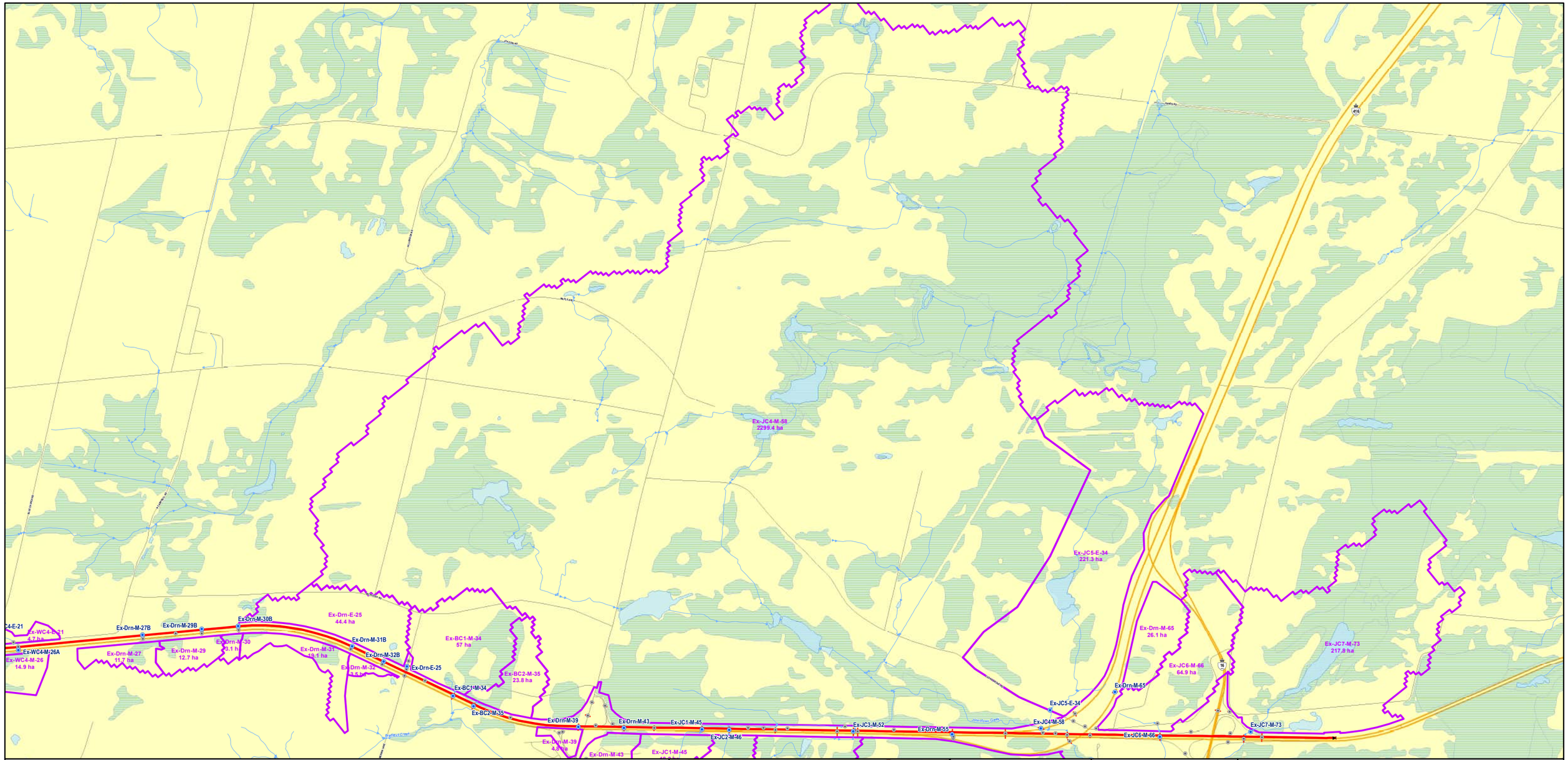
November 2023

Scale: 1:12,500

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-6: Soil Slopes Length



Legend

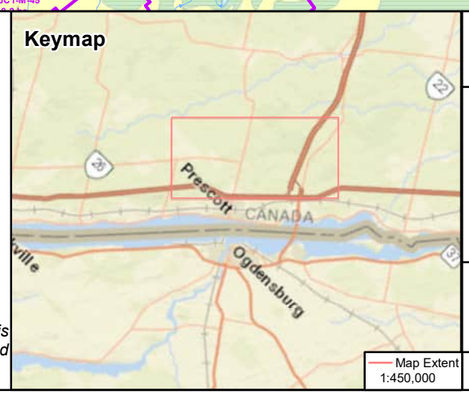
- Major Culverts
- Other Culverts
- Project Limits
- King's Highway
- Local Road
- Watercourse
- Wetland
- Waterbody
- Catchments

Slope Length

- < 70 m
- > 70 m

Note: Slope length was estimated based on flow length data. This information is preliminary and should be confirmed during the detailed design phase.

Keymap



AECOM

Ontario Ministry of Transportation

Datum: NAD 1983 CSRS MTM 9

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0 300 600 900 1,200

Meters

November 2023

Scale: 1:30,000

Ontario Ministry of Transportation
Eastern Region

Project No. 60638228
Highway 401
Highway 16 Interchange to Maitland Road Interchange
GWP: 4024-20-00

Figure 4-7: Soil Slopes Length

Table 8.1 Procedural BMPs for ESC on Highway Construction Sites

Name		Applicability							Comments
		Slopes	Watercourses	Drainage Channels	Pipes and Culverts	Large Flat Surface	Borrow / Stockpile	Adjacent Properties	
Site Management	Design and Implement ESC Plan	✓	✓	✓	✓	✓	✓	✓	It is essential to properly design and implement a site-specific ESCP to reduce erosion and ensure that sediment is not released from the construction site. This includes monitoring, maintenance and decommissioning, as discussed in Section 8.
	Minimize Exposed Soils	✓	✓	✓	✓	✓	✓		By minimizing the total disturbed soil area and the disturbed soil area at any time, the erosion potential is reduced and the quantity of sediment control measures is reduced. Stripping of new areas should be delayed as long as possible and restoration of constructed areas should be done as soon as possible. Grubbing of roots should also be delayed as long as possible based on work schedules - as root systems will help to stabilize soils even after surface vegetation has been cleared.
	Perimeter Control	✓	✓	✓	✓	✓	✓	✓	During clearing and grubbing, the minimized limits of construction activity should be clearly marked.
	Site Access Management	✓				✓		✓	The site should be accessible from a limited number of points. Frequently-used access roads should be paved or graveled to minimize the tracking of material off site. Vehicle washing on stabilized worksite entrances will minimize off-site sediment tracking.
	Stockpile Management						✓		Stockpiles should not be located near watercourses, adjacent developed areas or environmentally sensitive areas. Stockpiles should be protected against erosion by water and wind immediately after they are established. This can be done by seeding, hydroseeding or applying a synthetic cover.
	Dust Management	✓				✓	✓		Wind-blown dust from disturbed soil and surfaces can be minimized by: • Seeding or mulching areas that will not be traveled on; • Constructing wind breaks or screens; • Enforcing reduced vehicle speeds on unpaved roads; and • Using water or chemicals for dust control. Note that care must be taken to prevent mud tracking if this is done.
	Sensitive Area Signage	✓	✓	✓	✓	✓	✓	✓	Areas that are sensitive to disturbance and areas that must not be disturbed should be clearly signed to convey that message. Areas that represent a safety hazard, such as deep ponds, should be signed as such and barricaded if necessary.
Scheduling	Maximize Favorable Weather	✓	✓	✓	✓	✓	✓	✓	Erosion potential is reduced by working during relatively dry conditions. This includes consideration of the season of construction and may require a larger number of resources to complete the project in a shorter time.
	Operate During Fisheries Windows		✓	✓					It is not acceptable to release sediment to receiving waterbodies at any time. However, scheduling work in or near fish-bearing waterbodies during open fisheries windows is recommended to reduce potential effects on fish and fish habitat. Note that this will not necessarily reduce the risk of harmful alteration, disruption or destruction (HADD) of fish habitat.
	Optimize Construction Sequence	✓	✓	✓	✓	✓	✓	✓	The sequence of construction should be specified with consideration of site management and scheduling BMPs. The construction sequence should be compatible with plans for progressive reclamation, instream works, stockpile operation, etc.
	Install BMPs Early	✓	✓	✓	✓	✓	✓	✓	Erosion potential can be minimized by installing ESC BMPs as soon as practical and always before soil is exposed. Early installation may require site access or traffic control considerations.
	Restore Early	✓	✓	✓	✓	✓			Erosion potential can be minimized by restoring or reclaiming constructed areas as soon as possible by topsoiling and seeding. Temporary works (i.e. detention ponds, sediment controls) should be removed as soon as practical when they are no longer needed.

Table 8.2 Surface Water Management BMPs for ESC on Highway Construction Sites

Name	Applicability							Comments
	Slopes	Watercourses	Drainage Channels	Pipes and Culverts	Large Flat Surface	Borrow / Stockpile	Adjacent Properties	
Divert Clean Water Around the Site	✓	✓	✓	✓	✓	✓	✓	Clean water drainage from upstream areas should be diverted around the construction site wherever practical, to reduce the quantity of water that must be managed on site. This can be done using ditches, berms, pipes, hoses or temporary culverts as appropriate.
Keep Clean Water on the Site Clean	✓	✓	✓	✓	✓	✓		Clean water drainage from undisturbed areas within the construction site should be collected and allowed to discharge to receiving streams without being mixed with runoff from disturbed areas.
Use Existing Drainage		✓	✓	✓				Existing watercourses tend to be well-vegetated and have natural rates of erosion. Discharges from the construction site containing natural levels of sediment should be conveyed to existing, undisturbed watercourses. Care should be taken to ensure that peak flows in the existing watercourse should not be increased significantly (i.e., more than 30% increase in the 10-year flood event).
Integrate New Drainage into the Project Design		✓	✓	✓				If it is necessary to construct new ditches, pipes or culverts for on-site surface water management, integrating these with the project design will prevent future disturbance due to removal of temporary measures.
Keep Drainage Areas Small	✓	✓	✓	✓	✓	✓		Smaller drainage areas generally require less complex erosion control BMP arrangements and smaller drainage channels, so they are preferred if local topography permits. By discharging from a number of small discharge points rather than a few large ones, the size of sediment control measures is reduced and the magnitude of effects from a potential failure is reduced.
Design Drainage Channels Appropriately		✓	✓					Drainage channels should be designed with appropriate depths, slopes, cross-sections and linings (armored or vegetated). Natural channel design is recommended for watercourse diversions.
Manage Shallow Groundwater	✓					✓		Slopes, excavations and areas around retaining walls may be sensitive to piping failure or erosion due to high pore water pressures. These can be managed by temporary dewatering or by incorporating permanent drains to reduce pore water pressures. Aggregate or rock covers (refer to erosion control BMPs) can also be installed to protect the ground surface. Dewatering wells, if properly screened, may produce clean water and be suitable for direct discharge to receiving streams.

Table 8.3 Erosion Control BMPs for ESC on Highway Construction Sites

Name			Applicability							Comments	Temporary	Permanent	BMP
			Slopes	Watercourses	Drainage Channels	Pipes and Culverts	Large Flat Surface	Borrow / Stockpile	Adjacent Properties				
Exposed Surface Protection	Vegetated	Topsoiling	✓		✓		✓	✓	✓	Topsoil absorbs energy from rain splash and provides water storage and an essential medium to support vegetation. It must be applied with seed or sod and soil moisture must be managed. Topsoil should not be applied to slopes steeper than a target maximum of 3H:1V with an absolute maximum of 2.5H:1V to 2H:1V, depending on the region.		✓	1
		Seeding	✓		✓		✓	✓	✓	Applying seed during restoration allows control over vegetation that will develop. Seeded areas are susceptible to erosion until leaf and root masses are developed, so monitoring is needed. Contouring and reseeding will be required if erosion occurs.	✓	✓	2
		Mulching	✓		✓		✓	✓	✓	Mulching is effective at protecting exposed areas from rain splash erosion for short periods. It preserves soil moisture and protects germinating seeds to promote revegetation. Mulching on steep slopes may not be effective.	✓	✓	3
		Hydro-Seeding or Hydro-Mulching	✓		✓		✓	✓	✓	Seeding with mulch is an effective way of achieving higher germination rates and reducing erosion potential before substantial revegetation. Tackifier applied during hydro-seeding or hydro-mulching can provide immediate protection during germination and revegetation and is more effective on steep slopes.	✓	✓	4
		Sodding	✓		✓	✓	✓	✓	✓	Sod placement provides immediate cover protection, buffer strip and vegetated channel lining. It is more expensive and labor intensive than various methods of seeding.		✓	5
		Riparian Zone Preservation		✓						Watercourse erosion potential is significantly reduced by preserving natural vegetation, to reduce runoff velocity and enhance infiltration.		✓	6
	Non-Vegetated	Riprap/ Riverstone Armouring	✓	✓	✓	✓				Riprap and riverstone provide a flexible channel lining for protection against flowing water and can be used to construct drop structures and energy dissipation structures. Rock structure construction is relatively expensive and labor-intensive.		✓	7
		Gabions	✓	✓	✓	✓				Gabions provide a flexible channel lining for protection against flowing water and can be used to construct drop structures and energy dissipation structures.		✓	8
		Aggregate Cover	✓	✓	✓	✓				Gravel and rock blankets can stabilize soil surfaces including areas with seepage piping erosion. Rock revetments are increasingly used to restore slumping areas in high precipitation regions. Aggregate and rock covers should be designed by a qualified engineer.		✓	9

Name			Applicability							Comments	Temporary	Permanent	BMP
			Slopes	Watercourses	Drainage Channels	Pipes and Culverts	Large Flat Surface	Borrow / Stockpile	Adjacent Properties				
		Stabilized Worksite Entrances							✓	Gravel pads located at site entrances can reduce the amount of sediment carried off construction sites by vehicles, by collecting sediment from vehicle washing. They should include a water supply to wash off excess soil from vehicles prior to leaving the site	✓		10
		Rolled Erosion Control Products	✓		✓			✓		Rolled Erosion Control Products (RECP) provide a high degree of uniform and long-lasting erosion protection. Care should be taken to ensure that the product is suitable for the intended application and that it is applied in accord with the manufacturer's specifications. Permeable RECP's are used in conjunction with vegetation. Impermeable RECP's may be used for protection of stockpiles and if used as such, it may be necessary to protect areas where runoff is concentrated.	✓	✓	11
		Plastic sheeting	✓							Plastic sheeting can be used on sloped to provide immediate protection against erosion. It is relatively easy and inexpensive to install.	✓		12
		Cellular Confinement System	✓	✓	✓			✓		Cellular confinement systems are lightweight and use locally available soils or grout for fill. They may be used on slopes as steep as 1H:1V. They are relatively expensive and labor-intensive to install.		✓	13
		Chemical Stabilization	✓		✓			✓		Chemical treatments can be applied to increase soil cohesion. It may be applied in conjunction with hydro-treatments. Chemical treatments may be expensive and must be designed for site-specific conditions.	✓		14
Runoff Control		Slope Texturing / Grading	✓				✓	✓	✓	Slopes or flat surfaces may be textured using tracked equipment or a sheepsfoot packer. A rough slope retains more water, sediment and seed. This method is most suitable for application to clayey soils. Where possible, slopes can be graded and shaped to divert flows away from sensitive areas. Flatter slopes have less erosion potential. Where steep slopes are unavoidable, interceptor ditches can be effective in reducing effective slope lengths.	✓	✓	15
		Slope Drains	✓			✓				Slope drains convey surface water downslope through a pipe rather than over erodible soils. Pipes must be sized appropriately, anchored to the slope and provided with inlet and outlet erosion protection.	✓	✓	18
		Groundwater Control	✓							Subsurface drains can be used to lower the groundwater table, minimize piping erosion and enhance slope stability. They should be designed by a qualified professional.		✓	19

Name		Applicability							Comments	Temporary	Permanent	BMP
		Slopes	Watercourses	Drainage Channels	Pipes and Culverts	Large Flat Surface	Borrow / Stockpile	Adjacent Properties				
	Synthetic Permeable Barriers	✓							Synthetic permeable barriers reduce runoff velocities and are partially effective in retaining sediments. They can be moved and reused and are typically used as grade breaks on steep grades, in conjunction with drop structures. Synthetic barriers are easily damaged by construction or off-road traffic and become brittle in cold temperatures.	✓		20
	Fibre Rolls and Wattles	✓							Fibre rolls and wattles slow runoff and trap silt and can be effective on steep slopes. They function well in freeze-thaw conditions and are biodegradable. They are labor-intensive to install and are applicable to short slope lengths at a maximum slope of 1H:1V.	✓		27
	Check Dams			✓					Check dams can be constructed of rock, aggregate-filled sandbags or logs to reduce flow velocities in drainage channels. Regular inspection and maintenance of such structures is essential to their effective operation.	✓	✓	26
	Diversion Ditch	✓		✓		✓	✓	✓	Diversion ditches, often combined with berms above steep slopes, can be used to collect runoff at the top of a slope and convey it around exposed areas. Berms on steep slopes should never be built without drainage ditches.		✓	28
	Coffer Dam		✓	✓	✓				A temporary dam constructed of earth, sheet piling or other material to enclose a work area and permit the removal of water	✓		30
	Temporary stream diversions		✓	✓					Diversion of a watercourse into an artificial channel to permit construction “in the dry” of a culvert or bridge	✓		29
	Energy Dissipator	✓		✓	✓				Rock riprap, gabions or sandbags can be installed at areas such as culvert outlets or drop structures to reduce flow velocities and protect against erosion. Dissipators with high flow rates should be designed by a qualified professional.		✓	31

More detailed discussions of applicability are provided in the BMP Fact Sheets located in Appendix E. Table 9-5 provides information on the origin of the information in the Fact Sheets, and related Ontario Provincial Standard Specifications (OPSS), Ontario Provincial Standard Drawings (OPSD) and MTO Standard Drawings. MTO related standard tender item numbers and Special Provisions (SP) are also included where appropriate.

General factors to consider when selecting erosion control BMPs include:

- Flow quantity and velocity: Some measures are best applied to sheet flow on slopes, while others are only applicable to concentrated flows in channels;