



**FOUNDATION DESKTOP STUDY**  
**HWY 407 EAST EXTENSION – EASTERN SECTION**  
**W.O. 07 – 20017**

**Prepared for:**  
**Ministry of Transportation Ontario**

Table of Contents

INTRODUCTION ..... 1

SOURCES USED IN THE STUDY ..... 1

REGIONAL GEOLOGY ..... 2

    Physiography ..... 2

    Regional Geology and Hydrogeology ..... 2

    Groundwater Flow ..... 3

SITE SPECIFIC ASSESSMENTS..... 3

    Site Location Plans ..... 4

    Spread Footings on Engineered Fill ..... 4

    Spread Footings on Native Soil ..... 4

    Driven Steel H-Piles ..... 4

    Valley Slope Stability..... 5

    Swamps..... 5

MISCELLANEOUS ..... 5

    Numbering System ..... 5

    Acknowledgement ..... 5

    Report Preparation..... 6

Drawing 19-2805-9-1: Key Plan - showing structure locations

Figure 1: Abutment on Compacted Fill Showing Granular A Core

Individual Site Assessment Sheets for Mainline Structures and Culverts

Individual Site Assessment Sheets for East Link Structure and Culverts

Terrain/Drainage Mapping for Eastern Section by Gartner Lee Limited (including structure locations)

Input Comments by Gartner Lee Limited

Geotechnical Risk Assessment (Site Ranking) for the Eastern Section

Previous Geotechnical Investigations

**FOUNDATION DESKTOP STUDY**  
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**W.O. 07 – 20017**

**INTRODUCTION**

A foundations desktop study has been carried out for the Eastern Section of the East Extension of Highway 407. Thurber Engineering Ltd. was retained by Totten Sims Hubicki to undertake this study for Ministry of Transportation Ontario (MTO).

The purpose of the study is to assess the potential geotechnical conditions affecting foundation design at the sites of individual structures in this section in advance of site-specific site investigation and field testing. An interpretation of the site geology and geotechnical conditions has been made using existing sources of information. Based on this interpretation, a preliminary assessment has been made of the geotechnical parameters that may be used for structure planning and feasibility studies. A Key Plan showing the individual structure locations is included as Drawing 19-2805-9-1.

While the information presented in this report may be used for planning and feasibility purposes, it is not intended for, nor is it sufficient for preliminary or detail design purposes. Particularly, founding elevations for footings and pile lengths may be revised significantly after site specific investigation has been completed. Therefore, the information presented may be used for the development of an overall budget estimate but must not be used for detailed costing or for bidding purposes.

**SOURCES USED IN THE STUDY**

The main sources of information that have been used in the preparation of the foundations desktop study include the following:

1. Terrain/Drainage Mapping prepared by Gartner Lee Limited (GLL) as part of the Environmental Assessment. The plates prepared from this mapping for the Eastern Section are included in the report.
2. Comments prepared by GLL on a site-by-site basis, particularly comments regarding the geomorphology of the valleys, groundwater and dewatering. The table of comments supplied by GLL is included in the report.
3. The results of preliminary geotechnical investigations conducted in the past by MTO for planning purposes. The GEOCREs references used include: 30M15-83, 30M15-85, 31D-284 and 31D-288.
4. Gartner Lee Existing conditions report (Gartner Lee Limited, 2006; Natural Environment Revised Draft Existing Conditions Technical Report. Prepared for the Ontario Ministry of Transportation, Central Region. GLL Project # 50613. Submitted August 22, 2006).

**REGIONAL GEOLOGY**

This section of the report has been contributed by Gartner Lee Limited (AECOM) based on Reference 4.

**Physiography**

The analysis area is characterized, from north to south, by three east-west trending physiographic regions: the Oak Ridges Moraine (ORM), the South Slope, and the Iroquois Plain. The ORM is a lateral moraine that forms the northern boundary of the analysis area. The South Slope is a gently rolling till plain, characterized by numerous drumlins oriented upslope. The majority of the Technically Preferred Route (TPR) mainline is located within this region. The Iroquois Plain physiographic region is found extending from the till plain of the South Slope Region down to Lake Ontario. The majority of the East and West Durham Links are located within this region. This area is characterized by gravel beaches that formed along the shore of Glacial Lake Iroquois, while sand was deposited nearshore, grading to silts and clays in the more calm offshore areas.

**Regional Geology and Hydrogeology**

The following description proceeds from the lowermost (oldest) stratigraphic units to the uppermost (youngest) units.

The bedrock is comprised of flat-lying Paleozoic limestones and shales underlying thick overburden sediments throughout the analysis area. Both the limestone of the Lindsay Formation and the blue-grey shale of the Blue Mountain Formation are Upper Ordovician in age. The bedrock in the study area provides a deep aquifer unit, where groundwater flow occurs through bedding plane fractures.

The lowermost sediments were mainly deposited in proglacial lakes and overlie bedrock throughout the analysis area. Because these sediments are not exposed near ground surface, only a brief description of each stratigraphic unit is provided. The Scarborough Formation consists of 30 m of clayey silt, overlain by 20 m of sand aquifer. The Sunnybrook Drift, an aquitard, is a clayey silt diamicton with few stones. The Thorncliffe Formation, comprising laminated clay, silt, and sand, is a major regional aquifer (*Thorncliffe Aquifer*) due to its extent and thickness within the South Slope Region.

The Newmarket Till is a dense, stony, sandy silt diamicton, ranging in thickness from about 5 to 50 m. This unit is exposed at ground surface throughout much of the lower South Slope Physiographic Region. The *Newmarket Till Aquitard* is a major regional aquitard, given its low hydraulic conductivity ( $10^{-9}$  to  $10^{-8}$  m/s) and consistent presence throughout the analysis area. It separates the shallow aquifers from the deep aquifers (*Thorncliffe Aquifer*). Isolated lenses of silt, sand, and gravel are present within the till. Where Newmarket Till is exposed at the surface, the water table is often high because of the poorly drained nature of the soils.

The Oak Ridges Moraine was deposited about 13,300 years ago on the meltwater flood-scoured surface of the Newmarket Till in a deep glacial lake. Numerous “finger-like” protrusions of highly permeable ORM sediments extend southward toward Lake Ontario, but pinch out beneath

the Halton Till. These are occasionally exposed at surface where valleys have incised the Halton Till. The *Oak Ridges Moraine Aquifer* is a major regional aquifer and an important groundwater recharge area. Its sandy and gravelly composition gives it a high permeability and, combined with the hummocky surface topography, facilitates infiltration. Coarse-grained sediments associated with the ORM extend southward, acting as important aquifers for residential use.

The Halton Till ranges in thickness from about 10 to 20 m and has a predominantly clayey silt to silt matrix with isolated lenses of laminated sand, silt, and clay. The *Halton Till Aquitard* has hydraulic conductivities that range from about  $10^{-10}$  to  $10^{-6}$  m/s. On a regional scale, the Halton Till Aquitard acts as a surficial aquitard, inhibiting local groundwater recharge.

The Glacial Lake Iroquois Shoreline Sediments are characterized by gravelly beach sediments along the former shoreline. Nearshore glaciolacustrine deposits of sand and gravel overlie the Newmarket Till and grade to the south into laminated silts and clays. The high permeability of the sandy nearshore deposits of the *Iroquois Plain Shallow Aquifer* provides a pathway for local groundwater discharge. The water table is typically near surface because of the low permeability of the underlying Newmarket Till. Numerous wetlands and lowland stream headwaters coincide with the Iroquois Shoreline. The low permeability silt and clay plains further south inhibit both groundwater recharge and discharge.

**Groundwater Flow**

Water table contours and groundwater flow directions subtly reflect the topographic contours in the analysis area, indicating the influence of topography and soil type on the shallow groundwater flow system. Regional groundwater flow in the aquifers within the analysis area is downwards and south-southeast from the ORM towards Lake Ontario. Locally, groundwater flow paths bend into river valleys and isolated topographic depressions. Topographic highs are generally groundwater recharge zones. Groundwater discharge is predominant along the Iroquois shoreline and groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal due to the Newmarket Till Aquitard below. Regionally, streams that originate from the ORM warm up as they flow over the South Slope till soils due to little moderation by groundwater. Streams that originate on the low permeability till plain of the lower South Slope initially derive most of their water from surface runoff, but receive a significant proportion of their flow from groundwater discharge as they flow across the sandy Iroquois shoreline.

**SITE SPECIFIC ASSESSMENTS**

The information gathered for each site is presented in a single sheet that contains:

- A site location plan
- A photograph of the general site area (where these could be readily obtained)
- Reference to existing boreholes available for the site
- A description of the site geology based on terrain mapping
- A simplified stratigraphic log (where a borehole was available)
- Foundation design parameters to be used for planning and feasibility purposes
- Comments on stability and settlement of approach fills
- Comments on dewatering requirements
- A site ranking from a geotechnical perspective and a hydrogeological perspective

Typically, three foundation types have been considered in the desktop study. These are spread footings on engineered fill, spread footings on native soil, or driven steel H-piles (typically HP 310 X 110).

**Site Location Plans**

The site location plans on the individual sheets have been cut from the Terrain/Drainage Mapping supplied by GLL. The meanings of symbols can be found in the legend on any of the mapping plates attached to the report.

**Spread Footings on Engineered Fill**

At those sites where the use of spread footings on engineered fill is considered feasible, the report provides either a maximum elevation at which the engineered fill pad can be founded or a minimum depth below ground surface. The values have been determined from an existing borehole where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

Spread footings on engineered fill may be designed on the basis of geotechnical resistances of:

- 900 kPa factored ULS
- 350 kPa SLS

The geometry of the engineered fill pad must conform to the requirements set out in Figure 1, following the text. The recommended minimum thickness of engineered fill below the underside of the footing is 2 m.

**Spread Footings on Native Soil**

For those sites where the soil conditions are considered to be suitable, recommendations have been provided for the design of spread footings bearing on native soil.

Preliminary values are given for the geotechnical resistances at factored ULS and SLS. The recommendations also include the maximum elevation, or alternatively the minimum depth below existing ground surface, at which the footing may be founded. The values have been determined from an existing borehole where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

**Driven Steel H-Piles**

For the purposes of the desktop study, the pile section has been assumed to be HP 310 X 110.

Where the soil conditions appear to be suitable for driven piles, values of the geotechnical resistance have been given at factored ULS and at SLS. An anticipated pile tip elevation and/or pile length has also been provided. The values have been determined from an existing borehole



where one is located at or close to the site. Otherwise they have been assessed from interpreted surface elevations. In all cases they are subject to revision following site investigation.

In the desktop study, no attempt has been made to assess downdrag forces on piles. The requirement to consider downdrag must be assessed during site investigation for the detail design stage.

**Valley Slope Stability**

At valley crossings, comments from GLL regarding geomorphological evidence of slope instability has been included in the remarks column, where appropriate. No recommendations have been developed from this information but sites showing evidence of slope slumping should be flagged for close examination during detail design.

**Swamps**

No information is available in the wetland complexes and no recommendations have been provided regarding crossing these areas.

**MISCELLANEOUS**

The following convention has been used to categorize structures:

- Overpass – the main highway passes over the secondary road
- Underpass – the main highway passes under the secondary road
- Overhead – the highway passes over a railway track
- Subway – the highway passes under a railway track
- Ramp Underpass – the main highway passes under a highway ramp
- Ramp Overpass – the main highway passes over a highway ramp

**Numbering System**

The following examples illustrate the numbering system that has been developed by the Design Team to describe structure locations:

- EM – xx represents a structure on the Mainline in the Eastern Section
- EL – xx represents a structure on the East Link

**Acknowledgement**

Thurber gratefully acknowledges the contribution made by Gartner Lee Limited (AECOM) in the preparation of this report, in particular the Terrain/Drainage Mapping, description of geology and comments on groundwater and geomorphology.

**Report Preparation**

This report was prepared by Mr. Alastair E. Gorman, P.Eng., and was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

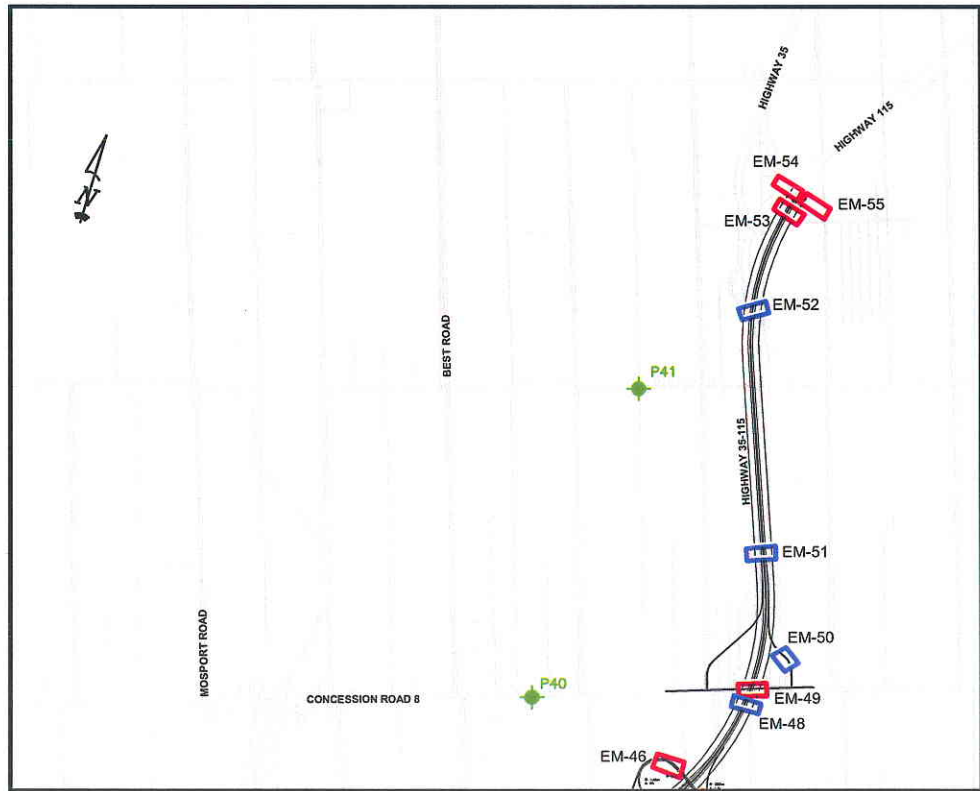
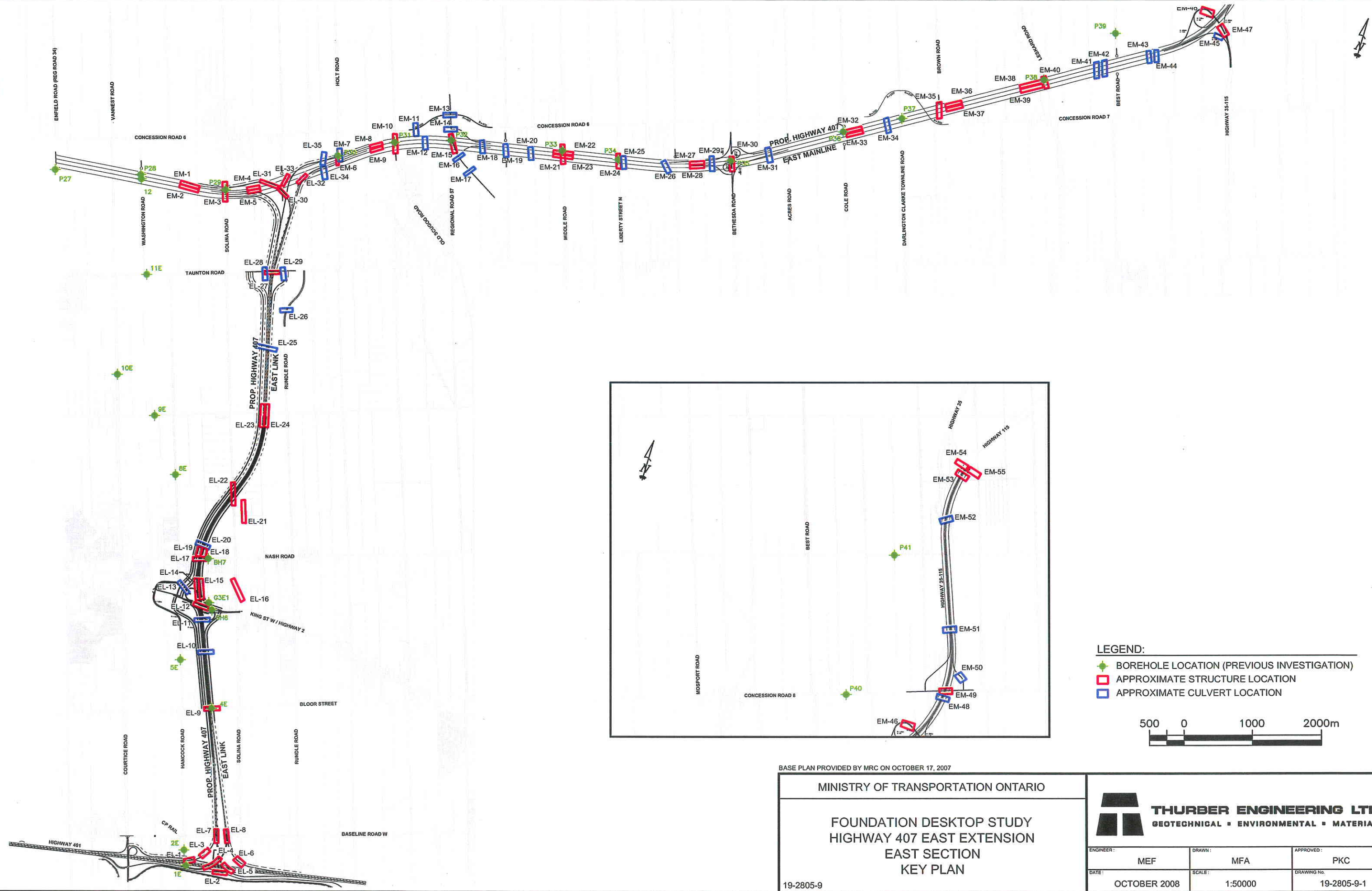
Thurber Engineering Ltd.



P.K. Chatterji, P.Eng.  
Review Principal



Alastair Gorman, P.Eng.  
Senior Foundations Engineer




BASE PLAN PROVIDED BY MRC ON OCTOBER 17, 2007

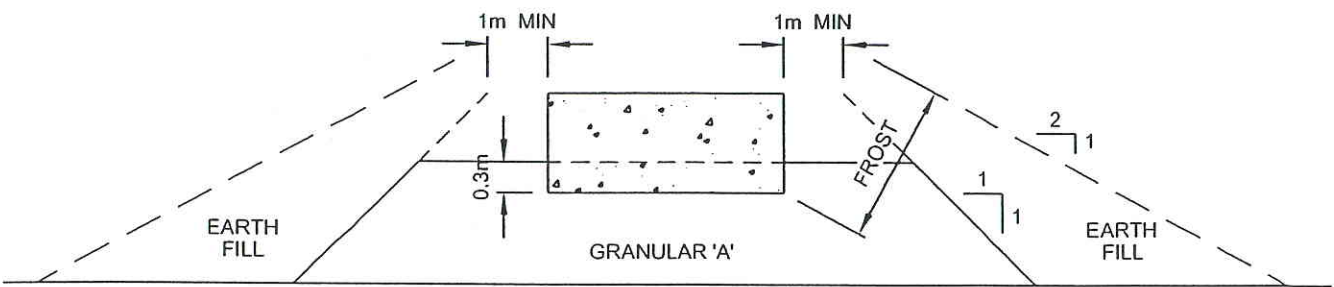
MINISTRY OF TRANSPORTATION ONTARIO

FOUNDATION DESKTOP STUDY  
HIGHWAY 407 EAST EXTENSION  
EAST SECTION  
KEY PLAN

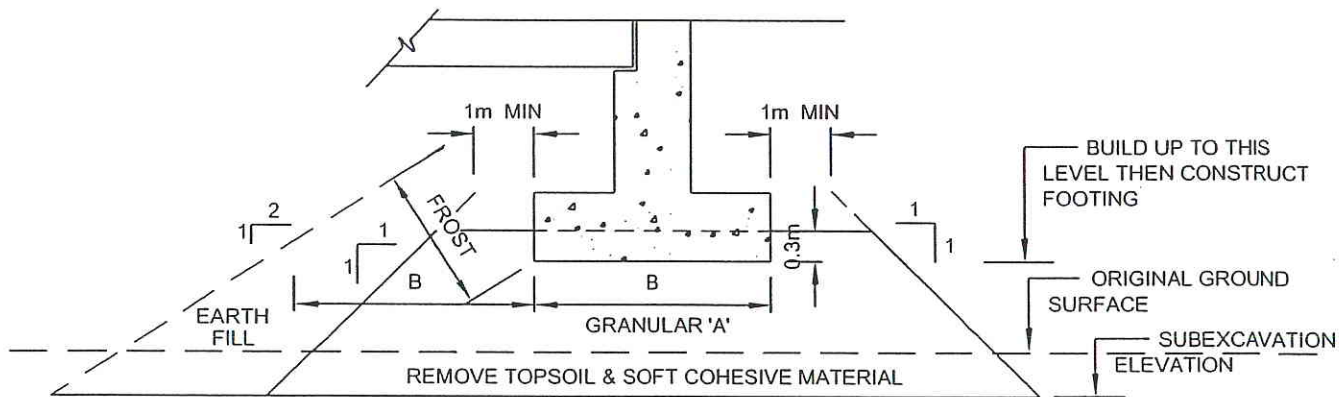
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**THURBER ENGINEERING LTD.**  
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

ENGINEER:	MEF	DRAWN:	MFA	APPROVED:	PKC
DATE:	OCTOBER 2008	SCALE:	1:50000	DRAWING No.	19-2805-9-1



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

- 1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
- 2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
- 3. CONSTRUCT CONCRETE FOOTING.
- 4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
- 5. SOURCE M.T.C. 1982.

ENGINEER	AEG
DRAWN	SS
DATE	April , 2004
APPROVED	PKC
SCALE	NTS

ABUTMENT ON COMPACTED FILL SHOWING  
GRANULAR A CORE



DWG. NO.

FIGURE 1

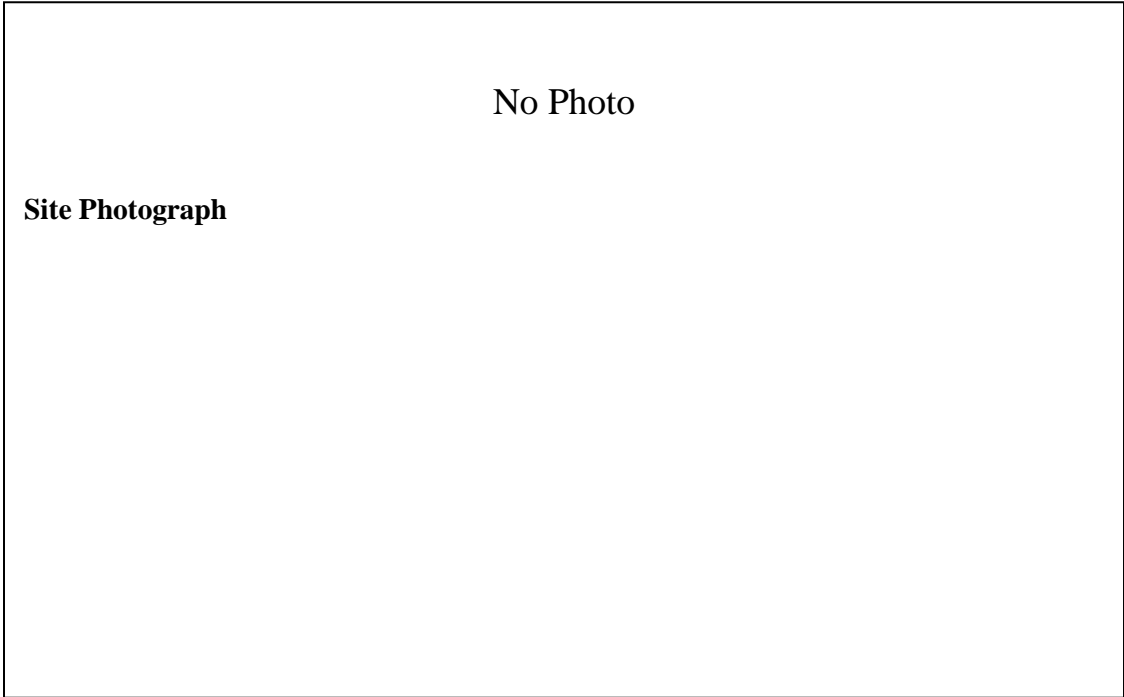
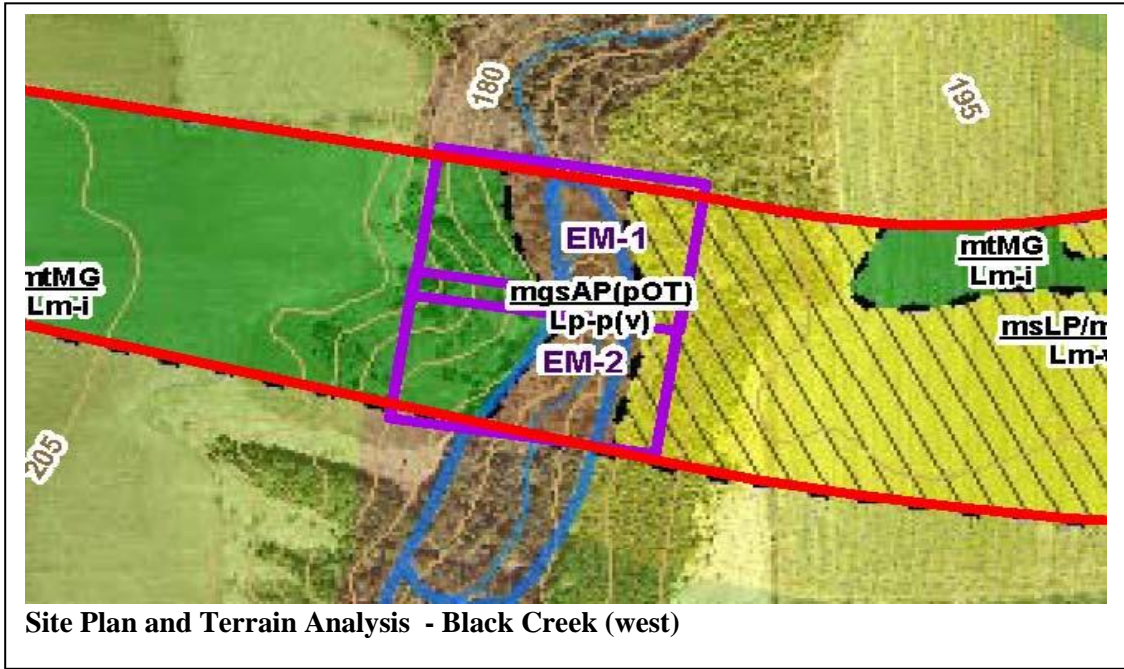


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-1
	EM-2

W.O: 07-20017    Section: Eastern    Location: Mainline over Black Creek    Sta. 11+960

Original Grade:    Proposed Grade:    Description: Watercourse crossing (twin bridges)



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 12 Book 8 BH P28, P29, Book 22, all ~700m distant.</b>  Mapping (East 1) shows 80 - 100m band of recent alluvium under the site, with the creek at the east. The alluvium consists of silt, sand, gravel and peaty soils. This alluvial plain is mapped as a PSW. To the west, the soil is silt till ground moraine. To the east, the moraine soils are overlain by shallow silty sand glaciolacustrine plain. Boreholes confirm 5m of very dense silty sand over hard clay till at Solina Road and compact then very dense sandy silt till at Washington Road.  <b>Groundwater</b>  Groundwater should be expected to be at creek level in the valley floor and to rise with increasing distance from the creek. Note PSW with potential for spring seepage.  Boreholes at the roads indicate GWL less than 3m below grade.  <b>Estimated Overburden Thickness – 65m</b>	<b>1. Abutments</b>  a. Driven piles are recommended as the preferred foundation solution at this site.  Piles are expected to be in the order of 15m long and may be assumed to have: – ULS resistance – 1,200 kN – SLS resistance – 1,000 kN  b. Integral abutments are expected to be feasible.  c. Bridges with foundations on or above the valley slopes may be suitable for abutments on spread footings. On native soil assume resistance to be: – Factored ULS – 600 kPa – SLS – 400 kPa  d. Perched abutments on the valley slopes may be supported on spread footings on engineered fill. Resistance: – Factored ULS – 900kPa – SLS – 350 kPa  <b>2. Pier</b>  If a pier is required, the recommended foundation is driven piles as in (a) above.	Approach fills constructed in the valley floor may lie in areas underlain by recent alluvium, possible including organic soils. Stripping will be required to remove unsuitable soils.  Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No settlement or global stability issues are anticipated based on available information, providing stripping is carried out.	The groundwater level is expected to be high and the valley floor will be subject to flooding.  Groundwater control will be required for excavations in valley floor and possible in the valley slopes.  Moderately wide, deep valley with locally steep valleysides; potential for undercutting where meandering channel impinges on valley side
		<b>Site Ranking</b>  <b>Foundations: High</b>  <b>Hydrogeology: High</b>	



HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

Site No: EM-3

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

W.O: 07-20017

Section: Eastern

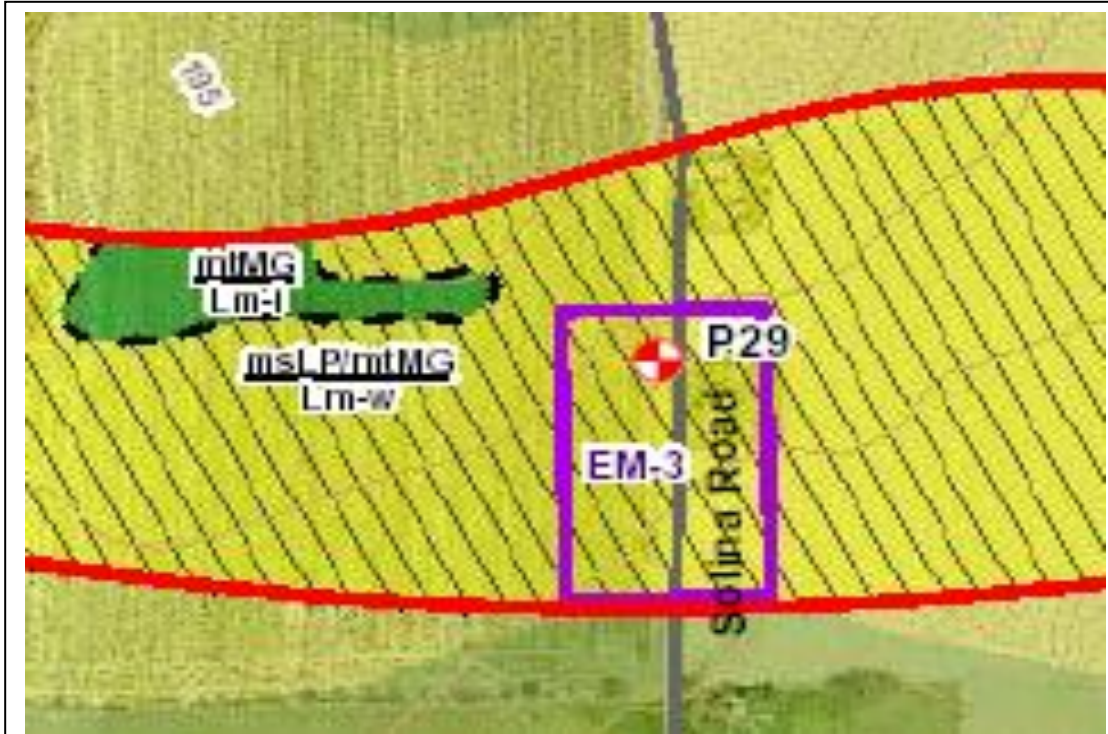
Location: Mainline and Solina Road

Sta. 12+520

Original Grade: ~188.5

Proposed Grade:

Description: Flyover crossing Hwy 407 and freeway/freeway ramps



Site Plan and Terrain Analysis – Solina Road (Mainline crossing)



Site Photograph – Solina Road looking north

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P29, Book 22</b>	<b>1. Abutments</b>		
Mapping (East 1) shows thin deposits of silty sand, glaciolacustrine plain overlying silt till ground moraine.  Borehole P29 encountered:  0.0 – 4.9 Silty sand, very dense 4.9 – 9.3 EOH Clayey silt till, hard  <b>Groundwater</b>  Borehole shows GWL at 2.5m below surface.  <b>Estimated Overburden Thickness – 70m.</b>	a. For perched abutments, footings may be founded on Granular A cores. – Factored resistance at ULS – 900 kPa – Resistance at SLS – 350 kPa  b. For closed abutments, footings may be founded on native soil below El. 186.0 – Factored resistance at ULS – 750 kPa – Resistance at SLS – 500 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0. – ULS resistance – 1,600 kN – SLS resistance – 1,400 kN  d. Pre-drilling may be required to achieve sufficient depth of embedment.  e. Integral abutments are feasible but CSPs required.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No settlement or global stability issues are anticipated based on available information.  Topsoil or other unsuitable soils must be stripped prior to construction.	Groundwater control will be required for excavations penetrating below the groundwater level.  Near surface silty sand soils will be readily disturbed, clay till less so.
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.	<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>High</b>
		<b>Hydrogeology:</b>	<b>High</b>

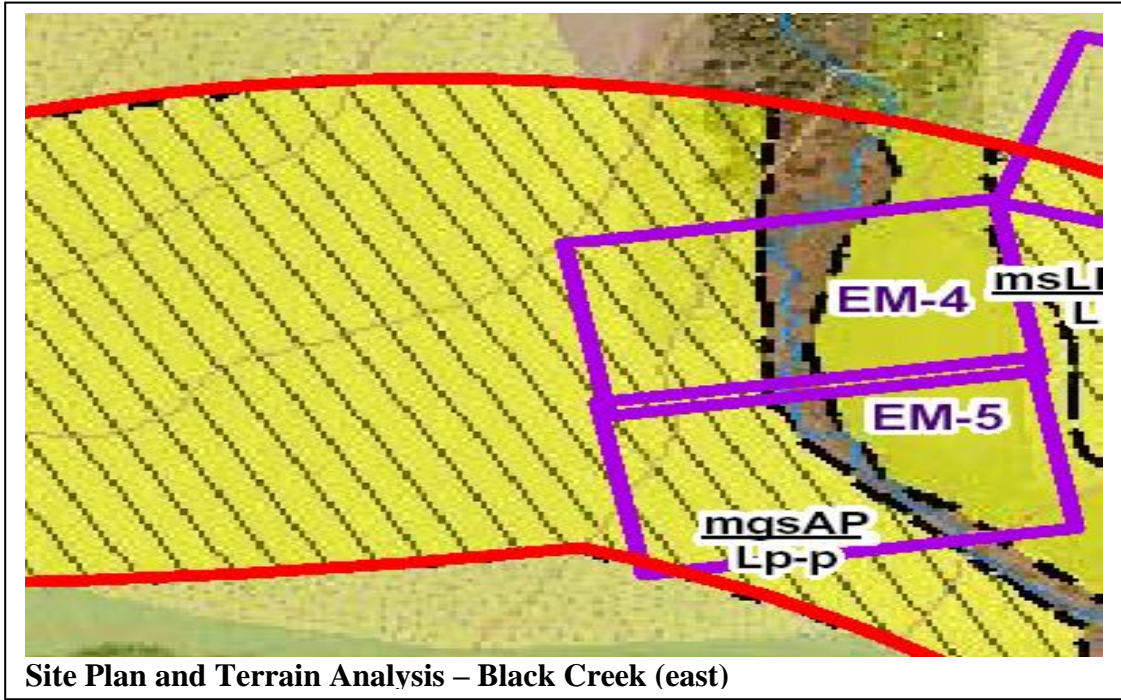


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-4
	EM-5

W.O: 07-20017    Section: Eastern    Location: Black Creek east of Solina Road    Sta. 12+930

Original Grade: ~188.5    Proposed Grade:    Description: Water crossing (twin bridges)



Site Photograph – from Solina Road looking east

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P29, Book 22 ~400m west at Solina Road</b>	<b>1. Abutments</b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	Groundwater control will be required for excavations penetrating below the groundwater level.
<p>Mapping (East 1) shows 20 to 60m wide band of recent alluvium with a meandering creek. The surrounding soils consist of thin deposits of silty sand, glaciolacustrine plain overlying silt till ground moraine.</p> <p>BH P29 encountered:</p> <p>0.0 – 4.9 Silty sand, very dense 4.9 – 9.3 EOH Clayey silt till, hard</p> <p><b>Groundwater</b></p> <p>Groundwater should be anticipated to be at the creek level and close to ground level.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	a. For perched abutments, footings may be founded on Granular A cores. – Factored resistance at ULS – 900 kPa – Resistance at SLS – 350 kPa	No settlement or global stability issues are anticipated based on available information.	Near surface sandy silt soils will be readily disturbed. Clayey silt till less so.
	b. For closed abutments, footings may be founded on native soil below El. 186.0 – Factored resistance at ULS – 750 kPa – Resistance at SLS – 500 kPa	Topsoil or other unsuitable soils must be stripped prior to construction.	Narrow, shallow valley with no geomorphic evidence of significant valleside instability
	c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0. – ULS resistance – 1,600 kN – SLS resistance – 1,400 kN		
	d. Pre-drilling may be required to achieve sufficient depth of embedment.		
	e. Integral abutments are feasible.		
	<b>2. Piers</b>	<b>Site Ranking</b>	
	Piers are not anticipated but if required may be supported using the same foundation.	<b>Foundations: Medium</b>	<b>Hydrogeology: High</b>

<b>Site No:</b>	EM-6
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Mainline and Holt Road    **Sta.** 14+220

An aerial photograph of a rural area. A vertical road on the left is labeled 'Holt Road'. Two purple rectangular boxes are drawn on the map. The upper box contains a red and white bullseye target labeled 'P30' and a red line segment labeled 'EM-7'. The lower box contains the text 'mtMG' and 'Lm-i' stacked vertically, and is labeled 'EM-6' to its right. Two red diagonal lines cross the map, with a road shield labeled '185' on the lower line. A road shield labeled '75' is visible in the bottom right corner.

A wide-angle photograph of a gravel road stretching into the distance. The road is flanked by green fields and trees. In the background, a tall tower is visible on the left side. The sky is clear and blue.

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P30, Book 22</b></p> <p>Mapping shows that the site is underlain by thin deposits of silty sand, glaciolacustrine plain overlying silt till ground moraine.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5.</p> <p><b>Estimated overburden thickness – 70m.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. For perched abutments, footings may be founded on Granular A cores.</p> <ul style="list-style-type: none"> <li>– Factored resistance at ULS – 900 kPa</li> <li>– Resistance at SLS – 350 kPa</li> </ul> <p>b. For closed abutments, footings may be founded on native soil below El. 190.0</p> <ul style="list-style-type: none"> <li>– Factored resistance at ULS – 750 kPa</li> <li>– Resistance at SLS – 500 kPa</li> </ul> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0.</p> <ul style="list-style-type: none"> <li>– ULS resistance – 1,600 kN</li> <li>– SLS resistance – 1,400 kN</li> </ul> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on the very dense native soil are recommended.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>Groundwater control should not be required unless deep cuts or excavations are required.</p>
		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Medium</b></p> <p><b>Hydrogeology:                    Low</b></p>	

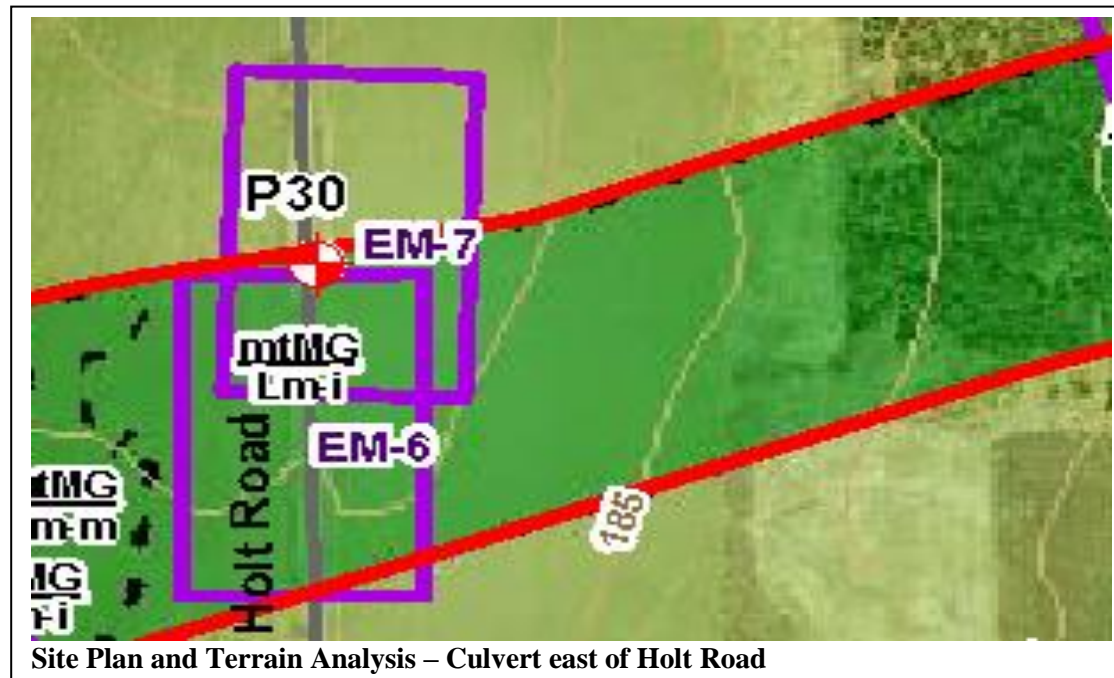


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EM-7
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Culvert east of Holt Road    **Sta.** 14+250

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses creek on culvert
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No Photo

### Site Photograph

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P30, 30M15-85, lies approx. 30m to the west.</b></p> <p>Mapping (East 2) shows that the site is underlain by thin deposits of silty sand, glaciolacustrine plain overlying silt till ground moraine.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5.</p> <p><b>Estimated overburden thickness – 70m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 450 kPa</li> <li>Resistance at SLS – 300 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Low</b></p>	

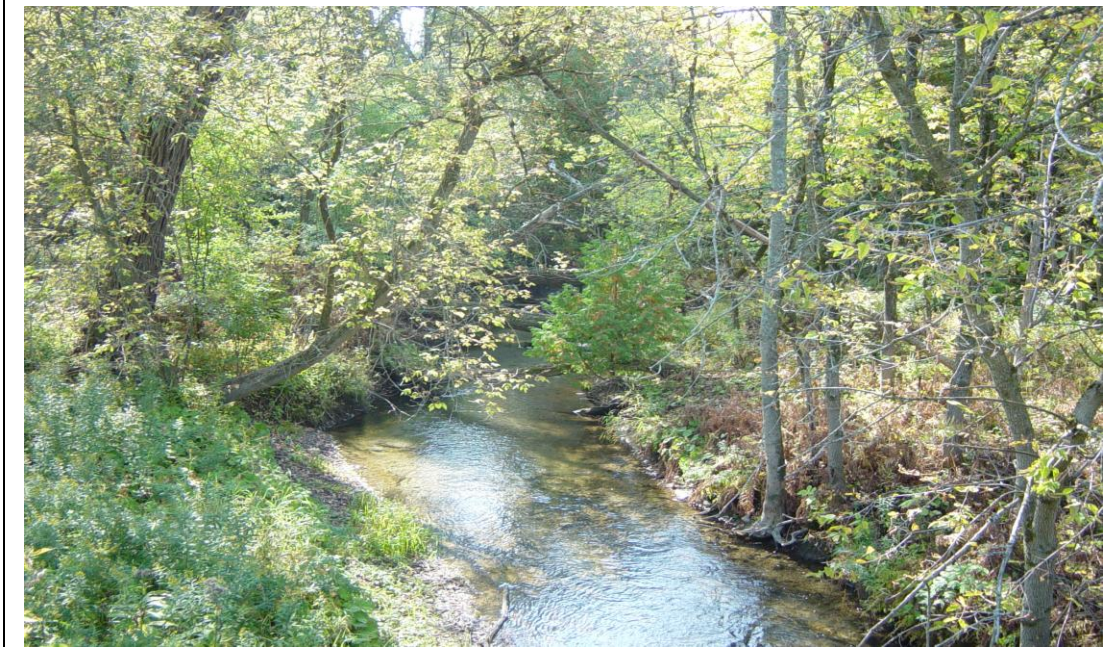
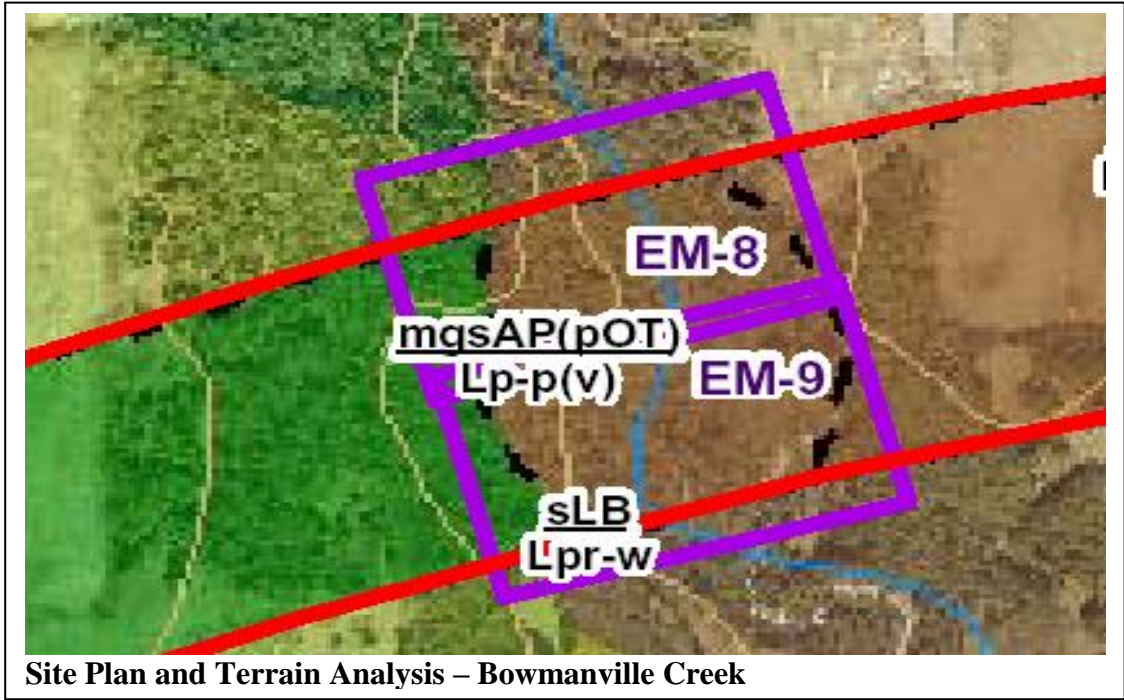


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-8
	EM-9

W.O: 07-20017    Section: Eastern    Location: Mainline over Bowmanville Creek    Sta. 14+770

Original Grade:    Proposed Grade:    Description: Watercourse crossing (twin bridges)



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P30, Book 22 ~500m west and BH P31, Book 22 ~300m east</b>	<b>1. Abutments</b>  a. For perched abutments, footings may be founded on Granular A cores. – Factored resistance at ULS – 900 kPa – Resistance at SLS – 350 kPa  b. For closed abutments, footings may be founded on native soil at an assumed depth of 2m below original grade. – Factored resistance at ULS – 750 kPa – Resistance at SLS – 500 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0. – ULS resistance – 1,600 kN – SLS resistance – 1,400 kN  d. Pre-drilling may be required to achieve sufficient depth of embedment of piles.  e. Integral abutments are feasible.	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.  No settlement or global stability issues are anticipated based on available information.  Topsoil or other unsuitable soils must be stripped prior to construction.	Groundwater control will be required for excavations penetrating below the groundwater level.  Near surface sandy silt soils will be readily disturbed. Clayey silt till less so.  Wide, shallow valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valleyside instability
Mapping (East 2) shows the footprint of the bridge to be underlain by silt gravel sand alluvial plain with peaty organic soils with the creek more-or-less in the middle. To the west the soil is mapped as silt till ground moraine, which presumably underlies the recent alluvium. The recent alluvial plain continues to the east of the site.  The borehole shows very dense silty sand to sandy silt till to the west at Holt Road and very stiff to hard silty clay to clayey silt till to the east at Old Scugog Road.  <b>Groundwater</b>  The groundwater is assumed to be at creek level adjacent to the creek and close to the ground surface away from the creek.  <b>Estimated overburden thickness – 50m.</b>	<b>2. Piers</b>  Piers are not anticipated but if required may be supported using the same foundation.  At this stage, piles foundations are recommended.	<b>Site Ranking</b>  <b>Foundations: Medium</b>  <b>Hydrogeology: High</b>	



<b>Site No:</b>	EM-10
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**Sta.** 15+100

**Sta.** 15+100

<b>Original Grade:</b> ~174.4	<b>Proposed Grade:</b>	<b>Description:</b> Underpass and partial diamond interchange
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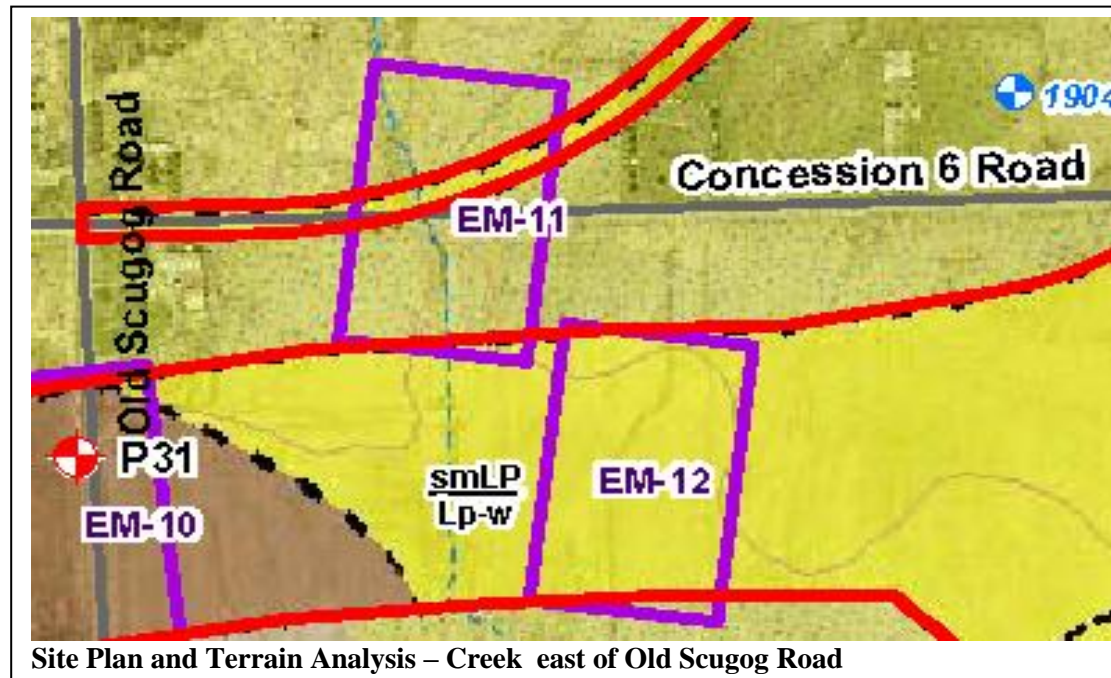
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P31, Book 22</b>	<b><u>1. Abutments</u></b>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	Groundwater control may be required for excavation into the alluvial soils.
<p>Mapping (East 2) shows the site to be underlain by a gravelly sand alluvial plain.</p> <p>BH P31 encountered:</p> <p>0.0 – 2.0 Very stiff silty clay to clayey silt till</p> <p>2.0 – 9.6 (EOH) Hard silty clay to clayey silt till</p> <p><b><u>Groundwater</u></b></p> <p>BH P31 indicates that the GWL is essentially at ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>a. For perched abutments, footings may be founded on Granular A cores.</p> <p>– Factored resistance at ULS – 900 kPa</p> <p>– Resistance at SLS – 350 kPa</p> <p>b. For closed abutments, footings may be founded on native soil below El. 171.0</p> <p>– Factored resistance at ULS – 600 kPa</p> <p>– Resistance at SLS – 400 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 172.0.</p> <p>– ULS resistance – 1,600 kN</p> <p>– SLS resistance – 1,400 kN</p> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment of piles.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on the hard native soil are recommended.</p>		
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>High</b>
		<b>Hydrogeology:</b>	<b>High</b>

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EM-11
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Creek East of Old Scugog Road    **Sta.** 15+340

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Realigned Concession 6 Road crosses creek
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**Site Photograph – looking east from Old Scugog Road**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P31 (30M15-85) lies 300m to the southwest.</b></p> <p>Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained.</p> <p>BH P31 encountered:</p> <p>0.0 – 2.0 Very stiff silty clay to clayey silt till</p> <p>2.0 - 9.6 (EOH) Hard silty clay to clayey silt till</p> <p><b><u>Groundwater</u></b></p> <p>BH P31 indicates that the GWL is essentially at the surface.</p> <p><b>Estimated overburden thickness 55m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 300 kPa</li> <li>Resistance at SLS – 200 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p>
		<p align="center"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      High</b></p>	

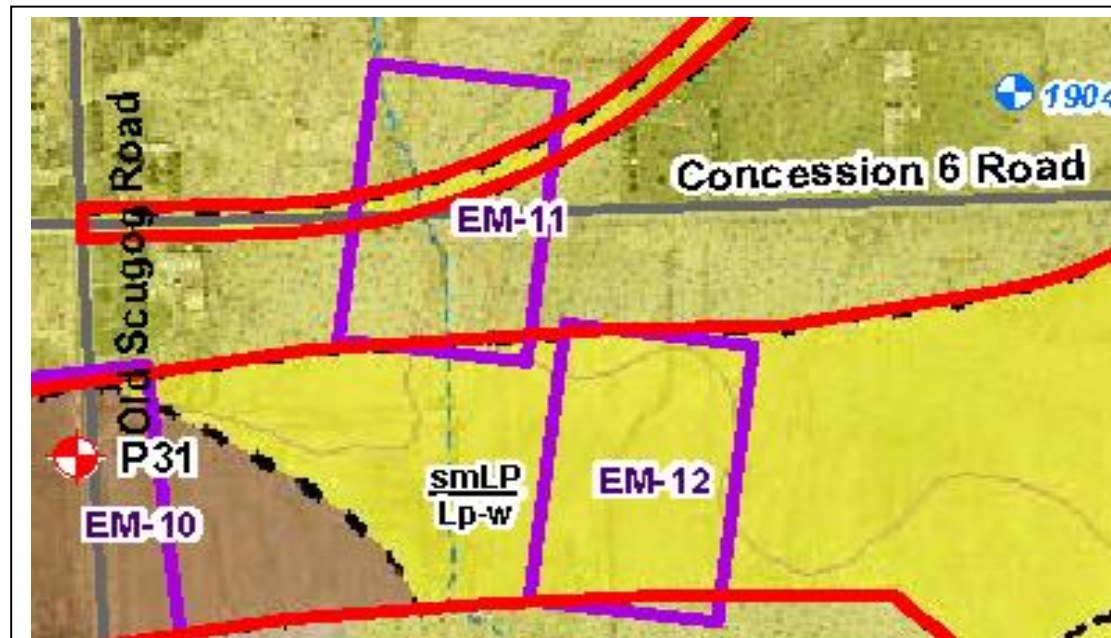


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EM-12
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Creek east of Old Scugog Road    **Sta.** 15+450

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses creek on culvert
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### Site Plan and Terrain Analysis – Creek east of Old Scugog Road



**Site Photograph – looking east from Old Scugog Road**

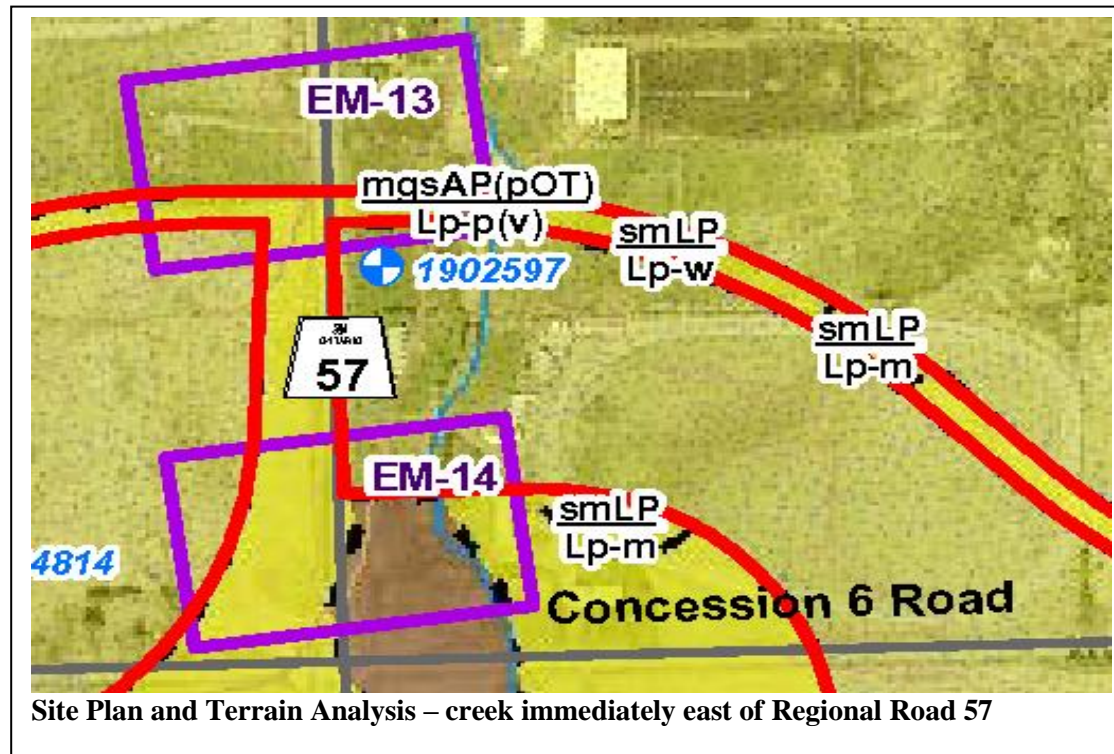
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P31 (30M15-85) lies 350m to the west.</b></p> <p>Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained.</p> <p>BH P31 encountered:</p> <p>0.0 – 2.0 Very stiff silty clay to clayey silt till</p> <p>2.0 - 9.6 (EOH) Hard silty clay to clayey silt till</p> <p><b><u>Groundwater</u></b></p> <p>BH P31 indicates that the GWL is essentially at the surface.</p> <p><b>Estimated overburden thickness 50m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 300 kPa</li> <li>Resistance at SLS – 200 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    High</b></p>	

<b>Site No:</b>	EM-13
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<b>Site No:</b>	EM-13
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<b>Site No:</b>	EM-13
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<b>Site No:</b>	EM-13
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No Photo

**Site Photograph**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P32 (30M15-85) lies approximately 400m to the south.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.
Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained.			Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.
BH P32 encountered silty clay as shown below:			Depending on stream flow and final design, temporary stream diversion may be required.
0.0 - 4.5 Stiff to hard silty clay			Groundwater control will be required for construction.
4.5 - 9.6 (EOH) Firm silty clay			
<b><u>Groundwater</u></b>			
GWL recorded at approx. Elev. 168.4.			
<b>Estimated overburden thickness 55m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>

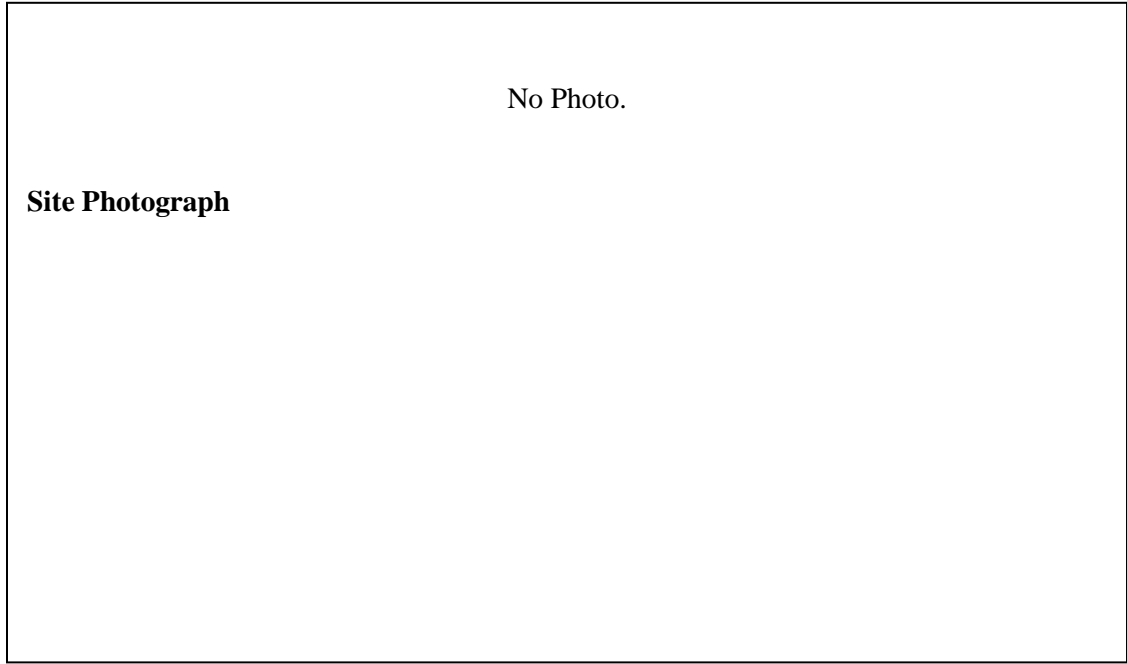
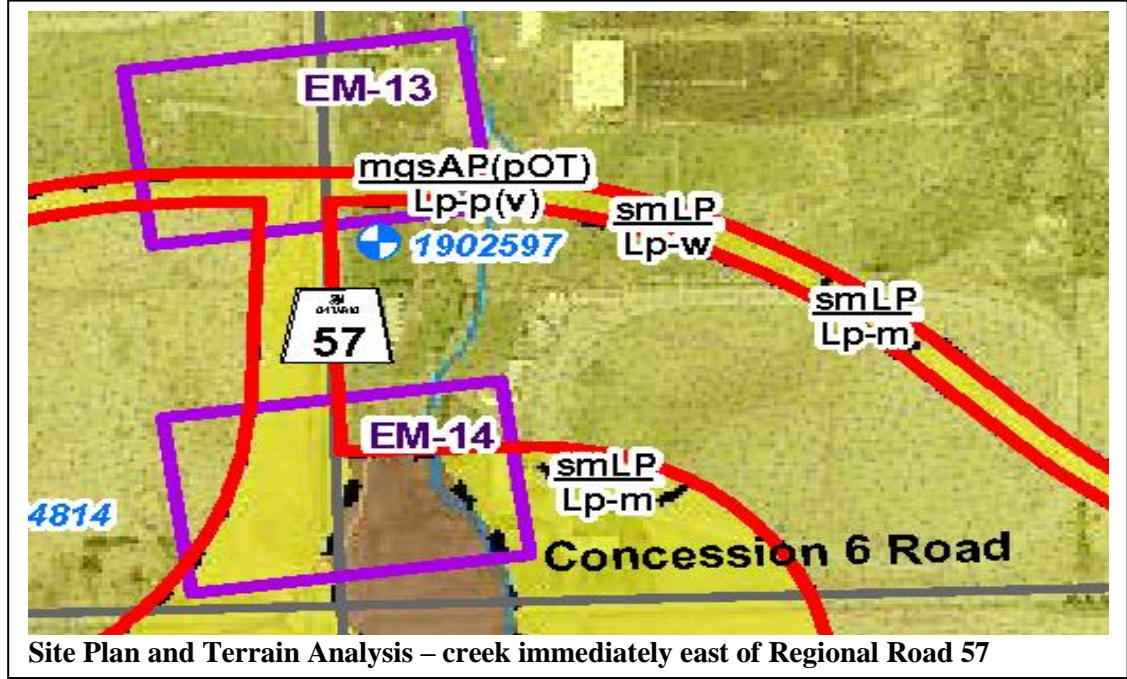


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-14

W.O: 07-20017    Section: Eastern    Location: Creek immediately east of Regional Road 57    Sta. 15+940

Original Grade:    Proposed Grade:    Description: E – N/S Ramp crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks	
	Structure	Approaches		
<b>Boreholes: BH P32 (30M15-85) lies approximately 250m to the south.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.</p>	
Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained. The stream lies in a narrow band of recent alluvium including organic soils.				<p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.</p>
BH P32 encountered silty clay as shown below:				<p>Depending on stream flow and final design, temporary stream diversion may be required.</p>
0.0 - 4.5 Stiff to hard silty clay				
4.5 - 9.6 (EOH) Firm silty clay				
<b><u>Groundwater</u></b>				
GWL recorded at approx. Elev. 168.4.			<p>Groundwater control will be required for construction.</p>	
<b>Estimated overburden thickness 50m.</b>				
		<b>Site Ranking</b>		
		<b>Foundations:</b>	<b>Low</b>	
		<b>Hydrogeology:</b>	<b>High</b>	

<b>Site No:</b>	EM-15
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**Sta.** 16+950

**Sta.** 16+950

**Sta.** 16+950

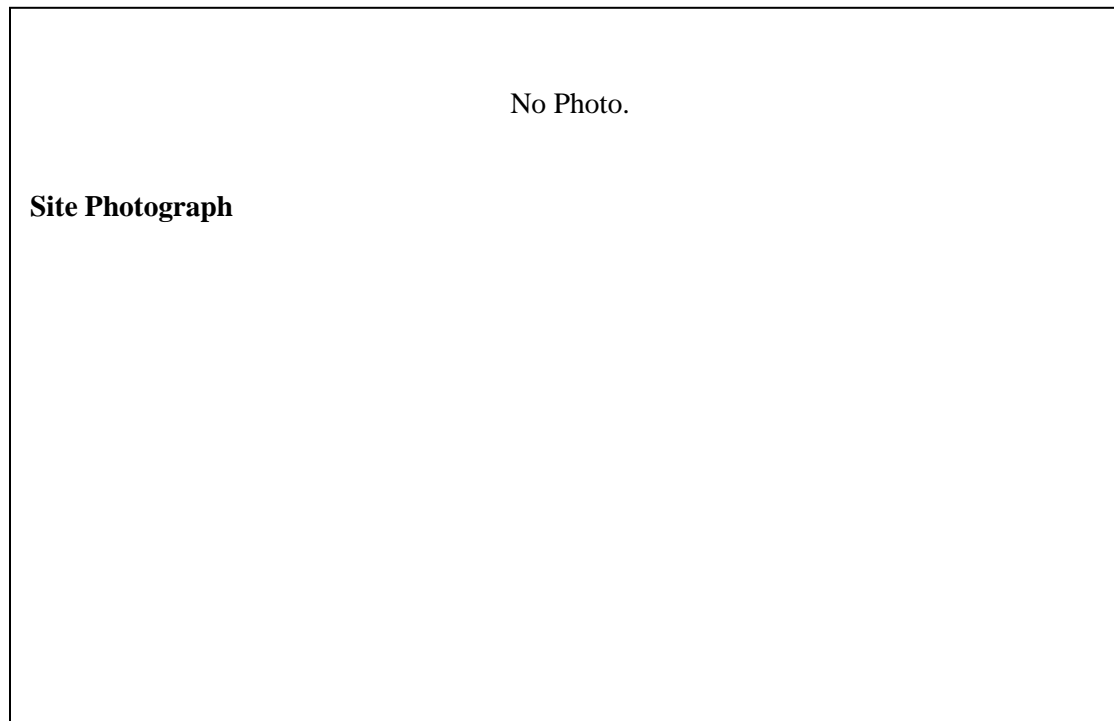


Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P32, Book 22</b>	<b><u>1. Abutments</u></b>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	It is considered unlikely that groundwater control will be required in the silty clay soils.
<p>Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained.</p> <p>BH P32 encountered silty clay as shown below:</p> <p>0.0 - 4.5 Stiff to hard silty clay</p> <p>4.5 - 9.6 (EOH) Firm silty clay</p> <p><b><u>Groundwater</u></b></p> <p>GWL recorded at approx. Elev. 168.4.</p> <p><b>Estimated overburden thickness 50m.</b></p>	<p>a. For perched abutments, footings may be founded on Granular A cores.</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 900 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS – 300 kPa</p> <p>b. For closed abutments, footings may be founded on native soil below El. 172.0</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 300 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS – 200 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles</p> <p style="padding-left: 40px;">a. ULS resistance – 1,400 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,200 kN</p> <p>d. Length of pile indeterminate at this time. Assume 25m.</p> <p>e. Integral abutments are feasible. A piled foundation is recommended.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>A piled foundation is recommended.</p>	<p>No global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>High</b>



<b>Site No:</b>	EM-16
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Creek immediately east of Regional Road 57    **Sta.** 16+000



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P32 (30M15-85) lies approximately 250m to the north.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valley-side instability.</p>
<p>Mapping (East 2) shows the site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained. The stream lies in a narrow band of recent alluvium including organic soils.</p> <p>BH P32 encountered silty clay as shown below:</p> <p>0.0 - 4.5    Stiff to hard silty clay</p> <p>4.5 - 9.6 (EOH) Firm silty clay</p> <p><b><u>Groundwater</u></b></p> <p>GWL recorded at approx. Elev. 168.4.</p> <p><b>Estimated overburden thickness 50m.</b></p>	<p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 300 kPa</li> <li>b. Resistance at SLS – 200 kPa</li> </ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.</p> <p>Depending on stream flow and final design, temporary stream diversion may be required.</p> <p>Groundwater control will be required for construction.</p>	<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    High</b></p>

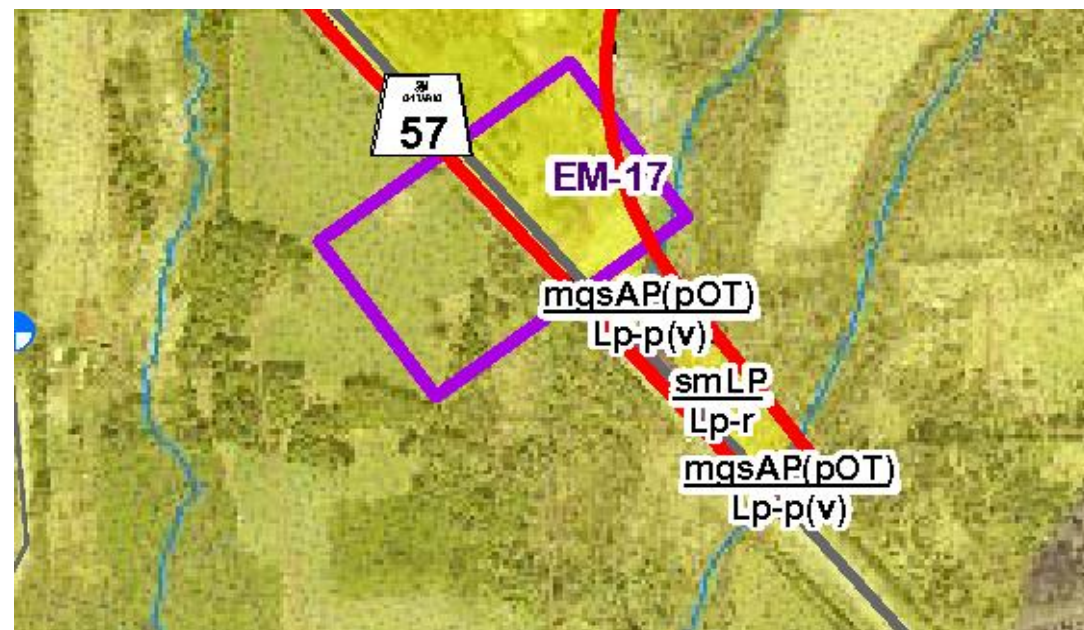


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EM-17
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Creek crossing Regional Road 57 south of Mainline    **Sta.** 16+250

Original Grade:	Proposed Grade:	Description:
		Regional Road 57 and possibly S – E Ramp cross creek on culvert.



### Site Plan and Terrain Analysis – creek immediately east of Regional Road 57



**Site Photograph – looking south on Regional Road 57 at Culvert EM-17**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P32 (30M15-85) lies approximately 550m to the north.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.
Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained.			Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.
BH P32 encountered silty clay as shown below:			Depending on stream flow and final design, temporary stream diversion may be required.
0.0 - 4.5 Stiff to hard silty clay			
4.5 - 9.6 (EOH) Firm silty clay			
<u><b>Groundwater</b></u>			
GWL recorded at approx. Elev. 168.4.			
<b>Estimated overburden thickness 50m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>

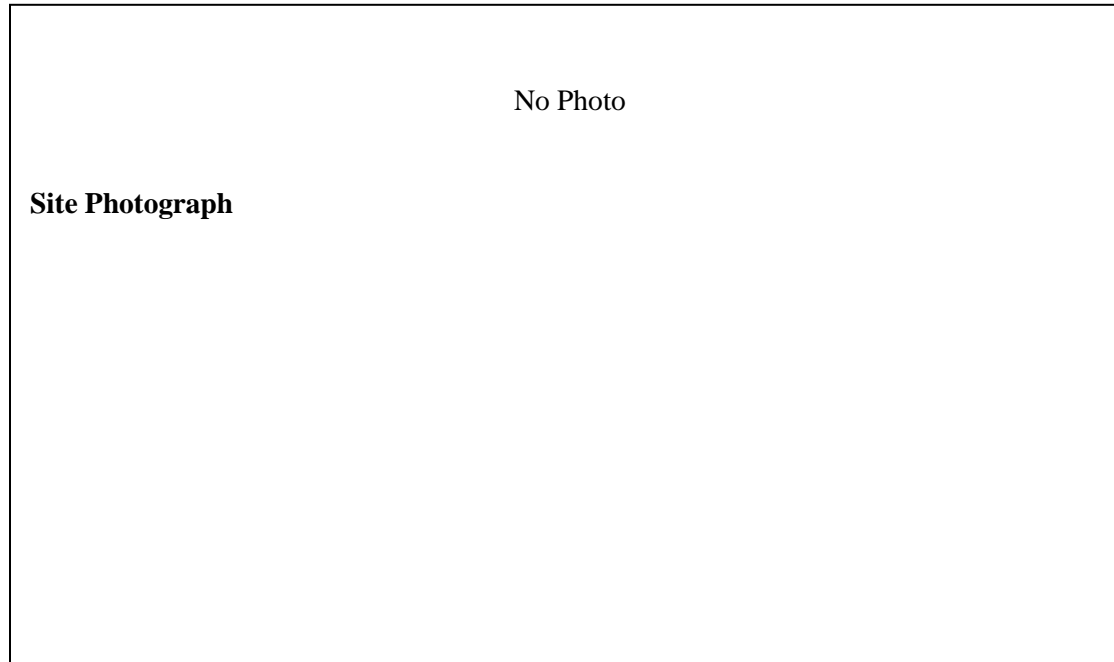
<b>Site No:</b>	EM-18
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Sta. 16+320

**Location:** Creek 400m east of Regional Road 57

Sta. 16+320

**Description:** Mainline crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at site.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 300 kPa</li> <li>b. Resistance at SLS – 200 kPa</li> </ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valley-side instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Depending on stream flow and final design, temporary stream diversion may be required.</p> <p>Groundwater control may be required for construction.</p>
<p>Mapping (East 2) shows the site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, rapidly drained.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL should be assumed to be near the surface.</p> <p><b>Estimated overburden thickness 50m.</b></p>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>



<b>Site No:</b>	EM-19
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Sta. 16+800

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses creek on culvert.
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### Site Photograph

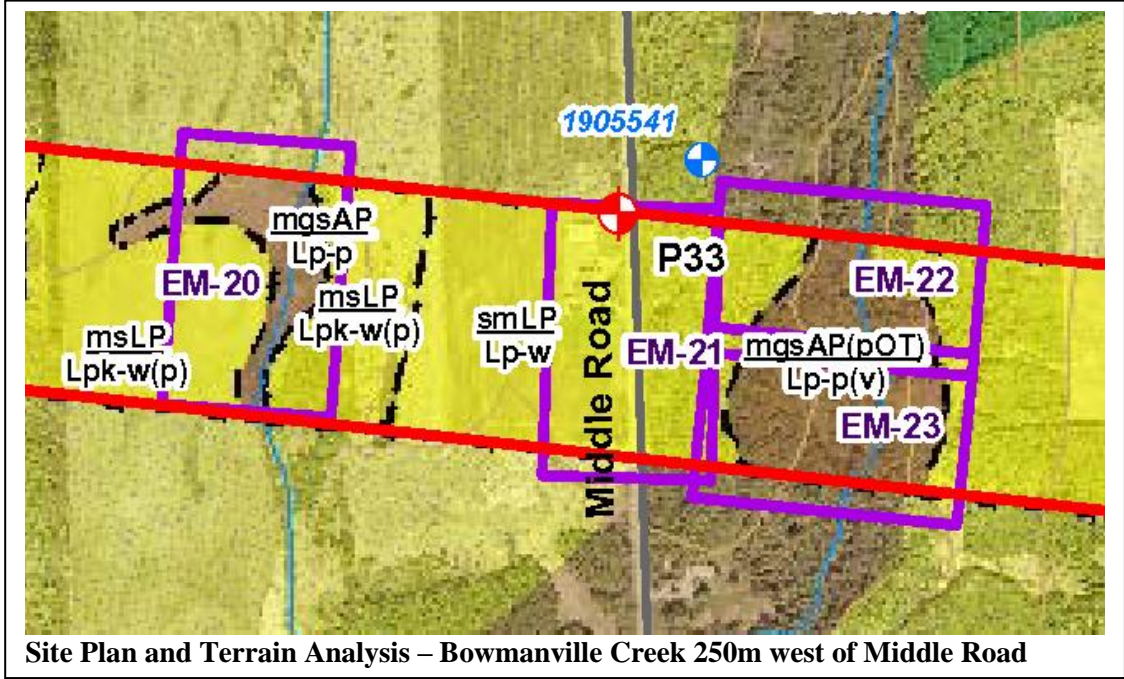
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability.</p>
<p>Mapping (East 2) shows to site to be underlain by a sandy silt glaciolacustrine plain. The relief is low plain, well drained. The stream lies in a narrow band of recent alluvium including organic soils.</p>			<p>Valley bottom material likely &gt;2 m deep, probably consisting of &lt;1 m silty gravelly sand alluvium overlying glaciolacustrine sandy silt, based on field check about 250 m upstream of proposed culvert footprint</p>
<p><b><u>Groundwater</u></b></p>			<p>Depending on stream flow and final design, temporary stream diversion may be required.</p>
<p>GWL should be assumed to be near the surface.</p>			<p>Groundwater control may be required for construction.</p>
<p><b>Estimated overburden thickness 50m.</b></p>			
<b>Site Ranking</b>			
<b>Foundations:</b>		<b>Low</b>	
<b>Hydrogeology:</b>		<b>High</b>	

**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-20

W.O: 07-20017    Section: Eastern    Location: Tributary of Bowmanville Creek 250m west of Middle Road    Sta. 17+310

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert



No Photo

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P33 (30M15-85) lies 250m east of site.</b></p> <p>Mapping (East 3) shows that the site is underlain by silty sand glaciolacustrine plain. The relief is low plain with kettles, well drained. The stream lies in a narrow band of recent alluvium.</p> <p>BH P33 encountered</p> <p>0.0-2.4    Loose silty sand till</p> <p>2.4-9.6 (EOH)    Very stiff to hard silty clay to clayey silt till</p> <p><b><u>Groundwater</u></b></p> <p>The GWL was recorded essentially at the surface.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p> <p>Dewatering will be required for construction at the stream. Depending on final design and stream flow, stream diversion may be required.</p>
	<b>Site Ranking</b>		
	<b>Foundations:</b>	<b>Low</b>	
	<b>Hydrogeology:</b>	<b>High</b>	



<b>Site No:</b>	EM-21
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**Sta.** 17+560**Sta.** 17+560**Sta.** 17+560

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P33, Book 22</b>	<b><u>1. Abutments</u></b>		
<p>Mapping (East 3) shows that the site is underlain by foreshore-basinal deposits, possibly overlain by alluvium at the south end of the site.</p> <p>Bowmanville Creek runs a short distance east of Middle Road.</p> <p>BH P33 encountered</p> <p>0.0-2.4 Loose silty sand till</p> <p>2.4-9.6 (EOH) Very stiff to hard silty clay to clayey silt till</p> <p><b><u>Groundwater</u></b></p> <p>The GWL was recorded essentially at the surface.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	<p>a. For perched abutments, footings may be founded on Granular A cores.</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 900 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS – 350 kPa</p> <p>b. For closed abutments, footings may be founded on native soil below El. 175.0</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 450 kPa</p> <p style="padding-left: 40px;">b. Resistance at SLS – 300 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El.168.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,400 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,200 kN</p> <p>d. Length of pile indeterminate at this time. Assume 25m.</p> <p>e. Integral abutments are feasible. A piled foundation is recommended.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on very stiff to hard native soil are recommended.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability or settlement issues are anticipated based on available information regarding the native mineral soil.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	Groundwater control will be required in excavations for foundations.
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>High</b>

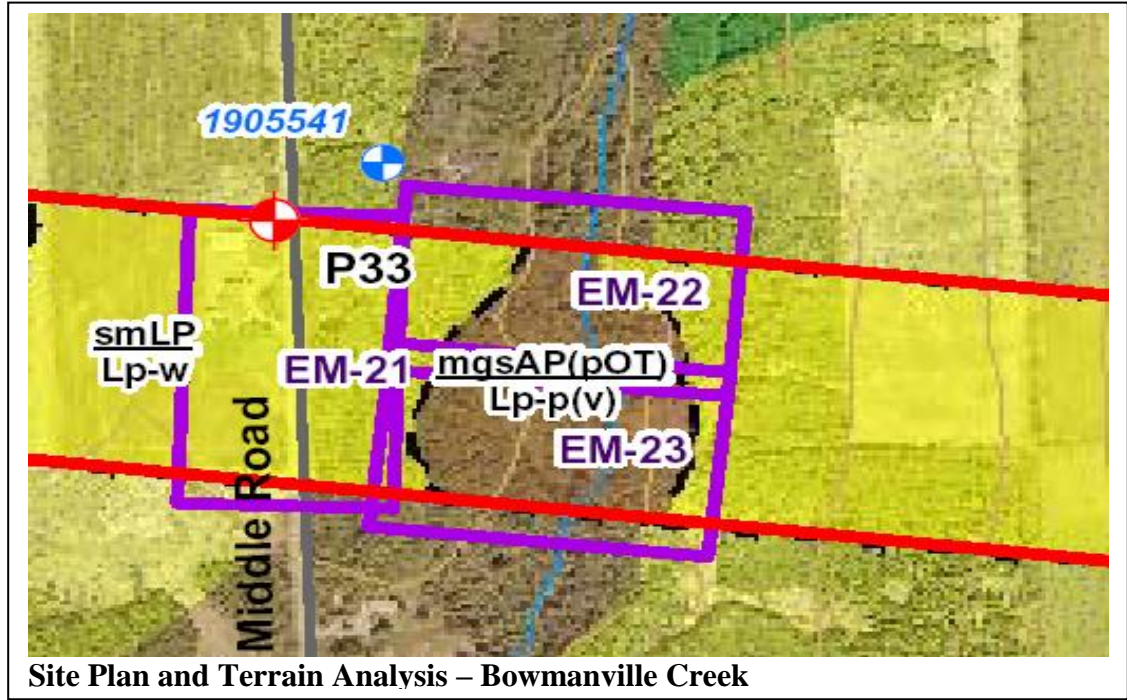


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-22
	EM-23

W.O: 07-20017    Section: Eastern    Location: Mainline at Bowmanville Creek, east of Middle Road    Sta. 17+730

Original Grade: ~176    Proposed Grade:    Description: Twin structures crossing Bowmanville Creek



Site Plan and Terrain Analysis – Bowmanville Creek

No Photo

Site Photograph

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P33, Book 22 lies approx. 100m west of creek.</b>	<p>It is understood that a structure span &gt;100m may be considered. However, the abutments may still lie in the area overlain by alluvium.</p> <p><b>1. Abutments</b></p> <p>a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 175.5.</p> <p>b. For closed abutments, footings may be founded on native soil below El. 175.0</p> <p>a. Factored resistance at ULS – 450 kPa</p> <p>b. Resistance at SLS – 300 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El.168.0.</p> <p>a. ULS resistance – 1,400 kN</p> <p>b. SLS resistance – 1,200 kN</p> <p>d. Length of pile indeterminate at this time. Assume 25m.</p> <p>e. Integral abutments are feasible. A piled foundation is recommended.</p> <p><b>2. Piers</b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>A piled foundation is recommended.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability or settlement issues are anticipated based on available information regarding the native mineral soil.</p> <p>Substantial stripping of topsoil, alluvium or other unsuitable soils may be required prior to construction.</p>	<p>Groundwater control will be required in excavations for foundations.</p> <p>Groundwater control, or rock fill construction may be required for the approach fills. Stream diversion may be necessary.</p> <p>Moderately wide, shallow valley with no geomorphic evidence of significant valleyside instability</p>
Mapping (East 3) indicates a 50 to 150m wide band of alluvium overlying a sandy silt glaciolacustrine plain. The site has low relief and is poorly to very poorly drained.			
BH P33 encountered			
0.0-2.4 Loose silty sand till			
2.4-9.6 (EOH) Very stiff to hard silty clay to clayey silt till			
<b><u>Groundwater</u></b>			
The GWL was recorded essentially at the surface and can be expected to correspond to the creek level.			
<b>Estimated overburden thickness – 60m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations: Medium</b>	
		<b>Hydrogeology: High</b>	

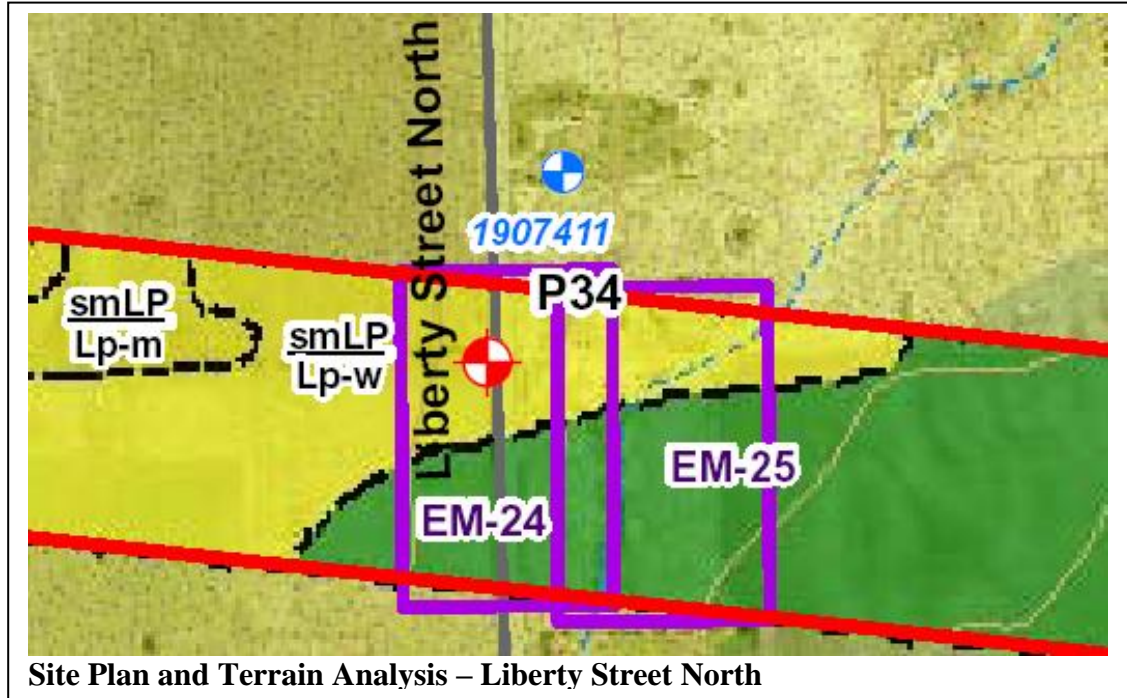
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-24

W.O: 07-20017    Section: Eastern    Location: Mainline at Liberty Street    Sta. 18+390

Original Grade: ~188    Proposed Grade:    Description: Underpass at Liberty Street



Site Photograph – Liberty Street looking north

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P34, Book 22</b>	<b>1. Abutments</b>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	No major dewatering requirements are anticipated.
<p>Mapping (East 3) shows that the site lies across the boundary between silt till ground moraine and glaciolacustrine plain. It is anticipated that the glaciolacustrine material is underlain by the till at relatively shallow depth.</p> <p>BH P34 encountered:</p> <p>0.0 – 4.0 Clayey silt till, very stiff to hard</p> <p>4.0 – 7.0 Silty sand to sandy silt till, very dense</p> <p>7.0 – 12.6 (EOH) Silty clay to clayey silt till, very stiff to hard</p> <p><b>Groundwater</b></p> <p>GWL recorded at approx. Elev. 179.2 An intermittent stream course flows along boundary of the two soil types.</p> <p><b>Estimated overburden thickness – 70m.</b></p>	<p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. For closed abutments, footings may be founded on native soil below Elev. 184.0</p> <p>a. Factored resistance at ULS – 600 kPa</p> <p>b. Resistance at SLS – 400 kPa</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.176.0.</p> <p>a. ULS resistance – 1,600 kN</p> <p>b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p>	No global stability issues are anticipated based on available information.	
	<b>2. Piers</b>	Piers may be supported using the same foundation options as for abutments.	<b>Site Ranking</b>
	Spread footings on hard native soil are considered a suitable foundation option.		
		<b>Foundations:</b> Medium	
		<b>Hydrogeology:</b> Medium	

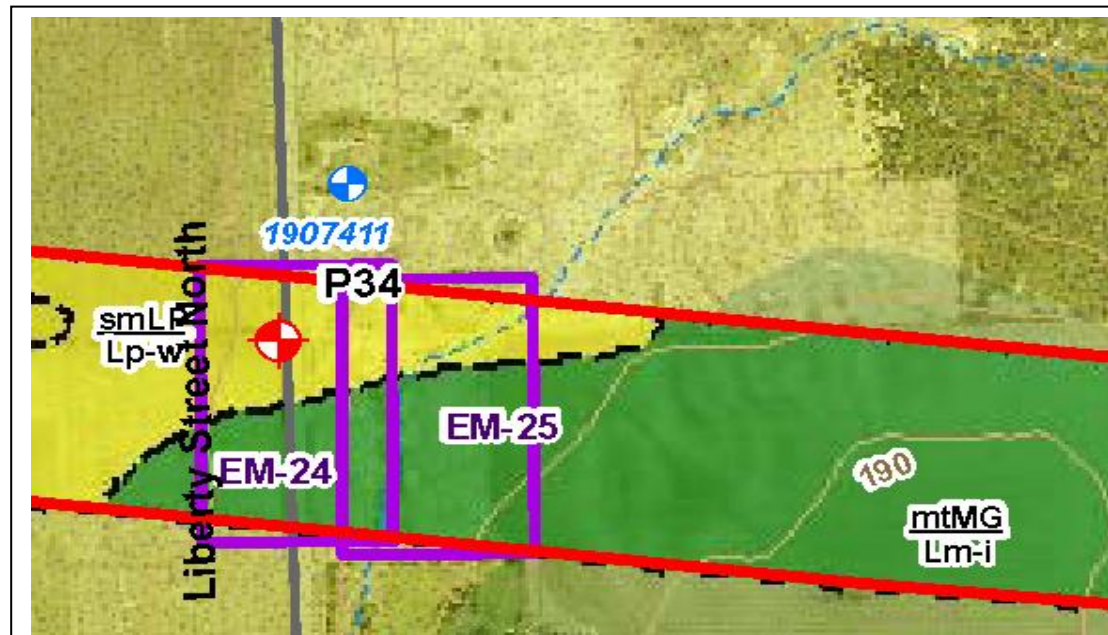


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EM-25
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Culvert immediately east of Liberty Street North    **Sta.** 18+450

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Mainline crosses small stream on culvert
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### Site Plan and Terrain Analysis – Creek east of Liberty Street North



**Site Photograph – looking across site from Liberty Street North**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P33 (30M15-85) lies 100m west of the site</b></p> <p>Mapping (East 3) shows that the site lies across the boundary between silt till ground moraine and glaciolacustrine plain. It is anticipated that the glaciolacustrine material is underlain by the till at relatively shallow depth.</p> <p>BH P34 encountered:</p> <p>0.0 – 4.0 Clayey silt till, very stiff to hard</p> <p>4.0 – 7.0 Silty sand to sandy silt till, very dense</p> <p>7.0 – 12.6 (EOH) Silty clay to clayey silt till, very stiff to hard</p> <p><b><u>Groundwater</u></b></p> <p>GWL recorded at approx. Elev. 179.2 An intermittent stream course flows along boundary of the two soil types.</p> <p><b>Estimated overburden thickness – 70m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 300 kPa</li> <li>Resistance at SLS – 200 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till or sandy silt plain. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p>
		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    Medium</b></p>	



<b>Site No:</b>	EM-26
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Sta.

**Location:**

**Description:** Mainline crosses Mackie Creek on culvert.



### Site Photograph

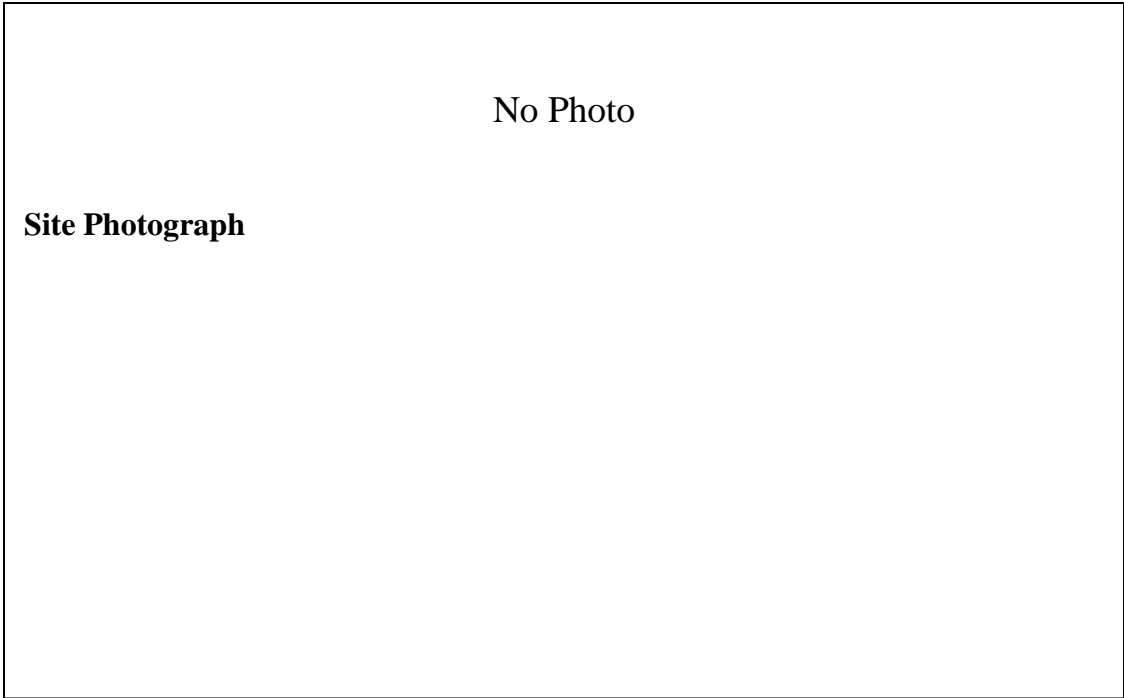
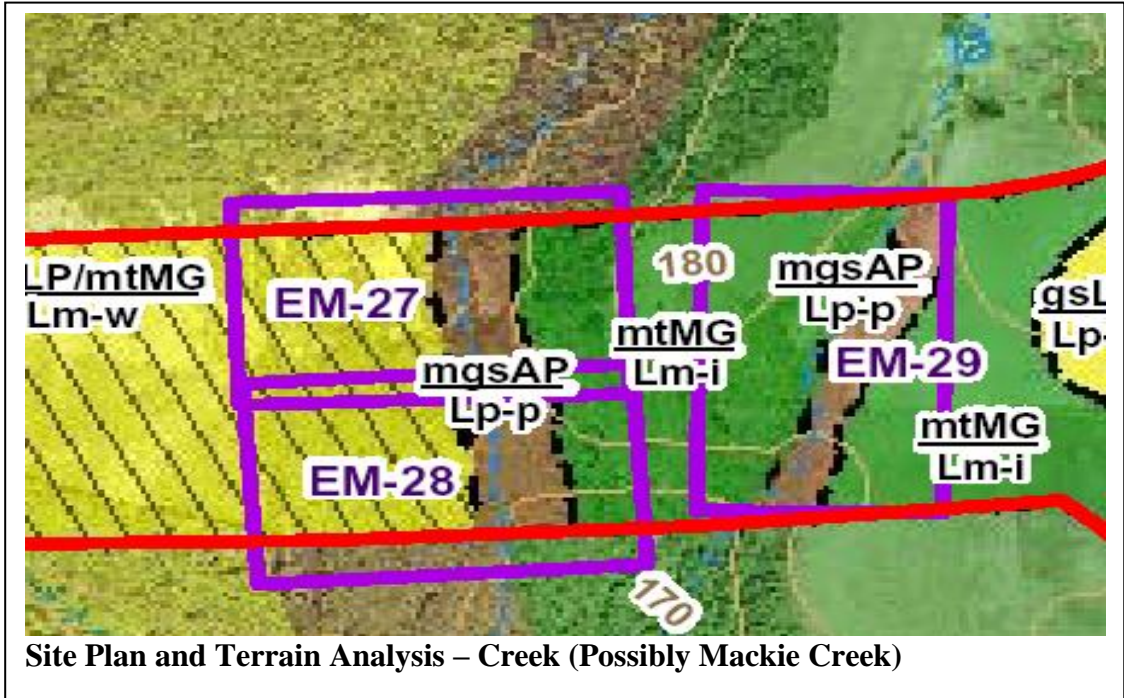
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <div><div>a.</div><div>Factored resistance at ULS – 300 kPa</div></div> <div><div>b.</div><div>Resistance at SLS – 200 kPa</div></div> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a sandy silt plain. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.</p>
<p>Mapping (East 3) shows that the site lies of thin silty sand glaciolacustrine plain overlying silt till ground moraine. The stream flows in a narrow band of silty, gravelly sand alluvium.</p> <p><b><u>Groundwater</u></b></p> <p>GWL should be assumed to be at the surface at the creek.</p> <p><b>Estimated overburden thickness – 45m.</b></p>			<p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys</p> <p>Depending on stream flow and final design, temporary stream diversion may be required.</p> <p>Groundwater control may be required for construction.</p>
<p><b>Site Ranking</b></p> <div><div>Foundations:</div><div>Low</div></div> <div><div>Hydrogeology:</div><div>High</div></div>			

**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-27
	EM-28

W.O: 07-0017    Section: Eastern    Location: Mainline west of Bethesda Road    Sta. 19+525

Original Grade: ~ 170±    Proposed Grade:    Description: Watercourse crossing (twin bridges)



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P35 Book 22 Lies 600m± to the east/</b>  Mapping (East 3) shows silt till ground moraine to the east of the watercourse, recent alluvium in the valley floor and glaciolacustrine deposits to the west. The stream valley is occupied by a 50m± band of recent alluvium.  BH P35 encountered:  0.0 - 9.6 (EOH) Silty sand to sandy silt, very dense  <b><u>Groundwater</u></b>  The near surface groundwater levels are expected to be controlled by the creek and to be slightly above the creek level. Well records indicate GWL within 2m of surface.  <b>Estimated overburden thickness – 45m.</b>	<b><u>1. Abutments</u></b>  a. Driven piles are recommended as the preferred foundation solution at this site.  Piles are expected to be in the order of 20 to 25m long and may be assumed to have: – ULS resistance – 1,200 kN – SLS resistance – 1,000 kN  b. Integral abutments are expected to be feasible.  c. Bridges with foundations on or above the valley slopes may be suitable for abutments on spread footings. On native soil assume resistance to be: – Factored ULS – 600 kPa – SLS – 400 kPa  d. Perched abutments on the valley slopes may be supported on spread footings on engineered fill. Resistance: – Factored ULS – 900kPa – SLS – 350 kPa  <b><u>2. Pier</u></b>  If a pier is required, the recommended foundation is driven piles as in (a) above.	Approach fills constructed in the valley floor may lie in areas underlain by recent alluvium, possible including organic soils. Stripping will be required to remove unsuitable soils.  Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No settlement or global stability issues are anticipated based on available information, providing stripping is carried out.	Groundwater control will be required for excavations in valley floor and possible in the valley slopes.  Narrow, shallow, channelized swale with no geomorphic evidence of significant valleside instability.
<b>Site Ranking</b>			
<b>Foundations: Medium</b>			
<b>Hydrogeology: High</b>			



<b>Site No:</b>	EM-29
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**Sta.** 19+700

**Sta.** 19+700

**Description:** Mainline crosses stream on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P35 lies approximately 300m to the east.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability.  Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.
Mapping (East 3) shows that the site lies in an area of silt till ground moraine. The stream lies in a narrow band of silty, gravelly sand alluvium. The relief is low plain, imperfectly to poorly drained.  BH P35 encountered:  0.0 - 9.6 (EOH) Silty sand to sandy silt till, very dense  <u>Groundwater</u>  The near surface groundwater levels are expected to be controlled by the creek and to be slightly above the creek level. Well records indicate GWL within 2m of surface. BH P35 shows GWL approximately 2m below surface.  <b>Estimated overburden thickness – 45m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>



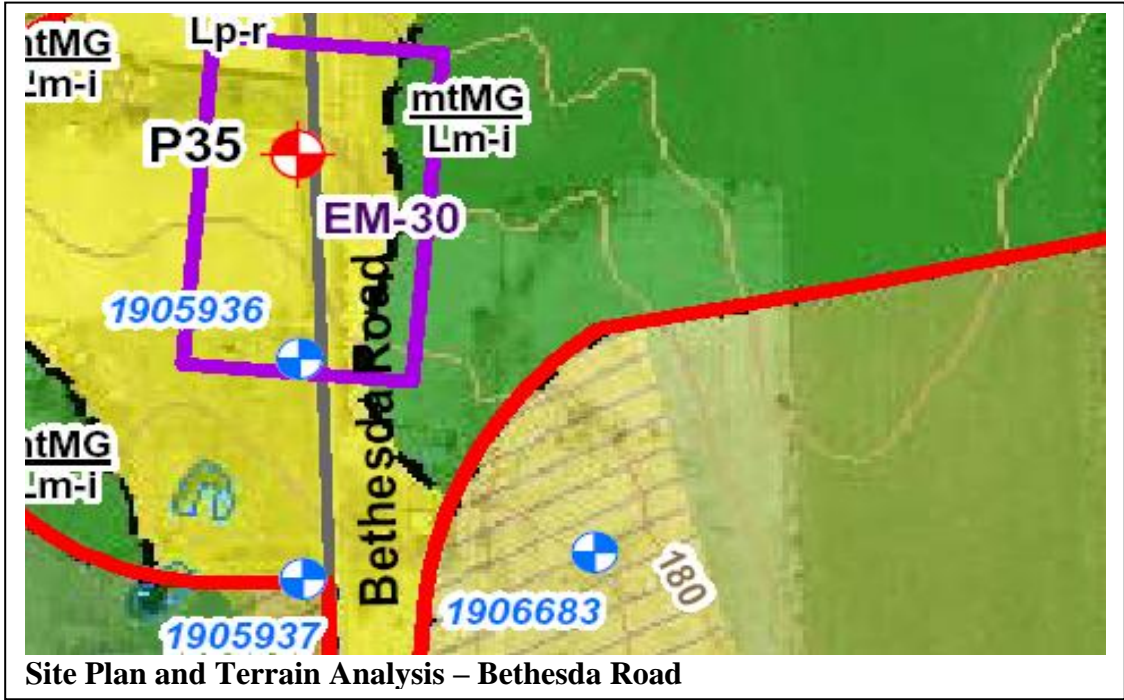
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-30

W.O: 07-20017    Section: Eastern    Location: Mainline at Bethesda Road    Sta. 20+050

Original Grade: ~184    Proposed Grade:    Description: Bethesda Road Underpass and I/C



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P35, Book 22</b>	<b>1. Abutments</b>  a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 184.0.  b. For closed abutments, footings may be founded on native soil below El. 183.5 a. Factored resistance at ULS – 750 kPa b. Resistance at SLS – 500 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El.172.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Length of pile indeterminate at this time. Assume 25m.  e. Integral abutments are feasible.  <b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  a. Spread footings on very dense native soil are recommended.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	Groundwater control may be required in excavations for foundations.
<p>Mapping (East 4) shows the immediate site area to be underlain by gravelly sand glaciolacustrine deposits. The relief is low and ridged. The surrounding area is underlain by till soils.</p> <p>0.0 - 9.6 (EOH) Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The near surface groundwater levels are expected to be controlled by the creek and to be slightly above the creek level. Well records indicate GWL within 2m of surface. BH P35 shows GWL approximately 2m below surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>Medium</b>



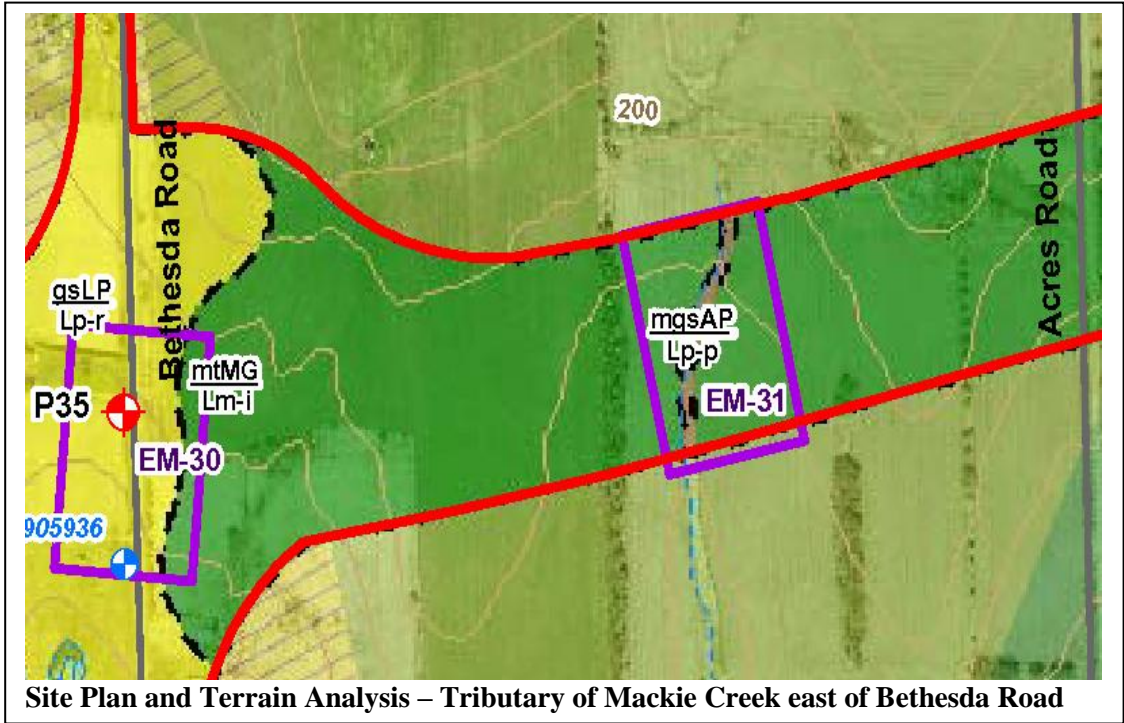
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-31
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W.O: 07-20017    Section: Eastern    Location: Tributary of Mackie Creek east of Bethesda Road    Sta. 20+550

Original Grade:    Proposed Grade:    Description: Mainline crosses stream on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> BH P35 lies approximately 500m to the west.</p> <p>Mapping (East 3) shows that the site lies in an area of silt till ground moraine. The stream lies in a very narrow band of silty, gravelly sand alluvium. The relief is low plain, imperfectly to poorly drained.</p> <p>BH P35 encountered:</p> <p>0.0 - 9.6 (EOH) Silty sand to sandy silt till, very dense</p> <p><b>Groundwater</b></p> <p>The near surface groundwater levels are expected to be controlled by the creek and to be slightly above the creek level. Well records indicate GWL within 2m of surface. BH P35 shows GWL approximately 2m below surface.</p> <p><b>Estimated overburden thickness – 45m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 450 kPa</li><li>b. Resistance at SLS – 300 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a silt and sand till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.</p> <p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations: Low</b></p> <p><b>Hydrogeology: Medium</b></p>	

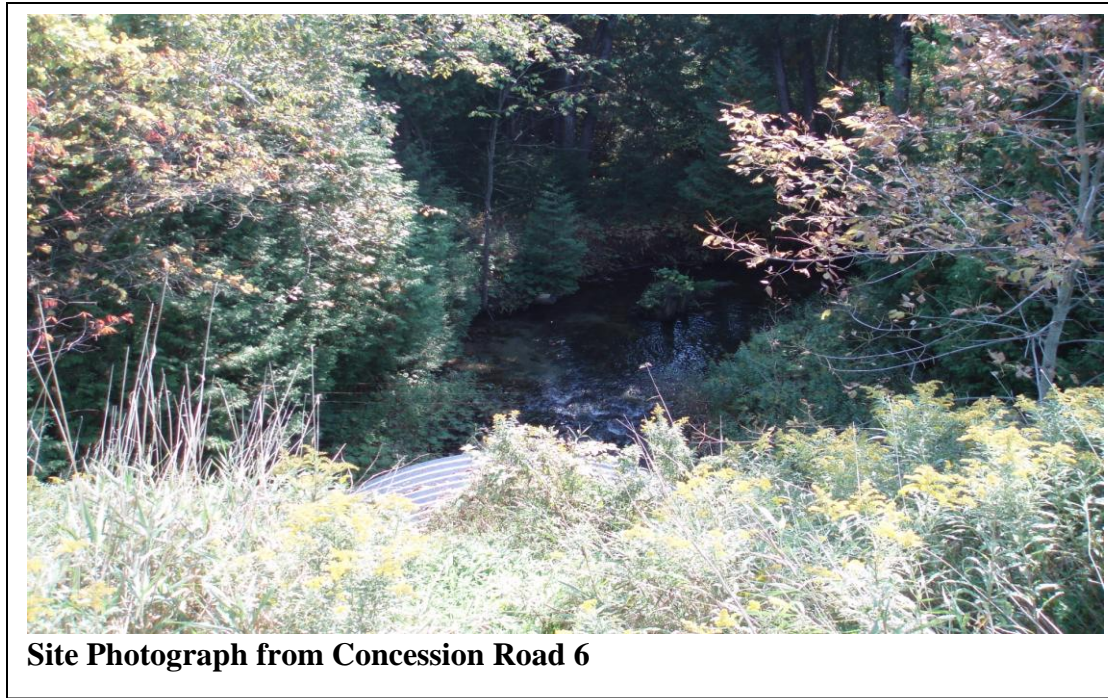
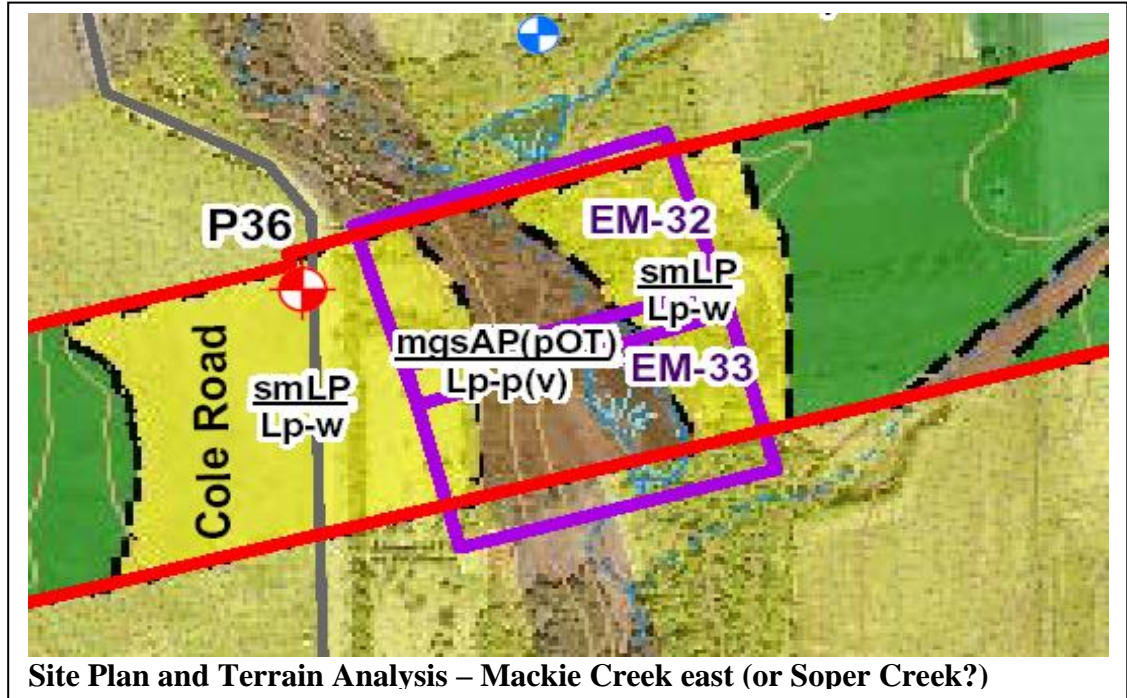


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-32
	EM-33

W.O: 07-20017    Section: Eastern    Location: Mainline over Mackie Creek (or Soper Creek?)    Sta. 21+890

Original Grade: ~171    Proposed Grade:    Description: Twin structures crossing Mackie Creek (east)



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P36, Book 22</b>	It is understood that a structure span >100m may be considered.  <b>1. Abutments</b>  a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 169.0.  b. For closed abutments, footings may be founded on native soil below El. 168.0 a. Factored resistance at ULS – 600 kPa b. Resistance at SLS – 400 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El.166.0. a. ULS resistance – 1,400 kN b. SLS resistance – 1,200 kN  d. Length of pile indeterminate at this time. Assume 20m.  e. Integral abutments are feasible. A piled foundation is recommended.  <b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  a. Spread footings on very dense native soil are recommended.	Approach fills constructed in the valley floor may lie in areas underlain by recent alluvium, possible including organic soils. Stripping will be required to remove unsuitable soils.  No global stability or settlement issues are anticipated based on available information regarding the native mineral soil.  Substantial stripping of topsoil, alluvium or other unsuitable soils may be required prior to construction.	Groundwater control should be anticipated for pier construction and possibly for abutment construction.  Moderately wide, moderately deep valley with no geomorphic evidence of significant valleyside instability.
Mapping (East 4) shows the creek valley occupied by alluvium with the surrounding area underlain by a sandy silt glaciolacustrine plain. The relief in the plain is low and well drained. The valley is low plain, poorly to very poorly drained.			
BH P36 encountered:  0.0 - 9.6 (EOH) Silty sand till, compact to very dense			
<b>Groundwater</b>  The GWL in the borehole was recorded at a depth of approx. 6m or Elev. 166.			
<b>Estimated overburden thickness 35m.</b>		<b>Site Ranking</b>  <b>Foundations: Medium</b>  <b>Hydrogeology: High</b>	



<b>Site No:</b>	EM-34
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Small watercourse running east from Townline Road    **Sta.** 22+450

The map displays a terrain analysis with various geological features labeled: **mtMG Lm-i** (multiple locations), **smLP Lp-w**, **mgsAP Lp-p**, **pOT Lp-v**, and **EM-34**. A red dashed line represents a boundary or road, with **Concession 6 Road** labeled. A red and white wind rose symbol is present near **P37**. A yellow area on the right is labeled **195**. The map is titled **Site Plan and Terrain Analysis**.

No photo

**Site Photograph**

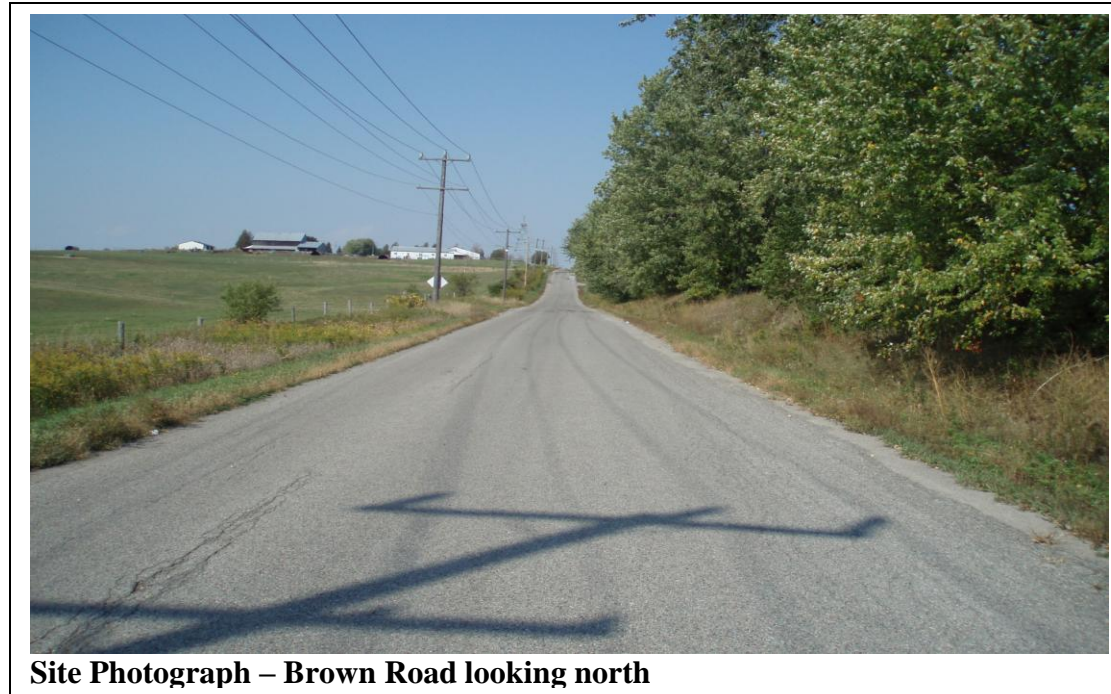
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P37 (30M15-85) lies approximately 250m to the east.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <div><div>a.</div><div>Factored resistance at ULS – 450 kPa</div></div> <div><div>b.</div><div>Resistance at SLS – 300 kPa</div></div> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a silt and sand till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.</p> <p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.</p> <p>The stream is mapped as intermittent. If construction is carried out in the summer, diversion and dewatering may be avoided.</p>
<p>Mapping (East 4) shows that the site lies in an area of silt till ground moraine. The relief is low plain poorly drained. The stream runs in a very narrow band of silty, gravelly sand alluvium.</p> <p>BH P37 encountered:</p> <p>0.0 – 7.0 silty sand to sandy silt, trace clay and gravel, very dense</p> <p>7.0 – 10.8 (EOH) Clayey silt, some sand, trace gravel, till, hard</p> <p><b><u>Groundwater</u></b></p> <p>Groundwater in BH P37 was recorded at Elev. 184.0</p> <p><b>Estimated overburden thickness – 50m.</b></p>			
<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Medium</b></p>			

<b>Site No:</b>	EM-35
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**Sta.** 23+160

**Sta.** 23+160

**Sta.** 23+160



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No boreholes close enough.</b></p>	<p>There is insufficient information on which to base any specific recommendations. However, moraine soils in this area generally provide reasonable founding conditions.</p>	<p>Typically, moraine soils will not present severe problems for the construction of approach fills.</p>	<p>No serious dewatering problems are anticipated.</p>
<p>Mapping (East 5) shows the site to be underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.</p> <p><b><u>Groundwater</u></b></p> <p>The nearest well logs indicate GWL at 2 to 3m below ground surface.</p> <p><b>Estimated overburden thickness – 75m.</b></p>			
		<p align="center"><b>Site Ranking</b></p> <p><b>Foundations:                      Medium</b></p> <p><b>Hydrogeology:                    Medium</b></p>	

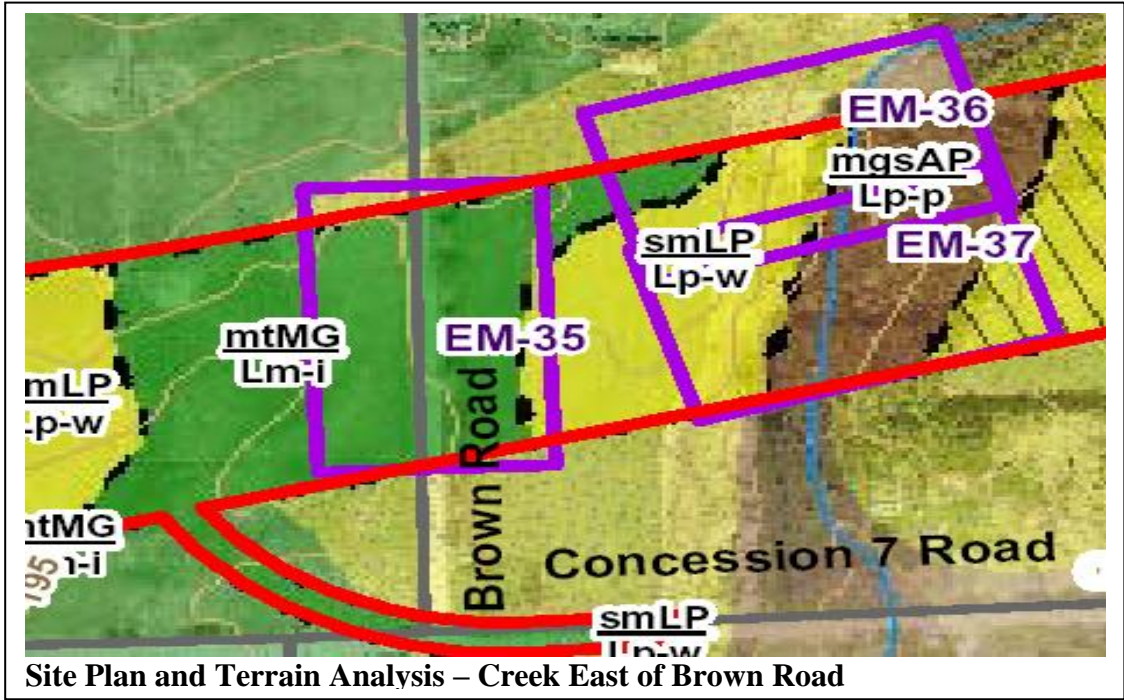


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-36
	EM-37

W.O: 07-20017    Section: Eastern    Location: Creek east of Brown Road    Sta. 23+380

Original Grade:    Proposed Grade:    Description: Twin structures to carry mainline over creek.



Site Plan and Terrain Analysis – Creek East of Brown Road

No Photo

Site Photograph

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> No boreholes close enough.</p> <p>Mapping (East 5) shows the site to be underlain by a band of silty gravelly sand alluvium approx. 100m wide within an area of silty sand glaciolacustrine soils.</p> <p><u>Groundwater</u></p> <p>The nearest well logs indicate GWL at 2 to 3m below ground surface.</p> <p><b>Estimated overburden thickness – 75m.</b></p>	<p>There is insufficient information on which to base any specific recommendations. However, glaciolacustrine soils could provide variable founding conditions and a piled foundation should be assumed at this time.</p>	<p>No serious problems are anticipated for approach fills.</p>	<p>Groundwater control will be required for excavation in the valley floor.</p> <p>Narrow, moderately deep valley; potential for undercutting of relatively steep valleysides by meandering channel.</p>
			<p><b>Site Ranking</b></p> <p><b>Foundations: Medium</b></p> <p><b>Hydrogeology: High</b></p>

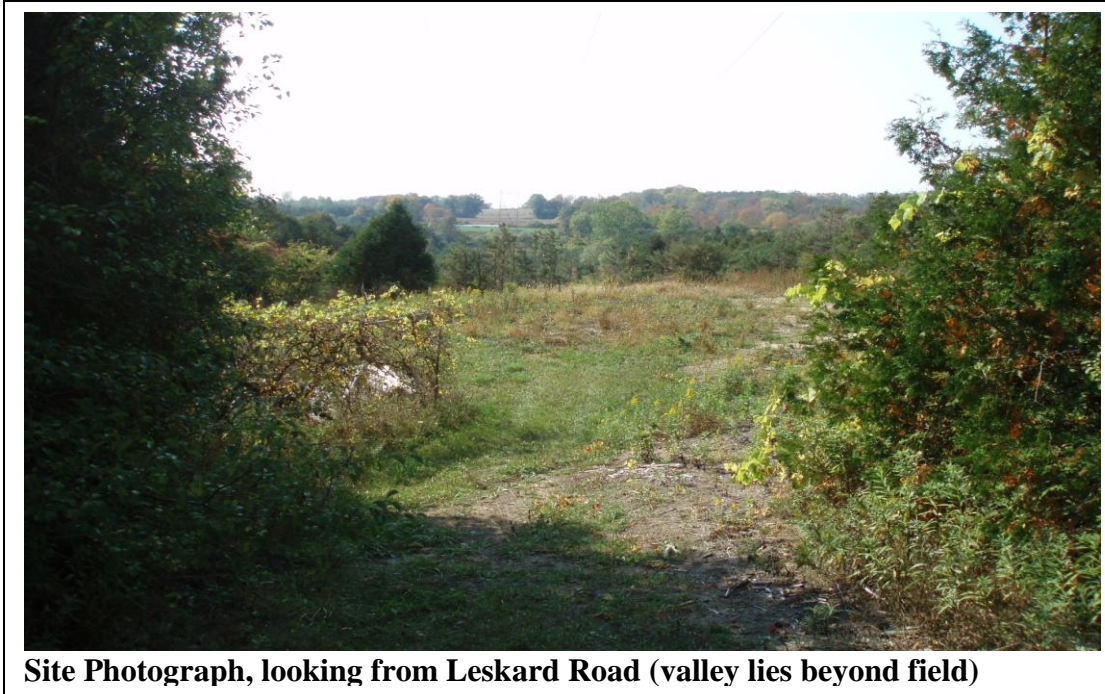
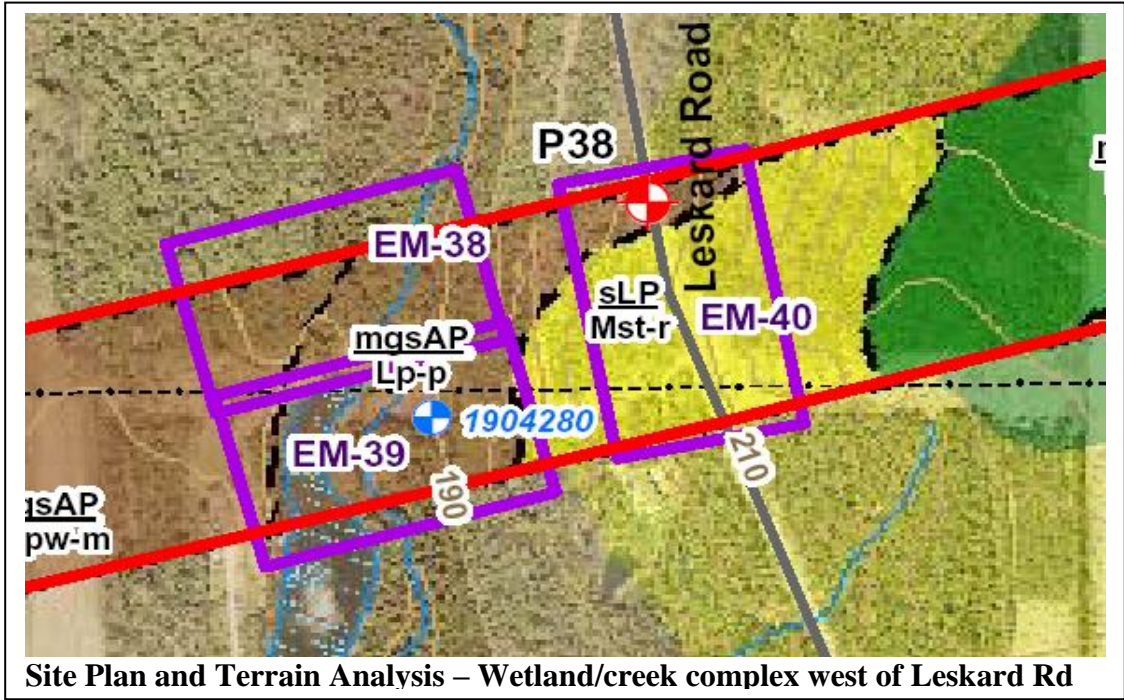


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-38
	EM-39

W.O: 07-20017    Section: Eastern    Location: Mainline crossing wetland complex west of Leskard Road    Sta. 24+570

Original Grade: ~184    Proposed Grade:    Description: Long structure, perhaps greater than 400m to span the wetland complex and Wilmot Creek, lying west of Leskard Road



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P38, Book 22 lies just east of the east end of this structure.</b>	There is insufficient information on which to base site specific recommendations. The presence of the extensive wetland complex indicates that the near surface soils may be weak organic and alluvial deposits not suitable for spread footings. Piled foundations should be assumed at this time, assume 25m deep.	There is a potential for soft, compressible soils. Extensive stripping may be required.	Major groundwater problems should be anticipated.
Mapping (East 5) shows that the site is underlain by a broad band of silty gravelly sand alluvium extending far west of the crossing. The land to the east and west is mapped as silty glaciolacustrine deposits. The site relief is low plain, poorly drained.			Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valleyside and terraced east valleyside; potential for undercutting of locally moderately steep valleysides by meandering channel
BH P38 encountered:			
0.0 - 9.5 (EOH) Silty sand, trace clay, trace gravel (Till), generally dense, possibly becoming very dense at the EOH			
<u><b>Groundwater</b></u>			THIS IS REGARDED AS A HIGH PRIORITY SITE FOR INVESTIGATION.
Based on the nature of the terrain, the GWL should be assumed to be at the ground surface.			
<b>Estimated overburden thickness – 65m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>High</b>
		<b>Hydrogeology:</b>	<b>High</b>

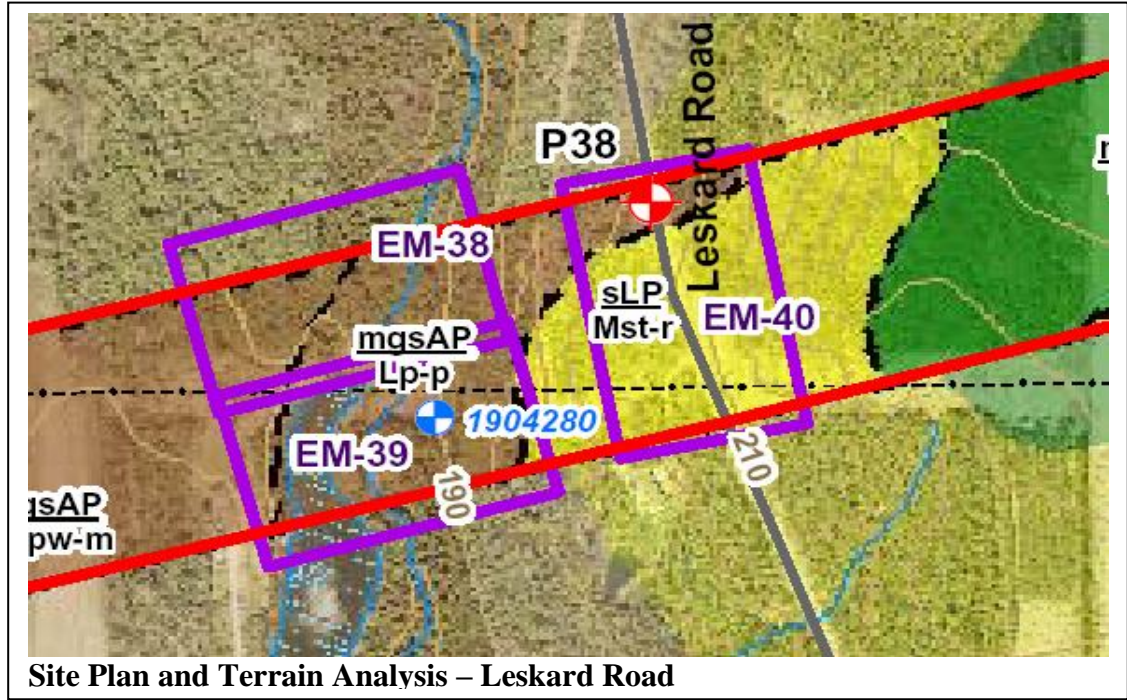


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-40

W.O: 07-20017    Section: Eastern    Location: Mainline at Leskard Road    Sta. 24+760

Original Grade: ~202    Proposed Grade:    Description: Mainline underpass under Leskard Road



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH P38, Book 22</b>	<b>1. Abutments</b>		
<p>Mapping (East 5) shows that the site is underlain by silty claciolacustrine soils, with alluvium associated with the Wilmot Creek wetland complex intruding into the north end. The relief is moderate, ridged and terraced and rapidly drained.</p> <p>BH P38 encountered:</p> <p>0.0 - 9.5 (EOH) Silty sand, trace clay, trace gravel (Till), generally dense, possibly becoming very dense at the EOH.</p> <p><b>Groundwater</b></p> <p>The borehole log shows GWL at approx. 7m. Elev. 195.</p> <p><b>Estimated overburden thickness 85m.</b></p>	a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 201.0.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Groundwater control may be required in excavations for foundations.
	b. For closed abutments, footings may be founded on native soil below El. 201.0	No global stability or settlement issues are anticipated based on available information.	Steep valley side comprising fine sand susceptible to ravelling if cut too steep
	a. Factored resistance at ULS – 450 kPa		
	b. Resistance at SLS – 300 kPa		
	c. Abutments may also be supported on driven HP 310X110 piles driven below El.194.0.	Stripping of topsoil or other unsuitable soils will be required prior to construction, especially at the north approach.	
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
	d. Length of pile indeterminate at this time. Assume 25m.		
	e. Integral abutments are feasible.		
	f. Piles are required for an integral abutment. Otherwise, designer may select foundation based on structure configuration and costs.		
	<b>2. Piers</b>		
	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on dense native soil are recommended.		
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>High</b>



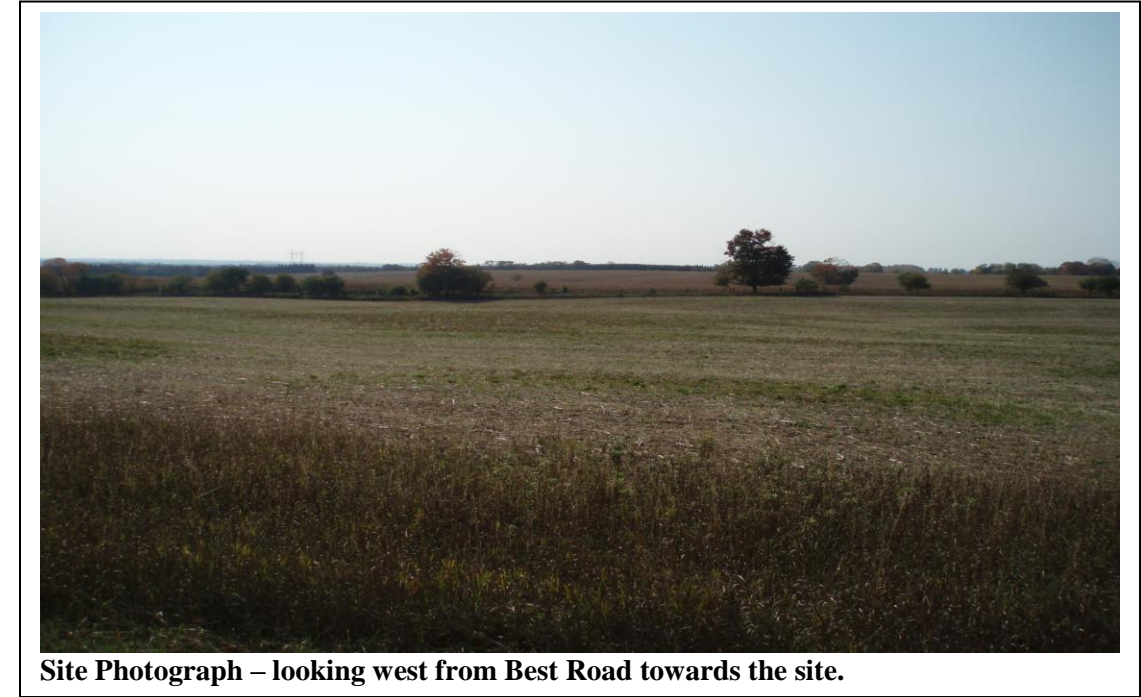
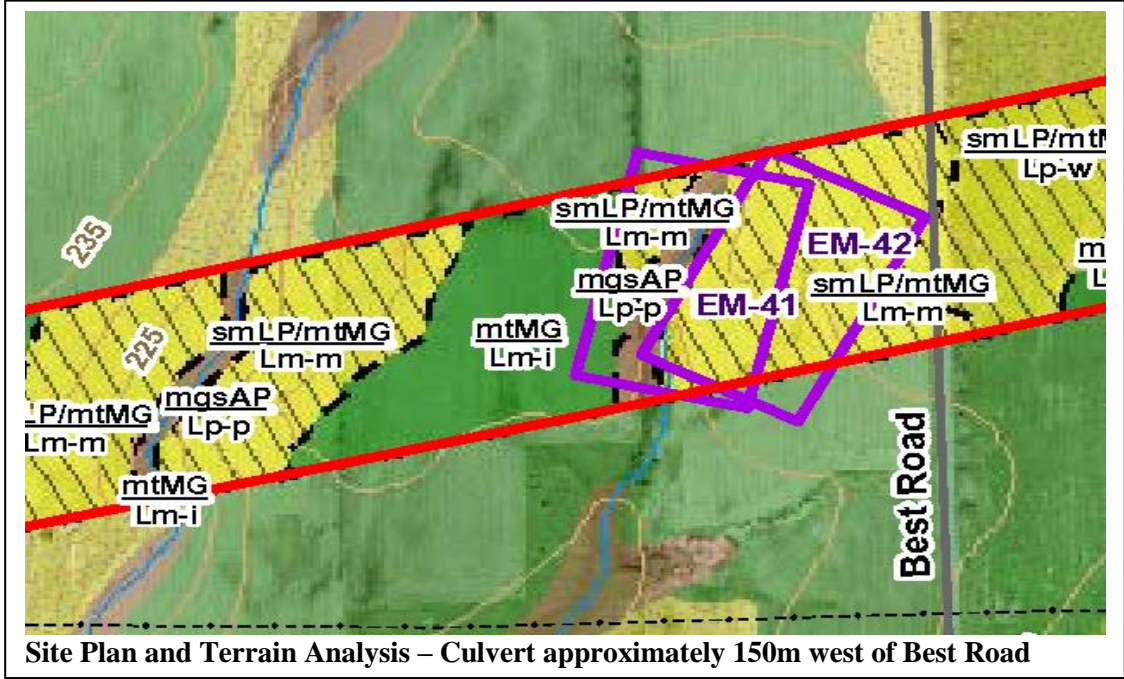
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-41
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W.O: 07-20017    Section: Eastern    Location: Culvert approximately 150m west of Best Road    Sta. 25+690

Original Grade:    Proposed Grade:    Description: Mainline crosses stream on culvert



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in sandy silt overlying silt till. No stability or settlement issues are anticipated.	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability.  Likely no appreciable alluvial deposits, based on field checks of similar swales.  Some surface and groundwater control; may be required, depending on the timing of construction.
Mapping (East 5) shows that the site lies in an area of thin sandy silt glaciolacustrine deposits overlying silt till ground moraine.  <u><b>Groundwater</b></u>  The GWL is expected to lie close to the ground surface.  <b>Estimated overburden thickness – 105m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>



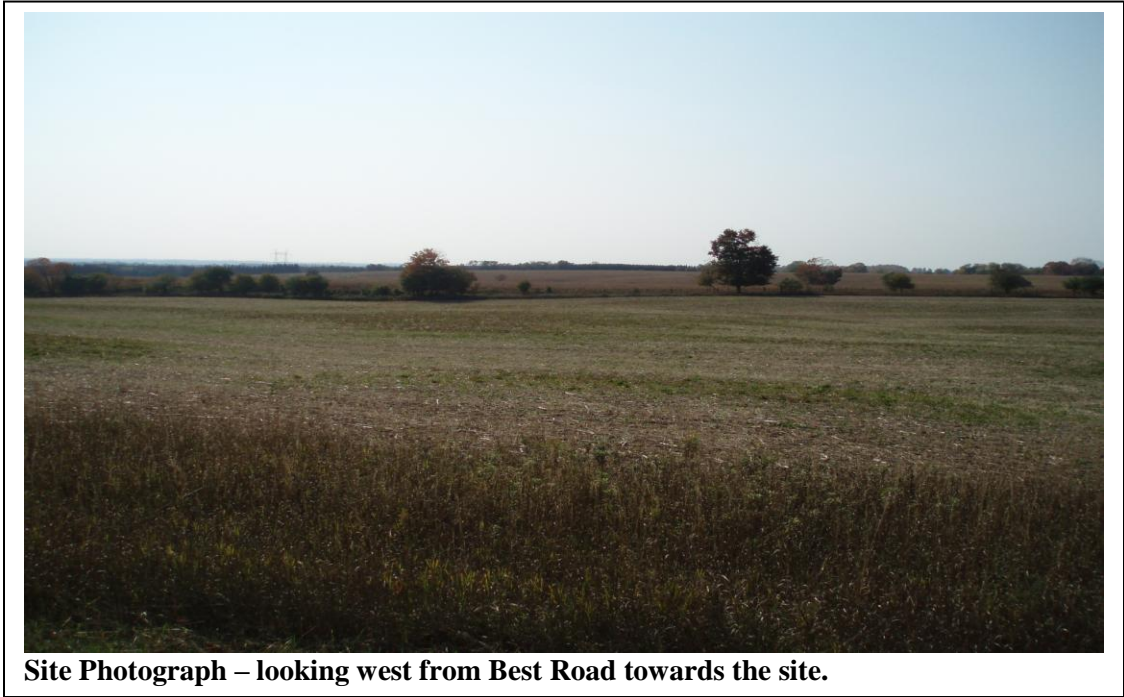
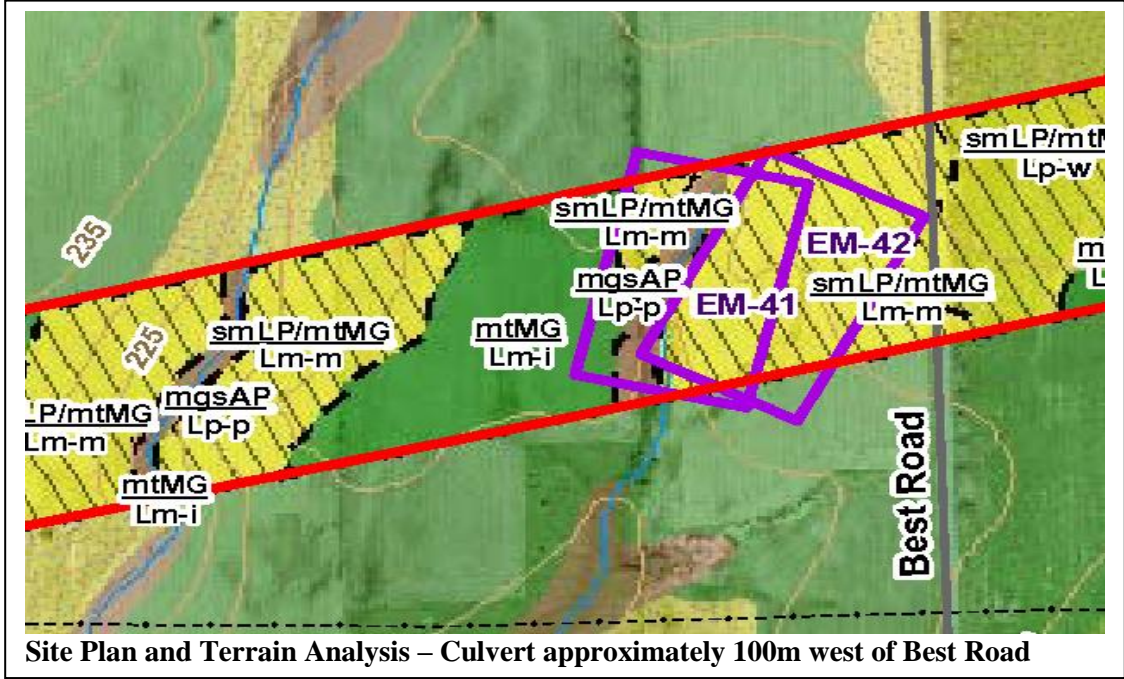
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-42
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W.O: 07-20017    Section: Eastern    Location: Culvert approximately 100m west of Best Road    Sta. 25+750

Original Grade:    Proposed Grade:    Description: Mainline crosses stream on culvert



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <p style="margin-left: 40px;">a. Factored resistance at ULS – 300 kPa</p> <p style="margin-left: 40px;">b. Resistance at SLS – 200 kPa</p> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in sandy silt overlying silt till. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleyside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p> <p>Some surface and groundwater control; may be required, depending on the timing of construction.</p>
<p>Mapping (East 5) shows that the site lies in an area of thin sandy silt glaciolacustrine deposits overlying silt till ground moraine.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>The GWL is expected to lie close to the ground surface.</p> <p><b>Estimated overburden thickness – 105m.</b></p>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>



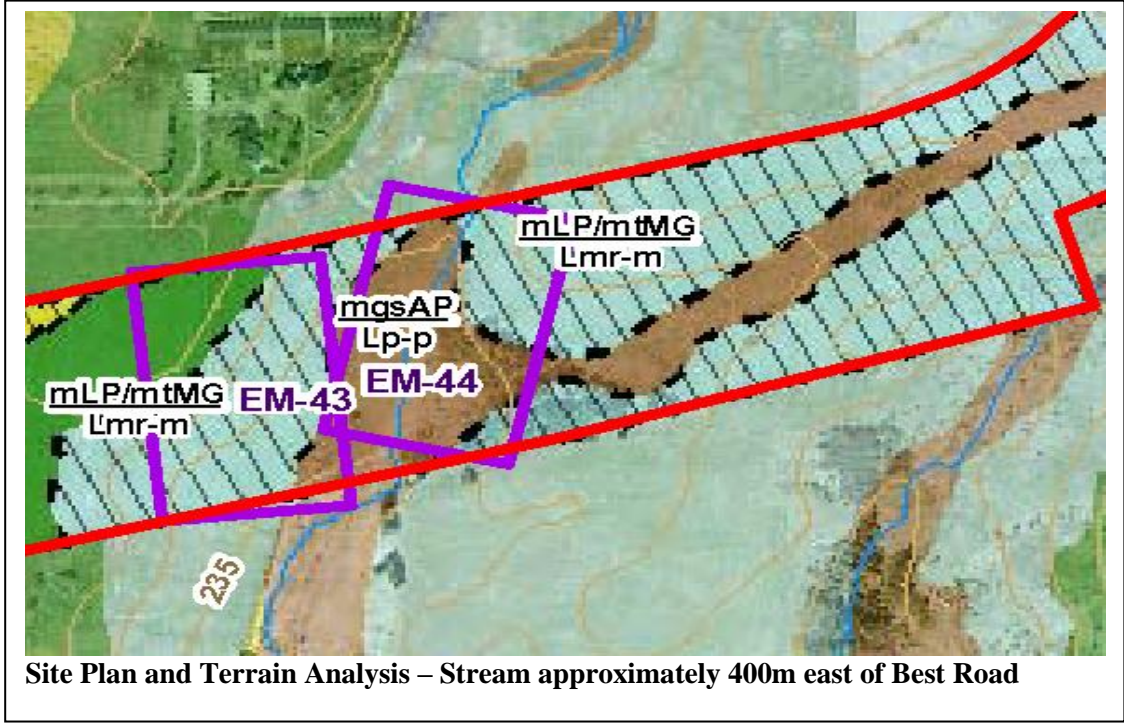
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-43
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W.O: 07-20017    Section: Eastern    Location: Stream approximately 400m east of Best Road    Sta. 26+300

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>  Mapping (East 6) shows that the site lies in an area of thin silty glaciolacustrine deposits overlying silt till ground moraine.  <b>Groundwater</b>  GWL is expected to be at the ground surface.  <b>Estimated overburden thickness – 105m.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in silt and silt till. No stability or settlement issues are anticipated.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Possibility of stream diversion and groundwater control; being required.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleyside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Possibility of stream diversion and groundwater control; being required.</p>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>



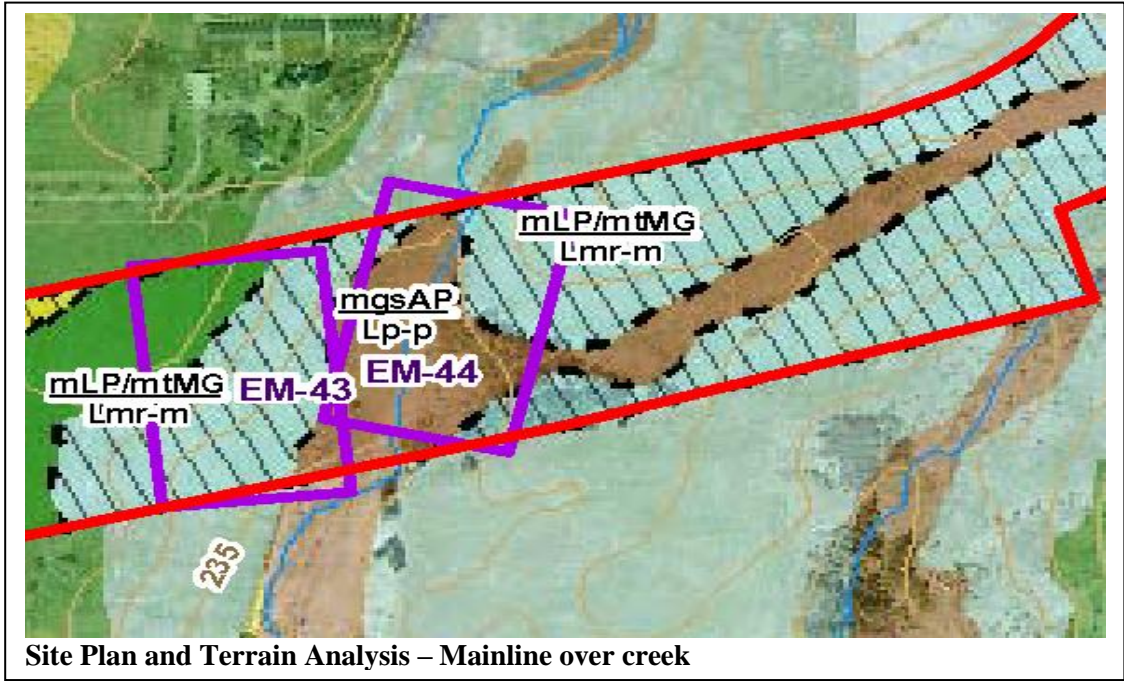
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-44
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W.O: 07-20017    Section: Eastern    Location: Stream approximately 400m east of Best Road    Sta. 26+300

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>  Mapping (East 6) shows that the site lies in an area of thin silty glaciolacustrine deposits overlying silt till ground moraine.  Stream runs in a comparatively narrow band of recent alluvium, including possible interbedded organic material.  <b>Groundwater</b>  GWL is expected to be at the ground surface.  <b>Estimated overburden thickness – 110m.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in silt and silt till. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valley-side instability.</p> <p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys</p> <p>Groundwater control will be required and also possible stream diversion.</p>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>

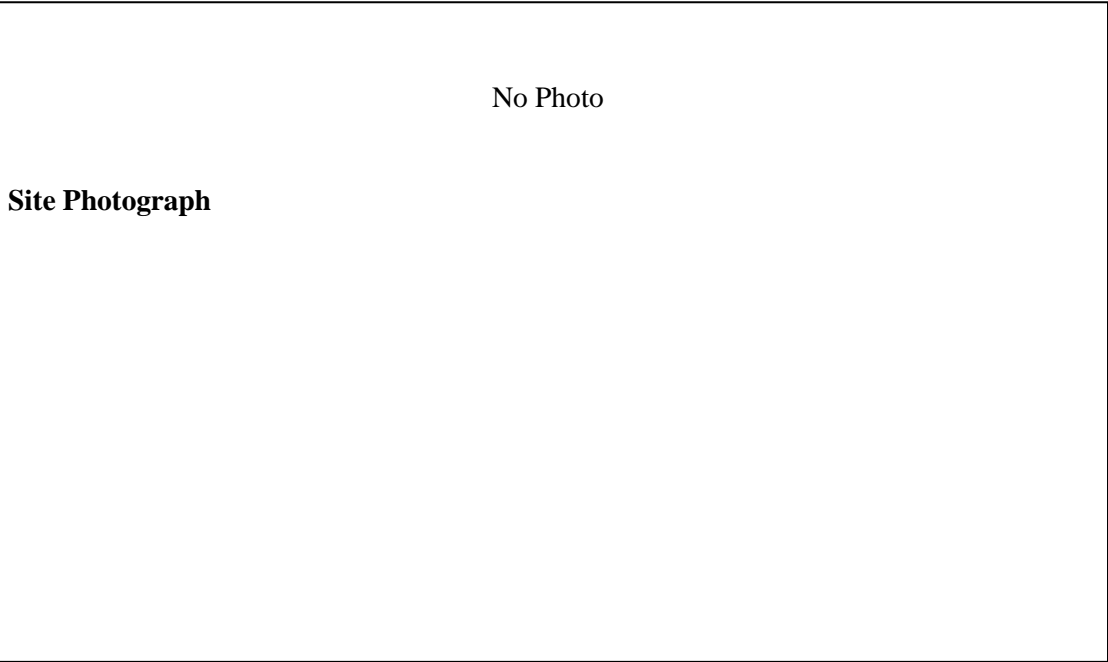
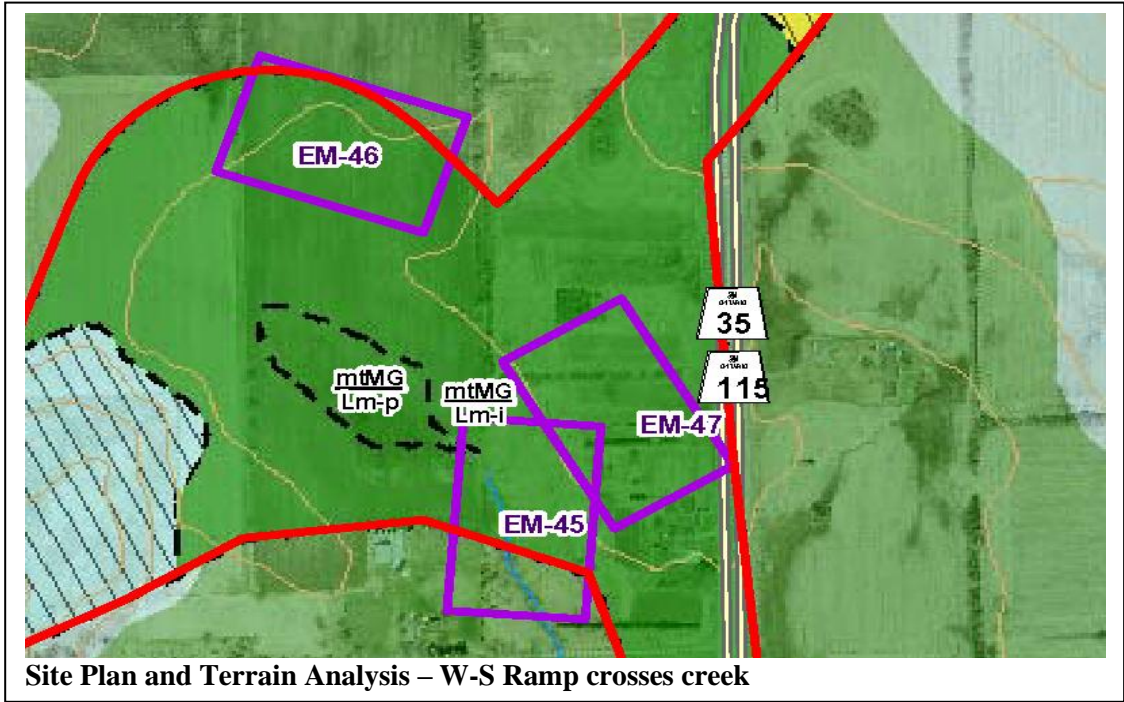
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-45
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W.O: 07-20017    Section: Eastern    Location: Creek located approximately 200m west of Highway 35/115    Sta. 27+300

Original Grade:    Proposed Grade:    Description: W-S Ramp crosses creek.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b>  Mapping (East 6) shows that the site lies in an area of silt till ground moraine. The relief is low, rolling, imperfectly drained.  <u>Groundwater</u>  GWL expected to lie at or close to ground surface  <b>Estimated overburden thickness – 130m.</b>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Site lies in a shallow valley in a silt till sheet. Comparatively high fills possible at interchange but no stability or settlement issues are anticipated.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p> <p>Possibility of groundwater control required.</p>	
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Low</b>

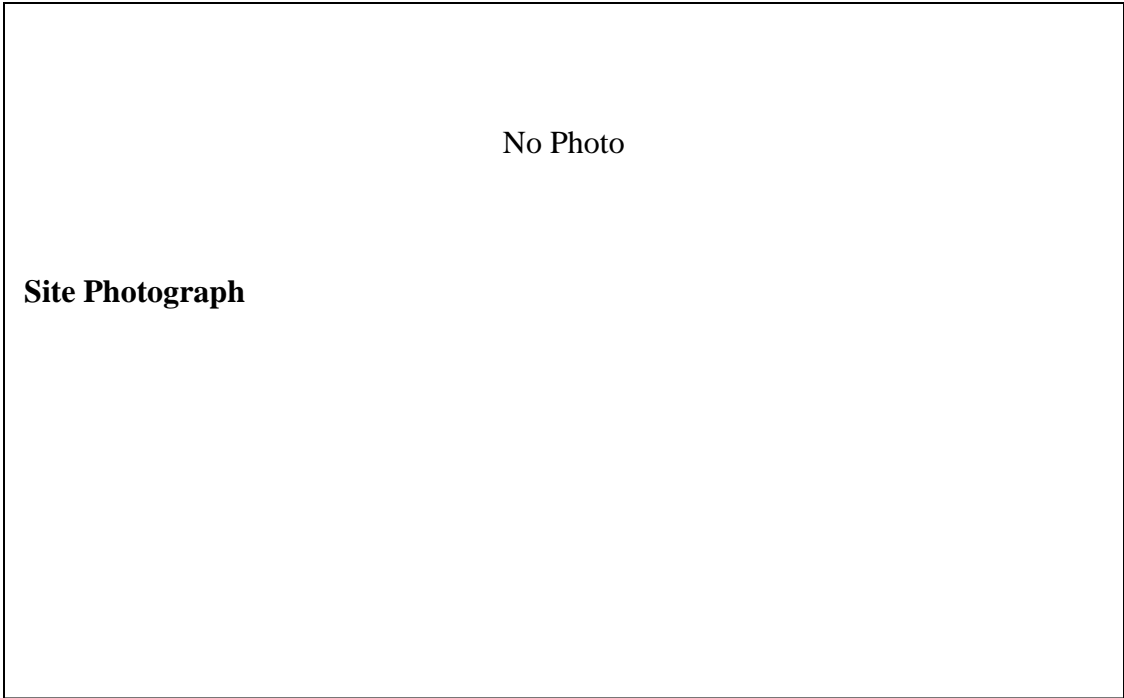
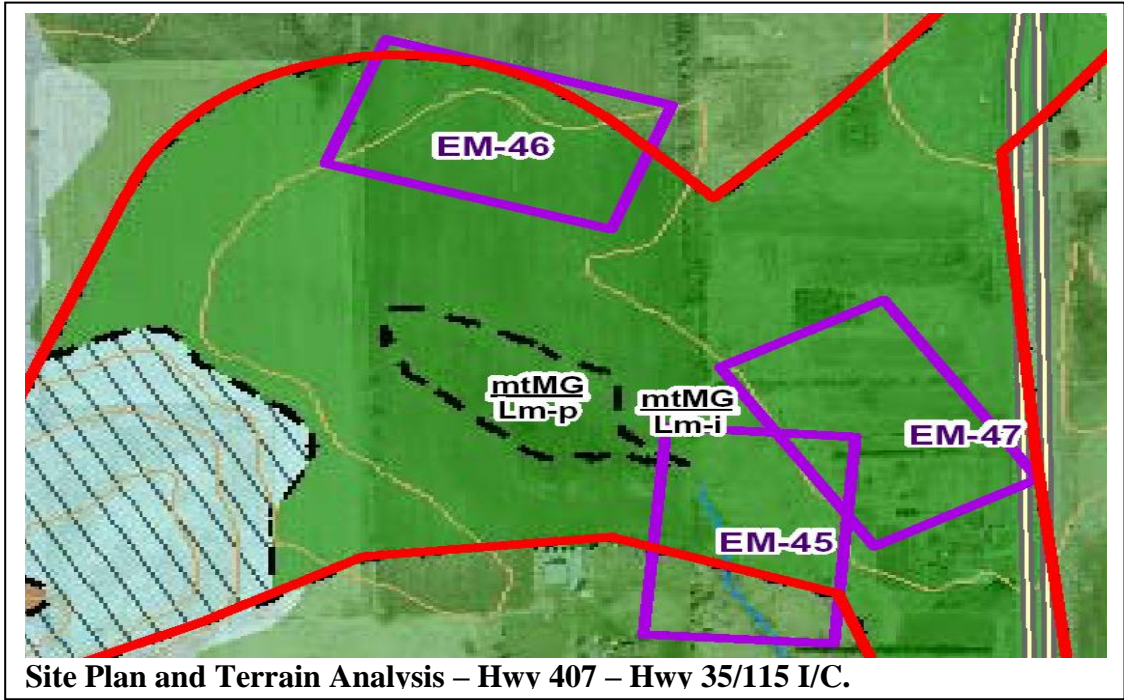


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-46
	EM-47

W.O: 07-20017    Section: Eastern    Location: Mainline at interchange with Hwy 115    Sta. N/A

Original Grade:    Proposed Grade:    Description: Freeway-Divided Highway I/C.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No borehole close to site.</b>  Mapping (East 6) shows that the bridge site is underlain by silt till ground moraine deposits. Typically in this area, these deposits are non-cohesive.  <u>Groundwater</u>  No information.  <b>Estimated overburden thickness – 130m.</b>	There is insufficient information on which to base site-specific recommendations. However, non-cohesive, moraine deposits can generally be expected to provide good founding conditions.	No problems are anticipated.	As a major interchange, this site should receive high priority for investigation.
			<b>Site Ranking</b>  <b>Foundations: High</b>  <b>Hydrogeology: Low</b>

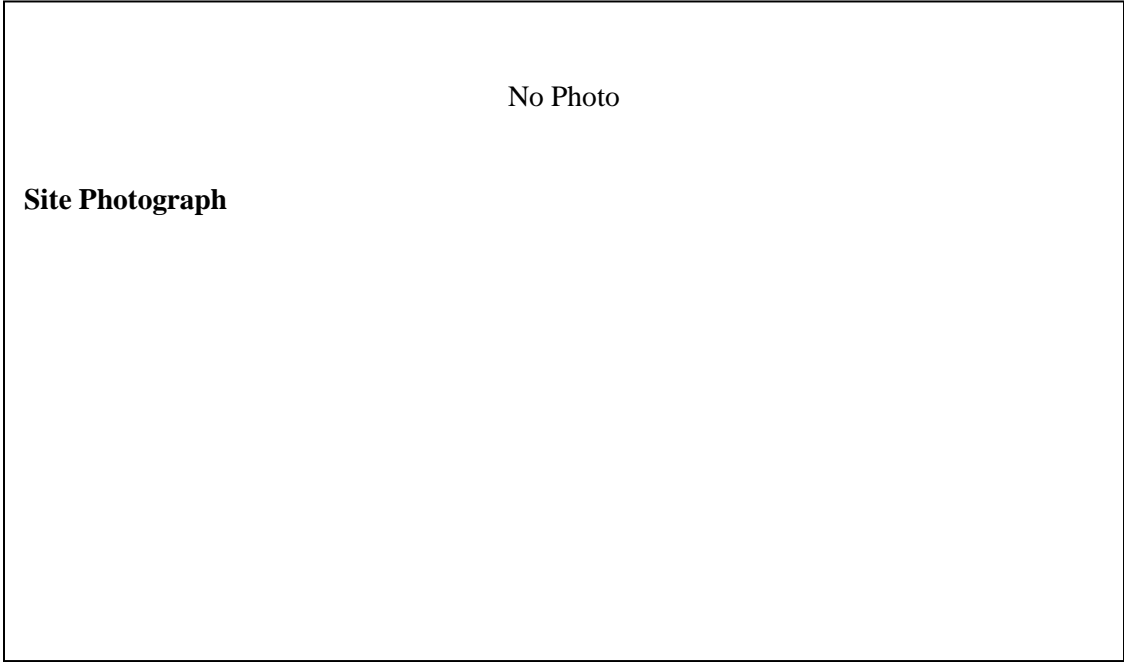
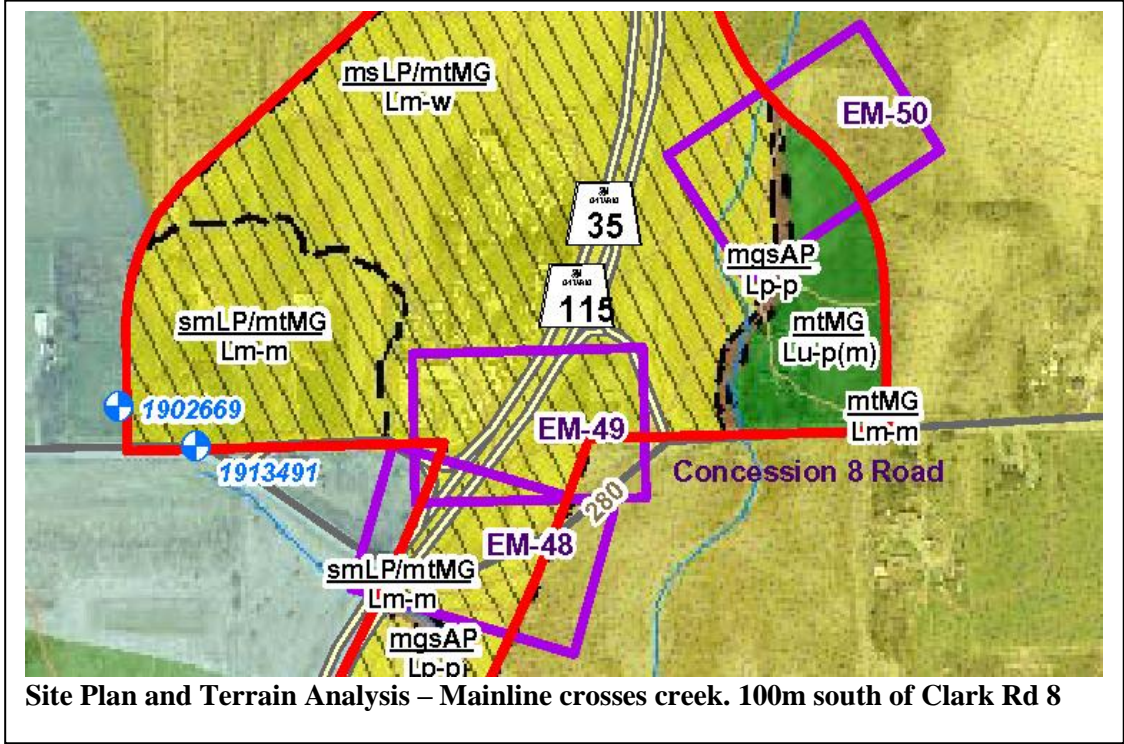
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-48
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W.O: 07-20017    Section: Eastern    Location: Creek 100m south of Clark Concession 8 Road    Sta. 28+100

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: Previous investigation 31D-284 100m to the north.</b></p> <p>Mapping (East 6) shows that the site lies in an area of this sandy silt glaciolacustrine deposit overlying silt till ground moraine.</p> <p>Boreholes typically show 8m of hard silty clay till overlying very dense sandy silt to sand.</p> <p><b>Groundwater</b></p> <p>GWL at 2 to 3m below ground surface.</p> <p><b>Estimated overburden thickness – 125m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 450 kPa</li><li>b. Resistance at SLS – 300 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleyside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p> <p>Groundwater control will be required and also possible stream diversion.</p>
Site Ranking			
Foundations:		Low	
Hydrogeology:		High	



<b>Site No:</b>	EM-49
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Sta. 28+200

**Sta.** 28+200

ng Hwy 115 I/C.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 1 through 5, GEOCRE 31D-284</b>	<b><u>1. Abutments</u></b>		
Mapping (East 6) shows the site to be underlain mainly by glaciolacustrine deposits.	a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 272.0.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Groundwater control not expected to be required in excavations for foundations.
The boreholes in 31D-284 can be summarized as:	b. For closed abutments, footings may be founded on native soil below El. 270.0 <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 450 kPa</li> <li>b. Resistance at SLS – 300 kPa</li> </ul>	No global stability or settlement issues are anticipated based on available information.	
0.0 – 2.0 Silty sand, very loose to loose	c. Abutments may also be supported on driven HP 310X110 piles driven below El.264.0. <ul style="list-style-type: none"> <li>a. ULS resistance – 1,600 kN</li> <li>b. SLS resistance – 1,400 kN</li> </ul>	Stripping of topsoil or other unsuitable soils will be required prior to construction.	
2.0 - 6.0 Silty clay till, stiff to hard	d. Length of pile indeterminate at this time. Assume 25m.		
6.0 – 12.0 (EOH) Sandy silt till, very dense.	e. Integral abutments are feasible.		
<b><u>Groundwater</u></b>	f. Piles are required for an integral abutment. Otherwise, designer may select foundation based on structure configuration and costs.		
The GWL in 31D-284 was found to lie at an approx. depth of 3m, Elev. 271.0.	<b><u>2. Piers</u></b>		
<b>Estimated overburden thickness – 125m.</b>	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on hard native soil are recommended.		
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>



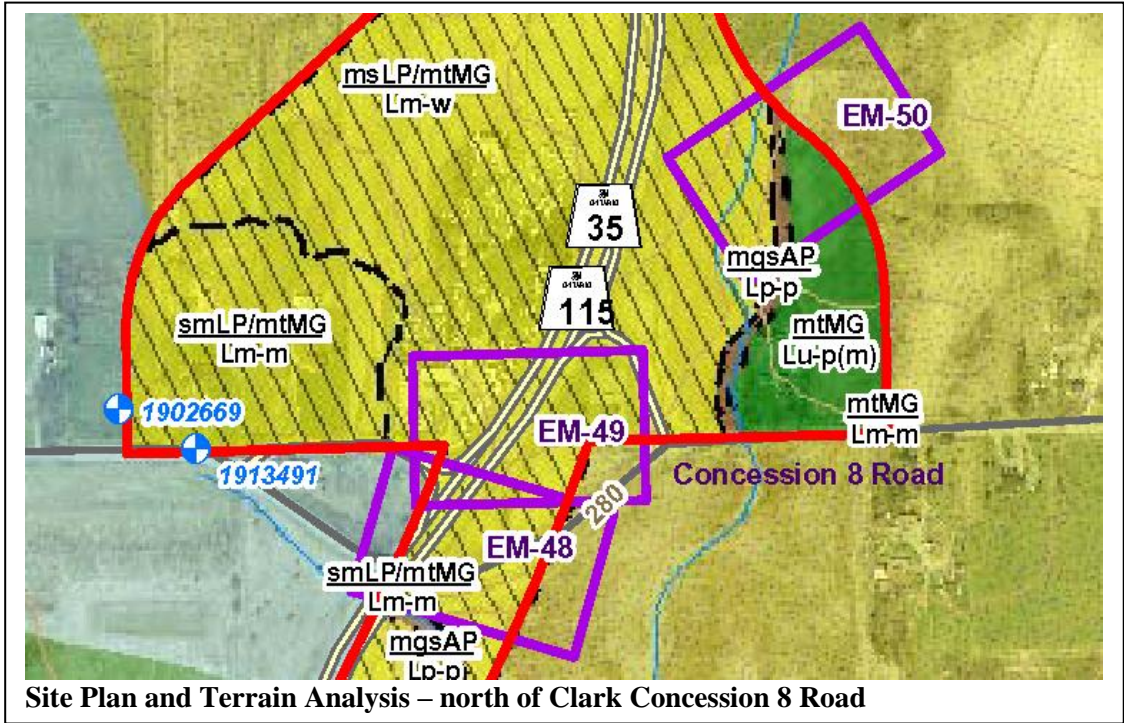
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-50
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W.O: 07-20017    Section: Eastern    Location: Creek 200m north of Clark Concession 8 Road    Sta. 28+475

Original Grade:    Proposed Grade:    Description: Ramp N – E/W crosses creek on culvert



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> Previous investigation 31D-284 2100m to the south.</p> <p>Mapping (East 6) shows that the site lies in an area of this silty, gravely sand glaciolacustrine deposit overlying silt till ground moraine. The relief is low plain, poorly drained.</p> <p>Boreholes typically show 8m of hard silty clay till overlying very dense sandy silt to sand.</p> <p><b>Groundwater</b></p> <p>GWL at 2 to 3m below ground surface.</p> <p><b>Estimated overburden thickness – 125m</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 450 kPa</li><li>b. Resistance at SLS – 300 kPa</li></ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow valley with no geomorphic evidence of significant valleyside instability</p> <p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.</p> <p>Groundwater control may be required depending on the final grades and the time of year that construction is carried out.</p>
Site Ranking			
Foundations:			Low
Hydrogeology:			High



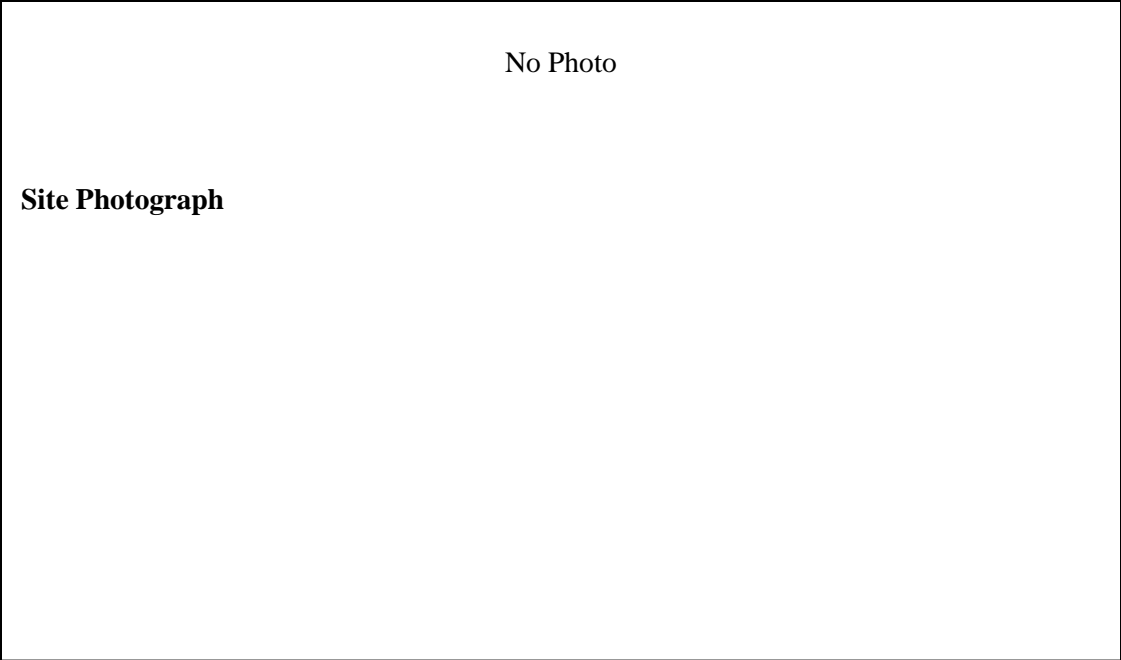
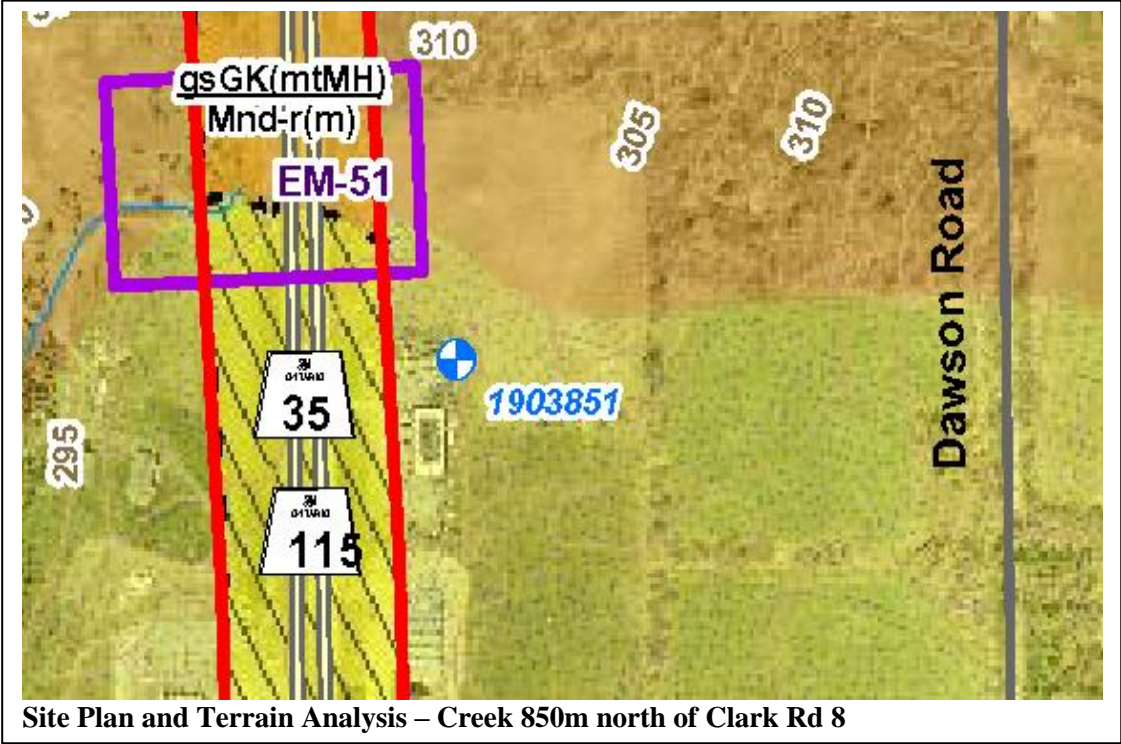
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-51
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W.O: 07-20017    Section: Eastern    Location: Creek 850m north of Clark Concession 8 Road    Sta. 29+160

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No boreholes at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Moderate approaches on non-cohesive soils. No stability or settlement issues are anticipated.	Narrow, shallow swale with no geomorphic evidence of significant valleside instability  Likely no appreciable alluvial deposits, based on field checks of similar swales.  Groundwater control may be required depending on the final grades and the time of year that construction is carried out.
Mapping (East 6) shows that the site lies at the boundary between silty sand glaciolacustrine plain to the south and a gravelly sand kame moraine to the north. The area exhibits moderate relief, hummocky and dissected.			
<u>Groundwater</u>  Shallow groundwater may be encountered at the creek.			
<b>Estimated overburden thickness – 140m.</b>			
	<b>Site Ranking</b>  <b>Foundations:                      Low</b>  <b>Hydrogeology:                      Medium</b>		

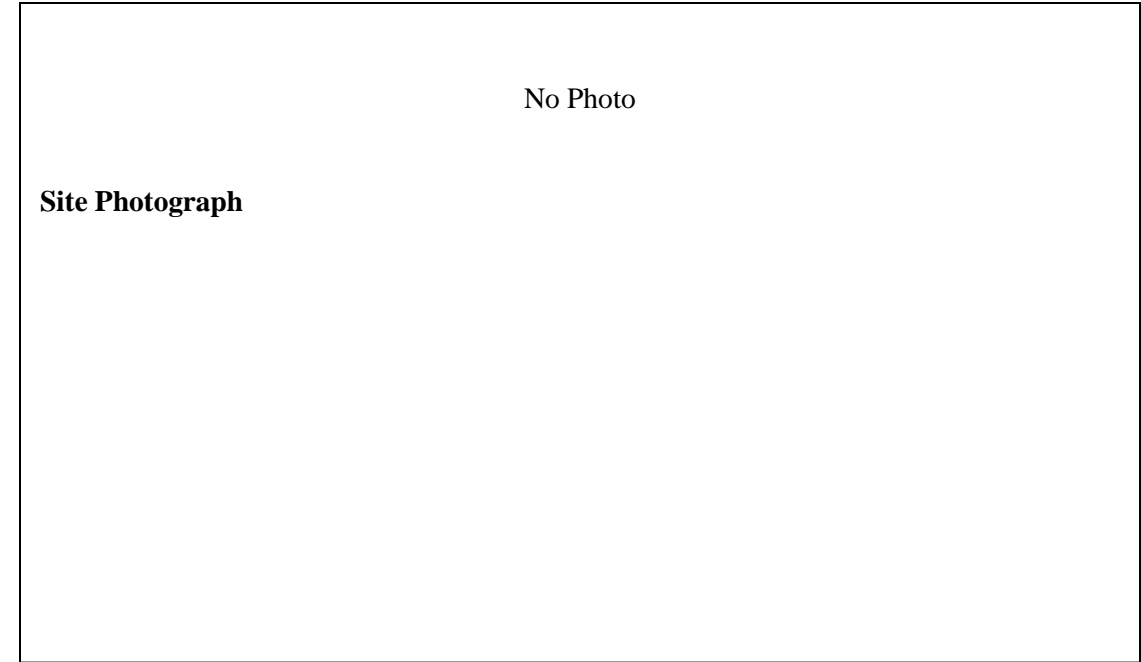
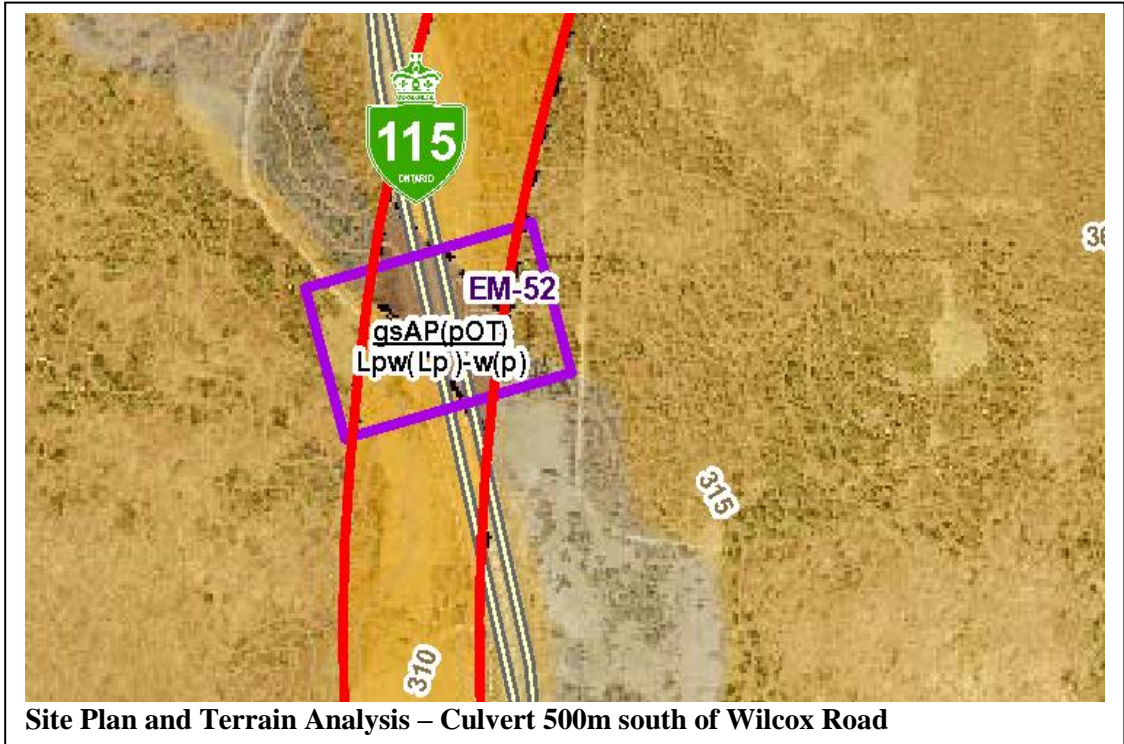
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EM-52
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W.O: 07-20017    Section: Eastern    Location: Culvert 500m south of Wilcox Road    Sta. 30+760

Original Grade:    Proposed Grade:    Description: Mainline crosses creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No boreholes at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.	Moderate approaches on non-cohesive soils. No stability or settlement issues are anticipated.	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valley-side instability.  Valley bottom material likely >2 m deep, probably consisting of silty gravelly sand alluvium locally interbedded with buried organic material, overlying gravelly sand ice-contact glaciofluvial deposits.  Groundwater control may be required depending on the final grades and the time of year that construction is carried out.
Mapping (East 7) shows that the site lies in an area of gravelly sand alluvial plain. The relief is low plain, reworked.  <b>Groundwater</b>  Shallow groundwater should be anticipated close to the creek.  <b>Estimated overburden thickness – 145m.</b>	Footings may be designed on the basis of <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 450 kPa</li><li>b. Resistance at SLS – 300 kPa</li></ul> A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.		
Site Ranking			
<b>Foundations:</b>			<b>Low</b>
<b>Hydrogeology:</b>			<b>Medium</b>

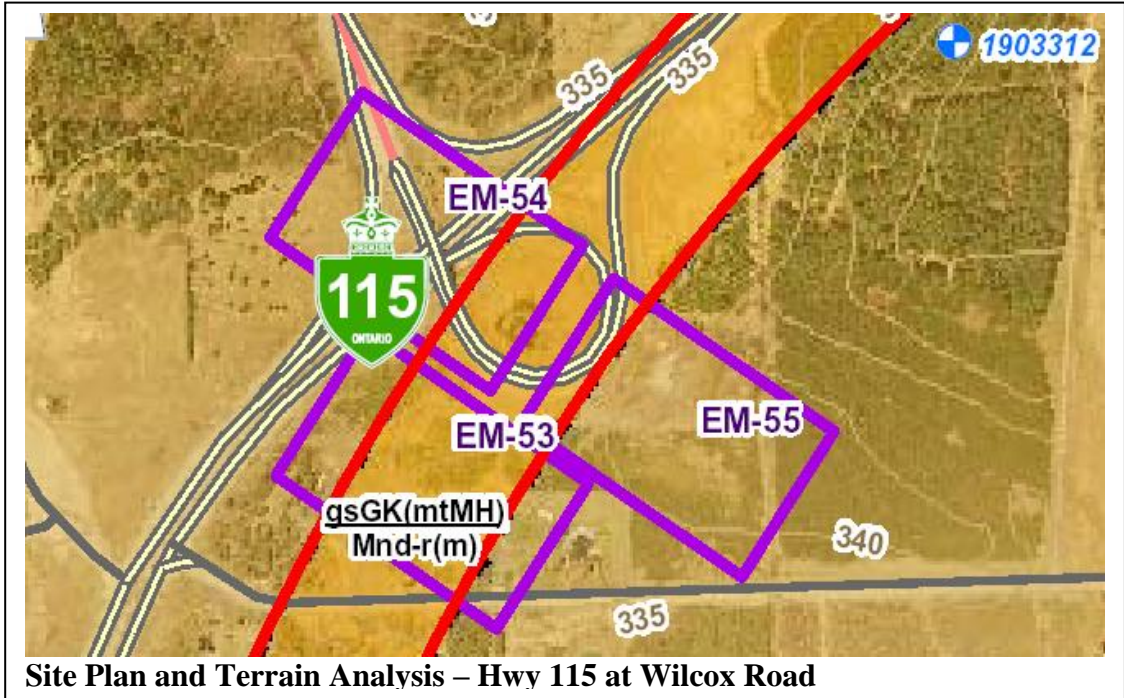


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EM-53

W.O: 07-20017    Section: Eastern    Location: Mainline/Hwy 115 at Wilcox Road    Sta. 31+550

Original Grade: ~342    Proposed Grade:    Description: Mainline underpass at Wilcox Road



Site Plan and Terrain Analysis – Hwy 115 at Wilcox Road



Site Photograph – Hwy 35/115 looking east

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No boreholes at the site. Nearest boreholes are at current Hwy115/Hwy 35 split, GEOCRE 31D-288</b>	<b>1. Abutments</b>  a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 340.0.  b. For closed abutments, footings may be founded on native soil below El. 339.0 a. Factored resistance at ULS – 750 kPa b. Resistance at SLS – 500 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El.338.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Length of pile indeterminate at this time. Assume 20m.  e. Integral abutments are feasible.  f. Piles are required for an integral abutment. Otherwise, designer may select foundation based on structure configuration and costs.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering problems are anticipated.
Mapping (East 7) shows the site to lie in a broad area of glaciofluvial deposits, particularly sandy kame deposits.  The 31D-288 boreholes may be summarized as:  0.0 to EOH (10 to 12m) Silty sand, dense to very dense  <b>Groundwater</b>  GWL was not encountered within the depth of exploration.  <b>Estimated overburden thickness – 180 m.</b>	<b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on very dense native soil are recommended.	<b>Site Ranking</b>  <b>Foundations: Medium</b>  <b>Hydrogeology: Medium</b>	

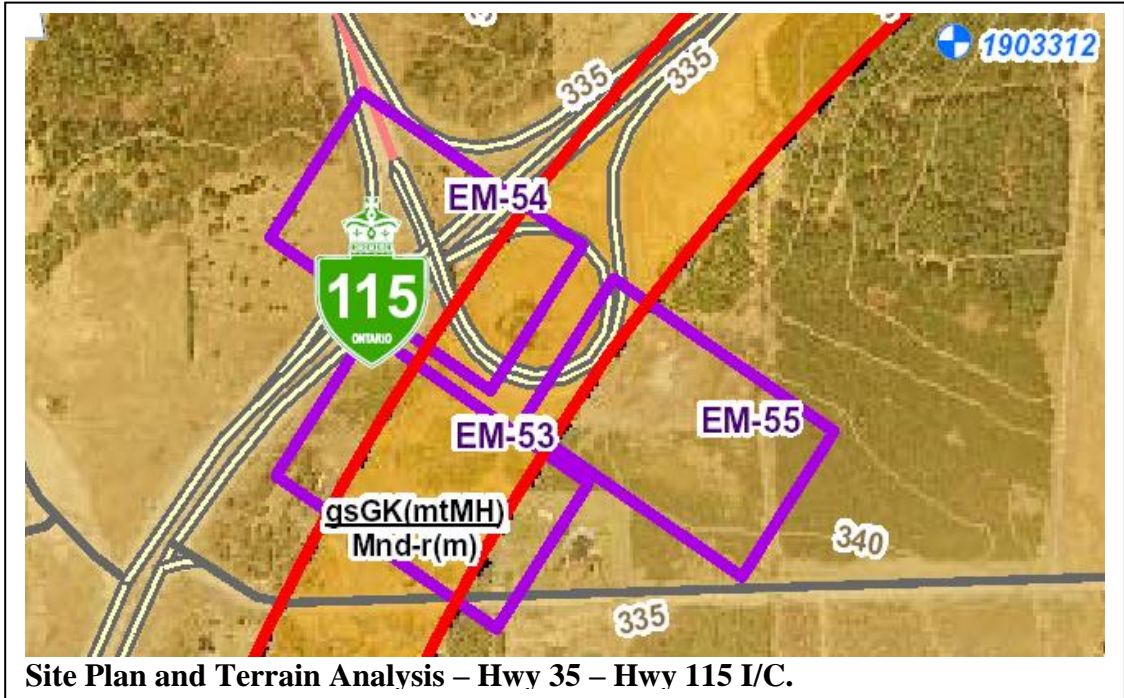


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

Site No:	EM-54
	EM-55

W.O: 07-20017    Section: Eastern    Location: Mainline/Hwy 115 at Hwy 35    Sta. N/A

Original Grade: ~342    Proposed Grade:    Description: Ramp structures at Mainline/Hwy 35



Site Photograph – Hwy 35/115 looking north

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 1 through 4 at current Hwy115/Hwy 35 split, GEOCRE 31D-288</b>  Mapping (East 7) shows the site to lie in a broad area of glaciofluvial deposits, particularly sandy kame deposits.  The 31D-288 boreholes may be summarized as:  0.0 to EOH (10 to 12m) Silty sand, dense to very dense  <b>Groundwater</b>  GWL was not encountered within the depth of exploration.  <b>Estimated overburden thickness – 185m.</b>	<b>1. Abutments</b>  a. Footings may be founded on Granular A cores as per standard recommendations and below Elev. 340.0.  b. For closed abutments, footings may be founded on native soil below El. 339.0 a. Factored resistance at ULS – 750 kPa b. Resistance at SLS – 500 kPa  c. Abutments may also be supported on driven HP 310X110 piles driven below El.338.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Length of pile indeterminate at this time. Assume 20m.  e. Integral abutments are feasible.  f. Piles are required for an integral abutment. Otherwise, designer may select foundation based on structure configuration and costs.  <b>2. Piers</b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on very dense native soil are recommended.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No global stability or settlement issues are anticipated based on available information.  Stripping of topsoil or other unsuitable soils will be required prior to construction.	No major dewatering problems are anticipated.
		<b>Site Ranking</b>  <b>Foundations: High</b>  <b>Hydrogeology: Medium</b>	

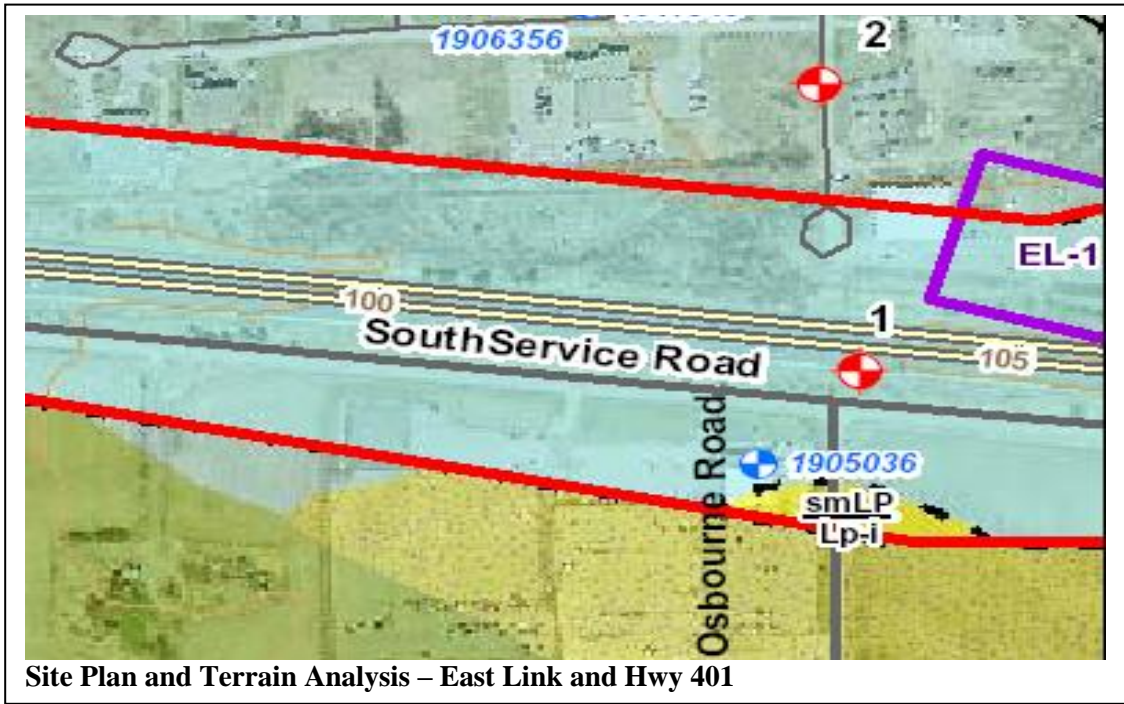


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EL-1

W.O: 07-20017    Section: Eastern    Location: East Link at Hwy 401    Sta. N/A

Original Grade: ~104.5    Proposed Grade:    Description: Hwy 401 E – Courtice N/S crosses Hwy 407 N – Hwy 401 W



Site Plan and Terrain Analysis – East Link and Hwy 401

No Photo

Site Photograph

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 1 and BH 2, Book 8, lie approximately 100m SW and NW of the site.</b>  Mapping (East 11 – East 12) shows that the site straddles the boundary between fine grained glaciolacustrine soils and silt till ground moraine. The relief is low plain and poorly drained.  BH 1 encountered:  0.0 – 1.6 Sand and gravel fill, dense 1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense  BH 2 similar.  <b><u>Groundwater</u></b>  GWL recorded at 3 to 6m below grade.  <b>Estimated overburden thickness – 30m.</b>	<b><u>1. Abutments</u></b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 1.0 m below existing grade.  b. For closed abutments, footings may be founded on very dense native soil below Elev. 101.5 a. Factored resistance at ULS – 1,000 kPa b. SLS – will not govern  c. Abutments may also be supported on HP 310X110 piles driven below El.90.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles.  <b><u>2. Piers</u></b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on very dense native soil are considered a suitable foundation option.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No global stability issues are anticipated based on available information.  Topsoil or other unsuitable soils must be stripped prior to construction.	No major dewatering requirements are anticipated.
<b>Site Ranking</b>			
<b>Foundations: High</b>			
<b>Hydrogeology: Medium</b>			

<b>Site No:</b>	EL-2
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<b>W.O:</b>	07-20017	<b>Section:</b>	Eastern	<b>Location:</b>	East link at Hwy 401	<b>Sta.</b>	N/A
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A photograph of a rural landscape. A paved road runs along the left side, bordered by a grassy shoulder and a line of utility poles with power lines. The background features a field of tall, dry grass and scattered trees under a clear blue sky.

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BHs at the site. BH 1 &amp; BH2, 30M15-83, are 400 &amp; 500m west, respectively.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. For closed abutments, footings may be founded on very dense native soil below Elev. 101 (assumed)</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 1,000 kPa</p> <p style="padding-left: 40px;">b. SLS – will not govern</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.90.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on very dense native soil are considered a suitable foundation option.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
<p>Mapping (East 12) shows that the site is underlain by fine grained glaciolacustrine soils with silt till ground moraine along the north edge. The relief is low plain and poorly drained.</p> <p>BH 1 encountered:</p> <p>0.0 – 1.6 Sand and gravel fill, dense</p> <p>1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense</p> <p>BH 2 similar.</p> <p><b><u>Groundwater</u></b></p> <p>GWL anticipated within 3m of the ground surface.</p> <p><b>Estimated overburden thickness – 35m.</b></p>			



<b>Site No:</b>	EL-3
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<b>W.O:</b>	07-20017	<b>Section:</b>	Eastern	<b>Location:</b>	East Link at Hwy 401	<b>Sta.</b>	N/A
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The map shows a study area with several sampling locations marked by purple polygons and labeled EL-2, EL-3, EL-4, EL-5, and EL-6. A red line runs diagonally across the map, likely representing a road or boundary. A black line with cross-ticks, possibly a canal or water body, runs horizontally. South Service Road is labeled in the center, and Solina Road is labeled vertically on the right. Sampling points are also labeled: mtMG Lm-i near EL-3 and EL-4, and cmLP Lp-p near EL-4. A road number 105 is visible near EL-4.

No Photo

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BHs at the site. BH 1 &amp; BH2, 30M15-83, are 250m southwest and west, respectively.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. For closed abutments, footings may be founded on very dense native soil below Elev. 103</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 1,000 kPa</p> <p style="padding-left: 40px;">b. SLS – will not govern</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.90.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p> <p>Railway protection may be required.</p>
<p>Mapping (East 12) shows that the site is essentially underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p>BH 1 encountered:</p> <p>0.0 – 1.6 Sand and gravel fill, dense</p> <p>1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense</p> <p>BH 3 similar.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL expected within 3m of ground surface.</p> <p><b>Estimated overburden thickness – 35m.</b></p>	<p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on very dense native soil are considered a suitable foundation option.</p>	<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                    Medium</b></p>	



<b>Site No:</b>	EL-4
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**Sta.** N/A

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	401 W – N Link Ramp crossing Hwy 401 and Railway
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BHs at the site. BH 1, 30M15-83, is 400m to the west.</b></p> <p>Mapping (East 12) shows that the site is underlain by silt till ground moraine. The relief low, rolling, imperfectly drained.</p> <p>BH 1 encountered:</p> <p>0.0 – 1.6 Sand and gravel fill, dense</p> <p>1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense</p> <p>BH 2 similar.</p> <p><b><u>Groundwater</u></b></p> <p>GWL is anticipated within 3m of the ground surface.</p> <p><b>Estimated overburden thickness – 35m.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. For closed abutments, footings may be founded on very dense native soil below Elev. 103</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 1,000 kPa</p> <p style="padding-left: 40px;">b. SLS – will not govern</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.90.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on hard native soil are considered a suitable foundation option.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
<b>Site Ranking</b>			
<b>Foundations:</b>		<b>High</b>	
<b>Hydrogeology:</b>		<b>Medium</b>	

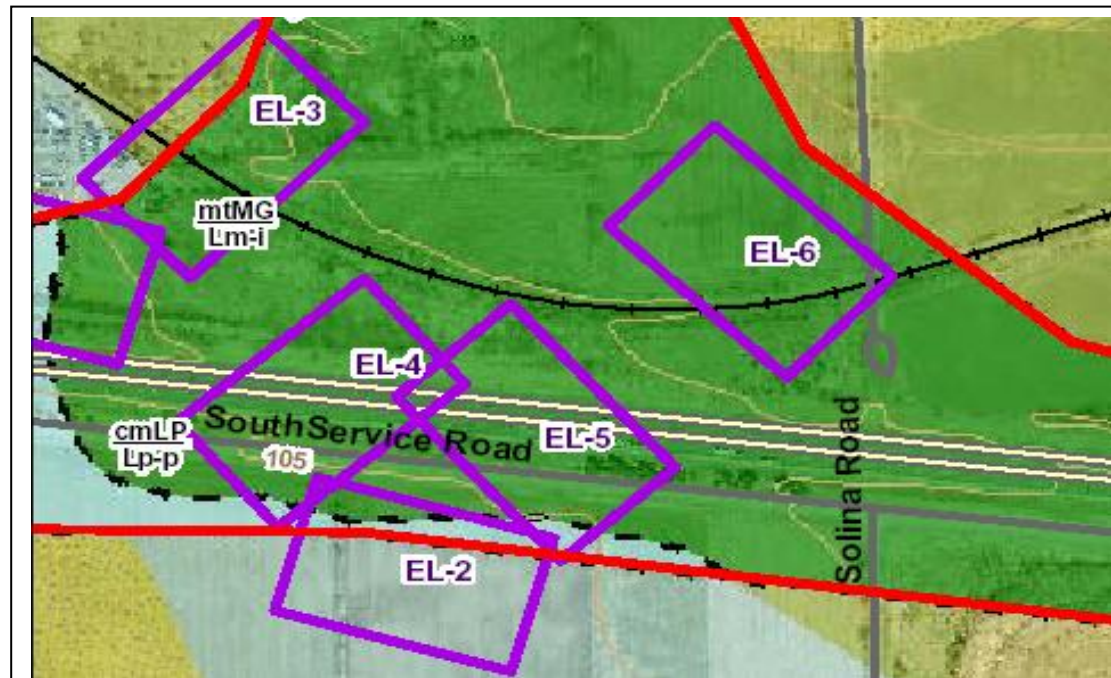


<b>Site No:</b>	EL-5
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<b>Site No:</b>	EL-5
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Sta. N/A

Railway and Courtice



## Site Plan and Terrain Analysis – East Link and Hwy 401



**Site Photograph – Service Road looking north**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BHs at the site. BH 1, 30M15-83, is 500m to the west.</b></p> <p>Mapping (East 12) shows that the site is underlain by silt till ground moraine. The relief low, rolling, poorly drained.</p> <p>BH 1 encountered:</p> <p>0.0 – 1.6 Sand and gravel fill, dense</p> <p>1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense.</p> <p><b><u>Groundwater</u></b></p> <p>GWL is expected within 3m of the ground surface.</p> <p><b>Estimated overburden thickness – 35m.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. For closed abutments, footings may be founded on very dense native soil below Elev. 103</p> <p style="padding-left: 40px;">a. Factored resistance at ULS – 1,000 kPa</p> <p style="padding-left: 40px;">b. SLS – will not govern</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.90.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on very dense native soil are considered a suitable foundation option.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>No global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                    Low</b></p>	

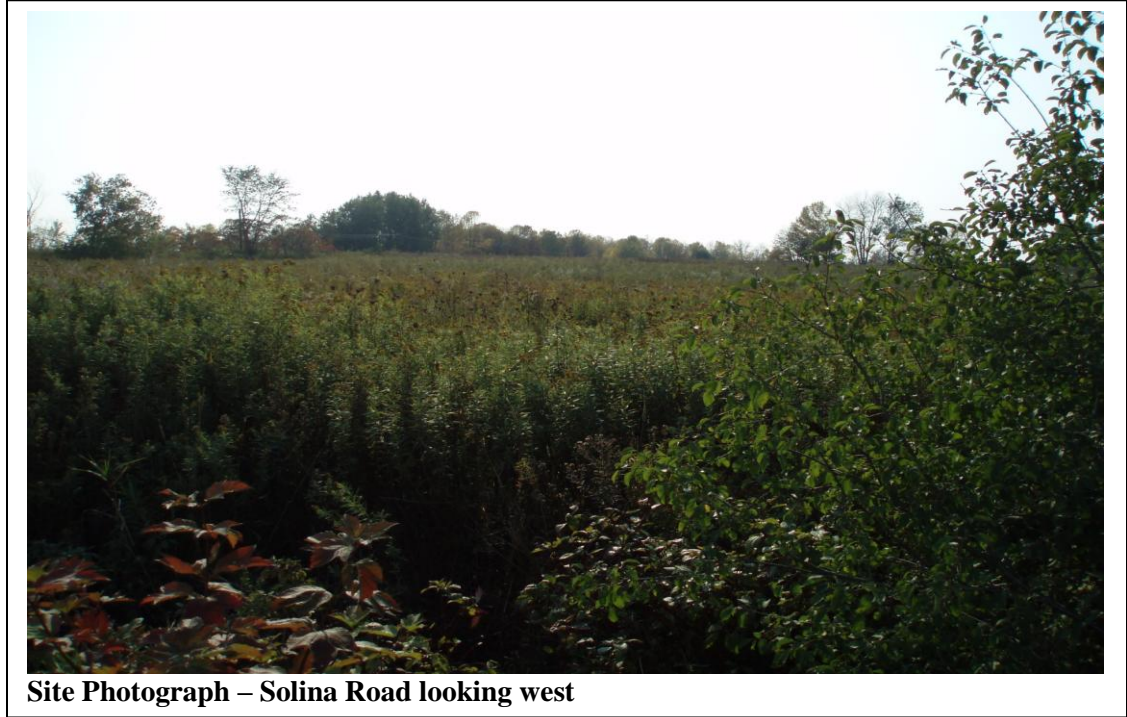
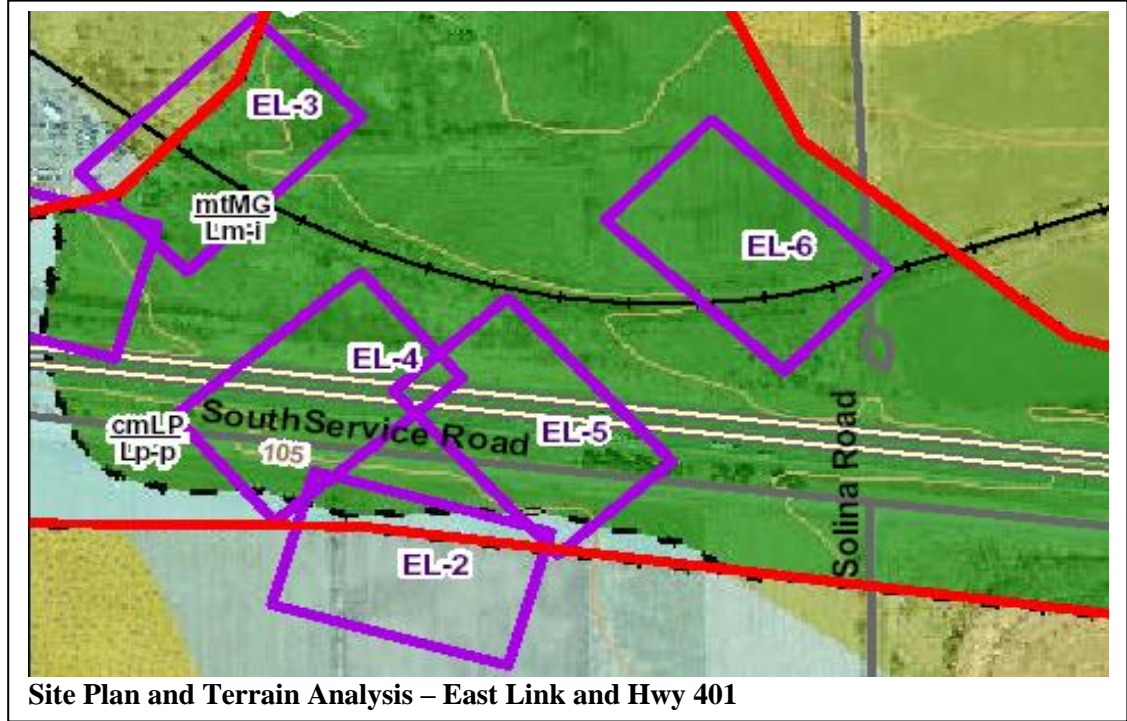


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EL-6

W.O: 07-20017    Section: Eastern    Location: East Link at Hwy 401    Sta. N/A

Original Grade: ~110    Proposed Grade:    Description: 401 E – N Link Ramp crossing Railway



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BHs at the site. BH 1, 30M15-83, is 700m to the west.</b>  Mapping (East 12) shows that the site is underlain by silt till ground moraine. The relief low, rolling, poorly drained.  BH 1 encountered:  0.0 – 1.6 Sand and gravel fill, dense 1.6 – 15.4 (EOH) Silt, sand and gravel (glacial till), compact to very dense.  <b><u>Groundwater</u></b>  GWL is expected within 3m of the ground surface.  <b>Estimated overburden thickness – 35m.</b>	<b><u>1. Abutments</u></b>  a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.  b. For closed abutments, footings may be founded on very dense native soil below Elev. 108 a. Factored resistance at ULS – 1,000 kPa b. SLS – will not govern  c. Abutments may also be supported on HP 310X110 piles driven below El.90.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 25m piles.  <b><u>2. Piers</u></b>  Piers may be supported using the same foundation options as for abutments.  Spread footings on hard native soil are considered a suitable foundation option.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  No global stability issues are anticipated based on available information.  Topsoil or other unsuitable soils must be stripped prior to construction.	No major dewatering requirements are anticipated.  Railway protection may be required.
<b>Site Ranking</b>			
<b>Foundations: High</b>			
<b>Hydrogeology: Low</b>			



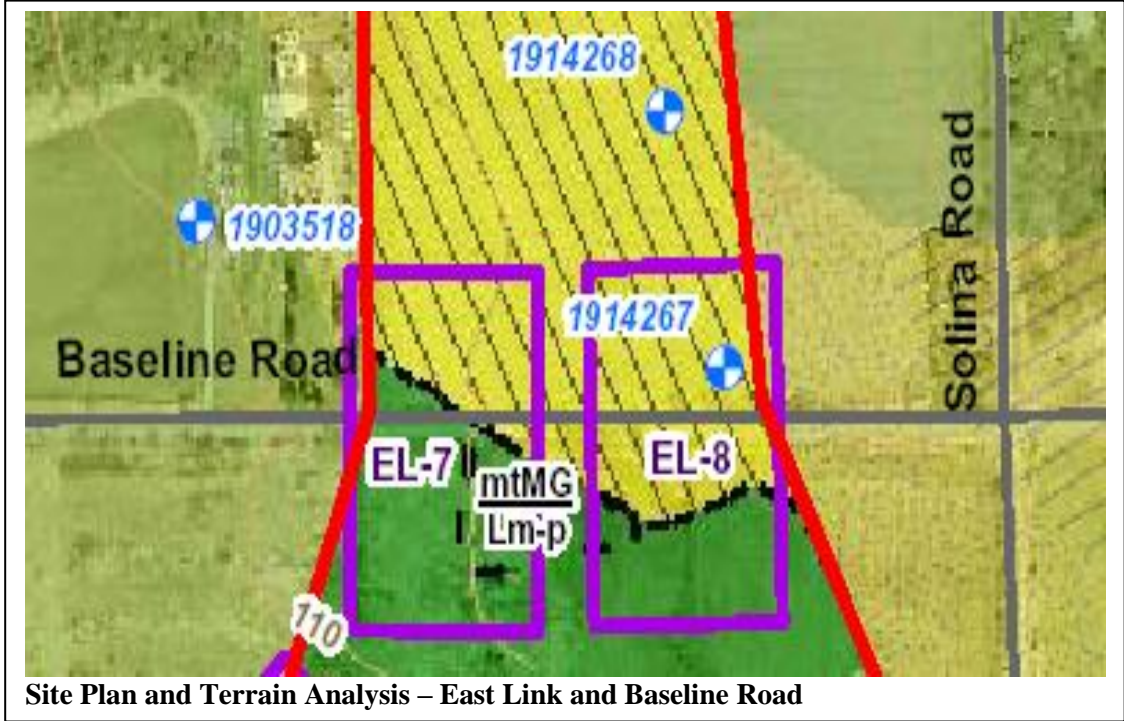
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-7
	EL-8

W.O: 07-20017    Section: Eastern    Location: East Link at Baseline Road    Sta. 10+555

Original Grade: 108.5    Proposed Grade:    Description: Twin structures carrying east link over Baseline Road



Site Photograph – Baseline Road looking west

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 3, 30M15-83</b>	<b>1. Abutments</b>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	No major dewatering requirements are anticipated.
Mapping (East 12) shows the site lies across the boundary between silt till ground moraine to the south and an area of silty glaciolacustrine soil to the north. The glaciolacustrine soil is interpreted as a thin veneer over the till. The relief low, rolling to plain, poorly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.  b. For closed abutments, footings may be founded on very dense native soil below Elev. 106 a. Factored resistance at ULS – 1,000 kPa b. SLS – will not govern  c. Abutments may also be supported on HP 310X110 piles driven below El.100.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Predrilling may be required to install piles.	No global stability issues are anticipated based on available information.  Topsoil or other unsuitable soils must be stripped prior to construction.	
BH 3 encountered:  0.0 – 1.0    Pavement and sand and gravel fill, compact 1.0 – 2.4    Clayey silt and compact silty sand 2.4 – 7.0    (EOH) Silt, sand and gravel (glacial till), very dense.	<b>2. Piers</b>	Piers may be supported using the same foundation options as for abutments.  Spread footings on very dense native soil are considered a suitable foundation option.	<b>Site Ranking</b>  <b>Foundations:            Medium</b>  <b>Hydrogeology:        Medium</b>
<b>Groundwater</b>  GWL approximately 3.5m below ground surface.			
<b>Estimated overburden thickness – 40m.</b>			

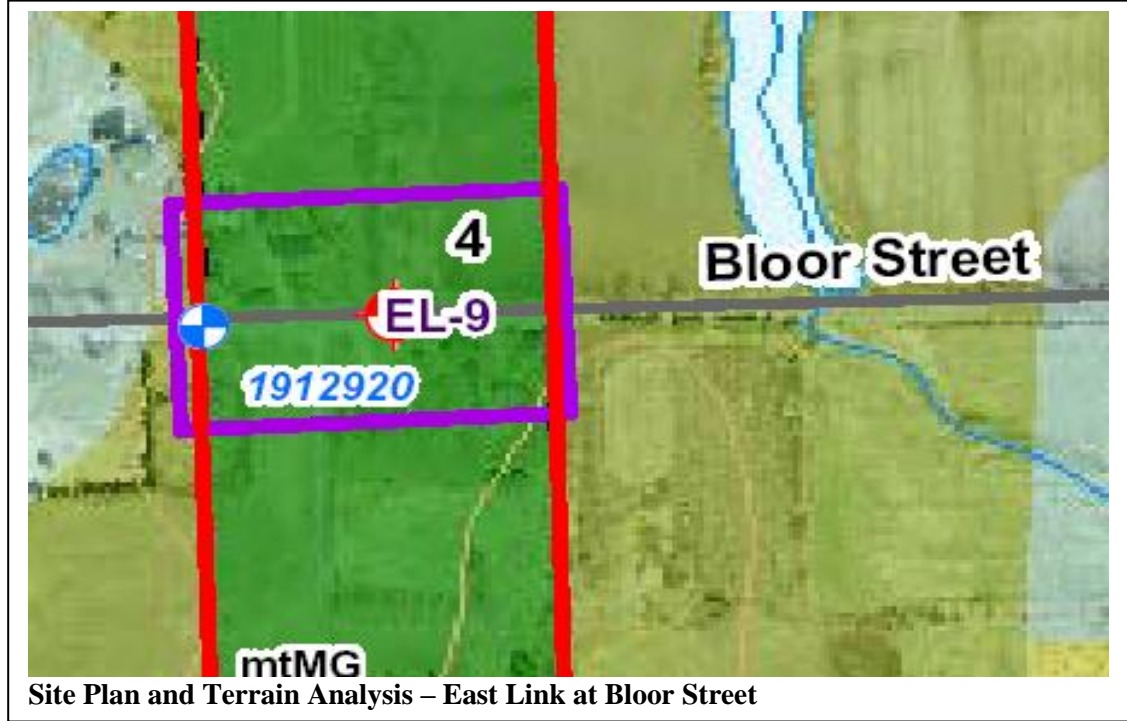


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EL-9

W.O: 07-20017    Section: Eastern    Location: East Link at Bloor Street    Sta. 12+350

Original Grade: 126.8    Proposed Grade:    Description: Underpass to carry Bloor Street over the East Link



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 4, 30M15-83</b>	<b>1. Abutments</b>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 10 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	No major dewatering requirements are anticipated.
Mapping (East 10) shows that the site is underlain by silt till ground moraine. The relief is low, rolling and imperfectly drained.	a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.		
BH 4 encountered:	b. For closed abutments, footings may be founded on very dense native soil below Elev. 121	No global stability issues are anticipated based on available information.	Topsoil or other unsuitable soils must be stripped prior to construction.
0.0 – 1.4 Pavement and sand and gravel fill, dense	a. Factored resistance at ULS – 450 kPa		
1.4 – 5.6 Silt sand and gravel, glacial till, very dense	b. SLS – 300 kPa		Higher resistance may be possible in the very dense crust.
5.6 – 10.9 Fine to medium sand, dense			
10.9 – 11.6 (EOH) Silt, sand and gravel, glacial till, very dense.	c. Abutments may also be supported on HP 310X110 piles driven below EL.116.0.		Integral abutments are feasible. Assume 20m piles.
	a. ULS resistance – 1,600 kN		
	b. SLS resistance – 1,400 kN		
<b>Groundwater</b>	d. Integral abutments are feasible. Assume 20m piles.		
GWL expected approximately 2m below ground surface.	<b>2. Piers</b>		
<b>Estimated overburden thickness – 45m</b>	Piers may be supported using the same foundation options as for abutments.		
	Spread footings on very dense native soil are considered a suitable foundation option.		
		<b>Site Ranking</b>	
		<b>Foundations: Medium</b>	
		<b>Hydrogeology: Medium</b>	



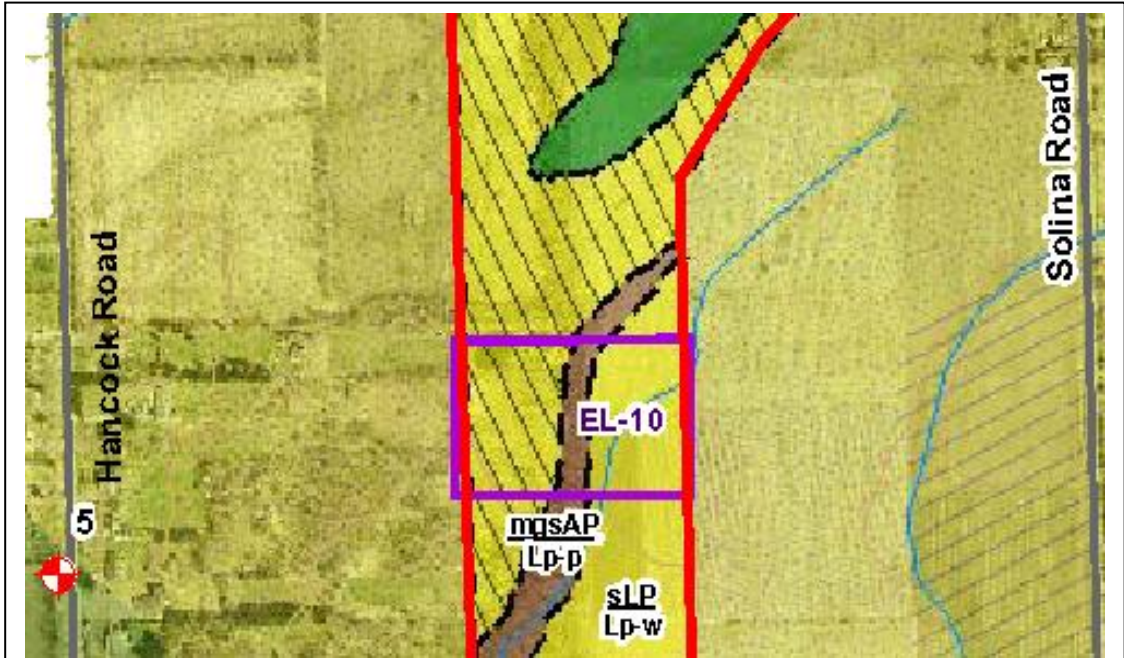
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-10
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W.O: 07-20017    Section: Eastern    Location: Culvert 800m north of Bloor Street    Sta. 13+175

Original Grade:    Proposed Grade:    Description: East Durham link crosses un-named creek on culvert.



Site Plan and Terrain Analysis – Culvert 800m north of Bloor Street



Site Photograph – looking west from Solina Road towards culvert site.

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No borehole at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.
Mapping (East 10) shows that the site lies in an area of sandy glaciolacustrine plain. The relief is low plain, locally poorly drained. A narrow band of recent alluvium is associated with the creek.	Footings may be designed on the basis of <ul style="list-style-type: none"><li>a. Factored resistance at ULS – 300 kPa</li><li>b. Resistance at SLS – 200 kPa</li></ul> A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.		Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys.
<u>Groundwater</u>			Groundwater control may be required depending on final design and the time of year that construction is carried out.
<b>Estimated overburden thickness – 50m.</b>		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>High</b>



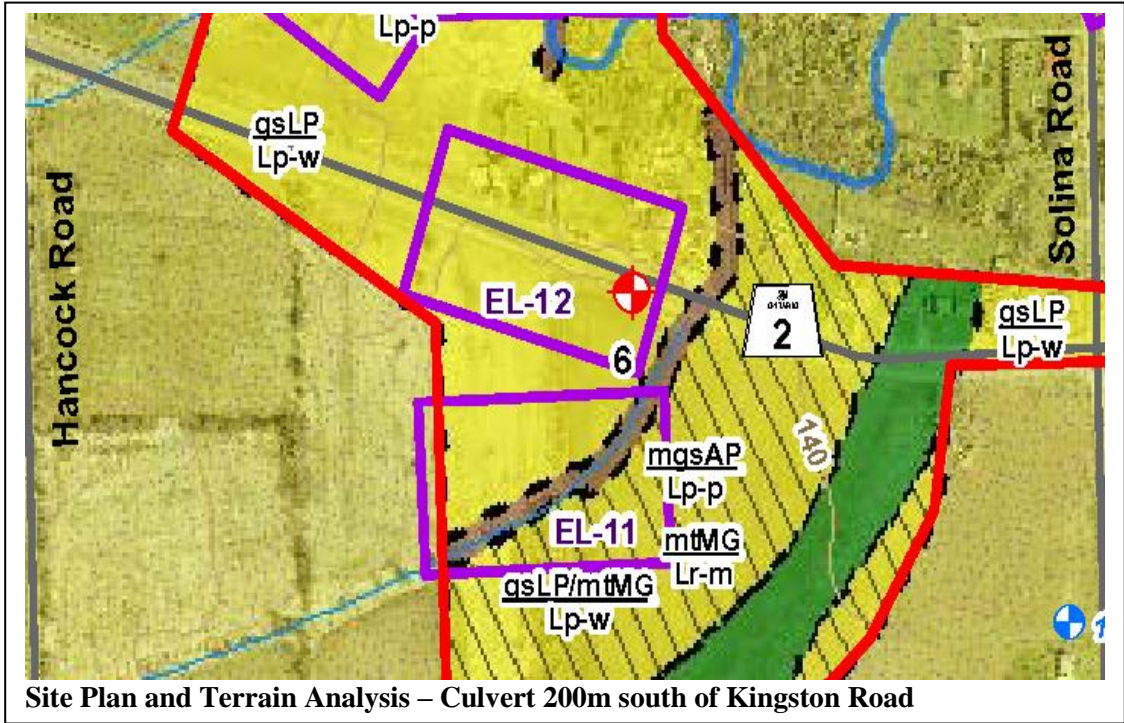
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-11
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W.O: 07-20017    Section: Eastern    Location: Culvert 200m south of Highway 2 (Kingston Road)    Sta. 13+650

Original Grade:    Proposed Grade:    Description: East Durham Link crosses un-named creek.



Site Photograph – looking south from Highway 2 (Kingston Road) towards site.

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> BH 6, 30M15-83, lies 150m to the north.</p> <p>Mapping ( East 10) shows that the site is underlain by a gravelly sand glaciolacustrine deposit. The relief is low plain, well drained.</p> <p>BH 6 encountered:</p> <p>0.0 – 1.4 Sand and gravel fill, dense</p> <p>1.4 – 2.5 Sandy silt, compact</p> <p>2.5 – 10.1 Clayey silt, firm to very stiff</p> <p>10.1 – 12.0 Sand and gravel, compact</p> <p>12.0 – 15.5 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><u>Groundwater</u></p> <p>GWL was recorded at approximately 2.0m below ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <p>a. Factored resistance at ULS – 300 kPa</p> <p>b. Resistance at SLS – 200 kPa</p> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valleside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p> <p>Groundwater control may be required depending on final design and the time of year that construction is carried out.</p>
Site Ranking			
Foundations:			Low
Hydrogeology:			High

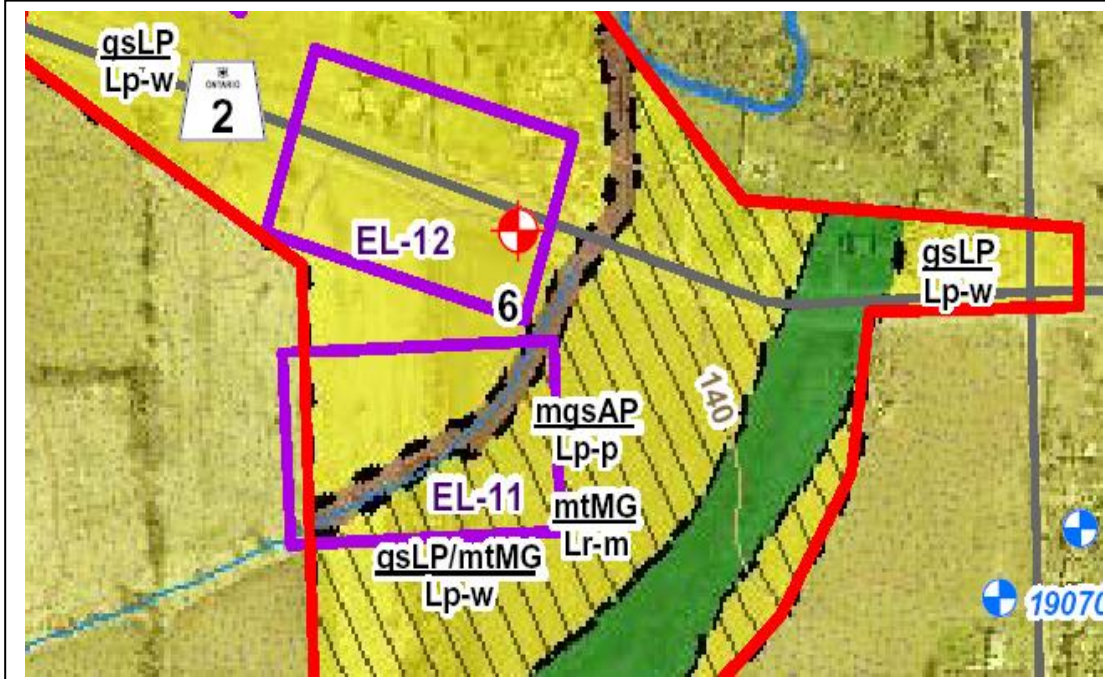


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EL-12

W.O: 07-20017    Section: Eastern    Location: East Link at Highway 2    Sta. 13+810

Original Grade: 139.6    Proposed Grade:    Description: Underpass to carry Highway 2 over East Link



Site Plan and Terrain Analysis – East Link and Hwy 2



Site Photograph – Hwy 2 looking west

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 6, 30M15-83</b>	<b>1. Abutments</b>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 8 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Excavations at this site should be expected to require major groundwater control and dewatering.
<p>Mapping ( East 10) shows that the site is underlain by a gravelly sand glaciolacustrine deposit. The relief is low plain, well drained.</p> <p>BH 6 encountered:</p> <p>0.0 – 1.4 Sand and gravel fill, dense</p> <p>1.4 – 2.5 Sandy silt, compact</p> <p>2.5 – 10.1 Clayey silt, firm to very stiff</p> <p>10.1 – 12.0 Sand and gravel, compact</p> <p>12.0 – 15.5 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b>Groundwater</b></p> <p>GWL was recorded at approximately 2.0m below ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>a. Footings may be founded on compacted Granular A cores as per current MTO standard practices at a minimum 2.0 m below existing grade.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below EL.125.0.</p> <p>a. ULS resistance – 1,600 kN</p> <p>b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b>2. Piers</b></p> <p>Driven piles are recommended for the support of piers.</p>	No global stability issues are anticipated based on available information.	Shallow depression with no geomorphic evidence of slope instability.
	<b>Site Ranking</b>		
	<b>Foundations:</b>	<b>Medium</b>	
	<b>Hydrogeology:</b>	<b>High</b>	



<b>Site No:</b>	EL-13
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Culvert 100m north of Highway 2 (Kingston Road)    **Sta.** 14+050

The map displays the Maple Grove Wetland Complex with several labeled units and features:

- Wetland Units:** EL-12, EL-13, EL-14, and EL-15 are outlined in purple.
- Roads:** Hancock Road is on the left, and Solina Road is on the right.
- Wetland Codes:**
  - mgsAP Lp-p is located within EL-13.
  - pOT Lp-v is located within EL-15.
  - nslP Lp-w is located near EL-12.
- Other Features:** A red line runs vertically through the center, and a blue line runs horizontally across the middle. A small red and white circular symbol is located near EL-12.

A photograph of a grassy field, likely a golf course, with a dense line of trees in the background. A small white marker with the number '1006' is visible in the grass. A road is visible in the foreground.

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> No Bh at the site, BH 6, 30M15-83, lies approx. 200m to the south.</p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleside instability.</p>
<p>Mapping (East 9 &amp; 10) shows that the site is underlain by a gravelly sand glaciolacustrine plain. The relief is low plain, poorly to very poorly drained.</p> <p>Specifically the site is associated with the PSW Maple Grove Wetland Complex.</p> <p>BH 6 encountered:</p> <p>0.0 – 1.4 Sand and gravel fill, dense</p> <p>1.4 – 2.5 Sandy silt, compact</p> <p>2.5 – 10.1 Clayey silt, firm to very stiff</p> <p>10.1 – 12.0 Sand and gravel, compact</p> <p>12.0 – 15.5 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b><u>Groundwater</u></b></p> <p>GWL is anticipated at or very close to the ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 300 kPa</li> <li>Resistance at SLS – 200 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Groundwater control may be required depending on final design and the time of year that construction is carried out.</p>	<p>Likely no appreciable alluvial deposits, based on field checks of similar swales.</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      High</b></p>	



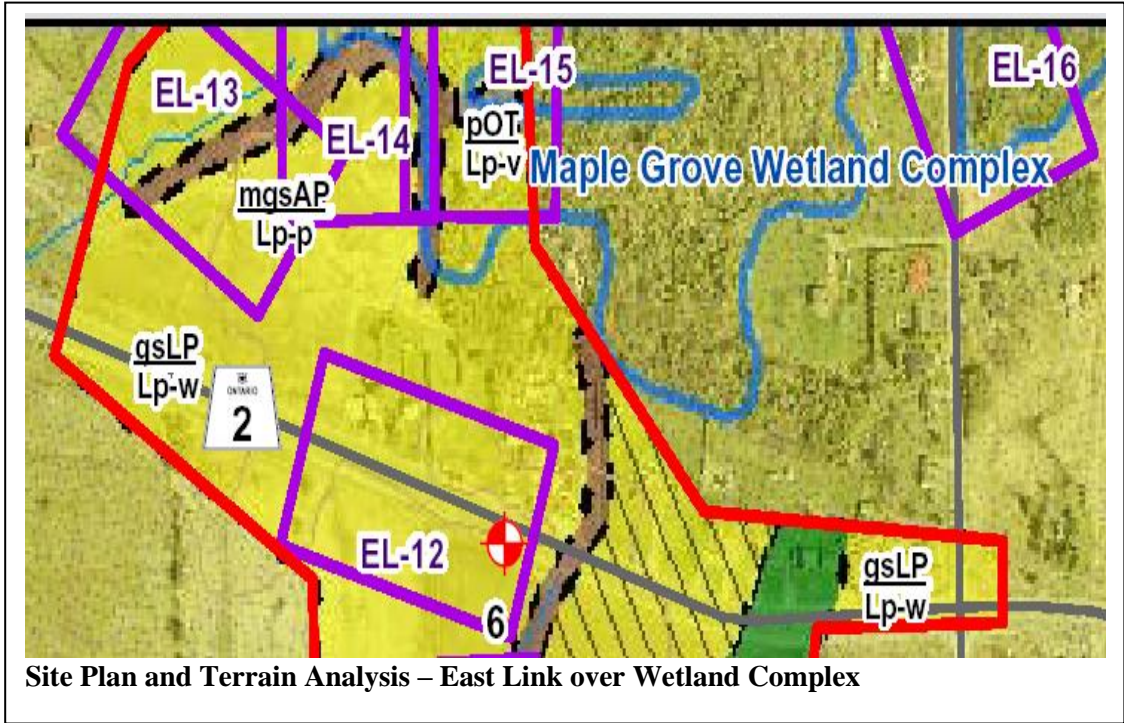
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-14
	EL-15

W.O: 07-20017    Section: Eastern    Location: East Link north of Highway 2    Sta. 14+075

Original Grade: ~139    Proposed Grade:    Description: Twin structures to carry East Link over a PSW (Maple Grove Wetland Complex).

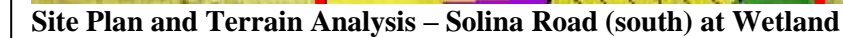


Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No Bh at the site, BH 6, 30M15-83, lies approx. 200m to the south.</b></p> <p>Mapping (East 9 &amp; 10) shows that the site is underlain by a gravelly sand glaciolacustrine plain. The relief is low plain, poorly to very poorly drained.</p> <p>Specifically the site span the PSW Maple Grove Wetland Complex.</p> <p>BH 6 encountered:</p> <p>0.0 – 1.4 Sand and gravel fill, dense</p> <p>1.4 – 2.5 Sandy silt, compact</p> <p>2.5 – 10.1 Clayey silt, firm to very stiff</p> <p>10.1 – 12.0 Sand and gravel, compact</p> <p>12.0 – 15.5 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b>Groundwater</b></p> <p>GWL is anticipated at or very close to the ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p><b>1. Abutments</b></p> <p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below EL.125.0.</p> <p>a. ULS resistance – 1,600 kN</p> <p>b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b>2. Piers</b></p> <p>Driven piles are recommended for the support of piers.</p>	<p>Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.</p> <p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 4 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>Global stability and settlement must be checked during detail design.</p>	<p>Excavations at this site should be expected to require major groundwater control and dewatering.</p> <p>Shallow depression with no geomorphic evidence of slope instability.</p> <p><b>HIGH PRIORITY AREA FOR FURTHER INVESTIGATION.</b></p>
		<p><b>Site Ranking</b></p> <p><b>Foundations: High</b></p> <p><b>Hydrogeology: High</b></p>	



<b>Site No:</b>	EL-16
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<b>Site No:</b>	EL-16
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**Sta.** 14+100

**Description:** Overpass to carry Solina Road over a PSW (Maple Grove Wetland Complex).

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No Bh at the site, BH 6, 30M15-83, lies approx. 500m to the southwest.</b>	<b><u>1. Abutments</u></b>  a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.  b. Footings on native soil not recommended at abutments based on existing information.  c. Abutments may also be supported on HP 310X110 piles driven below El.125.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 20m piles.  <b><u>2. Piers</u></b>  Driven piles are recommended for the support of piers.	Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.	Excavations at this site should be expected to require major groundwater control and dewatering.
Mapping (East 9 & 10) shows that the site is underlain by a gravelly sand glaciolacustrine plain. The relief is low plain, poorly to very poorly drained.  Specifically the site span the PSW Maple Grove Wetland Complex.  BH 6 encountered:  0.0 – 1.4 Sand and gravel fill, dense 1.4 – 2.5 Sandy silt, compact 2.5 – 10.1 Clayey silt, firm to very stiff 10.1 – 12.0 Sand and gravel, compact 12.0 – 15.5 (EOH) Silt, sand and gravel, glacial till, very dense.  <b><u>Groundwater</u></b>  GWL is anticipated at or very close to the ground surface.  <b>Estimated overburden thickness – 50m.</b>		Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 4 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.  Global stability and settlement must be checked during detail design.	Shallow depression with no geomorphic evidence of slope instability.  Based on the presence of the adjacent PSW, any widening or realignment may require substantial removal of organic and other unsuitable soil at the ground surface.  <b>HIGH PRIORITY AREA FOR FURTHER INVESTIGATION.</b>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>High</b>
		<b>Hydrogeology:</b>	<b>High</b>

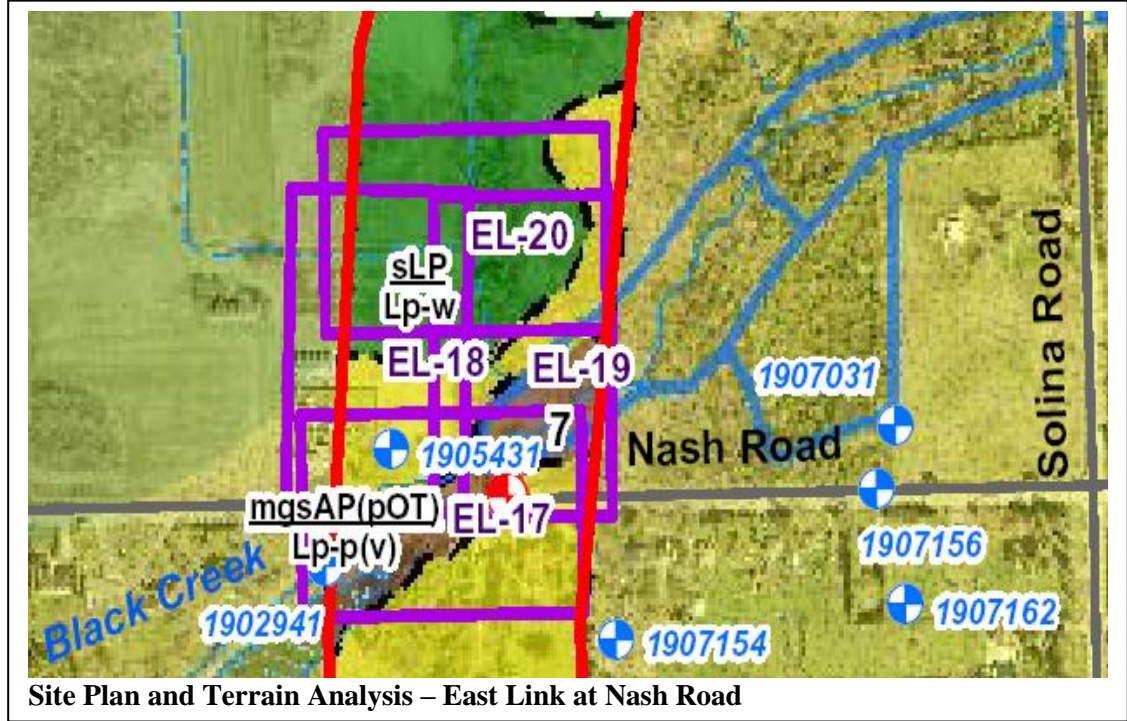


**HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS**  
(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No: EL-17

W.O: 07-20017    Section: Eastern    Location: East Link at Nash Road    Sta. 14+540

Original Grade: 140.7    Proposed Grade:    Description: Underpass to carry Nash Road over the East Link



Site Photograph – Nash Road looking east

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 7, 30M15-83</b>	<b>1. Abutments</b>	Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.	Excavations at this site should be expected to require major groundwater control and dewatering.
<p>Mapping (East 9) shows that the site is underlain by a 50m wide band of alluvium consisting of silty, gravelly sand with peat. The band of alluvium trends southwest to northeast across the site and the surrounding soil is mapped as gravelly sand, glaciolacustrine plain. The relief is low plain, poorly drained.</p> <p>BH 7 encountered:</p> <p>0.0 – 1.1 Pavement, base and organic silt, compact</p> <p>1.1 – 2.1 Sandy silt, compact</p> <p>2.1 – 11.9 Clayey silt, firm to stiff</p> <p>11.9 – 13.2 Sandy silt, trace gravel, compact</p> <p>13.2 – 15.7 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b>Groundwater</b></p> <p>GWL was recorded approximately 3.3m below ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below EL.125.0.</p> <p>a. ULS resistance – 1,600 kN</p> <p>b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b>2. Piers</b></p> <p>Driven piles are recommended for the support of piers.</p>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 8 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Shallow depression with no geomorphic evidence of slope instability.
		Global stability and settlement must be checked during detail design.	Based on the presence of the adjacent PSW, any widening or realignment may require substantial removal of organic and other unsuitable soil at the ground surface.
<b>Site Ranking</b>			
<b>Foundations:</b>		<b>Medium</b>	
<b>Hydrogeology:</b>		<b>High</b>	



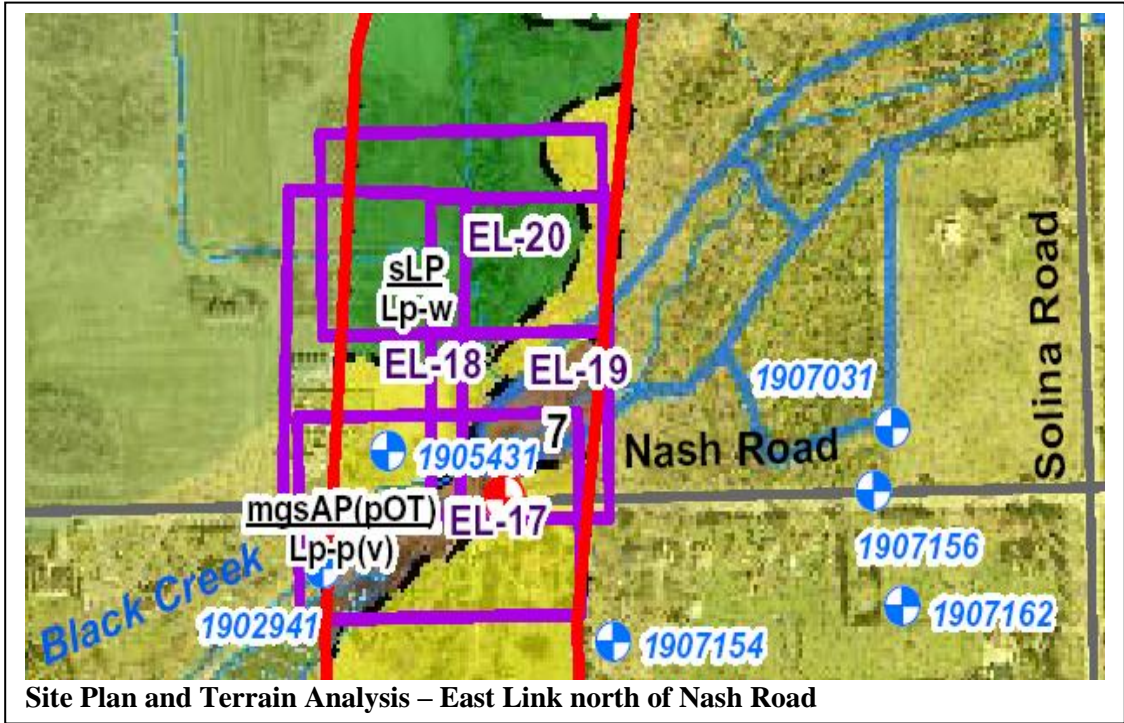
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-18
	EL-19

W.O: 07-20017    Section: Eastern    Location: East Link north of Nash Road    Sta. 14+600

Original Grade: ~140    Proposed Grade:    Description: Twin structures to carry the East Link over Black creek and PSW (Harmony-Farewell Iroquois Beach Wetland Complex)



Site Photograph – Nash Road looking northeast

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: BH 7, 30M15-83</b>	<b>1. Abutments</b>	Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.	Excavations at this site should be expected to require major groundwater control and dewatering.
<p>Mapping (East 9) shows that the site extends from a 50m wide band of alluvium consisting of silty, gravelly sand with peat northward across soil that is mapped as gravelly sand, glaciolacustrine plain. The relief is low plain, poorly drained. The area includes a PSW.</p> <p>BH 7 encountered:</p> <p>0.0 – 1.1    Pavement, base and organic silt, compact</p> <p>1.1 – 2.1    Sandy silt, compact</p> <p>2.1 – 11.9    Clayey silt, firm to stiff</p> <p>11.9 – 13.2    Sandy silt, trace gravel, compact</p> <p>13.2 – 15.7    (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b>Groundwater</b></p> <p>GWL was recorded approximately 3.3m below ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below EL.125.0.</p> <p>    a. ULS resistance – 1,600 kN</p> <p>    b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b>2. Piers</b></p> <p>Driven piles are recommended for the support of piers.</p>	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 4 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Moderately wide, shallow valley with no geomorphic evidence of slope instability.
		Global stability and settlement must be checked during detail design.	Based on the presence of the wetland, any new embankment construction may require substantial removal of organic soils.
<b>Site Ranking</b>			<b>HIGH PRIORITY AREA FOR PERMISSION TO ENTER</b>
<b>Foundations:</b>		<b>High</b>	
<b>Hydrogeology:</b>		<b>High</b>	



<b>Site No:</b>	EL-20
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**Sta.** 14+700

**Location:** Culvert 100m north of Nash Road

**Description:** East Durham Link crosses un-named creek on culvert.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH 7, 30M15-83, lies 100m to the south</b></p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p> <p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 300 kPa</li> <li>Resistance at SLS – 200 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability.</p> <p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Depending on final design and the time of year construction is carried out, groundwater control may be required. Temporary diversion may also be required.</p>
<p>Mapping (East 9) shows that the site is underlain by a 50m wide band of alluvium consisting of silty, gravelly sand with peat. The band of alluvium trends southwest to northeast across the site and the surrounding soil is mapped as gravelly sand, glaciolacustrine plain. The relief is low plain, poorly drained.</p> <p>BH 7 encountered:</p> <p>0.0 – 1.1 Pavement, base and organic silt, compact</p> <p>1.1 – 2.1 Sandy silt, compact</p> <p>2.1 – 11.9 Clayey silt, firm to stiff</p> <p>11.9 – 13.2 Sandy silt, trace gravel, compact</p> <p>13.2 – 15.7 (EOH) Silt, sand and gravel, glacial till, very dense.</p> <p><b><u>Groundwater</u></b></p> <p>GWL was recorded approximately 3.3m below ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    Medium</b></p>	

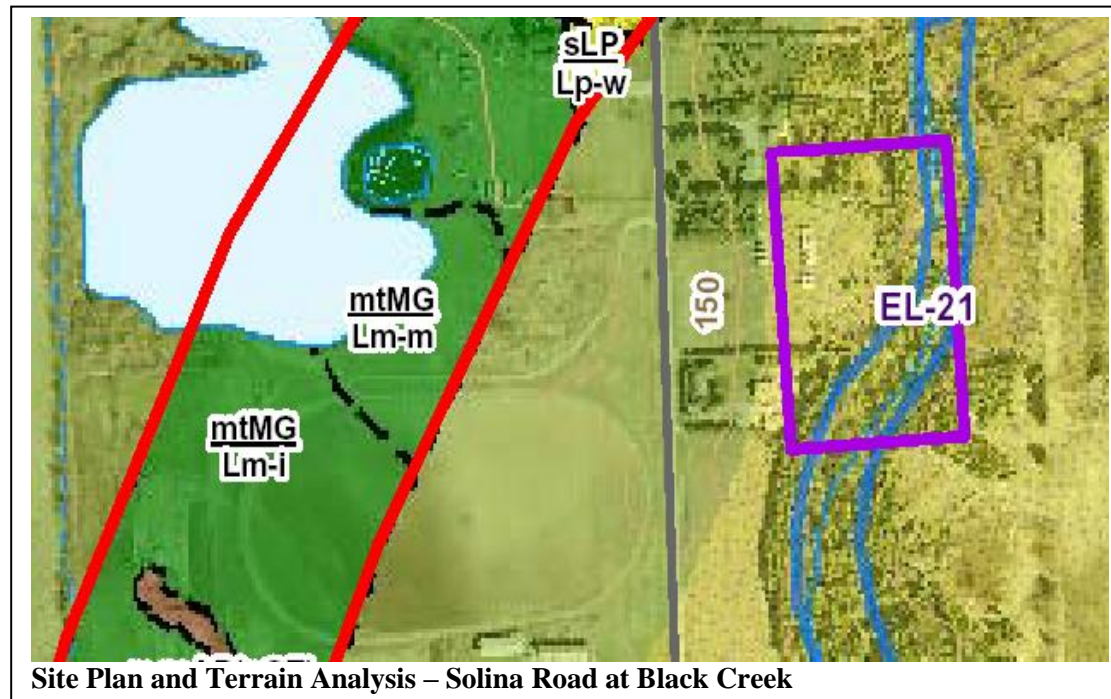


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EL-21
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Solina Road at Black Creek    **Sta.** 15+300

<b>Original Grade:</b> ~140	<b>Proposed Grade:</b>	<b>Description:</b> Structure to carry realigned Solina Road over Black Creek.
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at site.</b>	<b><u>1. Abutments</u></b>	Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.	Excavations at this site should be expected to require major groundwater control and dewatering.
<p>Mapping (East 9) shows that the site lies in an area of gravelly sand glaciolacustrine soil. Low relief predominates in the area. Black Creek is part of the Harmony-Farewell Iroquois Beach Wetland Complex.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>Groundwater level is anticipated close to the ground surface.</p> <p><b>Estimated overburden thickness – 50m.</b></p>	<p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.125.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 20m piles.</p> <p><b><u>2. Piers</u></b></p> <p>Driven piles are recommended for the support of piers.</p>	<p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 4 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p> <p>Global stability and settlement must be checked during detail design.</p>	<p>Based on the presence of the wetland, any new embankment construction may require substantial removal of organic soils.</p> <p>Moderately wide, shallow valley with no geomorphic evidence of slope instability.</p>
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Medium</b>
		<b>Hydrogeology:</b>	<b>Medium</b>

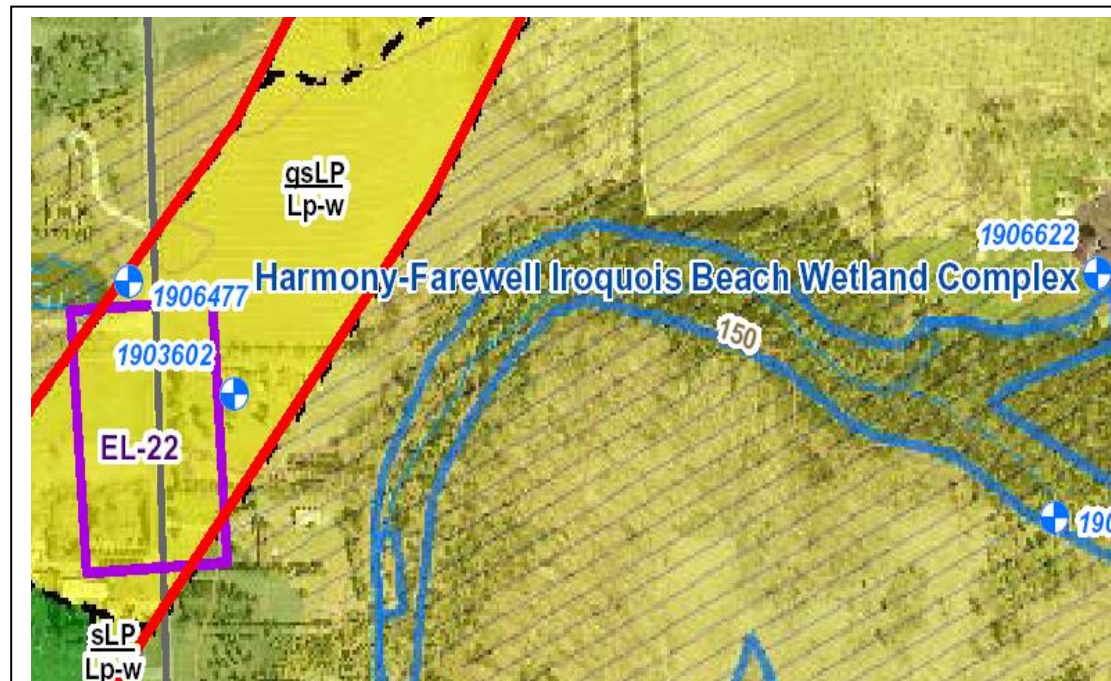


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EL-22
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**W.O:** 07-20017    **Section:** Eastern    **Location:** East Link at Solina Road    **Sta.** 15+600

<b>Original Grade:</b>	~150	<b>Proposed Grade:</b>		<b>Description:</b>	Underpass to carry Solina Road over the East Link
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### Site Plan and Terrain Analysis – East Link at Solina Road (north)



**Site Photograph – Solina Road looking north**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b><u>1. Abutments</u></b>  a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.  b. Footings on native soil not recommended at abutments based on existing information.  c. Abutments may also be supported on HP 310X110 piles driven below El.130.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN  d. Integral abutments are feasible. Assume 25m piles.  <b><u>2. Piers</u></b>  Driven piles are recommended for the support of piers.	Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 8 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.	Excavations at this site should be expected to require some groundwater control and dewatering.
<p>Mapping ( East 9) shows that the site is underlain by a gravelly sand glaciolacustrine plain. The relief is low plain well drained.</p> <p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>GWL is anticipated at 2 to 3m below ground surface.</p> <p><b>Estimated overburden thickness – 55m</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      Medium</b></p> <p><b>Hydrogeology:                    High</b></p>	



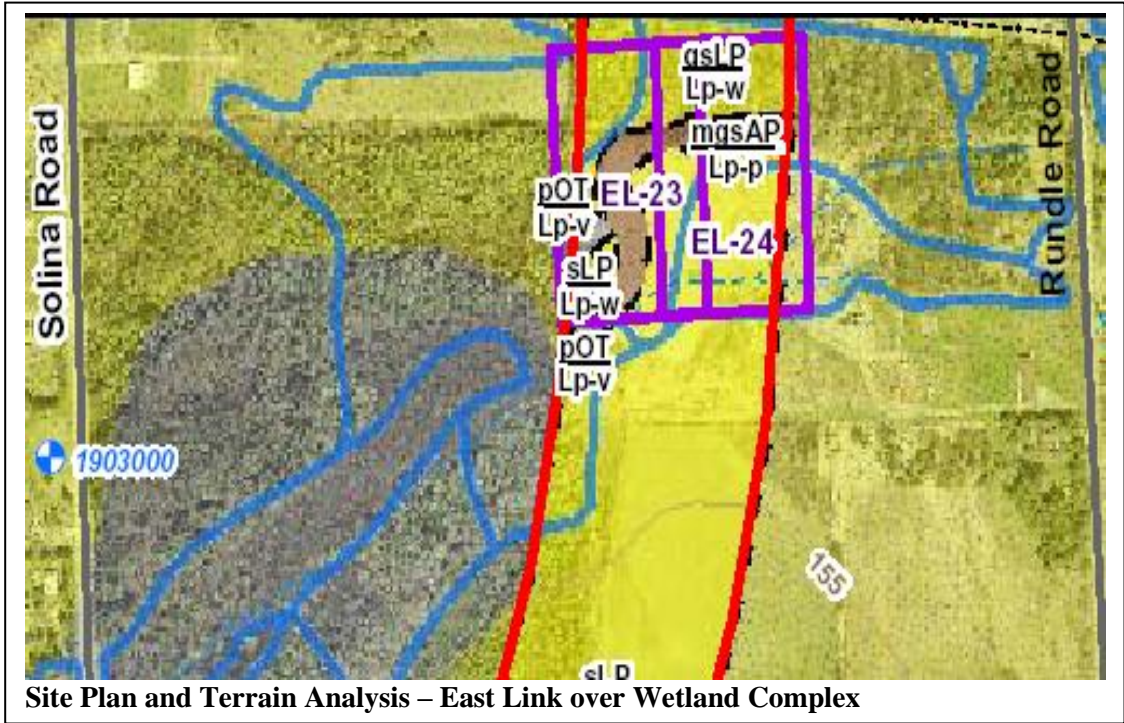
HIGHWAY 407 EAST EXTENSION – ANTICIPATED FOUNDATION CONDITIONS

(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)

Site No:	EL-23
	EL-24

W.O: 07-20017    Section: Eastern    Location: East Link at Harmony-Farewell Iroquois Beach Wetland Complex    Sta. 16+850

Original Grade: ~150    Proposed Grade:    Description: Twin structures to carry the East Link over the PSW.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site.</b></p> <p>Mapping (East 9) shows that the site is underlain by a sandy glaciolacustrine plain with some areas of peat. Specifically, the site spans a portion of the Harmony-Farewell Iroquois Beach Wetland Complex.</p> <p><b>Groundwater</b></p> <p>GWL is anticipated near the ground surface.</p> <p><b>Estimated overburden thickness – 55m.</b></p>	<p><b>1. Abutments</b></p> <p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. Footings on native soil not recommended at abutments based on existing information.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below EL.130.0.</p> <p>    a. ULS resistance – 1,600 kN</p> <p>    b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 25m piles.</p> <p><b>2. Piers</b></p> <p>Driven piles are recommended for the support of piers.</p>	<p>Based on the anticipated ground conditions, major stripping operations may be required to remove organic and other unsuitable soils at the ground surface.</p> <p>Subject to site investigation and laboratory testing, it is anticipated that approach fills up to 4 m high may be constructed at side slopes no steeper than 2H:1V using SSM or granular.</p>	<p>Excavations at this site should be expected to require major groundwater control and dewatering.</p> <p>Moderately wide, shallow valley with no geomorphic evidence of slope instability.</p> <p><b>HIGH PRIORITY AREA FOR PERMISSION TO ENTER</b></p>
<b>Site Ranking</b>			
<b>Foundations: High</b>			
<b>Hydrogeology: High</b>			



<b>Site No:</b>	EL-25
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Sta. 17+850

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	East Durham Link crosses un-named creek on culvert.
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No boreholes at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow valley with no geomorphic evidence of significant valleyside instability.  Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys  Intermittent stream. Culvert construction is recommended when stream bed is dry. Otherwise temporary diversion may be required. Groundwater control may be required.
Mapping ( East 8) shows that the site lies in an area of gravelly sand glaciolacustrine soil. The relief is low plain, poorly to very poorly drained. To the north of the creek, the glaciolacustrine deposit is interpreted to be a thin deposit overlying silt till ground moraine.			
<u>Groundwater</u>			
Groundwater level should be anticipated to be close to the ground surface.			
<b>Estimated overburden thickness – 55m.</b>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EL-26
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Culvert 60m south of Taunton Road    **Sta.** 18+350

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	Re-aligned Rundle Road crosses un-named creek on culvert.
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## Site Plan and Terrain Analysis



**Site Photograph – Rundle Road facing north at site EL-26**

Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No borehole at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.  Likely no appreciable alluvial deposits, based on field checks of similar swales
Mapping ( East 8) shows that the site lies in an area of gravelly sand glaciolacustrine soil overlying silt till ground moraine.			
<p style="text-align: center;"><b><u>Groundwater</u></b></p> <p>Groundwater should be anticipated to be close to the ground surface.</p> <p><b>Estimated overburden thickness – 55m.</b></p>			
		<b>Site Ranking</b>	
		<b>Foundations:</b>	<b>Low</b>
		<b>Hydrogeology:</b>	<b>Medium</b>



<b>Site No:</b>	EL-27
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Sta. 18+950

**Location:** East Link at Taunton Road

**Description:** Underpass to carry Taunton Road over the East Link



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b><u>1. Abutments</u></b>	Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.	No major dewatering requirements are anticipated.
Mapping (East 8) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.  <b><u>Groundwater</u></b>  GWL anticipated within 2 to 3m of ground surface.  <b>Estimated overburden thickness – 60m.</b>	a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.	No settlement or global stability issues are anticipated based on available information.	
	b. No information on which to base recommendations for spread footings. However, this option is frequently possible on till soils.	Topsoil or other unsuitable soils must be stripped prior to construction.	
	c. Abutments may also be supported on HP 310X110 piles driven below El.150.0. a. ULS resistance – 1,600 kN b. SLS resistance – 1,400 kN		
	d. Integral abutments are feasible. Assume 25m piles.		
	<b><u>2. Piers</u></b>		
	Driven piles are recommended for the support of piers.		
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<b>Site No:</b>	EL-28
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**Sta.** 18+950

**Location:** Culvert at Taunton Road on west side of East Durham Link

**Description:** Taunton Road crosses un-named creek.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> No borehole at the site.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 300 kPa b. Resistance at SLS – 200 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability  Likely no appreciable alluvial deposits, based on field checks of similar swales  Culvert construction at dry time of year is recommended. Otherwise, temporary diversion and/or groundwater control may be required.
Mapping (East 8) shows that the site lies in an area of silt till ground moraine. The relief is low and rolling and imperfectly drained.			
<u><b>Groundwater</b></u>  Groundwater should be anticipated to be at the ground surface.			
<b>Estimated overburden thickness – 60m.</b>			
<b>Site Ranking</b>			
<b>Foundations:                      Low</b>			
<b>Hydrogeology:                    Medium</b>			



<b>Site No:</b>	EL-29
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**Sta.** 18+950

**Location:** Culvert at Taunton Road on east side of East Durham Link

**Description:** Taunton Road crosses un-named creek.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> No borehole at the site.</p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 2 to 3 m below existing ground surface. Footings must bear below organics or recent alluvium.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability</p>
<p>Mapping (East 8) shows that the site lies in an area of silt till ground moraine. The relief is low and rolling and imperfectly drained.</p> <p><b><u>Groundwater</u></b></p> <p>Groundwater should be anticipated to be at the ground surface.</p> <p><b>Estimated overburden thickness – 60m.</b></p>	<p>Footings may be designed on the basis of</p> <ul style="list-style-type: none"> <li>a. Factored resistance at ULS – 300 kPa</li> <li>b. Resistance at SLS – 200 kPa</li> </ul> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p></p>	<p>Likely no appreciable alluvial deposits, based on field checks of similar swales</p> <p>Culvert construction at dry time of year is recommended. Otherwise, temporary diversion and/or groundwater control may be required.</p>
		<p align="center"><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                    Medium</b></p>	

**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

**Sta.** N/A

**Sta.** N/A

<b>Original Grade:</b> ~180	<b>Proposed Grade:</b>	<b>Description:</b> Structure to grade-separate freeway to freeway ramps
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes: No BH at the site.</b>	<b><u>1. Abutments</u></b>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	No major dewatering requirements are anticipated.
<p>Mapping (East 1) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p><b><u>Groundwater</u></b></p> <p>GWL anticipated within 2 to 3m of ground surface.</p> <p><b>Estimated overburden thickness – 65m.</b></p>	<p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. No information on which to base recommendations for spread footings. However, this option is frequently possible on till soils.</p> <p>c. Abutments may also be supported on HP 310X110 piles driven below El.160.0.</p> <p style="padding-left: 40px;">a. ULS resistance – 1,600 kN</p> <p style="padding-left: 40px;">b. SLS resistance – 1,400 kN</p> <p>d. Integral abutments are feasible. Assume 25m piles.</p> <p><b><u>2. Piers</u></b></p> <p>Driven piles are recommended for the support of piers.</p>	<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                      Low</b></p>	



<b>Site No:</b>	EL-31
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**Sta.** N/A

**Location:** Mainline at East Link

**Description:** 407 W – S Link Ramp over Black Creek



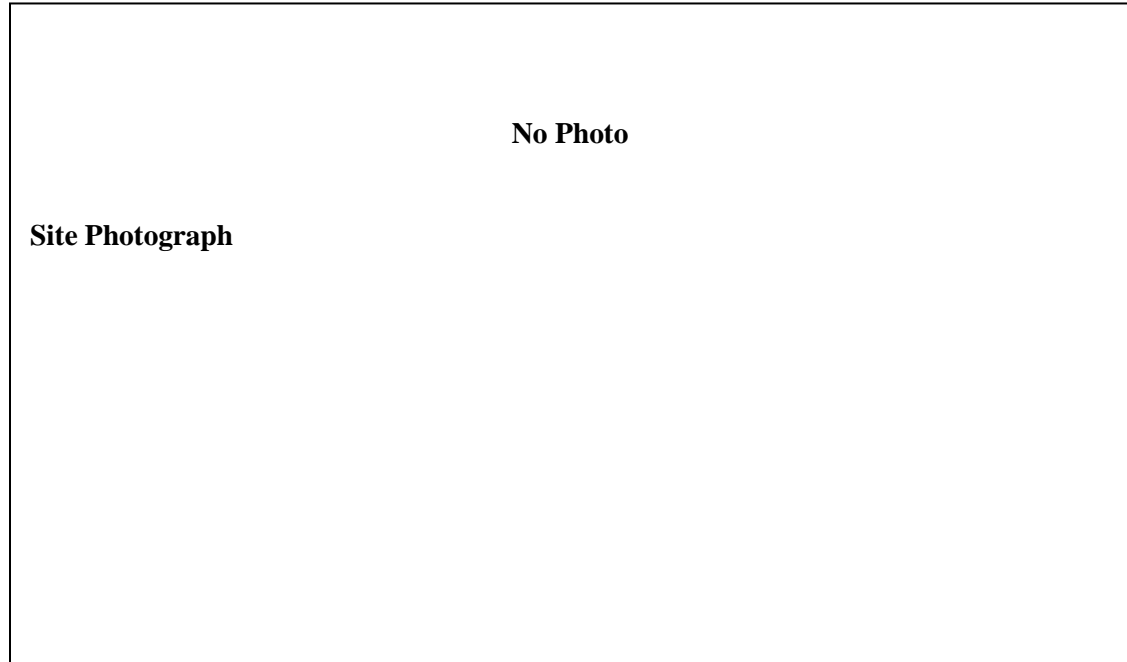
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: BH P29, Book 22 ~400m west at Solina Road</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. For perched abutments, footings may be founded on Granular A cores.            – Factored resistance at ULS – 900 kPa            – Resistance at SLS – 350 kPa</p> <p>b. For closed abutments, footings may be founded on native soil below El. 186.0            – Factored resistance at ULS – 750 kPa            – Resistance at SLS – 500 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0.            – ULS resistance – 1,600 kN            – SLS resistance – 1,400 kN</p> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers are not anticipated but if required may be supported using the same foundation.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>Groundwater control will be required for excavations penetrating below the groundwater level.</p> <p>Near surface sandy silt soils will be readily disturbed. Clayey silt till less so.</p>
<p>Mapping (East 1) shows 20 to 60m wide band of recent alluvium with a meandering creek. The surrounding soils consist of thin deposits of silty sand, glaciolacustrine plain overlying silt till ground moraine.</p> <p>BH P29 encountered:</p> <p>0.0 – 4.9 Silty sand, very dense            4.9 – 9.3 EOH Clayey silt till, hard</p> <p><b><u>Groundwater</u></b></p> <p>Groundwater should be anticipated to be at the creek level and close to ground level.</p> <p><b>Estimated overburden thickness – 65m.</b></p>		<p><b>Site Ranking</b></p> <p><b>Foundations: High</b></p> <p><b>Hydrogeology: Medium</b></p>	

<b>Site No:</b>	EL-32
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**Sta.** N/A

**Location:** Mainline at East Link

**Description:** Link S – W 407 Ramp crosses 407



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. BH P30, 30M15-85, lies 450m northeast.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. For closed abutments, footings may be founded on native soil below El. 190.0            – Factored resistance at ULS – 750 kPa            – Resistance at SLS – 500 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0.            – ULS resistance – 1,600 kN            – SLS resistance – 1,400 kN</p> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment. Assume 20m piles.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on the very dense native soil are recommended.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
<p>Mapping (East 1 &amp; 2) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5.</p> <p><b>Estimated overburden thickness – 65m.</b></p>		<p style="text-align: center;"><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                      Low</b></p>	

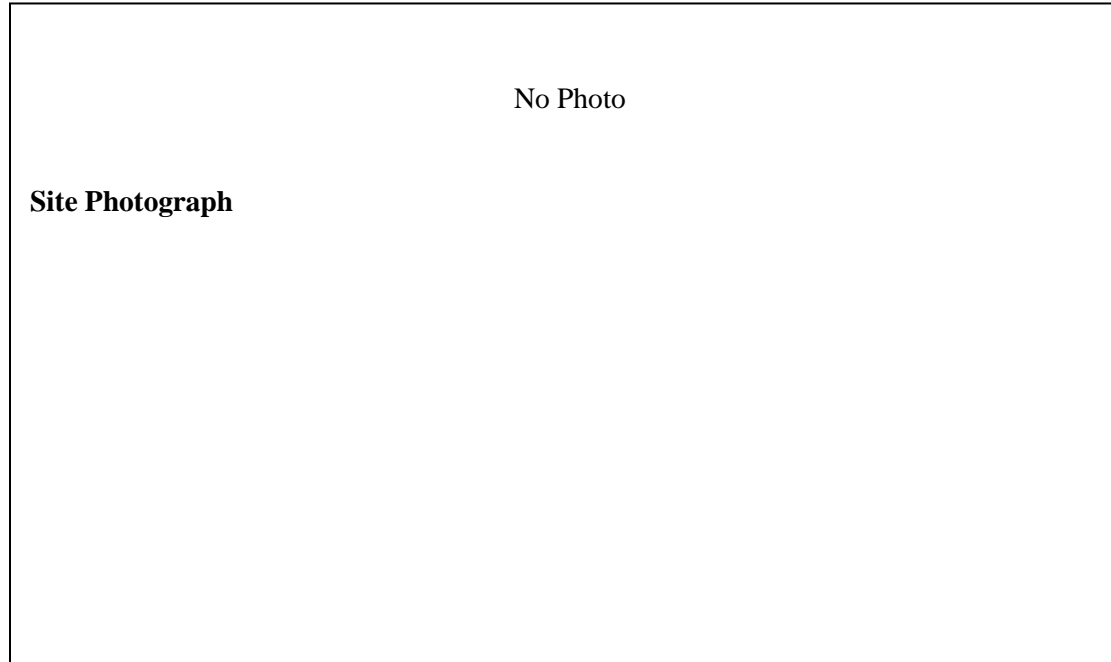


<b>Site No:</b>	EL-33
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**Sta.** N/A

**Location:** Mainline at East Link

**Description:** 407 E – S Link Ramp crosses 407

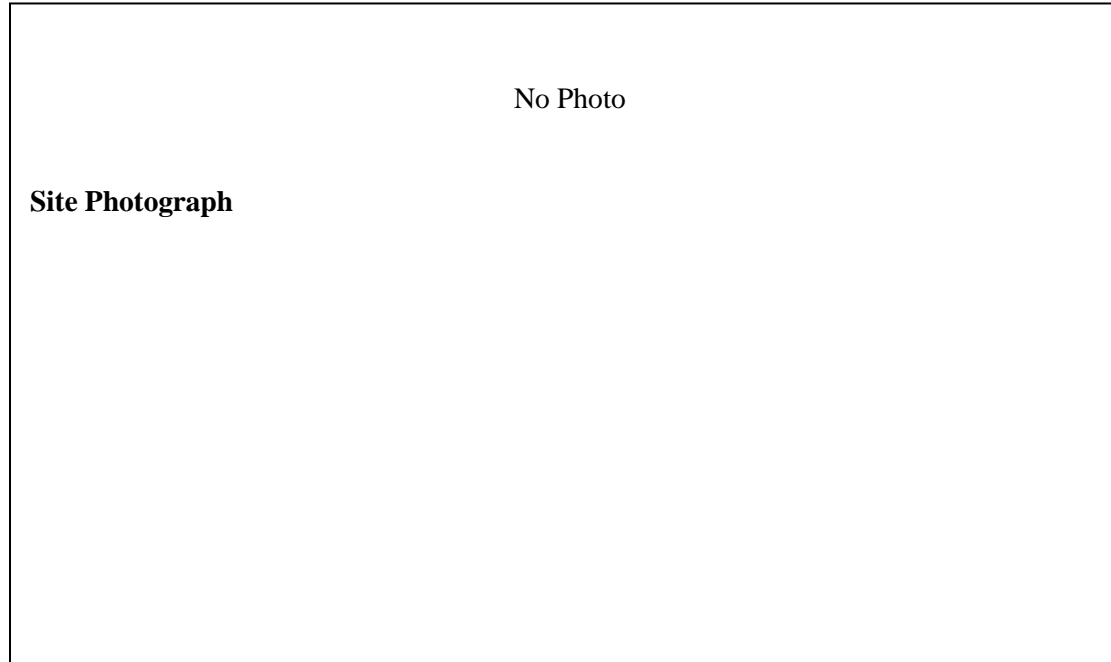


Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. BH P30, 30M15-85, lies 450m northeast.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. For closed abutments, footings may be founded on native soil below El. 190.0 – Factored resistance at ULS – 750 kPa – Resistance at SLS – 500 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0. – ULS resistance – 1,600 kN – SLS resistance – 1,400 kN</p> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment. Assume 20m piles.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on the very dense native soil are recommended.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
<p>Mapping (East 1 &amp; 2) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5.</p> <p><b>Estimated overburden thickness –70m.</b></p>		<p><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                      Low</b></p>	

<b>Site No:</b>	EL-33
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**Sta.** N/A

<b>Original Grade:</b> ~190	<b>Proposed Grade:</b>	<b>Description:</b> 407 E – S Link Ramp crosses 407
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Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes: No BH at the site. BH P30, 30M15-85, lies 450m northeast.</b></p>	<p><b><u>1. Abutments</u></b></p> <p>a. Footings on Granular A cores as per current MTO standard practices maybe possible but require detailed investigation.</p> <p>b. For closed abutments, footings may be founded on native soil below El. 190.0          – Factored resistance at ULS – 750 kPa          – Resistance at SLS – 500 kPa</p> <p>c. Abutments may also be supported on driven HP 310X110 piles driven below El. 186.0.          – ULS resistance – 1,600 kN          – SLS resistance – 1,400 kN</p> <p>d. Pre-drilling may be required to achieve sufficient depth of embedment. Assume 20m piles.</p> <p>e. Integral abutments are feasible.</p> <p><b><u>2. Piers</u></b></p> <p>Piers may be supported using the same foundation options as for abutments.</p> <p>Spread footings on the very dense native soil are recommended.</p>	<p>Approach fills up to 10 m high may be constructed at side slopes up to 2H:1V using SSM or better.</p> <p>No settlement or global stability issues are anticipated based on available information.</p> <p>Topsoil or other unsuitable soils must be stripped prior to construction.</p>	<p>No major dewatering requirements are anticipated.</p>
<p>Mapping (East 1 &amp; 2) shows that the site is underlain by silt till ground moraine. The relief is low, rolling, imperfectly drained.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5.</p> <p><b>Estimated overburden thickness –70m.</b></p>		<p><b>Site Ranking</b></p> <p><b>Foundations:                      High</b></p> <p><b>Hydrogeology:                      Low</b></p>	

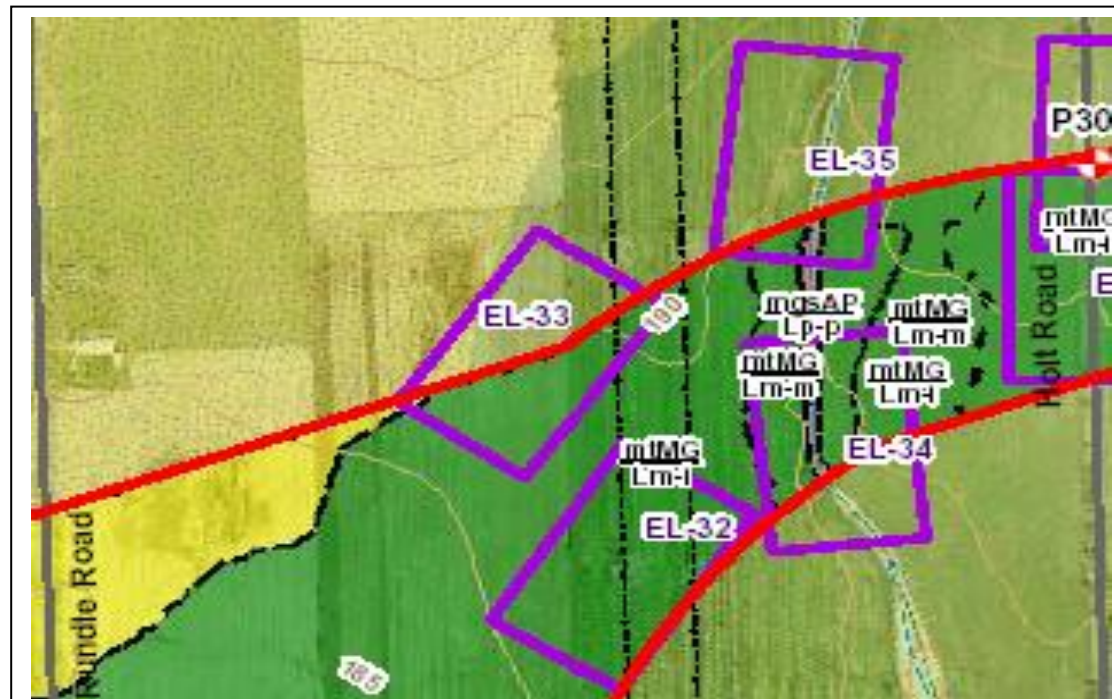


**(Based on interpolated or very limited data. The recommendations are for planning and preliminary design only and are not suitable for detail design)**

<b>Site No:</b>	EL-34
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**W.O:** 07-20017    **Section:** Eastern    **Location:** Culvert 200m west of Holt Road    **Sta.** 20+600

<b>Original Grade:</b>	<b>Proposed Grade:</b>	<b>Description:</b>	East Durham Link S-E Ramp crosses un-named creek.
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**Site Plan and Terrain Analysis – Link S-E Ramp crosses creek.**

No photo

### Site Photograph

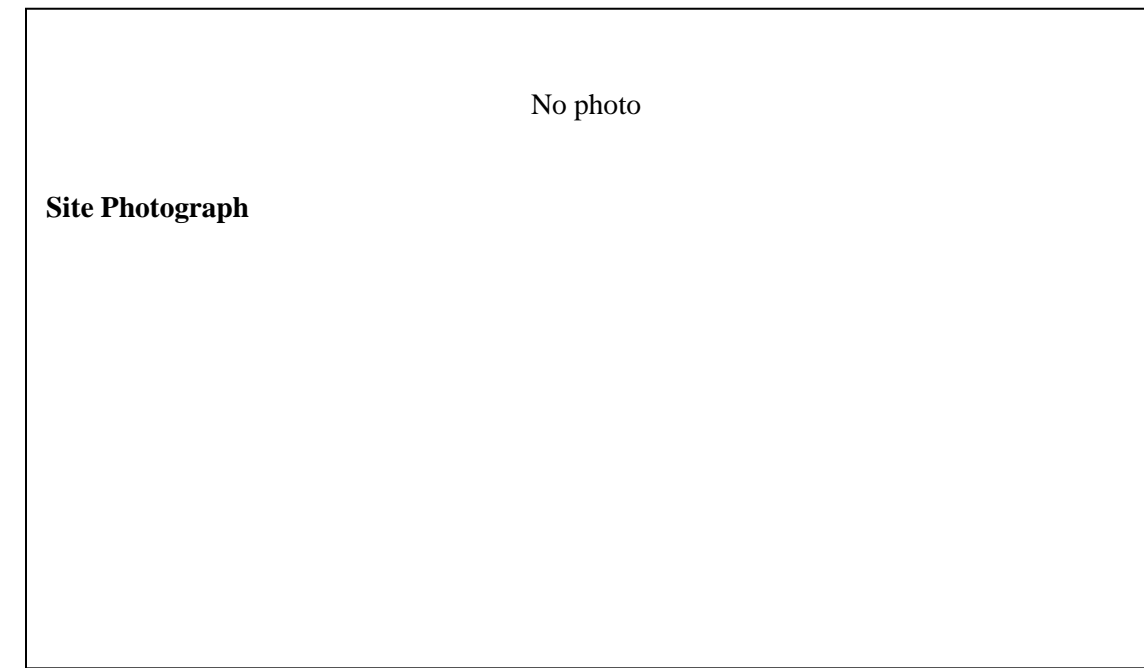
Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<b>Boreholes:</b> BH P30, 30M15-85, lies approx. 200m to the east.	For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.  Footings may be designed on the basis of a. Factored resistance at ULS – 450 kPa b. Resistance at SLS – 300 kPa  A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.	Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability.
Mapping (East 2) shows that the site lies in an area of silt till ground moraine. Locally, the creek lies in a narrow band of recent alluvium.			Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys
BH P30 encountered:  0.0 – 12.3 EOH Silty sand to sandy silt till, very dense			Groundwater control and temporary creek diversion may be required for construction of the culvert.
<u>Groundwater</u>			
The GWL recorded in the borehole at approx. Elevation 186.5 in the borehole. GWL at the ground surface should be anticipated at the creek.			
<b>Estimated overburden thickness – 65m.</b>			

<b>Site No:</b>	EL-35
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**Sta.** 20+600

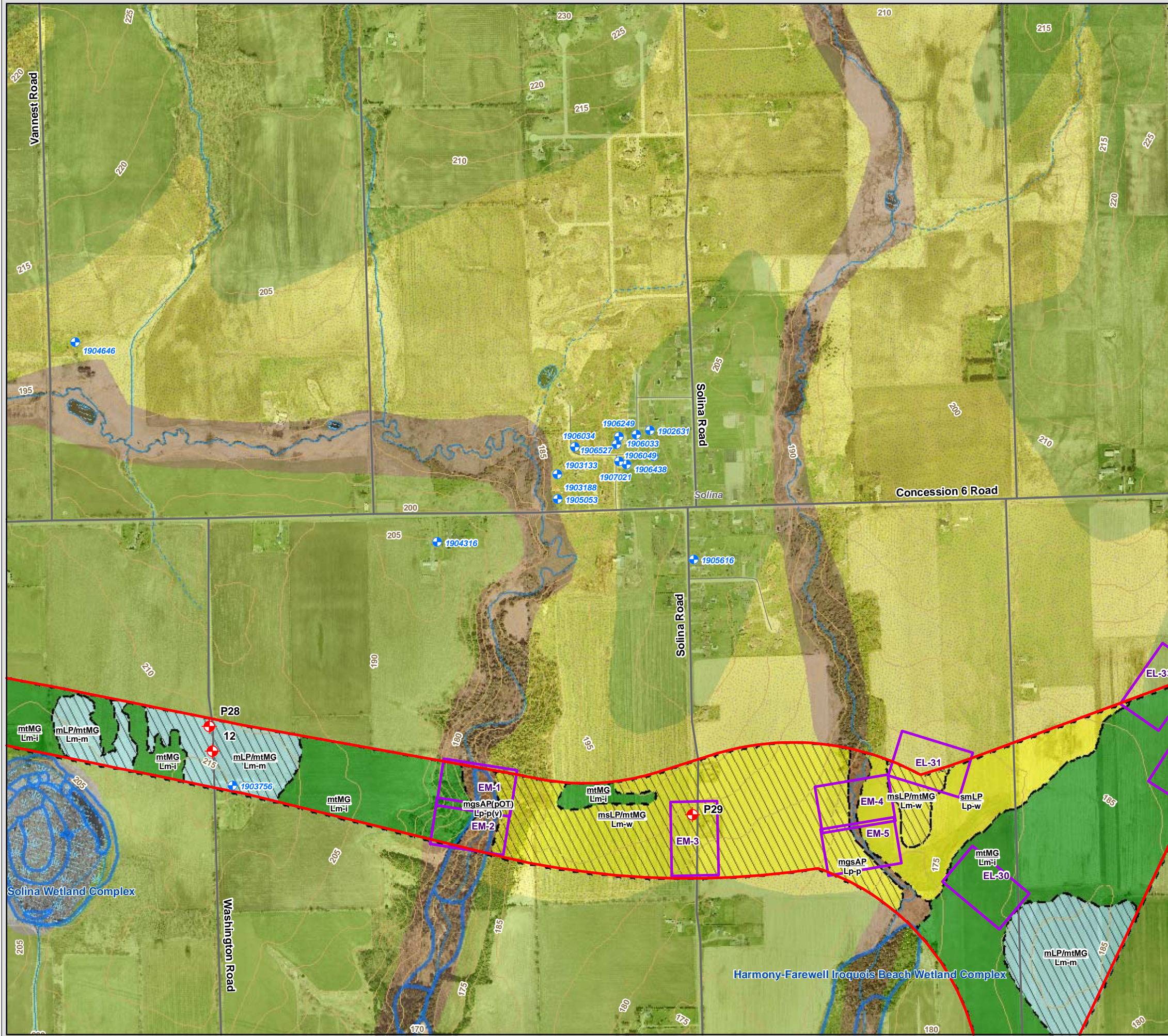
**Location:** Culvert 200m west of Holt Road

**Description:** East Durham Link E-S Ramp crosses un-named creek.



Summarized Subsurface Conditions	Recommendations		Remarks
	Structure	Approaches	
<p><b>Boreholes:</b> BH P30, 30M15-85, lies approx. 200m to the east.</p>	<p>For planning purposes, it may be assumed that an open footing culvert may be supported on the native soil at depths in the order to 1 to 2 m below existing ground surface. Footings must bear below organics or recent alluvium.</p>	<p>Comparatively low approaches across a shallow valley in a clayey silt till sheet. No stability or settlement issues are anticipated.</p>	<p>Narrow, shallow swale with no geomorphic evidence of significant valley-side instability.</p>
<p>Mapping (East 2) shows that the site lies in an area of silt till ground moraine. Locally, the creek lies in a narrow band of recent alluvium.</p> <p>BH P30 encountered:</p> <p>0.0 – 12.3 EOH Silty sand to sandy silt till, very dense</p> <p><b><u>Groundwater</u></b></p> <p>The GWL recorded in the borehole at approx. Elevation 186.5 in the borehole. GWL at the ground surface should be anticipated at the creek.</p> <p><b>Estimated overburden thickness – 65m.</b></p>	<p>Footings may be designed on the basis of</p> <ol style="list-style-type: none"> <li>Factored resistance at ULS – 450 kPa</li> <li>Resistance at SLS – 300 kPa</li> </ol> <p>A closed box culvert may also be used at this site. Assume the culvert will be bedded on Granular A. The required thickness of bedding must be determined during detail design.</p>	<p></p>	<p>Valley bottom sediments likely &lt;2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys</p> <p>Groundwater control and temporary creek diversion may be required for construction of the culvert.</p>
		<p><b>Site Ranking</b></p> <p><b>Foundations:                      Low</b></p> <p><b>Hydrogeology:                      Low</b></p>	





**Legend**

**LANDFORM**

ORGANIC

OT Organic terrain

ALLUVIAL

AP Alluvial plain

GLACIOLACUSTRINE

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

GLACIOFLUVIAL

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

MORAINAL

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

s sand, sandy

m silt, silty

t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)

M Mainly moderate local relief (15 - 60 m)

L Mainly low local relief (<15 m)

**VARIETY**

c channelled

d dissected, gullied

j jagged, rugged, cliffed

k kettled, pitted

n knobby, hummocky

p plain

r ridged

s sloping

t terraced

u undulating

m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

**Components of Terrain/Drainage Code**

Dominant landform

Material of subordinate landform

Subordinate landform

Material

Local relief of dominant landform

Topographic variety of dominant landform

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

tMG (pOT)

Lu (Lp) - m(v)

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

Notes:

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.

2. Mapping completed by R. McKillop (Gartner Lee Limited), based on the format of the Northern Ontario Engineering Geology Terrain Study (Gartner et al., 1981), with drainage classes assigned according to the British Columbia Field Manual for Describing Terrestrial Ecosystems.

3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.

4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.

5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).

6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

**Technically Recommended Route**

**Terrain/Drainage Map with**

**Proposed Structures**

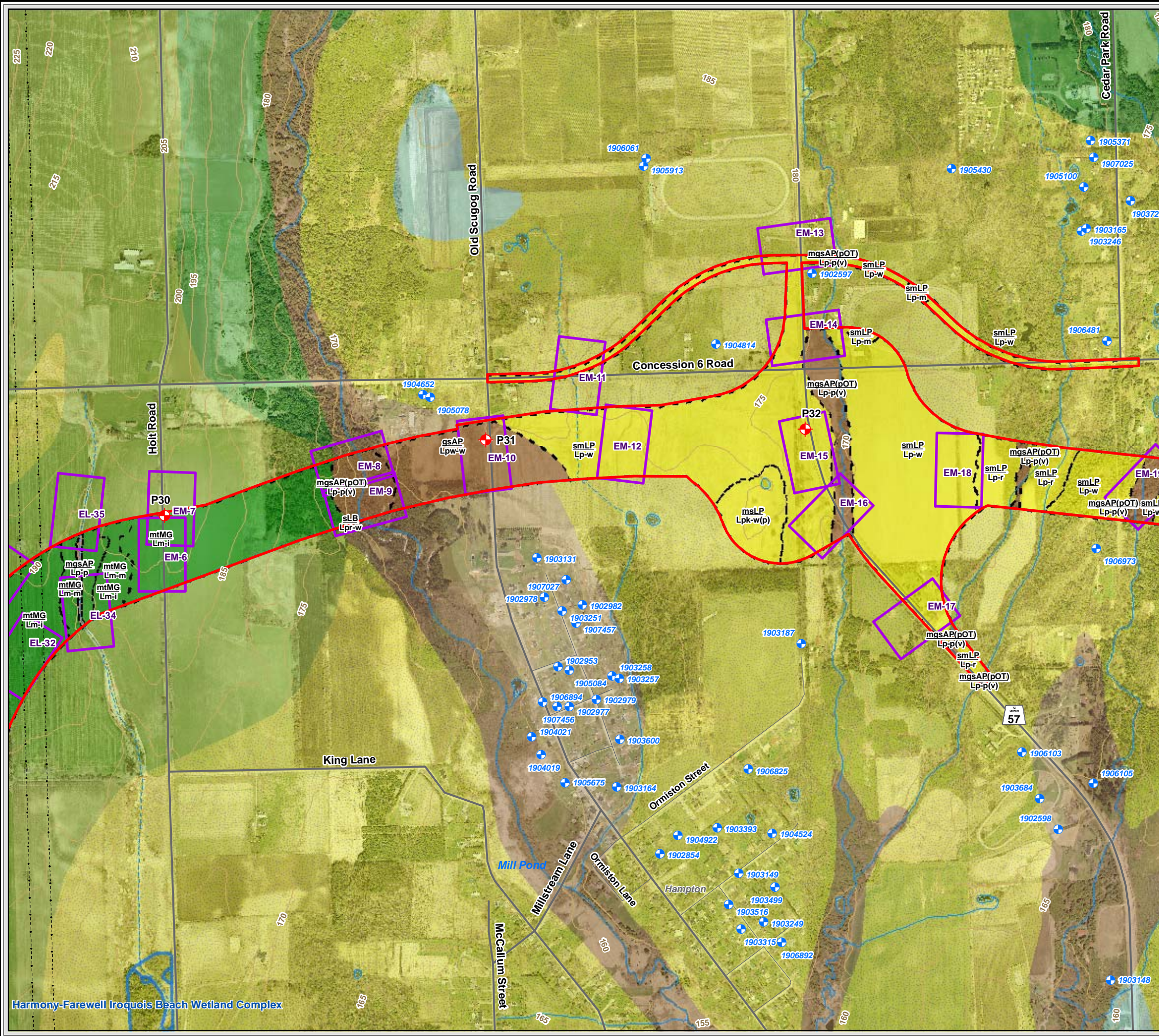
December 2007

Project 50613

Gartner Lee

East 1





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

**MATERIAL**

b boulders, bouldery  
c clay, clayey  
g gravel, gravelly  
p peat, muck  
r rubble  
s sand, sandy  
m silt, silty  
t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)  
M Mainly moderate local relief (15 - 60 m)  
L Mainly low local relief (<15 m)

**VARIETY**

c channelled  
d dissected, gullied  
j jagged, rugged, cliffed  
k kettled, pitted  
n knobby, hummocky  
p plain  
r ridged  
s sloping  
t terraced  
u undulating  
m rolling  
w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
p Poorly drained  
v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road  
Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

Notes:

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.
2. Mapping completed by R. McKillop (Gartner Lee Limited), based on the format of the Northern Ontario Engineering Geology Terrain Study (Gartner et al., 1981), with drainage classes assigned according to the British Columbia Field Manual for Describing Terrestrial Ecosystems.
3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.
4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.
5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).
6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

0 50 100 200 300 400 500  
1:10,000  
UTM Zone 17N, NAD 83

407 Environmental Assessment

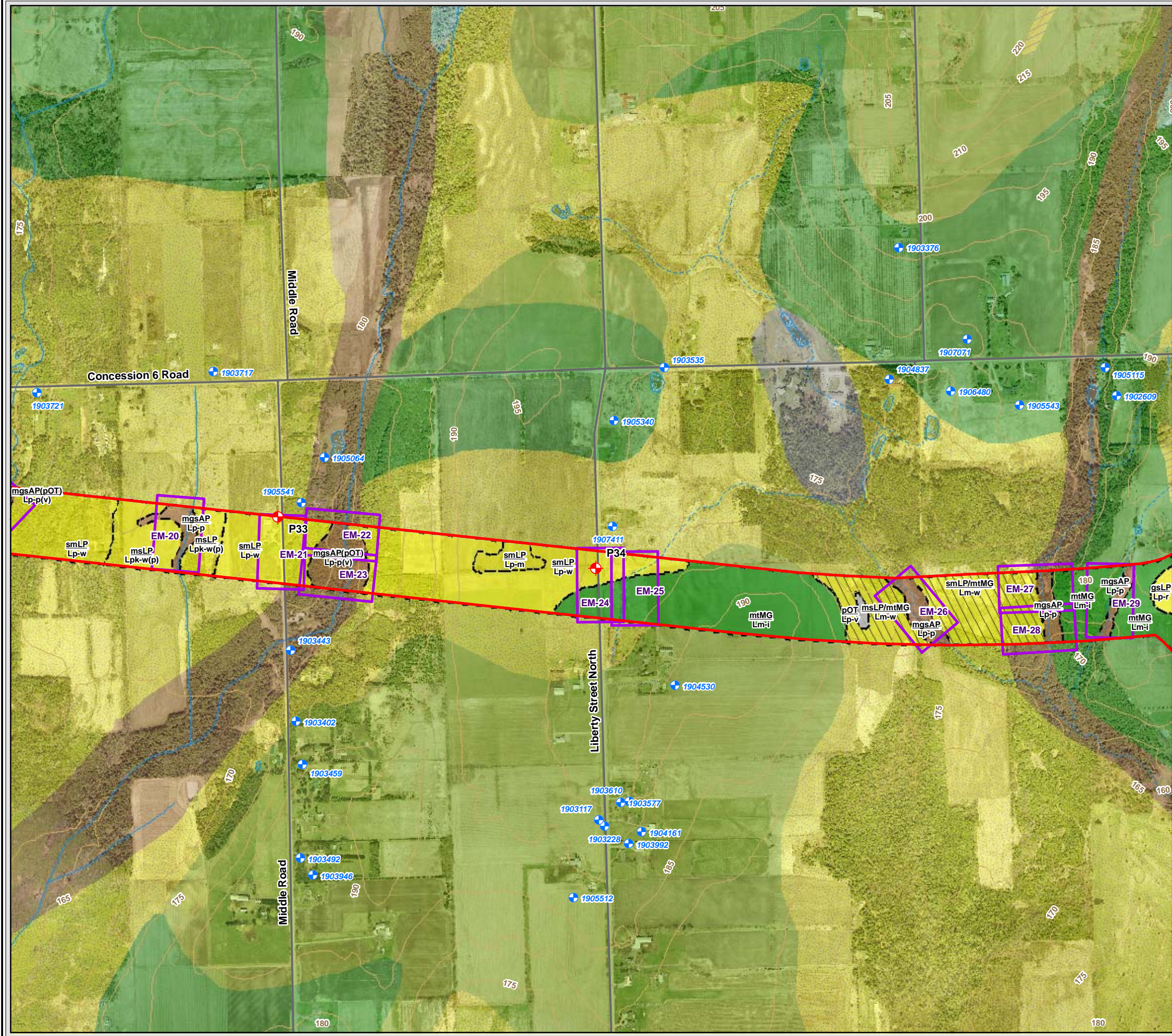
**Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures**

December 2007  
Project 50613

**Gartner Lee**

East 2





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

**MORAINAL**

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform — Material of subordinate landform — Subordinate landform

Material — Local relief of dominant landform — Topographic variety of dominant landform

Local relief of subordinate landform — Topographic variety of subordinate landform — Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

**tMG (pOT)**

**Lu (Lp) - m(v)**

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

s sand, sandy

m silt, silty

t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)

M Mainly moderate local relief (15 - 60 m)

L Mainly low local relief (<15 m)

**VARIETY**

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j jagged, rugged, cliffed

k kettled, pitted

n knobby, hummocky

p plain

r ridged

s sloping

t terraced

u undulating

m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

**Notes:**

1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.

2. Mapping completed by R. McKillop (Gartner Lee Limited), based on the format of the Northern Ontario Engineering Geology Terrain Study (Gartner et al., 1981), with drainage classes assigned according to the British Columbia Field Manual for Describing Terrestrial Ecosystems.

3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.

4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.

5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).

6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

0 50 100 200 300 400 500

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

**Technically Recommended Route**

**Terrain/Drainage Map with**

**Proposed Structures**

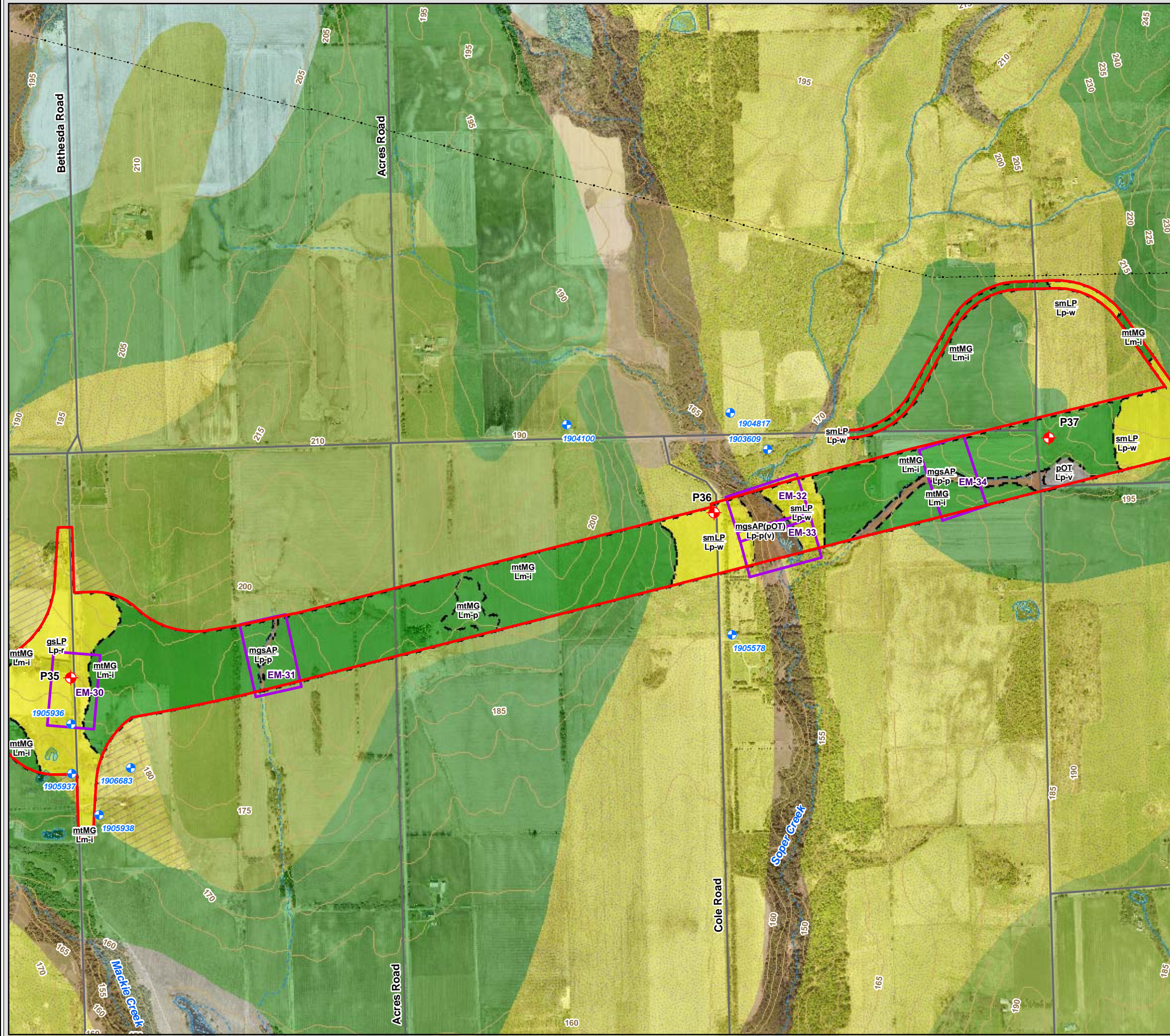
December 2007

Project 50613

**Gartner Lee**

East 3





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

**MORAINAL**

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform

Material  
Local relief of dominant landform  
Topographic variety of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

s sand, sandy

m silt, silty

t till

**TOPOGRAPHY**

**LOCAL RELIEF**

H Mainly high local relief (>60 m)

M Mainly moderate local relief (15 - 60 m)

L Mainly low local relief (<15 m)

**VARIETY**

c channelled

d dissected, gullied

j jagged, rugged, cliffed

k kettled, pitted

n knobby, hummocky

p plain

r ridged

s sloping

t terraced

u undulating

m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

**Notes:**

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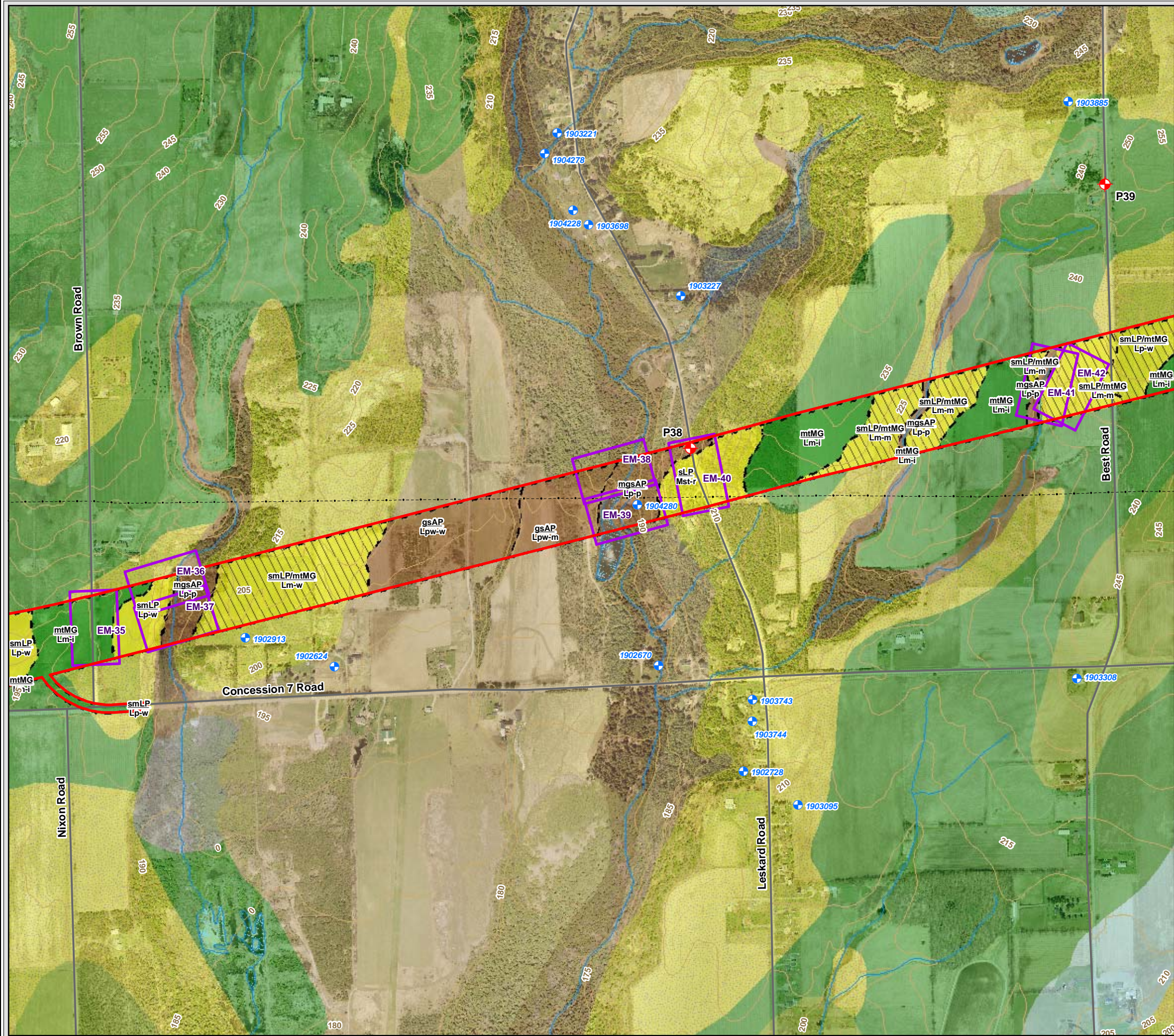
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6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

0 50 100 200 300 400 500  
1:10,000  
UTM Zone 17N, NAD 83





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

**tMG (pOT)**  
**Lu (Lp) - m(v)**

**MATERIAL**

b boulders, bouldery  
c clay, clayey  
g gravel, gravelly  
p peat, muck  
r rubble  
s sand, sandy  
m silt, silty  
t till

**TOPOGRAPHY**

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M Mainly moderate local relief (15 - 60 m)  
L Mainly low local relief (<15 m)

**VARIETY**

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j jagged, rugged, cliffed  
k kettled, pitted  
n knobby, hummocky  
p plain  
r ridged  
s sloping  
t terraced  
u undulating  
m rolling  
w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
p Poorly drained  
v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road  
Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

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0 50 100 200 300 400 500  
1:10,000  
UTM Zone 17N, NAD 83

407 Environmental Assessment

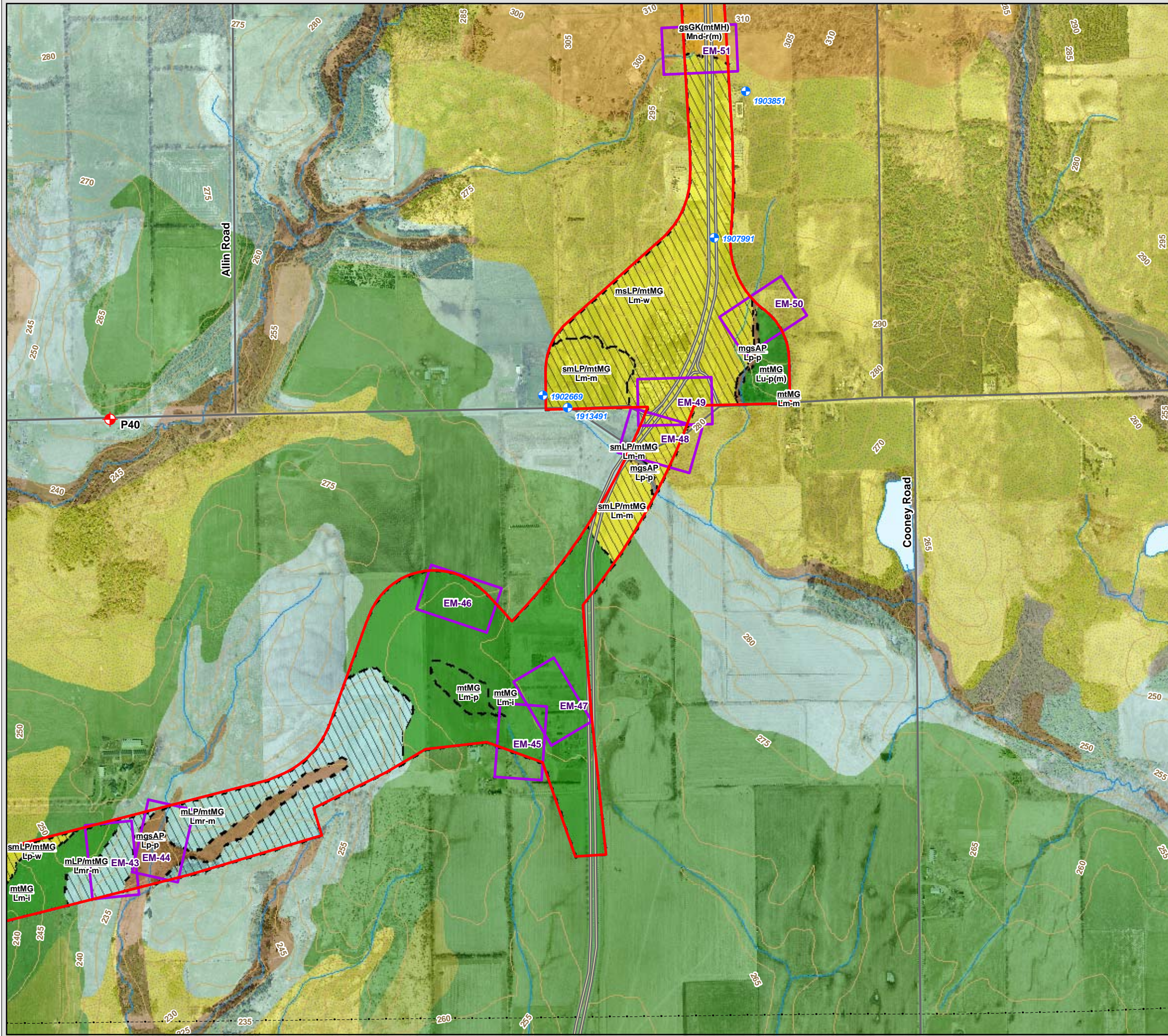
**Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures**

December 2007  
Project 50613

**Gartner Lee**

East 5





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine  
GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

**MATERIAL**

b boulders, bouldery  
c clay, clayey  
g gravel, gravelly  
p peat, muck  
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s sand, sandy  
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t till

**TOPOGRAPHY**

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r ridged  
s sloping  
t terraced  
u undulating  
m rolling  
w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
p Poorly drained  
v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road

Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

Scale: 0 50 100 200 300 400 500 m  
1:10,000  
UTM Zone 17N, NAD 83

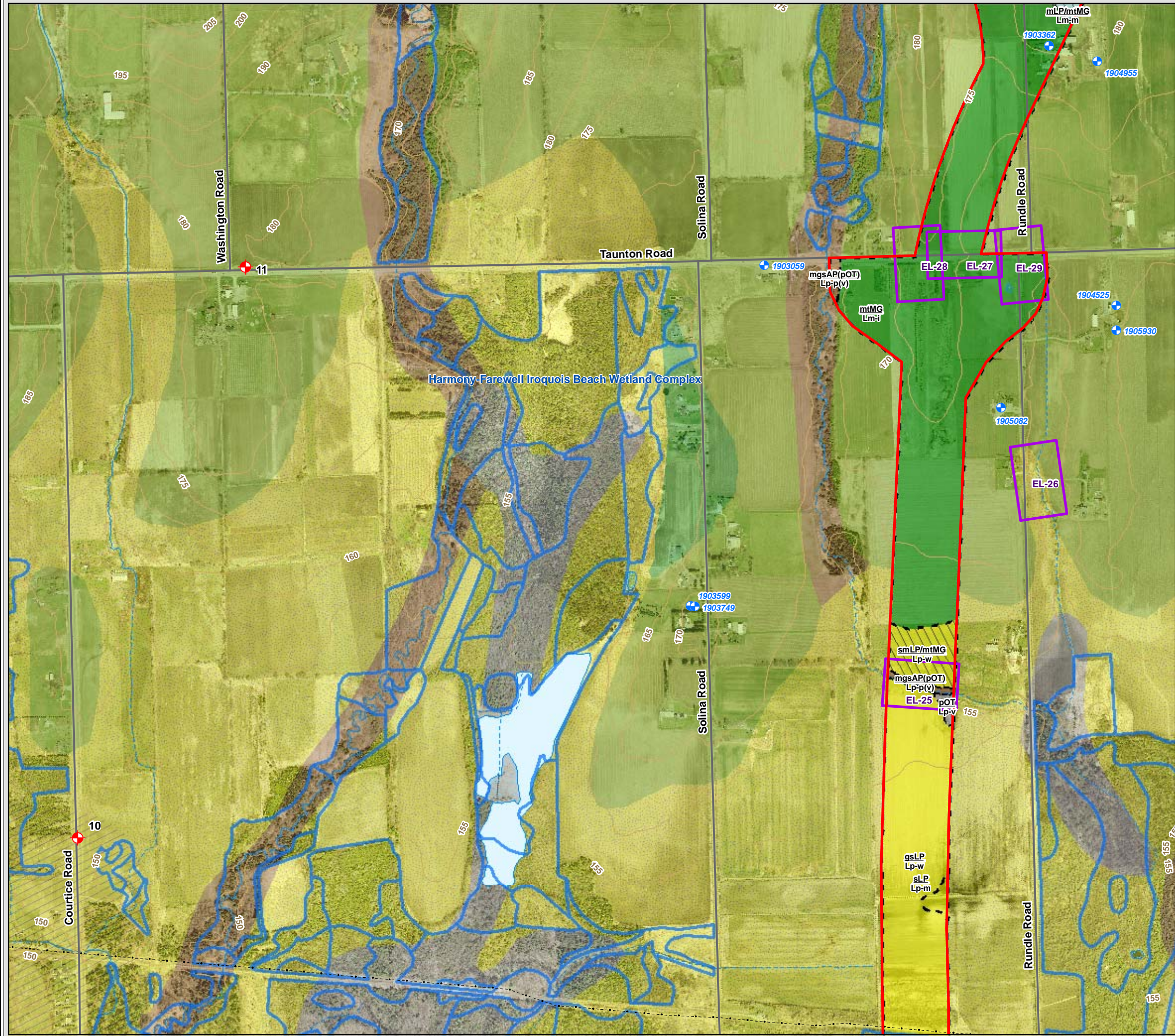
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**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

**MORAINAL**

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform — Material of subordinate landform — Subordinate landform

Material — Local relief of dominant landform — Surface drainage condition of subordinate landform

Topographic variety of dominant landform — Local relief of subordinate landform — Topographic variety of subordinate landform — Surface drainage condition of dominant landform

**tMG (pOT)**

**Lu (Lp) - m(v)**

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

s sand, sandy

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t till

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r ridged

s sloping

t terraced

u undulating

m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

0 50 100 200 300 400 500

1:10,000

UTM Zone 17N, NAD 83

**Notes:**

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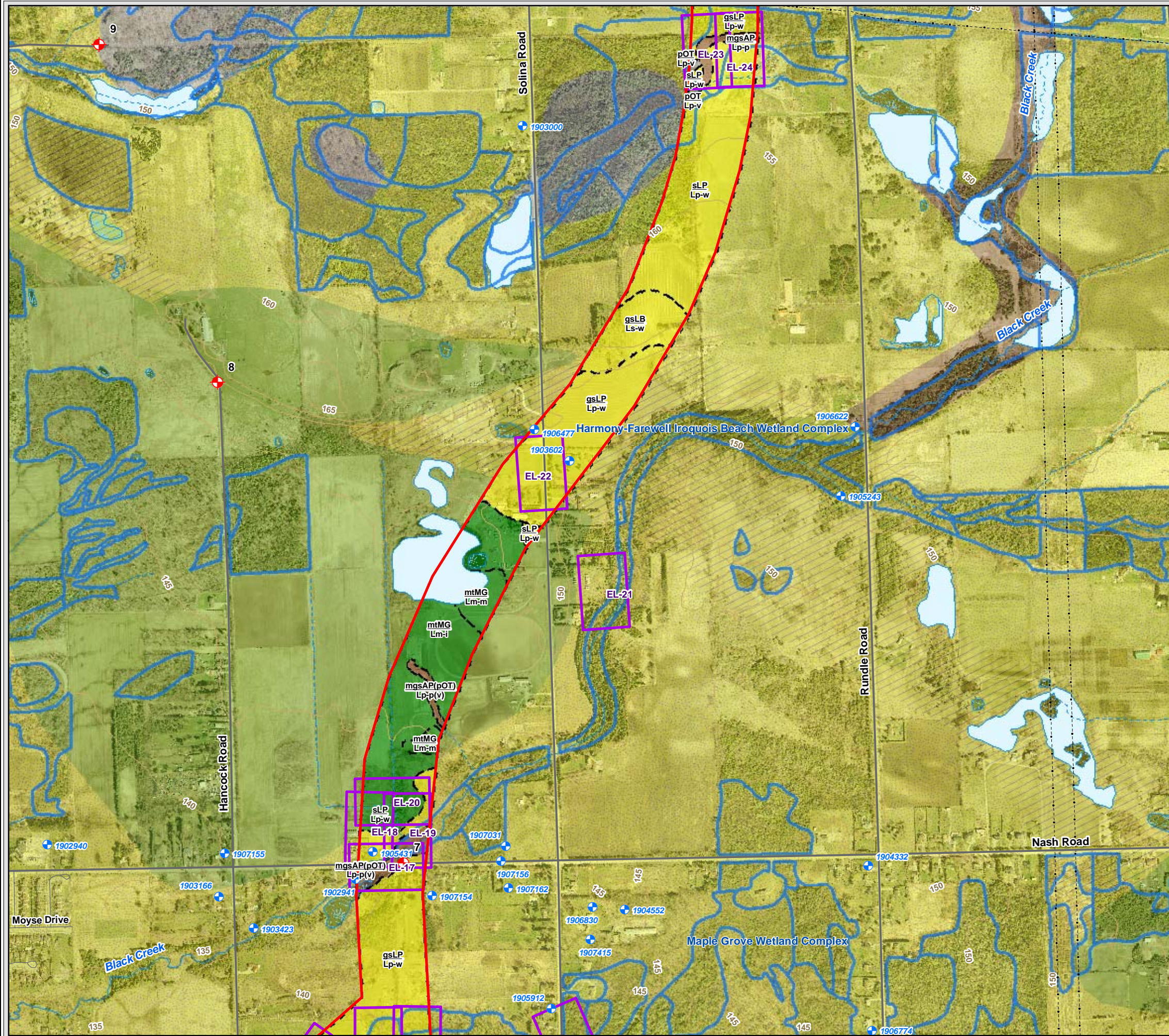
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ORGANIC

OT

Organic terrain

ALLUVIAL

AP

Alluvial plain

COARSE

FINE

GLACIOLACUSTRINE

LB

LD

LP

Raised (abandoned) beach form

Glaciolacustrine delta

Glaciolacustrine plain

GLACIOFLUVIAL

GD

GE

GK

GO

Ice contact delta, esker delta, kame delta, delta moraine

Esker, esker complex, crevasse filling

Kame, kame field, kame terrace, kame moraine

Outwash plain, valley train

MORAINAL

ME

MG

MH

End moraine

Ground moraine

Hummocky moraine

Underlying material within approx. 3 m of surface

Dominant landform

Material of subordinate landform

Subordinate landform

Material

Local relief of dominant landform

Topographic variety of dominant landform

tMG (pOT)

Lu (Lp) - m(v)

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

N

E

S

W

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0

50

100

200

300

400

500

m

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

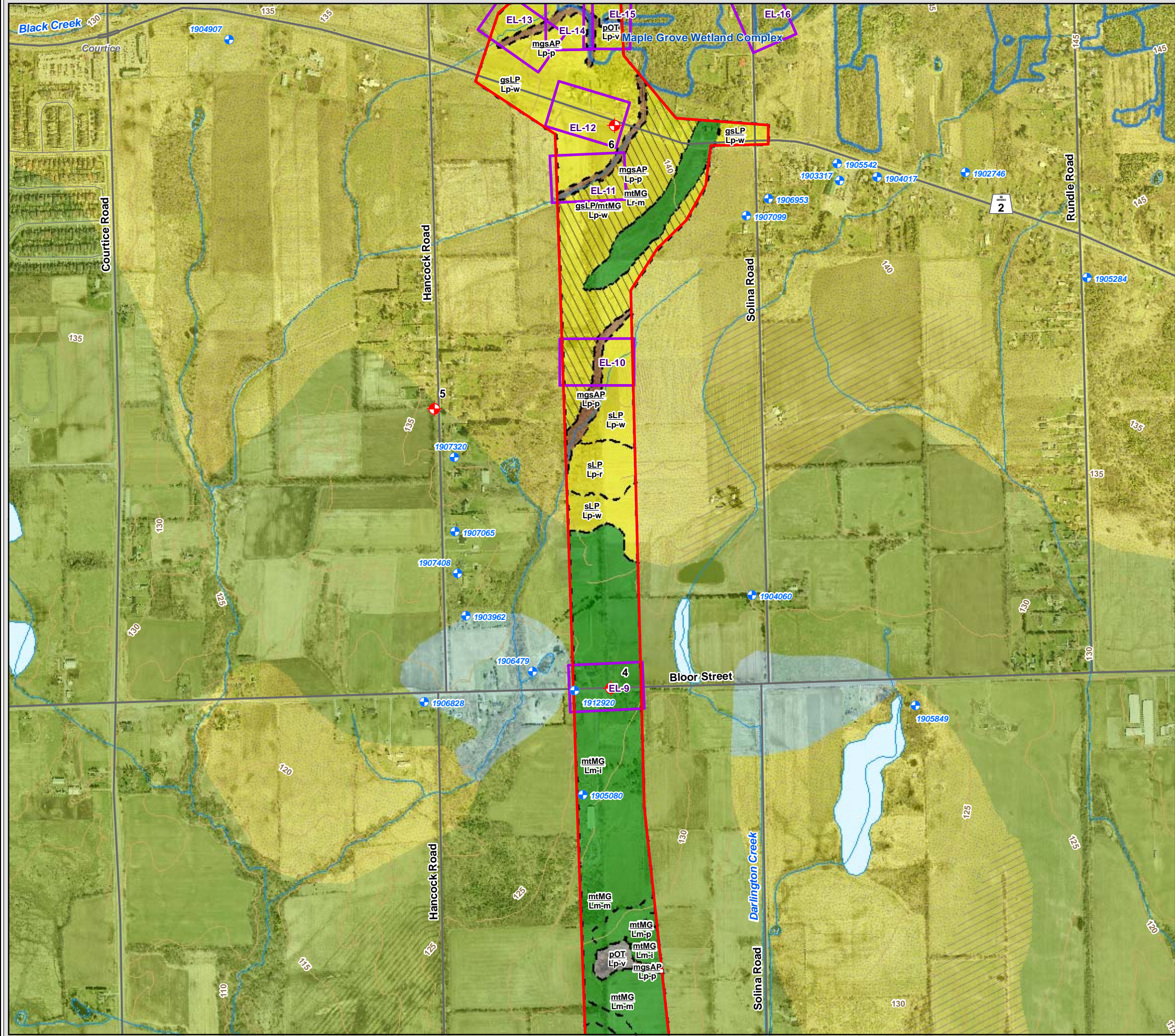
Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures

December 2007  
Project 50613

Gartner Lee

East 9





ORGANIC

OT

Organic terrain

ALLUVIAL

AP

Alluvial plain

COARSE

FINE

GLACIOLACUSTRINE

LB

LD

LP

Raised (abandoned) beach form

Glaciolacustrine delta

Glaciolacustrine plain

GLACIOFLUVIAL

GD

GE

GK

GO

Ice contact delta, esker delta, kame delta, delta moraine

Esker, esker complex, crevasse filling

Kame, kame field, kame terrace, kame moraine

Outwash plain, valley train

MORAINAL

ME

MG

MH

End moraine

Ground moraine

Hummocky moraine

Underlying material within approx. 3 m of surface

Dominant landform

Material of subordinate landform

Subordinate landform

Material

Local relief of dominant landform

Topographic variety of dominant landform

tMG (pOT)

Lu (Lp) - m(v)

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

N

W

E

S

Notes:

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0

50

100

200

300

400

500

m

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

Technically Recommended Route

Terrain/Drainage Map with

Proposed Structures

December 2007

Project 50613

Gartner Lee

East 10





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form

LD Glaciolacustrine delta

LP Glaciolacustrine plain

**GLACIOFLUVIAL**

GD Ice contact delta, esker delta, kame delta, delta moraine

GE Esker, esker complex, crevasse filling

GK Kame, kame field, kame terrace, kame moraine

GO Outwash plain, valley train

**MORAINAL**

ME End moraine

MG Ground moraine

MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform

Material of subordinate landform

Subordinate landform

Material

Local relief of dominant landform

Topographic variety of dominant landform

Local relief of subordinate landform

Topographic variety of subordinate landform

Surface drainage condition of subordinate landform

Surface drainage condition of dominant landform

**tMG (pOT)**

**Lu (Lp) - m(v)**

**MATERIAL**

b boulders, bouldery

c clay, clayey

g gravel, gravelly

p peat, muck

r rubble

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**TOPOGRAPHY**

**LOCAL RELIEF**

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m rolling

w washed, reworked

**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained

r Rapidly drained

w Well drained

m Moderately well drained

i Imperfectly drained

p Poorly drained

v Very poorly drained

h Suspected high water table

MOE Water Well

Existing Geotechnical Borehole

Contour (5m)

Freeway

Highway

Major Road

Local Road

Transmission Line

Railway

Proposed Structure

Provincially Significant Wetland

Locally Significant Wetland

Technically Recommended Route

Municipal Division

**Notes:**

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0 50 100 200 300 400 500

1:10,000

UTM Zone 17N, NAD 83

407 Environmental Assessment

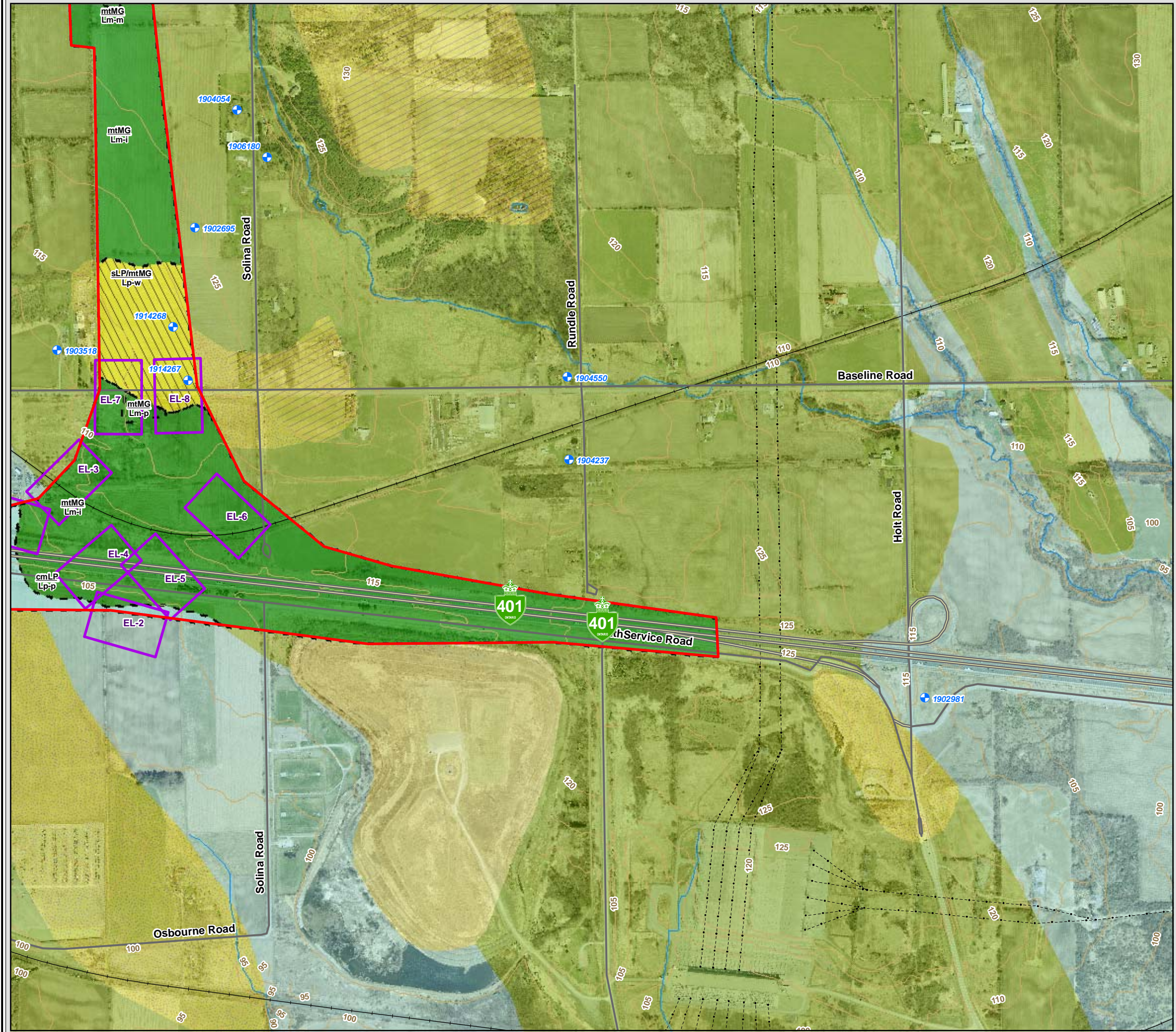
**Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures**

December 2007  
Project 50613

**Gartner Lee**

East 11





**Legend**

**LANDFORM**

**ORGANIC**

OT Organic terrain

**ALLUVIAL**

AP Alluvial plain

**GLACIOLACUSTRINE**

LB Raised (abandoned) beach form  
LD Glaciolacustrine delta  
LP Glaciolacustrine plain

**GLACIOFLUVIAL**

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GE Esker, esker complex, crevasse filling  
GK Kame, kame field, kame terrace, kame moraine  
GO Outwash plain, valley train

**MORAINAL**

ME End moraine  
MG Ground moraine  
MH Hummocky moraine

Underlying material within approx. 3 m of surface

**Components of Terrain/Drainage Code**

Dominant landform  
Material of subordinate landform  
Subordinate landform  
Material  
Local relief of dominant landform  
Topographic variety of dominant landform  
Local relief of subordinate landform  
Topographic variety of subordinate landform  
Surface drainage condition of subordinate landform  
Surface drainage condition of dominant landform

tMG (pOT)  
Lu (Lp) - m(v)

**MATERIAL**

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**TOPOGRAPHY**

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**DRAINAGE**

**SURFACE CONDITION**

x Very rapidly drained  
r Rapidly drained  
w Well drained  
m Moderately well drained  
i Imperfectly drained  
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v Very poorly drained  
h Suspected high water table

MOE Water Well  
Existing Geotechnical Borehole  
Contour (5m)  
Freeway  
Highway  
Major Road  
Local Road  
Transmission Line  
Railway  
Proposed Structure  
Provincially Significant Wetland  
Locally Significant Wetland  
Technically Recommended Route  
Municipal Division

Scale: 0 50 100 200 300 400 500 m  
1:10,000  
UTM Zone 17N, NAD 83

Notes:  
1. Terrain/drainage polygon boundaries and descriptions within Technically Recommended Route based on existing OGS/GSC surficial geology mapping, stereoscopic interpretation of 1:10,000 aerial photographs from 2000, and representative field checks of approximately 25% of the polygons. Existing OGS/GSC surficial geology mapping is displayed outside the Technically Recommended Route for context; its legend is provided separately.  
2. Mapping completed by R. McKillop (Gartner Lee Limited), based on the format of the Northern Ontario Engineering Geology Terrain Study (Gartner et al., 1981), with drainage classes assigned according to the British Columbia Field Manual for Describing Terrestrial Ecosystems.  
3. No significant colluvial or eolian deposits within Technically Recommended Route, and no attempt made to differentiate tills, given their similarity in shallow hydrogeological and geotechnical characteristics.  
4. A slash (/) is used to indicate near-surface layering of contrasting materials within a dominant or subordinate landform (e.g., sLP/tMG). The material left of the slash (sLP) overlies the material right of the slash (tMG), without specifying any particular depth, but usually the landform material in the numerator is shallow.  
5. A landform s composition may be modified by up to three materials, with increasing proportion from left to right. The example cmtMG represents ground moraine (MG) composed of clayey (c) silt (m) till (t).  
6. A landform may exhibit up to three topographic varieties, with decreasing prominence from left to right. For example, Lpkd represents a low-relief (L) planar (p) surface with kettles (k), which has been dissected (d).

407 Environmental Assessment

**Technically Recommended Route  
Terrain/Drainage Map with  
Proposed Structures**

December 2007  
Project 50613

**Gartner Lee**

East 12



ID	Type	Category	Name	Groundwater Comments	Groundwater Comments	SITE RANKING	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
				SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY				
EM - 1	Bridge	Overpass	Black Creek (west)	Surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface in river valley. PSW within study area.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage suspected in valley bottom, given depth of valley and presence of PSW.	High	Moderately wide, deep valley with locally steep valleysides; potential for undercutting where meandering channel impinges on valley side	Valley bottom material likely >2 m deep, probably consisting of <1 m organic material overlying silty gravelly sand alluvium, based on field checks of similar wetlands and valleys	50-100	65
EM - 2	Bridge	Overpass	Black Creek (east)	Surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface in river valley. PSW within study area.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage suspected in valley bottom, given depth of valley and presence of PSW.	High	Moderately wide, deep valley with locally steep valleysides; potential for undercutting where meandering channel impinges on valley side	Valley bottom material likely >2 m deep, probably consisting of <1 m organic material overlying silty gravelly sand alluvium, based on field checks of similar wetlands and valleys	50-100	65
EM - 3	Bridge	Flyover	Solina Rd.	Surficial silty sand to silt till. BHP29 confirms 4.9 m of silty sand underlain by clayey silt till with GWT at 4 mbgs.		High				70
EM - 4	Bridge	Overpass	Black Creek (west)	Surficial silty sand with alluvial materials in river valley. BHP29 confirms 4.9 m of surficial silty sand underlain by clayey silt till with GWT at 4 mbgs. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	60
EM - 5	Bridge	Overpass	Black Creek (east)	Surficial silty sand with alluvial materials in river valley. BHP29 confirms 4.9 m of surficial silty sand underlain by clayey silt till with GWT at 4 mbgs. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	60
EM - 6	Bridge	Flyover	Holt Rd.	Surficial silt till. BHP30 confirms sandy silt to silty sand till with GWT at 6 mbgs.	Nil	Low				70
EM - 7	Culvert			BHP30 confirms surficial sandy silt to silty sand till with GWT at 6 mbgs.	Nil	Low	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	70
EM - 8	Bridge	Overpass	Bowmanville Creek (west)	Surficial silt till with silty sand to sand organic alluvial in river valley. GWT near surface in river valley. BHP31 penetrated silty clay to clayey silt till with GWT at 0.5 mbgs.	Potential for dewatering if excavating alluvial sediments in valley.	High	Wide, shallow valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely >2 m deep, consisting of approx. 1 m deep silty gravelly sand alluvium, interbedded with buried organic material, overlying sandy silt glaciolacustrine deposits	20-50	50
EM - 9	Bridge	Overpass	Bowmanville Creek (east)	Surficial silt till with silty sand to sand organic alluvial in river valley. GWT near surface in river valley. BHP31 penetrated silty clay to clayey silt till with GWT at 0.5 mbgs.	Potential for dewatering if excavating alluvial sediments in valley.	High	Wide, shallow valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely >2 m deep, consisting of approx. 1 m deep silty gravelly sand alluvium, interbedded with buried organic material, overlying sandy silt glaciolacustrine deposits	20-50	50
EM - 10	Bridge	Flyover	Old Scugog Rd.	Surficial silt, gravel, sand alluvial plain. BHP31 penetrated silty clay to clayey silt till with GWT at 0.5 mbgs.	Potential to encounter perched water table within old alluvium overlying till.	High		Early post-glacial alluvium dominantly gravelly sand, with localized silt layers		50
EM - 11	Culvert			Surficial sandy silt. BHP31 penetrated silty clay to clayey silt till with GWT at 0.5 mbgs.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	High	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	55
EM - 12	Culvert			Surficial sandy silt. BHP31 penetrated silty clay to clayey silt till with GWT at 0.5 mbgs.	Nil	High	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
EM - 15	Bridge	Flyover	Regional Road 57	Surficial sandy silt. BHP32 penetrated 9.6 m surficial silty clay with GWT at 4 mbgs. Shallow unconfined well in area with no static recorded.	Nil	High				50
EM - 13	Culvert			Surficial silty sand with organics. Shallow unconfined well in area with no static recorded.	Adjacent to creek	High	Narrow, shallow valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	55
EM - 14	Culvert			Surficial sandy silt with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. Shallow unconfined well in area with no static recorded.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	50
EM - 16	Culvert			Surficial sandy silt with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. Shallow wells in area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	50



EM - 17	Culvert			Surficial sandy silt with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. Shallow wells in area.	Adjacent to creek	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	50
EM - 18	Culvert			Surficial sandy silt with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. Shallow unconfined well in area with no static recorded.	Nil	High	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
EM - 19	Culvert			Surficial sandy silt with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. Shallow confined well in area	Potential for dewatering if excavating alluvial sediments in valley.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom material likely >2 m deep, probably consisting of <1 m silty gravelly sand alluvium overlying glaciolacustrine sandy silt, based on field check about 250 m upstream of proposed culvert footprint	20-50	50
EM - 20	Culvert			Surficial silty sand with silty sand alluvial plain in river valley. GWT near surface in river valley. BHP33 confirms silty sand to 2.4 m underlain by clayey to silty till with GWT at 0.3 mbgs. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	60
EM - 21	Bridge	Flyover	Middle Rd.	Surficial sandy silt. BHP33 penetrates silty sand to 2.4 m underlain by clayey to silty till with GWT at 0.3 mbgs. Shallow confined wells in the area.	Nil	High				60
EM - 22	Bridge	Overpass	Bowmanville Creek (west)	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. BH P33 confirms silty sand to 2.4 m underlain by clayey to silty till with GWT at 0.3 mbgs. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments >0.5 m deep and dominantly silty gravelly sand alluvium, overlying glaciolacustrine sandy silt	20-50	60
EM - 23	Bridge	Overpass	Bowmanville Creek (east)	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. BHP33 confirms silty sand to 2.4 m underlain by clayey to silty till with GWT at 0.3 mbgs. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments >0.5 m deep and dominantly silty gravelly sand alluvium, overlying glaciolacustrine sandy silt	20-50	60
EM - 24	Bridge	Flyover	Liberty St.	Surficial sandy silt and silt till. BHP34 confirms silty till to 12.6 m with GWT at 9 mbgs. Shallow confined wells in the area.	Mapping indicates intermittent watercourse. Construction activities should take place when the stream bed is dry.	Medium				70
EM - 25	Culvert			Surficial sandy silt and silt till. BHP34 confirms silty till to 12.6 m with GWT at 9 mbgs. Shallow confined wells in the area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	70
EM - 26	Culvert			Surficial silty sand with underlying material within 3 m of surface and silty sand alluvial deposits in river valley. GWT near surface in river valley. Shallow confined wells in area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	45
EM - 27	Bridge	Overpass	WB freeway bridge	Surficial silty sand with underlying material within 3 m of surface and silty sand alluvial deposits in river valley, silt till east side of creek. GWT near surface in river valley. Shallow confined wells in area.	Mapping indicates intermittent watercourse. Construction activities should take place when the stream bed is dry.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	45
EM - 28	Bridge	Overpass	EB freeway bridge	Surficial silty sand with underlying material within 3 m of surface and silty sand alluvial deposits in river valley, silt till east side of creek. GWT near surface in river valley. Shallow confined wells in area.	Mapping indicates intermittent watercourse. Construction activities should take place when the stream bed is dry.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	20-50	45
EM - 29	Culvert			Surficial silt till with silty sand alluvial plain in river valley. GWT near surface in river valley. BH P35 confirms sandy to silty till to 9.8 m with GWT at 2.4 mbgs. Shallow confined well in area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	45
EM - 30	Bridge	Flyover	Bethesda Road	Surficial gravelly sand with silt till in east part of study area. BH P35 penetrated sandy to silty till to 9.8 m with GWT at 2.4 mbgs. Water wells generally deep confined.	Nil	Medium				50
EM - 31	Culvert			Surficial silt till with silty sand alluvial plain in river valley. GWT near surface in river valley. BHP35 confirms sandy to silty till to 9.8 m with GWT at 2.4 mbgs. Shallow confined well in area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	55
EM - 32	Bridge	Overpass	WB freeway bridge	Surficial sandy silt with silty sand organic alluvial plain in river valley. GWT near surface in river valley. BHP36 penetrated silty sand till with GWT at 5.7 mbgs. Shallow confined well in the area.	Mapping indicates intermittent watercourse. Construction activities should take place when the stream bed is dry.	High	Moderately wide, moderately deep valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments may be >2 m deep and probably dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	50-100	35



EM - 33	Bridge	Overpass	EB freeway bridge	Surficial sandy silt with silty sand organic alluvial plain in river valley. GWT near surface in river valley. BHP36 penetrated silty sand till with GWT at 5.7 mbgs. Shallow confined well in the area.	Mapping indicates intermittent watercourse. Construction activities should take place during dry creek periods.	High	Moderately wide, moderately deep valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments may be >2 m deep and probably dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	50-100	35
EM - 34	Culvert			Surficial silt till with silty sand alluvial plain in river valley. BHP37 penetrated 7 m silty sand to sandy silt underlain by silt till with a GWT at 7 mbgs. Shallow confined well in the area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
EM - 35	Bridge	Flyover	Brown Rd.	Surficial silt till with sandy silt at eastern edge.	Nil	Medium				80
EM - 36	Bridge	Overpass	WB freeway bridge	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Shallow confined wells.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, moderately deep valley; potential for undercutting of relatively steep valley-sides by meandering channel	Valley bottom sediments >1 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material	10-20	75
EM - 37	Bridge	Overpass	EB freeway bridge	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, moderately deep valley; potential for undercutting of relatively steep valley-sides by meandering channel	Valley bottom sediments >1 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material	10-20	75
EM - 38	Bridge	Overpass	WB freeway bridge	Surficial gravelly sand alluvial plain in river valley. GWT near surface in river valley. Shallow unconfined well in area with static at 2.4 mbgs.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage on lower east valley-side, at toe of terrace scarps	High	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valley-side and terraced east valley-side; potential for undercutting of locally moderately steep valley-sides by meandering channel	Valley bottom material likely >2 m deep, probably consisting of silty gravelly sand alluvium locally interbedded with buried organic material, overlying glaciolacustrine sand, based on field checks of similar valleys	50-100	65
EM - 39	Bridge	Overpass	EB freeway bridge	Surficial gravelly sand alluvial plain in river valley. GWT near surface in river valley. Shallow unconfined well in area with static at 2.4 mbgs.	Potential for dewatering if excavating alluvial sediments in valley. Spring seepage on lower east valley-side, at toe of terrace scarps.	High	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valley-side and terraced east valley-side; potential for undercutting of locally moderately steep valley-sides by meandering channel	Valley bottom material likely >2 m deep, probably consisting of silty gravelly sand alluvium locally interbedded with buried organic material, overlying glaciolacustrine sand, based on field checks of similar valleys	50-100	65
EM - 40	Bridge	Flyover	Leskard Rd.	Surficial sand with gravelly sand alluvial plain at north end of study area. BHP38 penetrated silty sand till to 9.5 m with GWT at 7.2 mbgs. Shallow wells in area with unconfined static at 2.4 mbgs.	Nil	High	Steep valley-side comprising fine sand susceptible to ravelling if cut too steep			85
EM - 41	Culvert			Surficial sandy silt with underlying material within 3 m of surface, Silty sand alluvial plain in river valley. Silt till in southwest corner of study area. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	105
EM - 42	Culvert			Surficial sandy silt with underlying material within 3 m of surface, Adjacent to silty sand alluvial plain in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	Medium	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	105
EM - 43	Culvert			Surficial silt with underlying material within 3 m of surface. Silt till in northwest corner and silty sand alluvial plain in southeast corner of study area. GWT near surface in river valley.	Adjacent to creek	Medium	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	110
EM - 44	Culvert			Surficial silt with underlying material within 3 m of surface. Silty sand alluvial plain in river valley. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	110
EM - 45	Culvert			Surficial silt till. GWT near surface in river valley.	Potential for dewatering if excavating in valley.	Low	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	130
EM - 46	Bridge	Overpass - Ramp	407/Hwy 35/115 N-S Ramp (south connection)	Surficial silt till.	Nil	Low				130
EM - 47	Bridge	Overpass - Ramp	407/Hwy 35/115 S-W Ramp (south connection)	Surficial silt till.	Nil	Low				130
EM - 48	Culvert			Surficial sandy silt with underlying material within 3 m of surface. Silty sand alluvial plain in river valley. Fine grained deposits in east side of study area. GWT near surface in river valley. Shallow unconfined well in area with static at 7 mbgs.	Adjacent to creek	High	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	125
EM - 49	Bridge	Flyover	Concession Rd. 8	Surficial sandy silt with underlying material within 3 m of surface. Shallow unconfined well in area with static at 7 mbgs.	Nil	High				125



EM - 50	Culvert			Surficial sandy silt with underlying material within 3 m of surface. Silty sand alluvial plain in river valley. Silt till in central portion and sandy deposits on east side of study area. GWT near surface in river valley. Shallow unconfined well in area with static at 7 mbgs.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	125
EM - 51	Culvert			Surficial silty sand on south end and gravelly sand on north end of study area. GWT near surface in river valley. Deep confined well in area.	Potential for dewatering if excavating in valley.	Medium	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	140
EM - 52	Culvert			Surficial gravelly sand with gravelly sand and organic alluvial plain in river valley. GWT near surface in river valley.	Potential for dewatering if excavating alluvial sediments in valley.	High	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valley-side instability	Valley bottom material likely >2 m deep, probably consisting of silty gravelly sand alluvium locally interbedded with buried organic material, overlying gravelly sand ice-contact glaciofluvial deposits		145
EM - 53	Bridge	Flyover	Wilcox Rd.	Surficial gravelly sand. Deep confined well in area.	Nil	Medium				180
EM - 54	Bridge	Overpass - Ramp	407/Hwy 35 S-N Ramp ('35/115 split')	Surficial gravelly sand. Deep confined well in area.	Nil	Medium				180
EM - 55	Bridge	Overpass - Ramp	407/Hwy 35 N-E Ramp ('35/115 split')	Surficial gravelly sand. Deep confined well in area.	Nil	Medium				185
EL - 1	Bridge	Overpass - Ramp	401/Courtice Rd. E-N/S Ramp	Surficial sandy silt with fine grained in northwest corner and silt till in east end of study area. BH1 penetrated 1.6 m sand and gravel underlain by silt and sand till with GWT at 2 mbgs. BH2 penetrated 1.4 m of clay silt underlain by 0.7 m silty sand underlain by silt and sand till with GWT at 6 mbgs. Shallow confined wells in area.	Nil	Medium				30
EL - 2	Bridge	Overpass - Ramp	401/Courtice N/S-E & Holt Rd. W-N/S Ramps	Surficial sandy silt with silt till at north edge of study area.	Nil	Medium				35
EL - 3	Bridge	Overpass	East Link/401 N-W Ramp	Surficial silt till. Shallow confined wells in area.	Nil	Medium				35
EL - 4	Bridge	Overpass	East Link/401 W-N Ramp	Surficial silt till. Shallow confined well in area.	Nil	Medium				35
EL - 5	Bridge	Overpass	East Link/401 N-E Ramp	Surficial silt till with sandy silt at south corner of study area.	Nil	Low				35
EL - 6	Bridge	Overpass	East Link/401 E-N Ramp	Surficial silt till. Deep confined well in area.	Nil	Low				35
EL - 7	Bridge	Underpass/ Overpass	Baseline Rd. - West Side (over/under?)	Surficial silt till with sand with underlying material within 3 m of surface in north portion of study area. Shallow confined well in area.	Nil	Medium				40
EL - 8	Bridge	Underpass/ Overpass	Baseline Rd. - East Side (over/under?)	Surficial sand with underlying material within 3 m of surface with silt till in south portion of study area. Shallow confined well in area.						40
EL - 9	Bridge	Overpass	Bloor St.	Surficial silt till. BH4 confirmed 5.6 m silt and sand till underlain by 5.3 m sand underlain by sand and silt till with GWT at 3 mbgs. Shallow confined wells in the area.	Nil	Medium				45
EL - 10	Culvert			Surficial sand with silty sand alluvial plain in river valley. BH5 shows GWT within 1 m of surface. GWT near surface in river valley. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	50
EL - 11	Culvert			Surficial gravelly sand with silty sand alluvial deposits in river valley. BH 6 penetrated 10.1 m of silt underlain by sand and gravel with GWT at 2.4 mbgs. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
EL - 12	Bridge	Flyover	Highway 2	Surficial gravelly sand. BH6 penetrated 10.1 m of silt underlain by sand and gravel with GWT at 2.4 mbgs. Shallow confined wells in the area.	Nil	High				50
EL - 14	Bridge	Overpass	SB freeway bridge	Surficial gravelly sand with silty sand alluvial deposits in river valley. BH6 penetrated 10.1 m of silt underlain by sand and gravel with GWT at 2.4 mbgs. PSW within study area. Shallow wells in the area with unconfined static at 1.5 mbgs.	Potential for dewatering if excavating alluvial sediments and wetland area.	High	Shallow depression with no geomorphic evidence of slope-side instability	Wetland likely contains <1 m organic material, based on field checks of similar wetlands, overlying >4 m saturated glaciolacustrine silt and sand, based on nearby water well records		50



East Section - Foundations Risk Assessment with Groundwater Comments for Desktop Study Tables

EL - 15	Bridge	Overpass	NB freeway bridge	Surficial gravelly sand with silty sand alluvial deposits in river valley. BH6 penetrated 10.1 m of silt underlain by sand and gravel with GWT at 2.4 mbgs. PSW within study area. Shallow wells in the area with unconfined static at 1.5 mbgs.	Potential for dewatering if excavating alluvial sediments and wetland area.	High	Shallow depression with no geomorphic evidence of slope-side instability	Wetland likely contains <1 m organic material, based on field checks of similar wetlands, overlying >4 m saturated glaciolacustrine silt and sand, based on nearby water well records		50
EL - 13	Culvert			Surficial gravelly sand with silty sand alluvial deposits in river valley. BH6 penetrated 10.1 m of silt underlain by sand and gravel with GWT at 2.4 mbgs. Shallow confined wells in the area.	Potential for dewatering if excavating alluvial sediments in valley.	High	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
EL - 16	Bridge	Overpass	Solina Rd.	Surficial silt till. PSW within study area. Shallow wells in the area with unconfined static at 1.5 mbgs.	Potential for dewatering if excavating in wetland area.	Medium	Shallow depression with no geomorphic evidence of slope-side instability	Wetland likely contains <1 m organic material, based on field checks of similar wetlands, overlying >4 m saturated glaciolacustrine silt and sand, based on nearby water well records		50
EL - 17	Bridge	Underpass/ Overpass	Nash Rd.	Surficial gravelly sand with silty sand organic alluvial deposits in river valley. GWT near surface in river valley. PSW within study area. Shallow wells in the area with unconfined static at 1.5 mbgs.	Potential for dewatering if excavating alluvial sediments and wetland area.	High				50
EL - 18	Bridge	Overpass	SB freeway bridge	Surficial gravelly sand with silt till in north portion of study area. Adjacent to PSW. Shallow wells in the area with unconfined static at 1.5 mbgs.	Adjacent to creek and PSW.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom likely contains <1 m organic material, based on field checks of similar wetlands, overlying silty gravelly sand alluvium and >4 m saturated glaciolacustrine silt and sand, based on nearby water well records	20-50	50
EL - 19	Bridge	Overpass	NB freeway bridge	Surficial gravelly sand with silty sand organic alluvial deposits in river valley. Silt till north portion of study area. GWT near surface in river valley. PSW within study area. Shallow wells in the area with unconfined static at 1.5 mbgs.	Potential for dewatering if excavating alluvial sediments and wetland area.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom likely contains <1 m organic material, based on field checks of similar wetlands, overlying silty gravelly sand alluvium and >4 m saturated glaciolacustrine silt and sand, based on nearby water well records	20-50	50
EL - 20	Culvert			Surficial silt till. Adjacent to PSW. Shallow wells in the area with unconfined static at 1.5 mbgs.	Nil	Medium	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
EL - 21	Bridge	Overpass	Solina Rd.	Surficial silt till. PSW within study area. GWT near surface in wetland area.	Potential for dewatering if excavating in wetland area.	Medium	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom likely contains <1 m organic material, based on field checks of similar wetlands, overlying silty gravelly sand alluvium and >4 m saturated glaciolacustrine silt and sand, based on nearby water well records	20-50	50
EL - 22	Bridge	Overpass	Solina Rd.	Surficial gravelly sand. Shallow wells in area. Unconfined well with static at 2.7 mbgs.	Nil	High				55
EL - 23	Bridge	Overpass	SB freeway bridge	Surficial gravelly sand with peat organic materials in wetland area. PSW within study area. GWT near surface in wetland area.	Potential for dewatering if excavating organic sediments in wetland area.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom likely contains <1 m organic material, based on field checks of similar wetlands, overlying silty gravelly sand alluvium and >5 m saturated glaciolacustrine silt and sand, based on nearby water well records	10-20	55
EL - 24	Bridge	Overpass	NB freeway bridge	Surficial gravelly sand with silty sand alluvial plain in low lying area. PSW within study area. GWT near surface in wetland area.	Potential for dewatering if excavating alluvial sediments in wetland area.	High	Moderately wide, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom likely contains <1 m organic material, based on field checks of similar wetlands, overlying silty gravelly sand alluvium and >5 m saturated glaciolacustrine silt and sand, based on nearby water well records	10-20	55
EL - 25	Culvert			Surficial sandy silt with silty sand alluvial plain in river valley.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, shallow valley with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	10-20	55
EL - 26	Culvert			Surficial silt till. Shallow confined wells in the area.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	55
EL - 27	Bridge	Flyover	Taunton Road	Surficial silt till. Shallow confined wells in the area.	Nil	Medium				60
EL - 28	Culvert			Surficial silt till. Shallow confined wells in the area.	Nil	Medium	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	60
EL - 29	Culvert			Surficial silt till. Shallow confined wells in the area.	Nil	Medium	Narrow, shallow, channelized swale with no geomorphic evidence of significant valley-side instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	60
EL - 30	Bridge	Overpass - Ramp	East Link/407 S-W Ramp	Surficial silt till	Nil	Low				65
EL - 32	Bridge	Overpass - Ramp	East Link/407 S-W Ramp	Surficial silt till. BHP30 confirms surficial sandy silt to silty sand till with GWT at 6 mbgs.	Nil	Low				65



EL - 31	Bridge	Overpass - Ramp	East Link/407 W-S Ramp	Surficial silty sand to sandy silt.	Nil	Medium				65
EL - 33	Bridge	Overpass - Ramp	East Link/407 E-S Ramp	Surficial silt till. BHP30 confirms surficial sandy silt to silty sand till with GWT at 6 mbgs.	Nil	Low				70
EL - 34	Culvert			Surficial silt till with silty sand alluvial sediments near stream. GWT near surface at stream.	Slight potential for dewatering if excavating near stream	Low	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	65
EL - 35	Culvert			Surficial silt till with silty sand alluvial sediments near stream. GWT near surface at stream.	Slight potential for dewatering if excavating near stream	Low	Narrow, shallow swale with no geomorphic evidence of significant valley-side instability	Valley bottom sediments likely <2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material, based on field checks of similar valleys	<10	70



ID	Type	Category	Name	Span	MRC Notes	Risk Level	Comments	Target	Boreholes Existing	Required	Entry
EM - 1	Bridge	Overpass	Black Creek (west)	11+960	Crosses Black Creek (west); may cross PSW	High	Major creek/possible PSW	4	0	4	
EM - 2	Bridge	Overpass	Black Creek (east)	11+960	Crosses Black Creek (west); may cross PSW	High	Major creek/possible PSW	4	0	4	
EM - 3	Bridge	Flyover	Solina Rd.	12+520	Crosses 407 & freeway-to-freeway interchange ramps	High	Freeway-freeway	4	1	3	Public Road
EM - 4	Bridge	Overpass	Black Creek (west)	12+930	Crosses Black Creek (east)	Medium	Major creek, PSW adjacent	2	0	2	
EM - 5	Bridge	Overpass	Black Creek (east)	12+930	Crosses Black Creek (east)	Medium	Major creek, PSW adjacent	2	0	2	
EM - 6	Bridge	Flyover	Holt Rd.	14+220	Crosses 407 & freeway-to-freeway interchange ramps	Medium	Flyover on competent soil	2	1	1	Public Road
EM - 7	Culvert			14+250		Low	Smaller culvert	0	0	0	
EM - 8	Bridge	Overpass	Bowmanville Creek (west)	14+770	Crosses Bowmanville Creek (west)	Medium	Water crossing	2	0	2	
EM - 9	Bridge	Overpass	Bowmanville Creek (east)	14+770	Crosses Bowmanville Creek (west)	Medium	Water crossing	2	0	2	
EM - 10	Bridge	Flyover	Old Scupper Rd.	15+100	Crosses 407	High	Alluvial deposits, close to waercourses	4	1	3	Public Road
EM - 11	Culvert			15+340	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse/till soil	0	0	0	
EM - 12	Culvert			15+450	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse/till soil	0	0	0	
EM - 15	Bridge	Flyover	Regional Road 57	16+950	Half-diamond configuration (to/from the east)	Medium	Structure close to watercourse	2	1	1	Public Road
EM - 13	Culvert			15+940	Culvert in vicinity of IC. Other BHs in vicinity.	Low	Smaller watercourse, many BH in area	0	0	0	
EM - 14	Culvert			15+940	Culvert in vicinity of IC. Other BHs in vicinity.	Low	Smaller watercourse, many BH in area	0	0	0	
EM - 16	Culvert			16+000	Culvert in vicinity of IC. Other BHs in vicinity.	Low	BHs in area	0	0	0	
EM - 17	Culvert			16+250	Water crossing south of IC.	Medium	Watercourse	2	0	2	
EM - 18	Culvert			16+320	Culvert in vicinity of IC. Other BHs in vicinity.	Low	Watercourse	0	0	0	
EM - 19	Culvert			16+800	Water crossing east of IC	Low	Watercourse	0	0	0	
EM - 20	Culvert			17+310	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse/till soil	0	0	0	
EM - 21	Bridge	Flyover	Middle Rd.	17+560	Crosses 407	Medium	Flyover in area of competent soils	2	1	1	Public Road
EM - 22	Bridge	Overpass	Bowmanville Creek (west)	17+730	WB freeway bridge Crosses Bowmanville Creek (east)	Medium	Watercourse	2	0	2	
EM - 23	Bridge	Overpass	Bowmanville Creek (east)	17+730	EB freeway bridge Crosses Bowmanville Creek (east)	Medium	Watercourse	2	0	2	
EM - 24	Bridge	Flyover	Liberty St.	18+390	Crosses 407	Medium	Flyover in area of competent soils	2	0	2	
EM - 25	Culvert			18+450	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse/till soil. Adjacent to Liberty Street	0	0	0	
EM - 26	Culvert			19+200		Low	Smaller watercourse/till soil	0	0	0	
EM - 27	Bridge	Overpass	WB freeway bridge	19+525	Crosses Mackie Creek (west)	Medium	Potentially in alluvium	2	0	2	
EM - 28	Bridge	Overpass	EB freeway bridge	19+525	Crosses Mackie Creek (west)	Medium	Potentially in alluvium	2	0	2	
EM - 29	Culvert			19+700		Low	Smaller watercourse/till soil. Near mackie Creek	0	0	0	
EM - 30	Bridge	Flyover	Bethesda Road	20+050	Parcel A4 configuration	Medium	Flyover in area of competent soils	2	1	1	Public Road
EM - 31	Culvert			20+550	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse near Bethesda Road	0	0	0	
EM - 32	Bridge	Overpass	WB freeway bridge	21+890	Crosses Mackie Creek (east)	Medium	Major watercrossing	2	1	1	
EM - 33	Bridge	Overpass	EB freeway bridge	21+890	Crosses Mackie Creek (east)	Medium	Major watercrossing	2	0	2	
EM - 34	Culvert			22+450	Watercourse - Culvert Not Identified by GLL	Low	Smaller watercourse			0	

EM - 35	Bridge	Flyover	Brown Rd.	23+160	Crosses 407 (Note:Replaces Darlington-Clarke Townline Rd. flyover)	Medium	Flyover	2	0	2	Public Road
EM - 36	Bridge	Overpass	WB freeway bridge	23+380	Crosses valley (GLL identified culvert - terrain may require span)	Medium	Major valley	2	0	2	
EM - 37	Bridge	Overpass	EB freeway bridge	23+380	Crosses valley (GLL identified culvert - terrain may require span)	Medium	Major valley	2	0	2	
EM - 38	Bridge	Overpass	WB freeway bridge	24+570	Crosses Wilnot Creek	High	>400m span, alluvial deposits	4	0	4	HIGH PRIORITY
EM - 39	Bridge	Overpass	EB freeway bridge	24+570	Crosses Wilnot Creek	High	>400m span, alluvial deposits	4	0	4	HIGH PRIORITY
EM - 40	Bridge	Flyover	Leskard Rd.	24+760	Crosses 407	Medium	Flyover, numerous waercourses	2	1	1	Public Road
EM - 41	Culvert			25+690	Watercourse - Culvert Not Identified by GLL	Low	Culvert in till soils	0	0	0	
EM - 42	Culvert			25+750	Watercourse - Culvert Not Identified by GLL	Low	Culvert in till soils	0	0	0	
EM - 43	Culvert			26+300	Watercourse - Culvert Not Identified by GLL	Medium	Culvert in possible organic terrain	2	0	2	
EM - 44	Culvert			26+425	Watercourse - Culvert Not Identified by GLL	Medium	Culvert in possible organic terrain	2	0	2	
EM - 45	Culvert			27+300		Low				0	
EM - 46	Bridge	Overpass - Ramp	407/Hwy 35/115 N-S Ramp (south connection)		Crosses over 407; could be combined with S-W ramp (to be confirmed)	High	Freeway-freeway	4		4	
EM - 47	Bridge	Overpass - Ramp	407/Hwy 35/115 S-W Ramp (south connection)		Crosses over 407; could be combined with N-S ramp (to be confirmed)	High	Freeway-freeway	4		4	
EM - 48	Culvert			28+100	Watercourse - Culvert Not Identified by GLL	Medium	Culvert in possible organic terrain	2	0	2	
EM - 49	Bridge	Flyover	Concession Rd. 8	28+200	Half-diamond configuration (to/from the north)	Low	Use 31D-284	0		0	Public Road
EM - 50	Culvert			28+475	Watercourse - Culvert Not Identified by GLL	Low	Culvert in competent soils	0		0	
EM - 51	Culvert			29+160	Watercourse - Culvert Not Identified by GLL	Low	Culvert in competent soils	0		0	
EM - 52	Culvert			30+760	Snowmobile Culvert	Low	Culvert in competent soils	0		0	
EM - 53	Bridge	Flyover	Wilcox Rd.	31+550	Crosses 407/Hwy 35/115	Medium	Flyover	2	0	2	Hwy 115 ROW
EM - 54	Bridge	Overpass - Ramp	407/Hwy 35 S-N Ramp (35/115 split)		Crosses over 407/Hwy 115; could be combined with N-E ramp (to be confirmed)	High	Freeway-freeway Potentially use 31D-288	4	4	0	
EM - 55	Bridge	Overpass - Ramp	407/Hwy 35 N-E Ramp (35/115 split)		Crosses over 407/Hwy 115; could be combined with S-N ramp (to be confirmed)	High	Freeway-freeway Potentially use 31D-288	4	4	0	
EL - 1	Bridge	Overpass - Ramp	401/Courtoice Rd. E-N/S Ramp		Crosses East Link/401 N-W ramp	High	Freeway-freeway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 2	Bridge	Overpass - Ramp	Holt Rd. W-N/S Ramps		Holt ramp passes under Courtoice ramp (Courtoice ramp at grade)	High	Freeway-freeway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 3	Bridge	Overpass	East Link/401 W-N Ramp		Crosses railway	High	Freeway-freeway & railway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 4	Bridge	Overpass	East Link/401 W-N Ramp		Crosses 401 & railway	High	Freeway-freeway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 5	Bridge	Overpass	East Link/401 N-E Ramp		Crosses 401, railway & 401/Courtoice N/S-E ramp	High	Freeway-freeway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 6	Bridge	Overpass	East Link/401 E-N Ramp		Crosses railway	High	Freeway-freeway & railway	4	0	4	Hwy 401 ROW or Railway ROW
EL - 7	Bridge	Underpass/Overpass	Baseline Rd. - West Side (over/under?)	10+555	May be possible to have single Baseline Rd. crossing (for east & west), over or under East Link to be determined	Medium		2	0	2	Public Road
EL - 8	Bridge	Underpass/Overpass	Baseline Rd. - East Side (over/under?)	10+555	May be possible to have single Baseline Rd. crossing (for east & west), over or under East Link to be determined	Medium		2	0	2	Public Road
EL - 9	Bridge	Overpass	Blor St.	12+355	Crosses over East Link	Medium	>50m	2	1	1	Public Road
EL - 10	Culvert			13+175	Watercourse - Culvert Not Identified by GLL	Low	Smaller culvert	0		0	
EL - 11	Culvert			13+650		Low	Smaller culvert	0		0	







Jan 11/99

## FOUNDATION DESIGN SECTION

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 326-88-01 DIST 6  
HWY 407 STR SITE -

Feasibility Study for Hwy 407  
From Whitby/Oshawa Boundary to Hwy 35/115

foundation  
investigation and  
design report

1.2

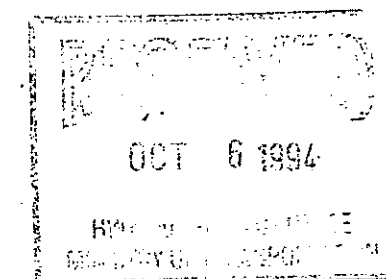
ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 326-88-01 DIST 6  
HWY 407 STR SITE -

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From Whitby/Oshawa Boundary to Hwy 35/115

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## FOUNDATION INVESTIGATION REPORT

For  
Feasibility Study For Hwy 407  
From Whitby/Oshawa Boundary to Hwy 35/115  
W.P. 326-88-01, Central Region

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2

### INTRODUCTION

This report summarizes the results of a foundation investigation for the preliminary design study of the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. The investigation was carried out at the request of Central Region Structural Section.

Several routes were proposed for Hwy 407 between Whitby/Oshawa boundary and Hwy 35/115. All proposed routes were within the City of Oshawa and Town of Newcastle, except for one northerly route which extended into the Township of Manvers. However, the technically preferred route, where this foundation investigation took place, was the most southerly one, within the City of Oshawa and Town of Newcastle in the Region of Durham. The proposed technically preferred route originates at the intersection of Winchester Road and Whitby/Oshawa boundary. From that point it runs in a southeast direction, intersects Conlin Road just east of Oshawa and Newcastle boundary and then runs more or less parallel to Concession Road 6 in a zigzag manner towards the east, until it intersects Regional Road No. 42. The proposed route then runs in a northeast direction and connects to Hwy 35/115 intersection. The details of the proposed technically preferred route and structures are illustrated on Drawing No. 3268801-A.

This Foundation investigation was intended for initial assessment of the feasibility of the proposed alignment from a foundation point of view, with a general coverage of the area by limited number of boreholes.

Before initiating the Foundation investigation, a Preliminary Geotechnical Conditions report by Geocon Inc., dated July 10, 1990 was reviewed by this office (Geocon Report T11547/53425, Highway 407 Route Planning and Environmental Assessment Study, Hwy 48 to Hwy 35-115).

### SITE DESCRIPTION

The site for the proposed Hwy 407 from Whitby/Oshawa boundary to Hwy 35/115 is located within the City of Oshawa and Town of Newcastle in the Region of Durham. Residential properties are primarily located along the major streets which the proposed highway would cross.

The existing ground elevation varies from 166.3m (BH P23) to 345.0m (east of BH P41, near Hwy 35/115 intersection). The proposed route is about 30.5 kilometre long (from station 9+500 to station 40+000). Between stations 31+000 and 40+000 the ground slopes down sharply from east to west at about 2.4 per cent slope (elevation drops from 345.0m to 163m). Further west of station 31+000 the ground surface is undulating, the slope ranges from 0.3 per cent to 2 per cent and the ground elevation varies from 155m and 225m.

Physiographically, the area is located in a region referred to as the "South Slope and Iroquois Plain" (Reference: Chapman and Putnam "The Physiography of Southern Ontario; 3rd Edition, 1984). This is the low land bordering Lake Ontario which was inundated in the Pleistocene time by Lake Iroquois. Subsoils in these areas generally are characterized by a mosaic of till plains, drumlins and areas of Glaciolacustrine deposits of silt, sand and clayey silt.

### INVESTIGATION PROCEDURES

The field work for the investigation was carried out between 94 05 25 and 94 05 30. The investigation consisted of twenty one (21) sampled boreholes (BH P21 through P41). In general, at least one borehole was put down at each proposed major interchange. The boreholes were advanced to depths of 9.3 (BH P29) to 16.9 (BH P26) <sup>meters</sup>.

The boreholes were advanced with three track mounted machines equipped with continuous flight augers. Conventional solid and hollow stem augers were used. The sampling program consisted of split spoon samples collected in the overburden. Soil samples were retrieved by split spoon sampler in accordance with Standard Penetration Test (ASTM D1586).



Standard Penetration 'N' values were recorded for assessment of the strength of the materials encountered. All subsoil samples were identified in the field and returned to the laboratory for further visual examination and testing. Groundwater levels were measured in each borehole and all boreholes were backfilled upon completion of the field work.

Surveying required to ascertain borehole locations and elevations was carried out by the Central Region Surveys and Plans Section.

### SUBSURFACE CONDITIONS

The record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The location and elevation of the boreholes are shown on Drawing No. 3268801-A.

Since the investigation was spread over a large area of 30.5 kilometre (station 9+500 to 40+000), individual borehole logs should be referred to for information on soil conditions at any structure location. However, the predominant soil strata encountered at the site consisted of glacial till (made up primarily of silty clay to clayey silt and silt to silty sand). The surficial deposit at the site was generally a glacial till.

The Standard Penetration test in cohesive glacial till recorded 'N' values from 8 blows to more than 100 blows. Based on the 'N' values, the cohesive glacial till has a stiff to hard consistency. In non-cohesive glacial till the 'N' value ranged from 9 to more than 100 blows indicating the material to be loose to very dense.

### GROUNDWATER CONDITIONS

Individual boreholes should be referred to for groundwater elevation at any proposed structure locations. Groundwater level was recorded in all boreholes except for Boreholes P27, P28, P39, and P41 where either the boreholes remained dry or water level couldn't be measured due to borehole collapse. The groundwater table stabilized at depths ranging from 0.7m (BH P24) to 9.1m (BH P34) below ground surface. The groundwater elevation ranged from 157.7m (BH P23) to 252.6m (BH P40). Groundwater levels are subject to seasonal fluctuations and may vary from the values provided in this report.

## DISCUSSION AND RECOMMENDATIONS

### General

This report contains recommendations pertaining to the structure foundations, approach embankments, cuts and hydrogeological aspects for various structures for the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. The recommendations given in the report are tentative based on the limited information available and should definitely be reviewed based on supplementary investigations. The site location is shown on Drawing No. 3268801-A.

Total 66 bridge structures (Structure 3 through 68) are proposed along the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham. This includes 22 watercourse structure sites (W), 28 grade separated structure sites (GS) and 16 interchange structure sites (I).

In general, the geotechnical conditions within the proposed route corridors are favourable. There are no foundation concerns that would require realignment of the proposed Hwy 407 route from Whitby/Oshawa boundary easterly to Hwy 35/115. Subsurface conditions over the site are uniform and competent for structure foundation and embankment loadings. The glacial till is expected to provide adequate bearing for most structures and may be able to sustain low to medium loads on shallow spread footings. However, deep foundations such as caissons and piles may be required to transfer heavier loads to greater depths and to more competent bearing material. Our comments from the feasibility, design and construction of the various structures are given on the Foundation Data Sheets included in the Appendix. Twenty one data sheets (Area 21 through 41) are provided for the 66 structures; the area locations are also shown on Drawing No. 3268801-A. An explanation of information provided on the data sheet is outlined below:

1. The structure number (i.e. 03, 04, 05 etc.) are the numbers assigned to the structures for the purpose of the feasibility study. The area number such as 21, 22, 23, etc is based on the borehole numbers P21, P22, P23, etc drilled in those areas. The actual location is shown on Drawing No. 3268801-A
2. The original ground elevation is based on the survey results of the borehole locations along the proposed Hwy 407 from Whitby/Oshawa boundary easterly to Hwy 35/115 in the City of Oshawa and Newcastle, Region of Durham.



3. The grades of roadway given is based on the proposed grades of proposed Hwy 407 at the respective sites, obtained from a profile of the Technically Preferred Route supplied to us (no reference no).
4. Subsurface conditions are described very briefly and are based on generally one borehole per area.
5. Structure Foundations

The recommendations are for pier and abutment foundations. The options for structure foundations are given in preferential order based on geotechnical/economical considerations. Further elaboration of structure recommendations made on the data sheets are given below:

Compacted Granular 'A' Core (Engineered Fill) - This option is generally for abutments where subsurface conditions are competent. The minimum requirements of a compacted granular 'A' core are shown on Figure No. 1 (attached). Furthermore, the footing for this scheme could be designed using the following parameters:

Factored Bearing Capacity at U.L.S. = 900 kPa  
 Bearing Capacity at S.L.S. Type II = 350 kPa

Spread Footings: This option is given for abutments and piers where subsurface conditions are competent. The highest elevation and corresponding maximum design load is given. It is to be noted the spread footing should be provided with a minimum of 1.2m of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, subject to softening upon exposure to construction or weather conditions, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a non cohesive deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from "boiling" due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required.

End-Bearing Piles: This founding scheme is recommended for the abutments and piers where appropriate. The recommendation gives the estimated pile tip elevation. Generally, the end-bearing piles can be designed for the factored axial capacity at U.L.S. and the axial capacity at S.L.S. Type II which is dependent on the pile section chosen. The following design parameters are recommended for the pile foundation:

Pile Type	Factored Axial Capacity at U.L.S. (kN)	Axial Capacity at S.L.S. Type II (kN)
310X79	1150	900
310X110	1600	1150

It is generally assumed that steel 'H' piles will be used. Pile driving would be controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil.

## 6. Approaches

The recommendation for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current MTO Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also, discussed under this heading is special treatment, i.e. benching, slope protection, etc., that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

## 7. Other Considerations

The granular 'A' or 'B' backfill should be in accordance with Special Provision. The following properties will be used for the calculation of lateral pressure:

Granular 'A'	$\gamma = 22.8 \text{ kN/m}^3$ , $\phi = 35^\circ$ , $K_o = 0.43$ , $K_a = 0.27$
Granular 'B'	$\gamma = 21.2 \text{ kN/m}^3$ , $\phi = 30^\circ$ , $K_o = 0.50$ , $K_a = 0.33$
Native Soil	$\gamma = 20.0 \text{ kN/m}^3$ , $\phi = 26^\circ$ , $K_o = 0.56$ , $K_a = 0.39$



If the structure is to be designed as a rigid frame then the coefficient of earth pressure at rest ( $K_0$ ) will be used.

All foundation elements should have a minimum of 1.2m earth cover for frost protection. The concrete for the footings should be placed 'in the dry'. Consequently a dewatering scheme will be required if the concrete is poured below the prevailing water level

#### 8. Remarks

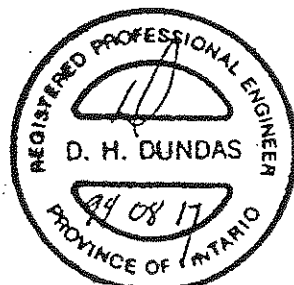
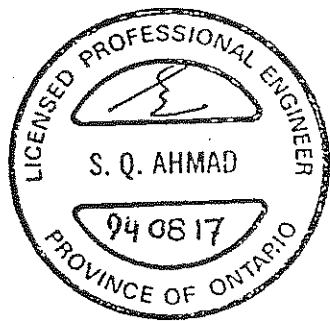
In this column comments are made about any construction difficulties, dewatering and hydrogeological concerns at any given site.

#### MISCELLANEOUS

The tentative foundation recommendations outlined in this report are for feasibility study or preliminary planning purposes only as they are based on very limited subsurface information. It will be necessary to carry out a detailed foundation investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, groundwater studies and special in-situ field testing may be warranted.

The field work for this investigation was carried out under the supervision of Todd Barlow, Lori O'Malley and Tanya Cross Engineering students, using equipment owned and operated by Master Soil Investigation and Atcost Soil Drilling.

The report was prepared by K.S.Q. Ahmad, P. Eng. Foundation Engineer and reviewed and approved by D. Dundas, P. Eng. Acting Chief Foundation Engineer.



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Chief Foundation Engineer (Acting)

## APPENDIX



# FOUNDATION DATA SHEETS

# FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 21 STRUCTURE Nos. 03.04.05.06 LOCATION Oshaw Creek Bridges, Thornton Road Overpasses

ORIGINAL GROUND ELEV. 172.0 m PROPOSED HWY 407 GRADE ELEV. 173.0 m, 177.0 m

Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 21 0.0 - 9.4 m Clayey Silt Hard (Glacial Till)	1.) For pier and abutments, spread footings placed within hard glacial till below elevation 171.0 m and below a frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa 2.) For foundations at higher elevations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 3.) Higher Bearing Capacities can be utilized at a lower depth below elevation 166.0 m.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.
<u>Groundwater Elevation</u> 169.2 m			



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 22 STRUCTURE Nos. 07 LOCATION Simcoe Road Underpass  
ORIGINAL GROUND ELEV. 184.9 m PROPOSED HWY 407 GRADE ELEV. 182.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 22 0.0 - 5.5 m Clayey Silt Hard (Glacial Till)  5.5 - 12.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  181.8 m	1.) For abutments and piers, spread footings placed within hard glacial till below elevation 182.0 m and below a frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 600 kPa - Bearing Capacity at S.L.S. Type II = 400 kPa  2.) Higher Bearing Capacities can be utilized at a lower depth below elevation 176.0 m.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 23 STRUCTURE Nos. 08, 09, 10, 11 LOCATION Oshawa Creek Bridges, Ritson Road Overpasses  
ORIGINAL GROUND ELEV. 166.3 m PROPOSED HWY 407 GRADE ELEV. 177.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 23 0.0 - 5.5 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  5.5 - 9.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  157.7 m	1.) For pier and abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 24 STRUCTURE Nos. 12, 13, 14 LOCATION Wilson Road, Harmony Road, Grandview Road Underpasses  
ORIGINAL GROUND ELEV. 203.2 m PROPOSED HWY 407 GRADE ELEV. 183.0 m, 200.0 m, 196.0 m. Respectively.  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 24 0.0 - 9.6 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  202.5 m	1.) For pier and abutment foundations, spread footings placed within hard glacial till below elevation 200.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 800 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 25 STRUCTURE Nos. 15 LOCATION West Townline Road Underpass  
ORIGINAL GROUND ELEV. 212.3 m PROPOSED HWY 407 GRADE ELEV. 202.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 25 0.0 - 13.8 m Sandy Silt to Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  211.9 m	1.) For abutment and pier foundations, spread footings placed within V. Dense glacial till below elevation 202.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) Dewatering will be required for excavation below water table. Dewatering may be limited to oversize excavation.  3.) This is not a suitable site for an infiltration pond. Due to possible high water table after construction.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 26 STRUCTURE Nos. 16,17 LOCATION Conlin Road, Langmaid Road Underpasses  
ORIGINAL GROUND ELEV. 210.6 m PROPOSED HWY 407 GRADE ELEV. 198.0 m, 202.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 26 0.0 - 9.8 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  9.8 - 16.9 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  203.6 m	1.) For abutment and pier foundations, spread footings placed within V. Dense or Hard glacial till below elevation 202.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 27 STRUCTURE Nos. 18,19 LOCATION Regional Road 34 Overpasses  
ORIGINAL GROUND ELEV. 205.4 m PROPOSED HWY 407 GRADE ELEV. 213.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 27 0.0 - 9.6 m Silty Sand to Sandy Silt Dense to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  Dry	1.) For pier foundations, spread footings placed within Dense to V. Dense glacial till below elevation 204.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa  2.) For abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) Higher bearing capacities can be utilized at a lower depth below elevation 202.0 m.  4.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond, but should be verified by further investigation.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 28 STRUCTURE Nos. 20, 21 LOCATION Farewell Creek Bridge, Solina Road Underpass  
ORIGINAL GROUND ELEV. 211.1 m PROPOSED HWY 407 GRADE ELEV. 190.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 28 0.0 - 12.4 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  Hole Collapsed	1.) For pier and abutment, spread footings placed within V. Dense glacial till below elevation 190.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 29 STRUCTURE Nos. 22, 23, 24 LOCATION Solina Road Underpass, Rundle Road Overpasses  
ORIGINAL GROUND ELEV. 188.5 m PROPOSED HWY 407 GRADE ELEV. 187.0 m, 184.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 29 0.0 - 4.9 m Silty Sand V. Dense 4.9 - 9.3 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  184.9 m	1.) For Abutment and pier, spread footings placed within V. Dense Silty Sand or Hard glacial till below elevation 187.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Applicable  2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.  Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 30 STRUCTURE Nos. 25 LOCATION Holt Road Underpass  
ORIGINAL GROUND ELEV. 192.6 m PROPOSED HWY 407 GRADE ELEV. 182.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 30 0.0 - 12.3 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u> 186.5 m	1.) For abutment and pier, spread footings placed within V. Dense glacial till below elevation 182.0 m and below frost depth of 1.2 m may be designed for:  - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = Not Governed	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 31 STRUCTURE Nos. 26, 27, 28, 29 LOCATION Bowmanville Creek Bridges, Old Seugog Road Overpass  
ORIGINAL GROUND ELEV. 174.4 m PROPOSED HWY 407 GRADE ELEV. 180.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 31 0.0 - 9.8 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  <u>Groundwater Elevation</u> 173.9 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for:  - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) Higher bearing capacities can be utilized at a lower depth below elevation 170.0 m.  3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



# FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 32 STRUCTURE Nos. 30, 31, 32, 33, 34, 35, 36, 37 LOCATION Regional Road 57, Cedar Park Road and Creek Structures

ORIGINAL GROUND ELEV. 172.9 m PROPOSED HWY 407 GRADE ELEV. 182.0 m, 184.0 m, 187.0 m

Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 32 0.0 - 9.6 m Silty Clay Firm to Hard	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 3.) For higher bearing capacities this structure can be supported on deep foundations. If deep foundations are considered, further investigation will be required.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.
<u>Groundwater Elevation</u> 168.5 m			

# FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 33 STRUCTURE Nos. 38, 39, 40, 41 LOCATION Middle Road and Creek East of Middle Road Structures

ORIGINAL GROUND ELEV. 178.2 m PROPOSED HWY 407 GRADE ELEV. 187.0 m

Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 33 0.0 - 2.4 m Silty Sand Loose 2.4 - 9.8 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 2.) For higher bearing capacity, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability and the water table is high.
<u>Groundwater Elevation</u> 177.9 m			



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 34 STRUCTURE Nos. 42 LOCATION Regional Road 14 Underpass  
ORIGINAL GROUND ELEV. 188.4 m PROPOSED HWY 407 GRADE ELEV. 186.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 34 0.0 - 4.0 m Clayey Silt V. Stiff to Hard (Glacial Till) 4.0 - 7.0 m Silty Sand to Sandy Silt V. Dense (Glacial Till) 7.0 - 12.6 m Silty Clay to Clayey Silt V. Stiff to Hard (Glacial Till)  <u>Groundwater Elevation</u> 179.3 m	1.) For pier foundations, spread footings placed within V. Stiff to Hard glacial till below elevation 186.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 650 kPa - Bearing Capacity at S.L.S. Type II = 400 kPa 2.) For abutment foundation, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 35 STRUCTURE Nos. 43, 44, 45, 46, 47, 48 LOCATION Clemens Road, Mackie Creek and Bethesda Road Structures  
ORIGINAL GROUND ELEV. 184.4 m PROPOSED HWY 407 GRADE ELEV. 185.0 m, 189.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P 35 0.0 - 9.8 m Silty Sand to Sandy Silt V. Dense (Glacial Till)  <u>Groundwater Elevation</u> 182.0 m	1.) For pier foundations, spread footings placed within V. Dense glacial till below elevation 183.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 750 kPa - Bearing Capacity at S.L.S. Type II = 500 kPa 2.) For abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa 3.) For higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated. 2.) No major dewatering problems are anticipated. 3.) This is not a suitable site for an infiltration pond. The soil is of low permeability.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 36 STRUCTURE Nos. 49,50,51,52,53 LOCATION Acres Road, Cole Road and Soper Creek Structures  
ORIGINAL GROUND ELEV. 171.9 m PROPOSED HWY 407 GRADE ELEV. 188.0 m, 180.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P.36 0.0 - 9.6 m Silty Sand Compact to V. Dense (Glacial Till)  <u>Groundwater Elevation</u>  166.2 m	1.) For abutment and pier foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  2.) Piles and caissons are also feasible, but should be selected on a cost comparison basis. If this option is selected, further investigation would be required.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. Further investigation will be required to prove this site to be suitable for an infiltration pond.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 37 STRUCTURE Nos. 54,55 LOCATION Darlington Town Line Road and Brown Road Structures  
ORIGINAL GROUND ELEV. 191.0 m PROPOSED HWY 407 GRADE ELEV. 187.0 m, 197.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> P.37 0.0 - 7.0 m Silty Sand to Sandy Silt V. Dense  7.0 - 10.8 m Clayey Silt Hard (Glacial Till)  <u>Groundwater Elevation</u>  184.0 m	1.) For pier and abutment foundations, spread footings placed within V. Dense glacial till below elevation 187.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 1000 kPa - Bearing Capacity at S.L.S. Type II = 500 kPa  2.) For pier and abutment foundations at higher elevations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For Higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.  Cuts up to 6 m deep will be stable at 2 H : 1 V side slope. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. The permeability of the soil is low to medium. Further study will be required to determine if the site is suitable for an infiltration pond.



FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 38 STRUCTURE Nos. 56,57,58,59,60,61 LOCATION Mosport Road, Wilnot Creek and Leskard Road Structures  
ORIGINAL GROUND ELEV. 202.3 m PROPOSED HWY 407 GRADE ELEV. 204.0 m, 209.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
REFERENCE BOREHOLE P 38 0.0 - 9.5 m Silty Sand Compact to V. Dense (Glacial Till)  Groundwater Elevation  195.1 m	1.) For pier foundations, spread footings placed within Compact to V. Dense glacial till below elevation 201.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 500 kPa - Bearing Capacity at S.L.S. Type II = 300 kPa  2.) For pier and abutment foundations, spread footings can be placed on a well compacted granular 'A' pad designed for: - Factored Bearing Capacity at U.L.S. = 900 kPa - Bearing Capacity at S.L.S. Type II = 350 kPa  3.) For higher bearing capacities, piles and caissons are also feasible, but should be selected on a cost comparison basis.	Fill up to 8 m high can be constructed at 2 H : 1 V side slopes. A mid height berm would be required for higher fill.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) This may be a potential site for an infiltration pond. Further investigation would be required to confirm this.

FOUNDATION DATA SHEET

W.P. 326-88-01 AREA 39 STRUCTURE Nos. 62 LOCATION Best Road Structures  
ORIGINAL GROUND ELEV. 244.4 m PROPOSED HWY 407 GRADE ELEV. 238.5 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
REFERENCE BOREHOLE P 39 0.0 - 12.3 m Silty Sand to Sandy Silt Compact to V. Dense (Glacial Till)  Groundwater Elevation  Not Established	1.) For pier and abutment foundations, spread footings placed within Dense to V. Dense glacial till below elevation 238.0 m and below frost depth of 1.2 m may be designed for: - Factored Bearing Capacity at U.L.S. = 650 kPa - Bearing Capacity at S.L.S. Type II = 400 kPa  2.) Higher bearing capacities can be utilized at a lower depth below elevation 237.0 m.  3.) Piles and caissons are also feasible, but should be selected on a cost comparison basis.	Cuts up to 6 m deep will be stable at 2 H : 1 V side slopes. A berm would be required for deeper cuts.	1.) No serious foundation problems are anticipated.  2.) No major dewatering problems are anticipated.  3.) May be a candidate site for an infiltration pond. Further investigation will be required to prove this.



RECORD OF BOREHOLE No P21															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords: N 4 868 931.8, E 351 038.5			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 30			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100	20
172.0	Ground Surface																	
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	31													
	Sandy Silt		2	SS	31													
			3	SS	41													
			4	SS	57													
			5	SS	104													
162.5			6	SS	120													
9.4	End of Borehole																	

+3, x<sup>5</sup> Numbers refer to 20  
+3, x<sup>5</sup> 15-5 (x) STRAIN AT FAILURE

RECORD OF BOREHOLE No P23															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords: N 4 869 724.6, E 354 258.5			ORIGINATED BY LO												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 27			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100	20
166.3	Ground Surface																	
0.0	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		1	SS	16													
			2	SS	52													
			3	SS	27													
160.8			4	SS	76													
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		5	SS	46													
			6	SS	53													
156.7																		
9.8	End of Borehole																	

+3, x<sup>5</sup> Numbers refer to 20  
+3, x<sup>5</sup> 15-5 (x) STRAIN AT FAILURE



RECORD OF BOREHOLE No P22															1 of 1		METRIC				
W.P. 326-88-01			LOCATION Coords.: N 4 869 896.0, E 352 482.8			ORIGINATED BY LO															
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO															
DATUM Geodetic			DATE 1994 05 26			CHECKED BY KA															
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa													
							20	40	60	80	100	○ UNCONFINED      + FIELD VANE • QUICK TRIAXIAL    × LAB VANE 20 40 60 80 100					10	20	30		
184.9	Ground Surface																				
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	74																
			2	SS	100																
179.4			3	SS	39																
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		4	SS	41																
			5	SS	108																
			6	SS	100																
172.3			7	SS	101																
12.6	End of Borehole																				

+3, x<sup>5</sup> Numbers refer to 20  
15-0.5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P24															1 of 1		METRIC				
W.P. 326-88-01			LOCATION Coords.: N 4 869 574.1, E 356 028.6			ORIGINATED BY LO															
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO															
DATUM Geodetic			DATE 1994 05 27			CHECKED BY KA															
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa													
							20	40	60	80	100	○ UNCONFINED      + FIELD VANE • QUICK TRIAXIAL    × LAB VANE 20 40 60 80 100					10	20	30		
203.2	Ground Surface																				
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	44																
			2	SS	78																
			3	SS	120																
			4	SS	85																
			5	SS	104																
193.6			6	SS	105																
9.6	End of Borehole																				

+3, x<sup>5</sup> Numbers refer to 20  
15-0.5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No P25															1 OF 1		METRIC								
W.P. 326-88-01			LOCATION Coords.: N 4 869 427.6, 357 821.1			ORIGINATED BY LO																			
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO																			
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES																				
213.2	Ground Surface																								
0.0	Sandy Silt to Silt Trace Clay, Trace Gravel V. Dense (Glacial Till)   Clayey Silt		1	SS	58																				
			2	SS	150	/8cm																			
			3	SS	150	/8cm																			
			4	SS	150	/18cm																			
			5	SS	111																				
			6	SS	150	/10cm																			
199.3	End of Borehole																								

+3, x, 5 Numbers refer to 20  
15-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P26															1 OF 1		METRIC								
W.P. 326-88-01			LOCATION Coords.: N 4 869 399.7, E 359 124.9			ORIGINATED BY LO																			
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO																			
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA																			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES																				
210.8	Ground Surface																								
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	135																				
			2	SS	150																				
			3	SS	138																				
			4	SS	150	/15cm																			
200.8	Clayey Silt Some Sand, Some Gravel Hard (Glacial Till)		5	SS	150	/18cm																			
9.8			6	SS	150	/18cm																			
			7	SS	138																				
			8	SS	150	/15cm																			
			9	SS	150	/15cm																			
193.6	End of Borehole																								

+3, x, 5 Numbers refer to 20  
15-5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No P27															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION			Coords.: N 4 889 259.2 E 360 032.5			ORIGINATED BY LO									
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem / Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 30			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100				W <sub>p</sub> W W <sub>L</sub>						
205.4	Ground Surface																	
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		1	SS	33													
			2	SS	105													
			3	SS	150													
			4	SS	89													
			5	SS	70													
195.8			6	SS	116													
9.6	End of Borehole																	

RECORD OF BOREHOLE No P28															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION			Coords.: N 4 889 551.5 E 361 241.7			ORIGINATED BY TC									
DIST 6 HWY 407			BOREHOLE TYPE Hollow Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100				W <sub>p</sub> W W <sub>L</sub>						
211.1	Ground Surface																	
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	107													
			2	SS	96													
			3	SS	150													
			4	SS	120													
			5	SS	130													
198.7			6	SS	130													
12.4	End of Borehole																	
	Unable to Measure Ground Water Due to the Hole Collapsing																	



RECORD OF BOREHOLE No P29															1 OF 1		METRIC												
W.P. 326-88-01			LOCATION			Coords.: N 4 869 697.3 E 362 491.2			ORIGINATED BY: JC																				
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY: LO																							
DATUM Geodetic			DATE 1994 05 26			CHECKED BY: KA																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																								
188.5	Ground Surface																												
0.0	Silty Sand Trace of Clay, Trace of Gravel V. Dense																												
183.6																													
4.9	Clayey Silt Same Sand, Trace Gravel Hard (Glacial Till)																												
179.2																													
9.3	End of Borehole																												

1, 3, 5: Numbers refer to 20 15-20% (X) STRAIN AT FAILURE

RECORD OF BOREHOLE No P30															1 OF 1		METRIC												
W.P. 326-88-01			LOCATION			Coords.: N 4 870 650.8 E 363 911.5			ORIGINATED BY: JC																				
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY: LO																							
DATUM Geodetic			DATE 1994 05 26			CHECKED BY: KA																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																								
192.6	Ground Surface																												
0.0																													
			1	SS	120	/15cm																							
			2	SS	120																								
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Pockets of Gravelly Sand V. Dense (Glacial Till)																												
			3	SS	90	/15cm																							
			4	SS	160	/15cm																							
			5	SS	157	/15cm																							
180.3																													
12.3	End of Borehole																												

1, 3, 5: Numbers refer to 20 15-20% (X) STRAIN AT FAILURE



RECORD OF BOREHOLE No P31															1 OF 1		METRIC	
W.P. 326-88-01		LOCATION Coords.: N 4 871 079.4, E 364 649.2					ORIGINATED BY IC											
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO											
DATUM Geodetic		DATE 1994 05 27					CHECKED BY KA											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
174.4	Ground Surface																	
0.0	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Clacial Till)  Lacustrine		1	SS	25													
			2	SS	42													
			3	SS	55													
			4	SS	55													
			5	SS	128													
164.8			6	SS	122													
9.6	End of Borehole																	

+ 3 x 5 Numbers refer to 20  
15-5 (X) STRAIN AT FAILURE

RECORD OF BOREHOLE No P32															1 OF 1		METRIC	
W.P. 326-88-01		LOCATION Coords.: N 4 871 347.3, E 365 431.0					ORIGINATED BY IC											
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO											
DATUM Geodetic		DATE 1994 05 30					CHECKED BY KA											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
172.9	Ground Surface																	
0.0	Silty Clay Trace of Sand, Trace of Gravel  Stiff to Hard Firm		1	SS	19													
			2	SS	43													
			3	SS	13													
			4	SS	6													
			5	SS	5													
163.3			6	SS	8													
9.6	End of Borehole																	

+ 3 x 5 Numbers refer to 20



RECORD OF BOREHOLE No P35															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 872 244.1, E 369 422.3			ORIGINATED BY TB												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	10 20 30	WATER CONTENT (%)	γ	KN/m <sup>3</sup>	GR SA SI CL				
184.4	Ground Surface						184											
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	66		182											
			2	SS	77		180											
			3	SS	81		178											
			4	SS	83		176											
			5	SS	152													
174.8			6	SS	125													
9.6	End of Borehole																	

+3, x5 Numbers refer to 20 15-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P36															1 OF 1		METRIC	
W.P. 326-88-01			LOCATION Coords.: N 4 873 130.2, E 370 875.9			ORIGINATED BY TB												
DIST 6 HWY 407			BOREHOLE TYPE Solid Stem			COMPILED BY LO												
DATUM Geodetic			DATE 1994 05 25			CHECKED BY KA												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	10 20 30	WATER CONTENT (%)	γ	KN/m <sup>3</sup>	GR SA SI CL				
171.9	Ground Surface						170											
0.0	Silty Sand Trace of Clay, Trace of Gravel Compact to V. Dense (Glacial Till)		1	SS	18		168											
			2	SS	48		166											
			3	SS	63		164											
			4	SS	63													
			5	SS	26													
162.3			6	SS	20													
9.6	End of Borehole																	

+3, x5 Numbers refer to 20 15-5 (%) STRAIN AT FAILURE



70

+3, x5: Numbers refer to  $\frac{20}{15 \times 5}$  (X) STRAIN AT FAILURE



RECORD OF BOREHOLE No P39																				1 OF 1		METRIC	
W.P. 326-88-01				LOCATION				Coords.: N 4 875 662.9, E 374 279.7				ORIGINATED BY TB											
DIST 6				HWY 407				BOREHOLE TYPE Solid Stem				COMPILED BY LO											
DATUM Geodetic				DATE 1994 05 30				CHECKED BY KA															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT $\gamma$ $\text{KN/m}^3$	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>								
244.4	Ground Surface																						
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Occasional Layers of Gravelly Sand Compact to V. Dense (Glacial Till)																						
			1	SS	18																		
			2	SS	37																		
			3	SS	120																		
			4	SS	99																		
	Sandy Gravel		5	SS	120	/12cm																	
232.0			6	SS	123	/15cm																	
12.3	End of Borehole																						
	• Ground Water Not Established																						

+3, x<sup>3</sup> Numbers refer to 20  
15-0.5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P40																				1 OF 1		METRIC	
W.P. 326-88-01				LOCATION				Coords.: N 4 876 521.2, E 374 481.4				ORIGINATED BY TB											
DIST 6				HWY 407				BOREHOLE TYPE Solid Stem				COMPILED BY LO											
DATUM Geodetic				DATE 1994 05 26				CHECKED BY KA															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT $\gamma$ $\text{KN/m}^3$	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>								
255.9	Ground Surface																						
0.0	Clayey Silt Some Sand, Traces of Gravel Stiff (Glacial Till)		1	SS	11																		
			2	SS	8																		
252.0	Silt to Silty Sand V. Dense		3	SS	49																		
4.0			4	SS	94																		
			5	SS	25																		
			6	SS	57																		
246.3																							
9.8	End of Borehole																						

+3, x<sup>3</sup> Numbers refer to 20  
15-0.5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No P41 1 OF 1 METRIC																													
W.P. 326-88-01		LOCATION		Coords.: N 4 878 682.4, E 374 562.7		ORIGINATED BY TB																							
DIST 6		HWY 407		BOREHOLE TYPE Solid Stem		COMPILED BY LO																							
DATUM Geodetic		DATE 1994 05 30				CHECKED BY KA																							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (Z)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES																								
319.0	Ground Surface																												
0.0	Silty Clay to Clayey Silt Some Sand, Traces of Gravel V. Stiff to Hard		1	SS	26																								
	Silty Sand		2	SS	17																								
			3	SS	24																								
313.6			4	SS	49																								
5.5	Silt to Silty Sand V. Dense		5	SS	46																								
309.4			6	SS	144																								
9.8	End of Borehole																												
	• Ground Water Not Established																												

+3, x5: Numbers refer to 20  
15-0.5 (X) STRAIN AT FAILURE

## EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING			MECHANICAL PROPERTIES OF SOIL		
SS	SPLIT SPOON	TP	THINWALL PISTON	$m_v$	$kPa^{-1}$ COEFFICIENT OF VOLUME CHANGE
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE	$c_c$	1 COMPRESSION INDEX
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE	$c_s$	1 SWELLING INDEX
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY	$c_a$	1 RATE OF SECONDARY CONSOLIDATION
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY	$c_v$	$m^2/s$ COEFFICIENT OF CONSOLIDATION
TW	THINWALL OPEN	FS	FOIL SAMPLE	H	m DRAINAGE PATH
				$T_v$	1 TIME FACTOR
				U	% DEGREE OF CONSOLIDATION
$u_w$	kPa PORE WATER PRESSURE	$\sigma'_{vo}$	kPa EFFECTIVE OVERBURDEN PRESSURE	$\sigma'_p$	kPa PRECONSOLIDATION PRESSURE
$r_u$	1 PORE PRESSURE RATIO	$\tau_f$	kPa SHEAR STRENGTH	$c'$	kPa EFFECTIVE COHESION INTERCEPT
$\sigma$	kPa TOTAL NORMAL STRESS	$\phi'$	-° EFFECTIVE ANGLE OF INTERNAL FRICTION	$c_u$	kPa APPARENT COHESION INTERCEPT
$\sigma'$	kPa EFFECTIVE NORMAL STRESS	$\phi_u$	-° APPARENT ANGLE OF INTERNAL FRICTION	$\tau_R$	kPa RESIDUAL SHEAR STRENGTH
$\tau$	kPa SHEAR STRESS	$\tau_r$	kPa REMOULDED SHEAR STRENGTH	$S_l$	1 SENSITIVITY = $\frac{c_u}{\tau_r}$
$\sigma_1, \sigma_2, \sigma_3$	kPa PRINCIPAL STRESSES				
$\epsilon$	% LINEAR STRAIN				
$\epsilon_1, \epsilon_2, \epsilon_3$	% PRINCIPAL STRAINS				
E	kPa MODULUS OF LINEAR DEFORMATION				
G	kPa MODULUS OF SHEAR DEFORMATION				
$\mu$	1 COEFFICIENT OF FRICTION				

## PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup> DENSITY OF SOLID PARTICLES	e	1, % VOID RATIO	$e_{min}$	1, % VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup> UNIT WEIGHT OF SOLID PARTICLES	n	1, % POROSITY	$I_D$	1 DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup> DENSITY OF WATER	w	1, % WATER CONTENT	D	mm GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup> UNIT WEIGHT OF WATER	$S_r$	% DEGREE OF SATURATION	$D_n$	mm n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup> DENSITY OF SOIL	$w_L$	% LIQUID LIMIT	$C_u$	1 UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup> UNIT WEIGHT OF SOIL	$w_p$	% PLASTIC LIMIT	h	m HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup> DENSITY OF DRY SOIL	$w_s$	% SHRINKAGE LIMIT	q	m <sup>3</sup> /s RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup> UNIT WEIGHT OF DRY SOIL	$I_p$	% PLASTICITY INDEX = $w_L - w_p$	v	m/s DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup> DENSITY OF SATURATED SOIL	$I_L$	1 LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1 HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup> UNIT WEIGHT OF SATURATED SOIL	$I_C$	1 CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup> DENSITY OF SUBMERGED SOIL	$e_{max}$	1, % VOID RATIO IN LOOSEST STATE	j	kN/m <sup>2</sup> SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup> UNIT WEIGHT OF SUBMERGED SOIL				



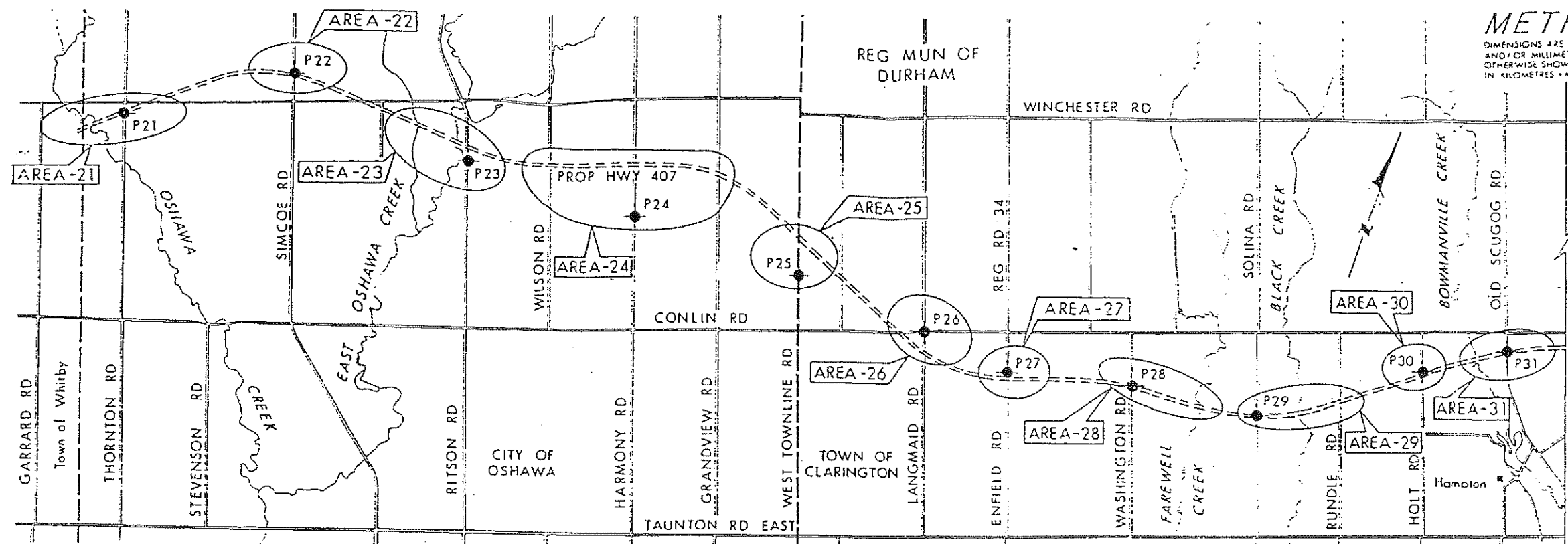
CONT No  
WP No 326-88-01

FEASIBILITY STUDY FOR HWY 407  
FROM WHITBY/OSHAWA BOUNDARY  
TO HWY 35/115  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.



PLAN  
SCALE  
500m 0 500m

NOTE  
For Soil Details Refer to  
Record of Borehole Sheets

KEY PLAN  
SCALE

#### LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (5th Pen Test, 475 J/blow)
- CCNE Blows/0.3m (60° Cone, 475 J/blow)
- ⊕ WL at time of investigation 1994-05

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
21	P21	3	OSHAWA CREEK BRIDGE WBL (W)
		4	OSHAWA CREEK BRIDGE EBL (W)
		5	THORNTON RD OVERPASS WBL (I)
		6	THORNTON RD OVERPASS EBL (I)
22	P22	7	SIMCOE RD UNDERPASS (I)
23	P23	8	EAST OSHAWA CREEK BRIDGE WBL (W)
		9	EAST OSHAWA CREEK BRIDGE EBL (W)
		10	RITSON RD OVERPASS - ALT A (GS)
		11	RITSON RD OVERPASS - ALT A (GS)
24	P24	12	WILSON RD UNDERPASS - ALT A (GS)
		13	HARMONY RD UNDERPASS - ALT A (I)
		14	GRANDVIEW RD UNDERPASS - ALT A (GS)
25	P25	15	WEST TOWNLINE RD UNDERPASS - ALT A (I)
26	P26	16	CONLIN RD UNDERPASS - ALT A (GS)
		17	LANGMAID RD UNDERPASS - ALT A (GS)

#### LEGEND

- W - WATERCOURSE STRUCTURE SITES
- GS - GRADE SEPARATED STRUCTURE SITES
- I - INTERCHANGE STRUCTURE SITES

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
27	P27	18	REGIONAL RD 34 OVERPASS WBL - ALT A (I)
		19	REGIONAL RD 34 OVERPASS EBL - ALT A (I)
28	P28	20	FAREWELL CREEK BRIDGE WBL (W)
		21	FAREWELL CREEK BRIDGE EBL (W)
29	P29	22	SOLINA RD UNDERPASS (GS)
		23	RUNDLE RD OVERPASS WBL (I)
		24	RUNDLE RD OVERPASS EBL (I)
30	P30	25	HOLT RD UNDERPASS (GS)
31	P31	26	BOWMANVILLE CREEK BRIDGE WBL (W)
		27	BOWMANVILLE CREEK BRIDGE EBL (W)
		28	OLD SCUGOG RD OVERPASS WBL (GS)
		29	OLD SCUGOG RD OVERPASS EBL (GS)

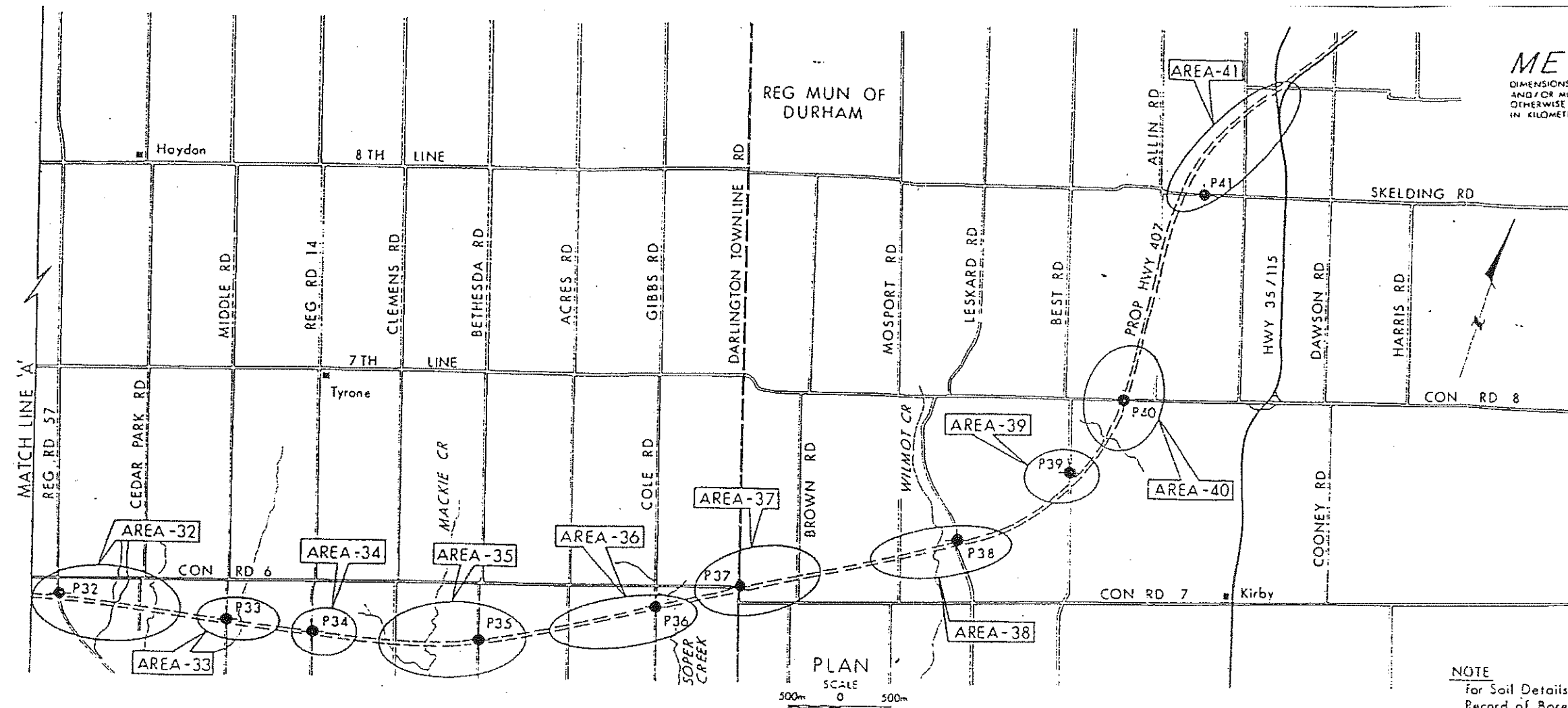
#### NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of GPS Gen Cons.

REV	DATE	BY	DESCRIPTION
1			
Geocres No 30M15-85			
HWY No 407			
SUBWD KA (CHECKED) DATE 1994 08 08 SITE			
DRAWN DT (CHECKED) DATE 1994 08 08 SITE			
REF No NTS Meas 30M/15e, 30M/15f, 30M/15g & 30M/15h			
DWG 3268801-2			

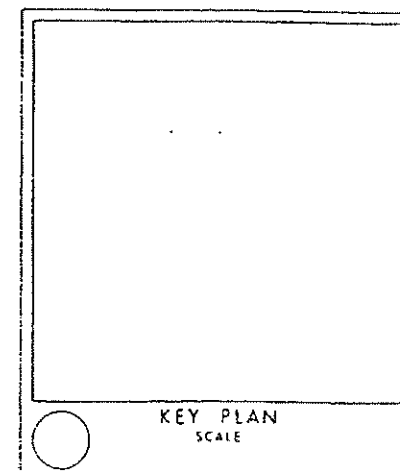




METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES - METRES.CONT No  
WP No 326-88-01FEASIBILITY STUDY FOR HWY 407  
FROM WHITBY/OSHAWA BOUNDARY  
TO HWY 35/115  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



## LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W/L at time of investigation 1994.05

NOTE  
For Soil Details Refer to  
Record of Borehole Sheets

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
32	P32	30	REGIONAL RD 57 OVERPASS WBL (I)
		31	REGIONAL RD 57 OVERPASS EBL (I)
		32	CREEK EAST OF REG RD 57 BRIDGE WBL (W)
		33	CREEK EAST OF REG RD 57 BRIDGE EBL (W)
		34	CEDAR PARK RD OVERPASS WBL (GS)
		35	CEDAR PARK RD OVERPASS EBL (GS)
		36	CREEK EAST OF CEDAR PARK RD BRIDGE WBL (W)
33	P33	37	CREEK EAST OF CEDAR PARK RD BRIDGE EBL (W)
		38	MIDDLE RD OVERPASS WBL (GS)
		39	MIDDLE RD OVERPASS EBL (GS)
		40	CREEK EAST OF MIDDLE RD BRIDGE WBL (W)
34	P34	41	CREEK EAST OF MIDDLE RD BRIDGE EBL (W)
		42	REGIONAL RD 14 UNDERPASS (I)
35	P35	43	CLEMENS RD OVERPASS WBL (GS)
		44	CLEMENS RD OVERPASS EBL (GS)
		45	MACKIE CREEK BRIDGE WBL (W)
		46	MACKIE CREEK BRIDGE EBL (W)
		47	BETHESDA RD OVERPASS WBL (I)
		48	BETHESDA RD OVERPASS EBL (I)

## LEGEND

- W - WATERCOURSE STRUCTURE SITES
- GS - GRADE SEPARATED STRUCTURE SITES
- I - INTERCHANGE STRUCTURE SITES

AREA	BOREHOLE No	STRUCT REF No	DESCRIPTION
36	P36	49	ACRES RD UNDERPASS (GS)
		50	COLE RD OVERPASS WBL (GS)
		51	COLE RD OVERPASS EBL (GS)
		52	SOPER CREEK BRIDGE WBL (W)
		53	SOPER CREEK BRIDGE EBL (W)
37	P37	54	DARLINGTON TOWNLINE RD U'PASS (I)
		55	BROWN RD UNDERPASS (GS)
38	P38	56	MOSPORT RD OVERPASS WBL (GS)
		57	MOSPORT RD OVERPASS EBL (GS)
		58	WILMOT CREEK BRIDGE WBL (W)
		59	WILMOT CREEK BRIDGE EBL (W)
		60	LESKARD RD OVERPASS WBL (GS)
		61	LESKARD RD OVERPASS EBL (GS)
39	P39	62	BEST RD UNDERPASS (GS)
40	P40	63	CREEK EAST OF BEST RD BRIDGE WBL (W)
		64	CREEK EAST OF BEST RD BRIDGE EBL (W)
		65	CON RD 8 OVERPASS WBL (GS)
		66	CON RD 8 OVERPASS EBL (GS)
41	P41	67	SKELDING RD UNDERPASS (GS)
		68	HWY 35/115 UNDERPASS (I)

## NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen Cons.

DATE	BY	DESCRIPTION
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Geocres No 30M15-25

HWY No 407	ISIST 6
SUBMIT KA CHECKED	DATE 1994 08 08 SITE
DRAWN DT CHECKED	DWG 3268801-2

REF No NTS Maps 30M/15b &amp; 30M/15g





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## FOUNDATION DESIGN SECTION

### ENGINEERING MATERIALS OFFICE FOUNDATION DESIGN SECTION

WP 663-89-00 DIST 7  
HWY 401 STR SITE -

Feasibility Study of Freeway Link  
Between Hwy 401 and Hwy 407  
Oshawa/Clarington Freeway Link

**foundation  
investigation and  
design report**

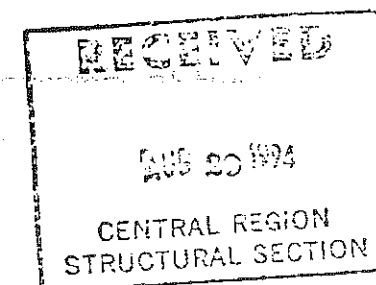
### ENGINEERING MATERIALS OFFICE FOUNDATION DESIGN SECTION

WP 663-89-00 DIST 7  
HWY 401 STR SITE -

Feasibility Study of Freeway Link  
Between Hwy 401 and Hwy 407  
Oshawa/Clarington Freeway Link

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GEOCRES 30M15-83

DATE AUG 29 1994



FOUNDATION INVESTIGATION REPORT  
For  
Feasibility Study of Freeway Link  
Between Hwy. 401 and Hwy. 407  
Oshawa/Clarington Freeway Link  
W.P. 663-89-00  
District 7, Toronto

INTRODUCTION

A request, dated April 2, 1993 to review the feasibility study of Oshawa/Clarington Freeway Link between Hwy. 401 and Hwy. 407 for 26 structures and 3 culverts sites, was received from Central Region Structural Section.

Based on the above request, the Phase II study report issued by Geocon Inc. has been reviewed by the Foundation Design Section (Geocon Report T11707B, July, 1992). This technical report presents a preliminary geotechnical route analyses of the alignments, for each study corridor, proposed by the transportation consultants.

Five major alignments have been proposed to link Hwy. 401 and the proposed Hwy. 407 within the Oshawa Link. Five connector junctions have been established at Hwy. 401 and four at the proposed Hwy. 407 to link the two highways. Underpass structures will be proposed along the link alignments at the crossing of Hwy. 2, Bloor Street, Nash Road, Pebblestone Road, and Regional Road No. 4 (Taunton Road). Interchange structures will also be established at Hwy. 401 and Hwy. 407 at the respective connector junctions.

The proposed major link alignments are located between existing north-south roadways and primarily within the central zone of the study corridor. Generally, the alignments encountered few existing properties and developed areas. Since the location of the proposed Hwy. 407 is tentative, several other alternative alignments for Hwy. 407 have been proposed further north of the current technically preferred alignment. Correspondingly, the proposed links between Hwy. 401 and Hwy. 407 have been extended to connect at the alternate proposed

- 2 -

Highway routes. Details of the route locations may be referenced from the Hwy. design consultant drawings (McCormick and Rankin, 1991).

The technically preferred freeway link is located in the western portion of the study corridor as shown on Drawing 6638900A. Twenty six (26) new bridge structures and three (3) culverts are proposed along this Oshawa Link as shown on Figure 1. Table 1 in the Appendix shows a chart listing the various structures, their locations and a brief description of the sites.

Based on the above request and our review, twelve boreholes (B.H. 1 to B.H. 12) were advanced and sampled between 93 12 06 and 93 12 13 as a part of the project by means of solid or hollow stem augers with washboring techniques. These boreholes extended down to depth of 7.0 m at B.H. 3 and 29.4 m at B.H. 9 below the existing ground surface.

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions, structure foundations, approach embankments and cuts and related earthworks for the sites as shown on Drawing No. 6638900A.

SITE DESCRIPTION AND GEOLOGY

The proposed structure sites extend from Hwy. 401 Interchange northerly <sup>10</sup>14 km to the proposed Hwy. 407 interchange (Drawing No. 6638900A). The sites are located in the Municipality of Clarington, Region of Durham.

The portion of the Oshawa Link Corridor under investigation is flanked by mosaic of urban land uses on the periphery of area municipal core also which includes major new residential and industrial subdivision development by traditional agricultural operations as well as specialty crop systems.

The topography of the area is generally flat to gently undulating, generally sloping down toward Lake Ontario from the north to the south.

Physiographically, the area is located in the region referred to as the "South



Slope and Iroquois Plain" (Chapman and Putnam, 1984). This is the lowland bordering Lake Ontario which was inundated in the Pleistocene time by Lake Iroquois. Subsoils in these areas generally are characterized by a mosaic of till plains, drumlins, and areas of glacial lacustrine deposits of silt, sand and clayey silt.

#### SUBSURFACE CONDITIONS

The subsoil encountered at these sites can be divided into seven deposits as follows:

- i) fill material
- ii) topsoil
- iii) clayey silt
- iv) sandy silt to silty sand
- v) sand to sand and gravel
- vi) heterogeneous mixture of silt, sand and gravel  
(non-cohesive glacial till)
- vii) heterogeneous mixture of clayey silt, sand and gravel  
(cohesive glacial till)

The maximum thickness of these deposits vary with the location and depths. A detailed description of the subsurface conditions encountered is given below.

#### Fill Material

This material was encountered at five borehole locations along the existing road. The material consists of a brown sand and gravel. The thickness of this layer varies from 1.0 metre at B.H. 3 to 1.6 metres at B.H. 1 as shown on the Record of Boreholes. No laboratory tests were carried out on the fill material. However, through visual observation, it can be classified as a sand and gravel.

#### Topsoil

Organic topsoil was found from the ground surface or just underneath the sand and gravel fill at nine (9) borehole locations out of twelve (12) borehole. The thickness of the topsoil varies from 0.1 metres at B.H.1 to 1.1 metres at B.H.7.

#### Clayey Silt

This stratum was encountered in five (5) boreholes (B.H.'s 2, 3, 6, 7 and 9). This material consists of a clayey silt ranging in thickness between 0.5 metres at B.H. 3 and 9.8 m at B.H. 7.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 2 and summarized as follows:

<u>Property</u>		<u>Range</u>
Natural Moisture Content (W)		13.0 - 30.0
Liquid Limit	(WL)	16.0 - 31.0
Plastic Limit	(Wp)	10.0 - 16.0
Plasticity Index	(Ip)	6.0 - 15.0

From the plasticity chart it is evident that the layer can be classified as an inorganic clayey silt with low plasticity (CL).

Undrained shear strengths of the soil were determined by in-situ vane tests. The results are plotted on the Record of Boreholes in the Appendix and summarized as follows:

<u>Undrained Shear Strength (cu)</u>	<u>kPa</u>	<u>Sensitivity</u>
Field Vane	25 - 80	2 - 6

As shown on the above table, recommended shear strength for this deposit can be assumed to be within the range of 25 to 80 kPa. Based on this conclusion, the soil has generally a firm to stiff consistency. The sensitivity of the soil is generally low to moderate.

#### Sandy Silt to Silty Sand

Sandy silt to silty sand was encountered above or below the clayey silt layer in seven (7) boreholes. The thickness of this layer ranges from 0.5 metres at B.H. 3 to 8.6 metres at B.H. 9.

The deposit contains minor variations in gravel content throughout its thickness.



Generally the deposit contains some gravel. Grain size distribution analysis indicates that the soil varies between a sandy silt to silty sand. This layer is basically non-plastic. Figure 3 in the Appendix shows the result of grain size distribution tests.

In this stratum, the 'N' values ranged from 6 to over 100 blows/0.3 m indicating a state of compaction described as loose to very dense.

#### Sand to Sand and Gravel

These stratum were encountered above or in between non-cohesive glacial till at five (5) borehole locations. The thickness of this layer ranges from 1.4 metres at B.H. 11 to 5.3 metres at B.H. 4.

No laboratory tests were carried out on this material. However, through visual observation, this material can be classified as a sand to sand and gravel.

In this stratum, the 'N' values ranged from 26 to over 100 blows/0.3 m indicated a state of compaction described as compact to very dense.

#### Heterogeneous Mixture of Silt, Sand and Gravel (Non-cohesive Glacial Till)

Underlying the sandy silt to silty sand and sand and gravel layers, a heterogeneous mixture of silt, sand and gravel of glacial origin was encountered at 11 boreholes. The proven thickness of this stratum ranges from 3.7 metres at B.H. 5 to greater than 11.9 metres at B.H. 9. Most of the samples recovered from the site investigation has a grey colour.

Grain size distribution analyses indicate that this layer can be classified as heterogeneous mixture of silt, sand and gravel (non-cohesive glacial till). Gradation limits for these soils are presented in an envelope form on Figure 4. This layer is basically non-plastic.

In the stratum, the 'N' values ranged from 21 to over 100 blows/0.3 m indicated a state of compaction described as compact to very dense.

#### Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Cohesive Glacial Till)

A cohesive glacial till deposit was found immediately below the fill material at one borehole location. This material consists of a cohesive heterogeneous mixture of clayey silt, sand and gravel with a thickness of greater than 14 m at B.H. 8.

Atterberg Limit Test was performed on this sample and the result is plotted on Figure 5 and summarized as follows:

Property	Range (10)
Natural Moisture Content (W)	6
Liquid Limit (WL)	15
Plastic Limit (WP)	9
Plasticity Index (Ip)	6

From the plasticity chart as shown on Figure 4, it is evident that the deposit can be classified as an inorganic clayey silt to silt with low plasticity (CL or CL-ML).

A grain size distribution analysis was carried out on this material. Figure 6 in Appendix shows the result.

Standard penetration test 'N' values between 60 and over 100 blows/0.3 m indicated that the soil can be interpreted as being hard.

#### Groundwater Conditions

Groundwater conditions were observed through the measurement of water level in the open boreholes. The depth of groundwater level after completion ranged from 0.6 metres at B.H. 5 to 6.2 metres at B.H. 9 below the existing ground surface. At two borehole locations (B.H.'s 8 and 12), groundwater in the boreholes was dry after completion. However it should be noted that a perched water was encountered at a depth of about 3.0 m in Borehole 8 below the ground surface. The following groundwater levels were observed during the field investigation.



<u>B.H.No.</u>	<u>Ground Elevation (m)</u>	<u>Groundwater Elevation (m)</u>	<u>Depth (m)</u>
1	104.5	101.6	2.9
2	105.0	99.2	5.8
3	108.5	105.0	3.5
4	126.8	123.8	3.0
5	134.0	133.4	0.6
6	139.6	137.7	2.1
7	140.4	137.0	3.4
8	153.3	Dry	3.0 (perched water)
9	152.1	145.9	6.2
10	152.6	151.0	1.6
11	180.3	175.9	4.4
12	214.3	Dry	-

#### DISCUSSION AND RECOMMENDATIONS

At present the planning and design staff is involved in the preliminary design phase for the Oshawa Link. This report contains the geotechnical aspect of the Oshawa Link from the proposed Hwy. 407 to the existing Hwy. 401 east of Courtice Road in the Municipality of Clarington, Region of Durham for various structures and culverts. Twenty six (26) bridge structures and three (3) culverts including seven (7) creek crossings were reviewed for this program (see Figure 1)

In general, subsurface conditions over the site are uniform and competent for structure foundation and embankment loadings.

Our comments from the feasibility, design and construction of the various structures and culverts are given on the Foundation Data Sheets included in the Appendix. A data sheet is provided for each of the 12 areas; the area location is described on these sheets and is also shown on Drawing No. 6638900A. An explanation of information provided on the data sheet is outlined below.

1. The structure number given (i.e. 1, 2, 3.....26, culvert 1.....etc.) is a numbering system developed for the purpose of the feasibility study. The area is the location of boreholes drilled for this study (1, 2,.....12). The actual location is shown on Drawing No. 6638900A and Figure 1.
2. The original ground elevation is based on the survey result for the proposed Oshawa Link profile.
3. The grades of roadway given is based on the proposed grades of Oshawa Link at the respective sites.
4. Subsurface conditions are described very briefly and are based on generally not more than one boring per area.



5. Recommendation - Structure

The recommendations are discussed separately for the structural elements (abutments and piers). The options for structure foundations are given in preferential order based on geotechnical/economical considerations. Further elaboration of structure recommendations made on the data sheets are given below.

Compacted Granular 'A' Core (Engineered Fill) - This option is for abutments only where subsurface conditions are competent. This option is not recommended for water crossings. The minimum requirements of a compacted granular 'A' core are shown on Figure 7 in the Appendix. Furthermore, the footing for this scheme could be designed using the following parameters:

Factored Bearing Capacity at U.L.S.: 900 kPa  
Bearing Capacity at S.L.S. : 350 kPa

Spread Footings - This option is given for abutments and piers where subsurface conditions are competent. The maximum elevation and corresponding maximum design load is given. It is to be noted the spread footings should be provided with a minimum of 1.2 m of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, subject to softening upon exposure to construction or weather conditions, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a granular deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from "boiling" due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required. Two alternative dewatering schemes are shown on Figure 8 and Figure 9.

End-Bearing Piles - This founding scheme is recommended for the abutments and piers where appropriate. The recommendation gives the estimated pile tip elevation. Generally, the end-bearing piles can be designed for the

factored axial capacity at U.L.S. and the axial capacity at S.L.S. which is dependent on the pile section chosen. The following design parameters are recommended for the pile foundation:

<u>Pile Type</u>	Factored Axial Capacity	Axial Capacity
	<u>at U.L.S. (kN)</u>	<u>at S.L.S. (kN)</u>
310 HP 79	1150	900
310 HP 110	1600	1150

It is generally assumed steel 'H' piles will be used, however, if a certain pile section is not suitable at the specific area, this fact is mentioned in the data sheet. Pile driving would be field controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil.

6. Recommendation - Approaches

The recommendations for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current M.T.O. Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also discussed under this heading is special treatment, i.e. benching, slope protection, etc., that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

7. Other Considerations

The granular 'A' or 'B' backfill should be in accordance with Special Provision No. 109F03 (dated March, 1988). The following parameters are recommended for the granular backfill"

	<u>Gran. 'A'</u>	<u>Gran. 'B'</u>
Angle of Internal Friction: $\phi$	35°	30°
Unit Weight (kN/m <sup>3</sup> ): $\gamma$	22.80	21.20
Coefficient of Active Earth Pressure (Ka)	0.27	0.33
Coefficient of Earth Pressure at Rest (Ko)	0.43	0.50



The earth pressure coefficient at rest is to be used when the design of abutment walls are rigid and unyielding. All foundation elements should have a minimum of 1.2 m earth cover for frost protection.

The concrete for the footings should be formed 'In The Dry'. Consequently a dewatering scheme will be required if the concrete is poured below the prevailing water level.

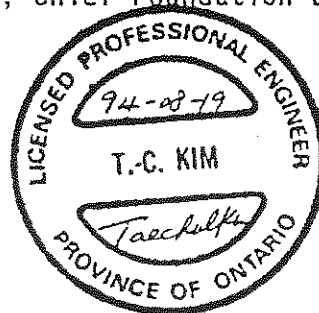
8. Remarks

In this column assumptions made and geotechnical preference of schemes if appropriate, are discussed, as well as other options or considerations to be evaluated during this stage of design.

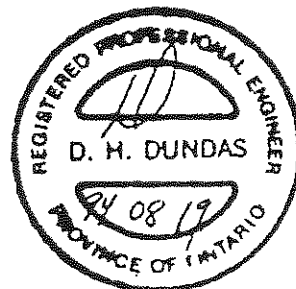
MISCELLANEOUS

The various comments outlined in this report are for feasibility study purposes based on limited field data. It will be necessary to carry out a detailed subsurface investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, surface and groundwater studies for stormwater detention ponds and special in-situ field testing may be warranted.

This report was prepared by Mr. T.C. Kim, Sr. Foundation Engineer and reviewed by Mr. D. Dundas, Chief Foundation Engineer (Acting).



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(Acting)

APPENDIX



TABLE 1 : LIST OF STRUCTURES

AREA	STRUCTURE REF.No.	DESCRIPTION
1	1	Freeway Link W-N ramp over relocated Courtrice Rd. (Regional Rd. 34)/Hwy 401 interchange N/S-E ramp
	2	Relocated Courtrice Rd. (Regional Rd. 34)/Hwy 401 interchange E-N/S ramp over Freeway Link N-W ramp
	3	Freeway Link W-N ramp over Highway 401
	4	Freeway Link N-E ramp over Highway 401
	5	Freeway Link N-E ramp over Freeway Link W-N ramp
2	6	Freeway Link N-W ramp over CP Rail
	7	Freeway Link N-E ramp over CP Rail
	8	Freeway Link W-N ramp over CP Rail
	9	Freeway Link E-N ramp over CP Rail
3	10	Freeway Link N-W ramp over Baseline Road
	11	Freeway Link N-E ramp over Baseline Road
	12	Freeway Link W-N ramp over Baseline Road
	13	Freeway Link E-N ramp over Baseline Road
4	14	Bloor Street over Freeway Link
5	Culvert-1	Freeway Link crossing North of Bloor Street
6	15	Highway 2 over Freeway Link
7	16	Nash Road over Freeway Link
	17	Freeway Link over Black Creek
8	18	Hancock Road over Freeway Link
9	Culvert-2	Freeway Link crossing South of Pebblestone Road
	Culvert-3	Freeway Link S-E/W ramp crossing South of Pebblestone Road
	19	Pebblestone Road over Freeway Link
10	20	Freeway Link over Farewell Creek
11	21	Regional Road 4 (Taunton Road) over Freeway Link
12	22	Freeway Link E-S ramp over Freeway Link S-W ramp
	23	Freeway Link S-W ramp over proposed Highway 407
	24	Freeway Link E-S ramp over proposed Highway 407
	25	Freeway Link S-E ramp over Farewell Creek
	26	Freeway Link E-S ramp over Farewell Creek

FOUNDATION DATA SHEET

W.P. 663-89-00
AREA 1
STRUCTURE Nos. 1, 2, 3, 4 and 5
LOCATION Oshawa Link at HWY 401 Interchange

ORIGINAL GROUND ELEV. 100.0 - 106.0 m
PROPOSED HWY 401 / 407
GRADE ELEV. Varied
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 1 (Gr.Elev. 104.5 m) 0.0 - 1.6 : Sand and Gravel Fill compact to dense 1.6 - 15.4: Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) compact to very dense <u>GROUNDWATER</u> Water level at 2.9 m below ground surface.	<u>ABUTMENTS AND PIERS</u> 1. <u>ABUTMENTS</u> a) A perched-type abutments founded on spread footings on Granular "A" core - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa b) Spread footings on the very dense glacial till at an elevation below 101.5 m - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed 2. <u>PIERS</u> Spread footings founded on the very dense glacial till - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed	1) Fill height up to 8.0 m will be stable with 2:1 side and forward slopes 2) Fill height greater than 8.0 m will be required a mid-height safety berm 3) Unsuitable material within the plan limit should be fully removed and replaced with well compacted material	1. No serious foundation problems are anticipated 2. No major dewatering problems are anticipated for excavation of footings



FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 2 STRUCTURE Nos. 6, 7, 8 and 9 LOCATION Oshawa Link ramps over CP Rail  
ORIGINAL GROUND ELEV. 105.0 - 109.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 113.0 - 120.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 2 (Gr.Elev. 105.0 m)  0.0 - 1.4 : Clayey Silt stiff  1.4 - 2.1 : Silty Sand compact  2.1 - 8.1 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense  <u>GROUNDWATER</u>  Water level at 5.8 m below ground surface	<u>ABUTMENTS AND PIERS</u>  <u>1. ABUTMENTS</u>  a) A perched-type abutments founded on spread footings on Granular "A" core - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa  b) Spread footings on the very dense glacial till at an elevation below 102.9 m - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed  <u>2. PIERS</u>  Spread footings founded on the very dense glacial till - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed	1) Fill height up to 8.0 m will be stable with 2:1 side and forward slopes  2) Fill height greater than 8.0 m will be required a mid-height berm  3) Unsuitable material within the plan limit of the proposed embankment should be fully removed and replaced with well compacted material	1. No serious foundation problems are anticipated  2. No major dewatering problems are anticipated for excavation of footings  3. Some railway protection would be required

FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 3 STRUCTURE Nos. 10, 11, 12 and 13 LOCATION Oshawa Link ramps over Baseline Rd.  
ORIGINAL GROUND ELEV. 106.0 - 108.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 112.0 - 116.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 3 (Gr.Elev. 108.5 m)  0.0 - 0.1 : Pavement  0.1 - 1.0 : Sand and Gravel Fill compact  1.0 - 1.9 : Clayey Silt trace of organics  1.9 - 2.4 : Silty Sand compact to very dense  2.4 - 7.0 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense  <u>GROUNDWATER</u>  Water level at 3.5 m below ground surface	<u>ABUTMENTS AND PIERS</u>  <u>1. ABUTMENTS</u>  a) A perched-type abutments founded on spread footings on Granular "A" core - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa  b) Spread footings on the very dense glacial till at an elevation below 106.5 m - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed  <u>2. PIERS</u>  Spread footings founded on the very dense glacial till - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed	1) Fill height up to 8.0 m will be stable with 2:1 side and forward slopes  2) Fill height greater than 8.0 m will be required a mid-height berm  3) Unsuitable material within the plan limit should be fully removed and replaced with well compacted material prior to fill placement	1. No serious foundation problems are anticipated  2. No major dewatering problems are anticipated for excavation of footings



FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 4 STRUCTURE Nos. 14 LOCATION Oshawa Link - Bloor St. over Freeway Link  
ORIGINAL GROUND ELEV. 125.5 m PROPOSED HWY 401 / 407 GRADE ELEV. 129.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 4 (Gr.Elev. 126.8 m) 0.0 - 0.1 : Pavement 0.1 - 1.4 : Sand and Gravel Fill dense 1.4 - 5.6 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense 5.6 - 10.9: Fine to medium Sand dense 10.6 - 11.6: Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense <u>GROUNDWATER</u> Water level at 3.0 m below ground surface	<u>ABUTMENTS AND PIERS</u> <u>1. ABUTMENTS</u> a) A perched-type abutments founded on spread footings on Granular "A" core - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa b) For a closed-type abutments, spread footing on dense fine to medium sand at an elevation below 121.0 m - Factored bearing Capacity at U.L.S. : 800 kPa - Bearing Capacity at S.L.S. : 340 kPa <u>2. PIERS</u> Spread footings founded on the dense fine to medium sand at an elevation below 121.0 m - Factored bearing Capacity at U.L.S. : 800 kPa - Bearing Capacity at S.L.S. : 340 kPa	1) Fill height up to 3.0 m will be stable with side slope of 2:1 2) Cuts to a depth of 3.5 m will be stable with 2:1 slopes 3) Overall slope of 6.5 m (3m fill and 3.5 m cuts) will be stable with 2:1 forward slopes 4) Unsuitable material within the plan limit should be fully removed and replaced with well compacted material prior to fill placement	1. No serious foundation problems are anticipated 2. Dewatering scheme would be required for foundation excavation.

FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 5 STRUCTURE Nos. Culvert - 1 LOCATION Oshawa Link Crossing Tooley Creek  
ORIGINAL GROUND ELEV. 135.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 137.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 5 (Gr.Elev. 134.0 m) 0.0 - 0.4 : Top Soil 0.4 - 4.1 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) dense to very dense 4.1 - 8.5 : Fine to medium Sand very dense <u>GROUNDWATER</u> Water level at 0.6 m below ground surface	<u>1. BOX CULVERT</u> a) Mat foundation founded on a 0.3 m Granular "A" pad b) Rigid concrete Box Culvert: Size is not known - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa <u>2.</u> A temporary earth dyke or stream diversion is required <u>3.</u> Excavation below the water table require a positive dewatering system	1) Fill height up to 2.5 m will be stable with forward and side slopes of 2:1 2) Cuts to a depth of 2.0 m will be stable with 2:1 side slope 3) Unsuitable material within the plan limit should be fully removed and replaced with well compacted material prior to fill placement.	1. Some positive dewatering system will be required 2. But no major foundation problems were anticipated.



# FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 6 STRUCTURE Nos. 15 LOCATION Oshawa Link Under HWY 2  
 ORIGINAL GROUND ELEV. 139.0 m PROPOSED HWY 2/401/407 GRADE ELEV. 146.0 m  
 Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS									
	STRUCTURE	APPROACHES										
<p><u>REFERENCE BOREHOLE</u></p> <p><u>BH 6 (Gr.Elev. 139.6 m)</u></p> <p>0.0 - 1.4 : Sand and Gravel Fill dense</p> <p>1.4 - 2.5 : Sandy Silt trace of organics compact</p> <p>2.5 - 10.1: Clayey Silt firm to very stiff</p> <p>10.1- 12.0: Sand and Gravel compact</p> <p>12.0- 15.5: Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense</p> <p><u>GROUNDWATER</u></p> <p>Water level at 2.1 m below ground surface</p>	<p><u>ABUTMENTS AND PIERS</u></p> <p>1. <u>ABUTMENTS</u></p> <p>a) A perched-type abutments founded on spread footings on Granular "A" core</p> <ul style="list-style-type: none"><li>- Factored bearing Capacity at U.L.S. : 900 kPa</li><li>- Bearing Capacity at S.L.S : 350 kPa</li></ul> <p>b) Alternatively, deep foundations founded on steel "H" piles driven to a very dense glacial till at a tip elevation below 126.0 m</p> <table><thead><tr><th>Type</th><th>Factored axial capacity at U.L.S.</th><th>Axial capacity at S.L.S.</th></tr></thead><tbody><tr><td>310H110</td><td>1600 kN</td><td>1150 kN</td></tr><tr><td>310H79</td><td>1150 kN</td><td>900 kN</td></tr></tbody></table> <p>2. <u>PIERS</u></p> <p>Deep foundations founded on steel "H" piles driven to a very dense glacial till at a tip elevation below 126.0 m</p> <ul style="list-style-type: none"><li>- Pile capacity is the same as above</li></ul>	Type	Factored axial capacity at U.L.S.	Axial capacity at S.L.S.	310H110	1600 kN	1150 kN	310H79	1150 kN	900 kN	<p>1) Fill heights up to 7.0 m will be stable with forward and side slopes of 2:1</p> <p>2) Unsuitable material within the plan limit of the proposed embankment should be fully removed and replaced with well compacted material prior to the fill placement.</p>	<p>1. No foundation problems are anticipated</p> <p>2. No major dewatering problems are anticipated</p>
Type	Factored axial capacity at U.L.S.	Axial capacity at S.L.S.										
310H110	1600 kN	1150 kN										
310H79	1150 kN	900 kN										

# FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 7 STRUCTURE Nos. 16 and 17 LOCATION Oshawa Link Under Nash Rd. and over Black Creek  
 ORIGINAL GROUND ELEV. 139.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 138.0 - 145.0 m  
 Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS									
	STRUCTURE	APPROACHES										
<p><u>REFERENCE BOREHOLE</u></p> <p><u>BH 7 (Gr.Elev. 140.7 m)</u></p> <p>0.0 - 0.1 : Pavement</p> <p>0.1 - 1.1 : Organic Silt</p> <p>1.1 - 2.1 : Sandy Silt compact</p> <p>2.1 - 11.9: Clayey Silt trace of Gravel firm to stiff</p> <p>11.9- 13.2: Sandy Silt trace of Gravel compact</p> <p>13.2- 15.7: Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense</p> <p><u>GROUNDWATER</u></p> <p>Water level at 3.4 m below ground surface</p>	<p><u>1. NASH ROAD UNDERPASS</u></p> <p><u>ABUTMENTS AND PIERS</u></p> <p>a) Deep foundations founded on steel "H" piles driven to a very dense glacial till at a tip elevation below 127.0 m</p> <table><tr><td>Type</td><td>Factored axial Capacity at U.L.S.</td><td>Axial Capacity at S.L.S.</td></tr><tr><td>310H110</td><td>1600 kN</td><td>1150 kN</td></tr><tr><td>310H79</td><td>1150 kN</td><td>900 kN</td></tr></table> <p><u>2. BLACK CREEK CROSSING</u></p> <p><u>BOX CULVERT</u></p> <p>a) Mat foundation founded on a 0.3 m Granular "A" pad</p> <p>b) Rigid concrete box culvert: size not known</p> <ul style="list-style-type: none"><li>- Factored bearing Capacity at U.L.S. : 225 kPa</li><li>- Bearing Capacity at S.L.S. : 150 kPa</li></ul>	Type	Factored axial Capacity at U.L.S.	Axial Capacity at S.L.S.	310H110	1600 kN	1150 kN	310H79	1150 kN	900 kN	<p><u>NASH ROAD UNDERPASS</u></p> <p>1) Fill height up to 5.0 m will be stable with 2:1 side and forward slopes</p> <p>2) Cuts to a depth of 2 m will be stable with 2:1 side slope</p>	<p>1. A temporary earth dyke or stream diversion is required for Black Creek crossing</p> <p>2. Some positive dewatering scheme will be required</p> <p>3. But no major foundation problems are anticipated</p>
Type	Factored axial Capacity at U.L.S.	Axial Capacity at S.L.S.										
310H110	1600 kN	1150 kN										
310H79	1150 kN	900 kN										



### FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 8 STRUCTURE Nos. 18 LOCATION Hancock Road over Oshawa Link  
 ORIGINAL GROUND ELEV. 160.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 158.0 m  
 Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 8 (Gr.Elev. 153.3 m) 0.0 - 1.4 : Sand and Gravel Fill compact 1.4 - 15.4: Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) hard <u>GROUNDWATER</u> Borehole dry after completion. Perched water at 3.0 m below the ground surface.	<u>ABUTMENTS AND PIERS</u> Spread footings founded in the hard cohesive glacial till - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed	Cut slope to a depth of 8.0 m will be stable with 2:1 side slope.	1. No serious foundation problems are anticipated 2. No dewatering problems are expected during the excavation

### FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 9 STRUCTURE Nos. 19 Culverts 2 and 3 LOCATION Oshawa Link near Pebblestone Road  
 ORIGINAL GROUND ELEV. 145.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 145.0 - 152.0 m  
 Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS									
	STRUCTURE	APPROACHES										
<p><u>REFERENCE BOREHOLE</u></p> <p><u>BH 9 (Gr.Elev. 151.2 m)</u></p> <p>0.0 - 8.8 : Silty Sand compact to very dense</p> <p>8.8 - 10.1: Clayey Silt firm</p> <p>10.1 - 17.5: Sandy Silt trace of Clay loose to compact</p> <p>17.5- 29.4: Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) dense to very dense</p> <p><u>GROUNDWATER</u></p> <p>Water level at 6.2 m below the ground surface</p>	<p><u>1. BRIDGE ABUTMENTS AND PIERS</u></p> <p>Deep foundations founded on steel "H" piles driven to a very dense glacial till at a tip elevation of approximately 130.0 m.</p> <table><thead><tr><th>Type</th><th>Factored axial Capacity at U.L.S.</th><th>Axial Capacity at S.L.S.</th></tr></thead><tbody><tr><td>310H110</td><td>1000 kN</td><td>800 kN</td></tr><tr><td>310H79</td><td>720 kN</td><td>630 kN</td></tr></tbody></table> <p><u>2. FAREWELL CREEK (TRIBUTARY) CROSSINGS</u></p> <p>a) Mat foundation on a 0.3 m Granular "A" pad</p> <p>b) Rigid concrete box culvert: size not known</p> <p>- Factored bearing Capacity at U.L.S. : 150 kPa</p> <p>- Bearing Capacity at S.L.S. : 250 kPa</p>	Type	Factored axial Capacity at U.L.S.	Axial Capacity at S.L.S.	310H110	1000 kN	800 kN	310H79	720 kN	630 kN	<p>1) Fill height up to 7.0 m will be stable with side and forward slopes</p> <p>2) Unsuitable material within the plan limit of the proposed embankment should be fully removed and replaced with well compacted material prior to the fill placement</p>	<p>1. A temporary earth dyke or stream diversion is required for Farewell crossings</p> <p>2. Some positive dewatering scheme will be required.</p> <p>3. But no major foundation problems are anticipated.</p>
Type	Factored axial Capacity at U.L.S.	Axial Capacity at S.L.S.										
310H110	1000 kN	800 kN										
310H79	720 kN	630 kN										



FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 10 STRUCTURE Nos. 20 LOCATION Oshawa Link over Farewell Creek  
ORIGINAL GROUND ELEV. 146.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 149.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 10 (Gr.Elev. 152.6 m) 0.0 - 0.4 : Organic Topsoil 0.4 - 1.4 : Silty Sand trace of gravel compact 1.4 - 2.9 : Sand and Gravel trace of Silt very dense 2.9 - 9.6 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense <u>GROUNDWATER</u> Water level at 1.6 m below the ground surface	<u>BRIDGE ABUTMENTS</u>  a) A perched-type abutments founded on spread footings on Granular "A" core - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa Organic material should be fully removed and replaced with well compacted Granular "A" pad  b) Spread footing on the very dense glacial till - Factored bearing Capacity at U.L.S. : 1,000 kPa - Bearing Capacity at S.L.S. : Not governed	1) Fill height up to 4.0 m will be stable with 2:1 side and forward slopes. 2) Unsuitable material within the plan limit should be fully removed and replaced with well compacted material.	1. A temporary earth dyke or stream diversion is required 2. Some positive dewatering scheme will be required. 3. But no major foundation problems are anticipated.

FOUNDATION DATA SHEET

W.P. 663-89-00 AREA 11 STRUCTURE Nos. 21 LOCATION Regional Road 4 over Oshawa Link  
ORIGINAL GROUND ELEV. 181.0 m PROPOSED HWY 401 / 407 GRADE ELEV. 180.0 - 187.0 m  
Reference:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>REFERENCE BOREHOLE</u> BH 11 (Gr.Elev. 180.3 m) 0.0 - 0.4 : Organic Top Soil 0.4 - 4.2 : Sandy Silt to Silty Sand compact to dense 4.2 - 5.6 : Sand and Gravel some Silt very dense 5.6 - 9.5 : Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense <u>GROUNDWATER</u> Water level at 4.4 m below the ground surface	<u>ABUTMENTS AND PIERS</u>  1. <u>ABUTMENTS</u>  a) A perched-type abutments founded on spread footings on Granular "A" core (minimum thickness of 3 m) - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa  b) A closed-type abutments founded on spread footings on Sandy Silt to Silty Sand material - Factored bearing Capacity at U.L.S. : 560 kPa - Bearing Capacity at S.L.S. : 220 kPa  2. <u>PIERS</u>  a) Spread footings on compact Silty Sand - Factored bearing Capacity at U.L.S. : 560 kPa - Bearing Capacity at S.L.S. : 220 kPa  b) Alternatively, excavate down to 177.5 m and backfilled with Granular "A" pad - Factored bearing Capacity at U.L.S. : 900 kPa - Bearing Capacity at S.L.S. : 350 kPa	1) Fill height up to 7.0 m will be stable with forward and side slopes of 2:1 2) Unsuitable organic material within the plan limit should be fully removed and replaced with well compacted material.	1. No serious foundation problems are anticipated 2. No major dewatering problems are anticipated for excavation of footings.



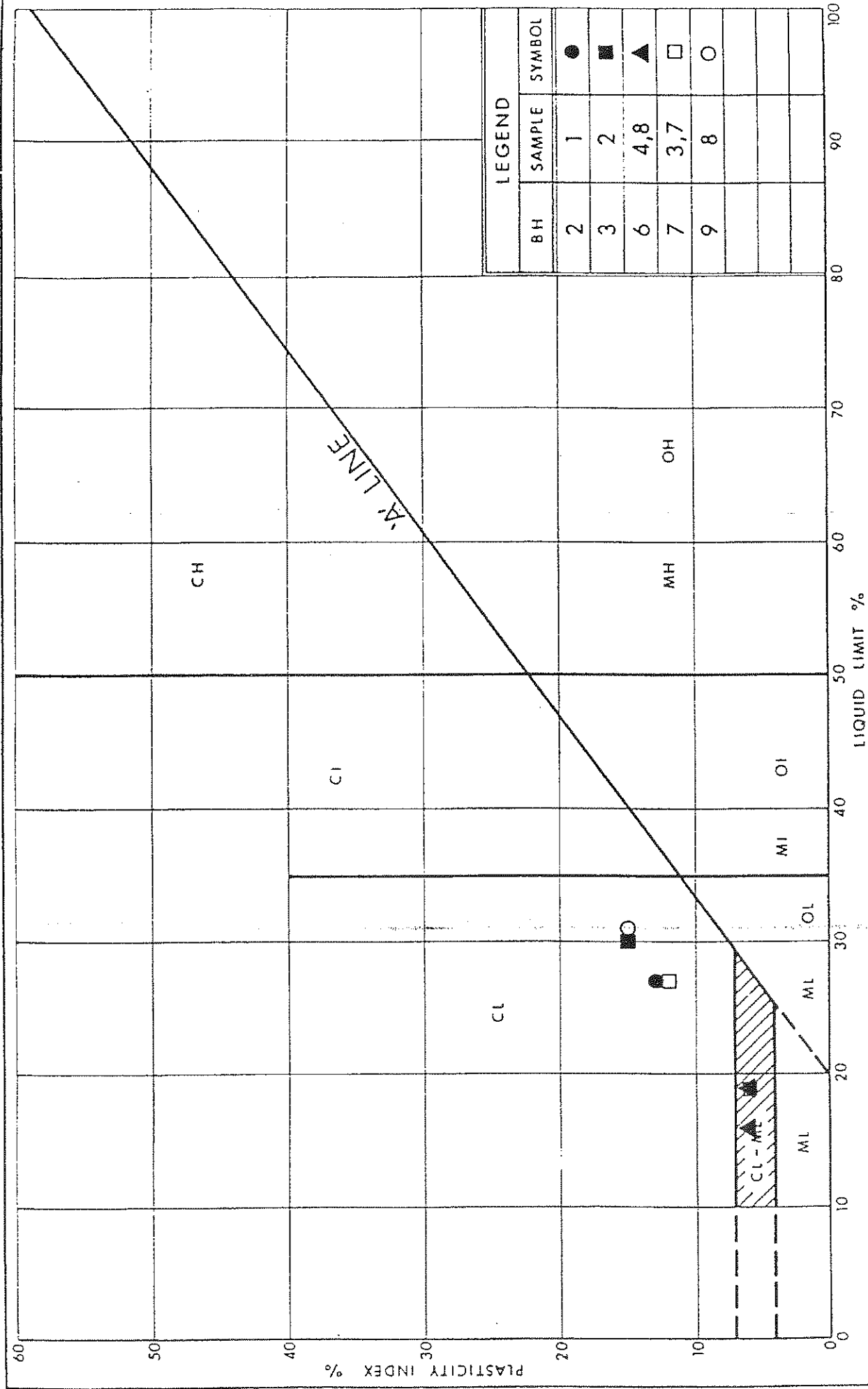


FIG No 2  
PLASTICITY CHART  
CLAYEY SILT

W P 663-89-00

78 12 M

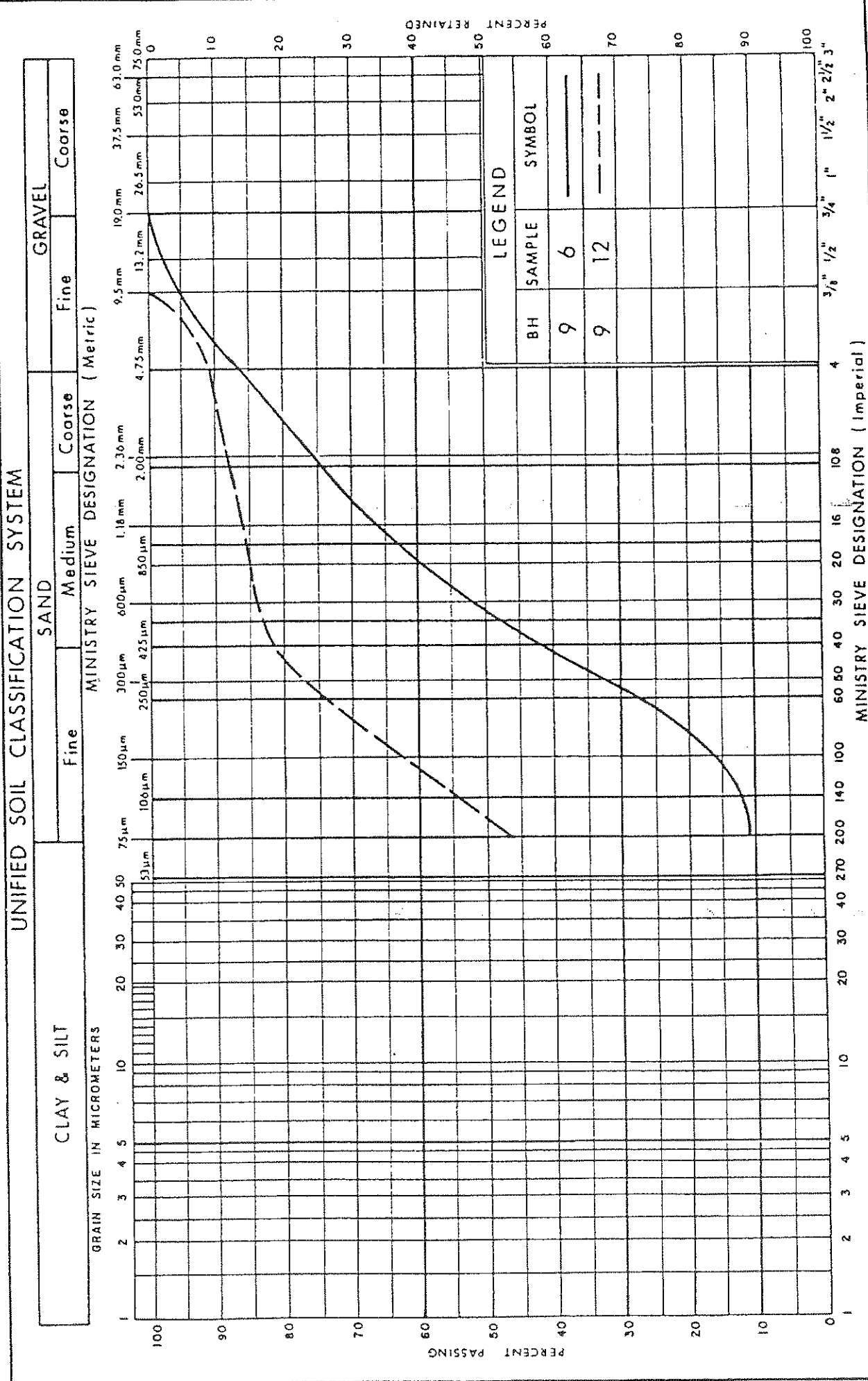
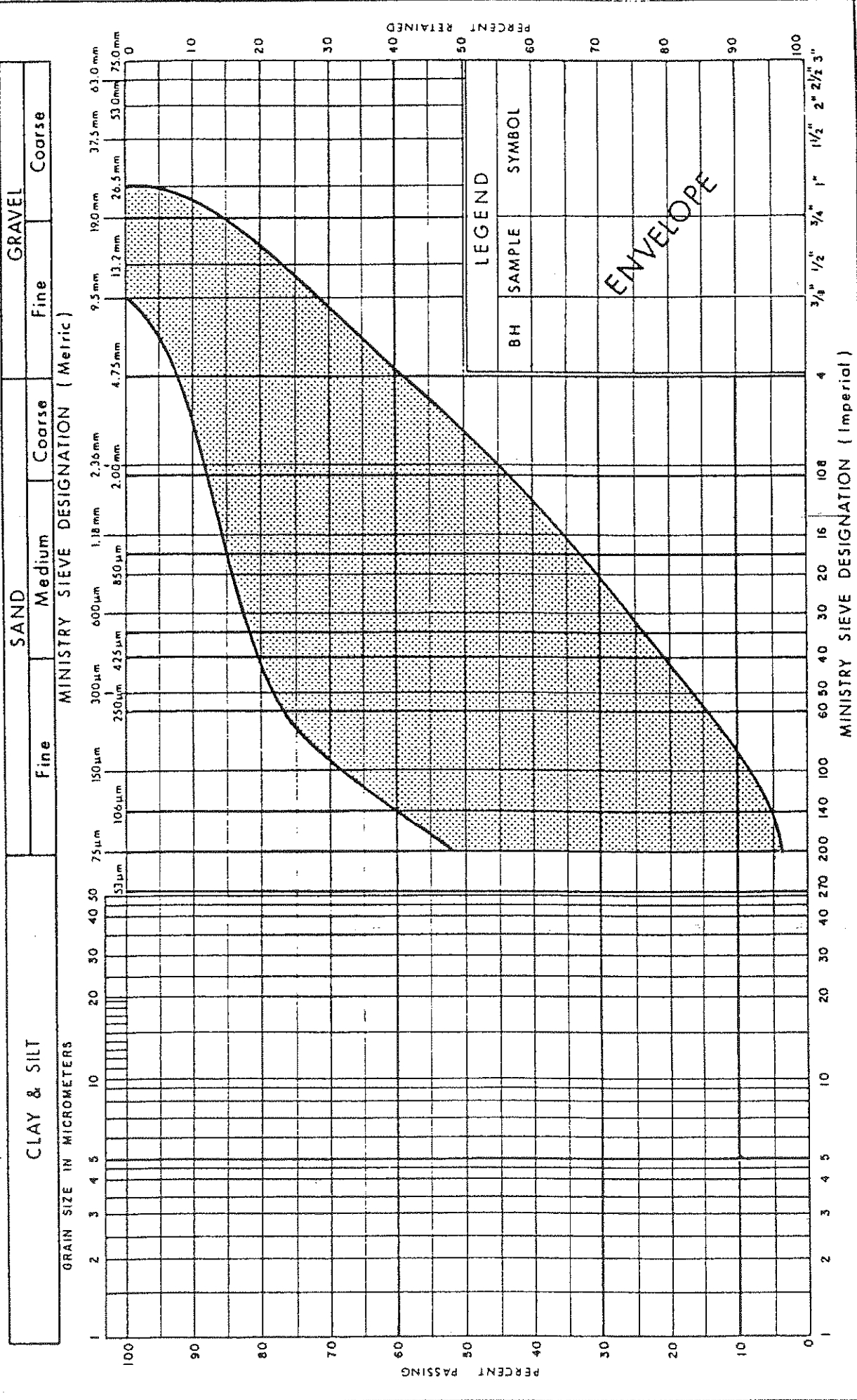


FIG No 3  
GRAIN SIZE DISTRIBUTION  
SANDY SILT TO SILTY SAND

W P 663-89-00

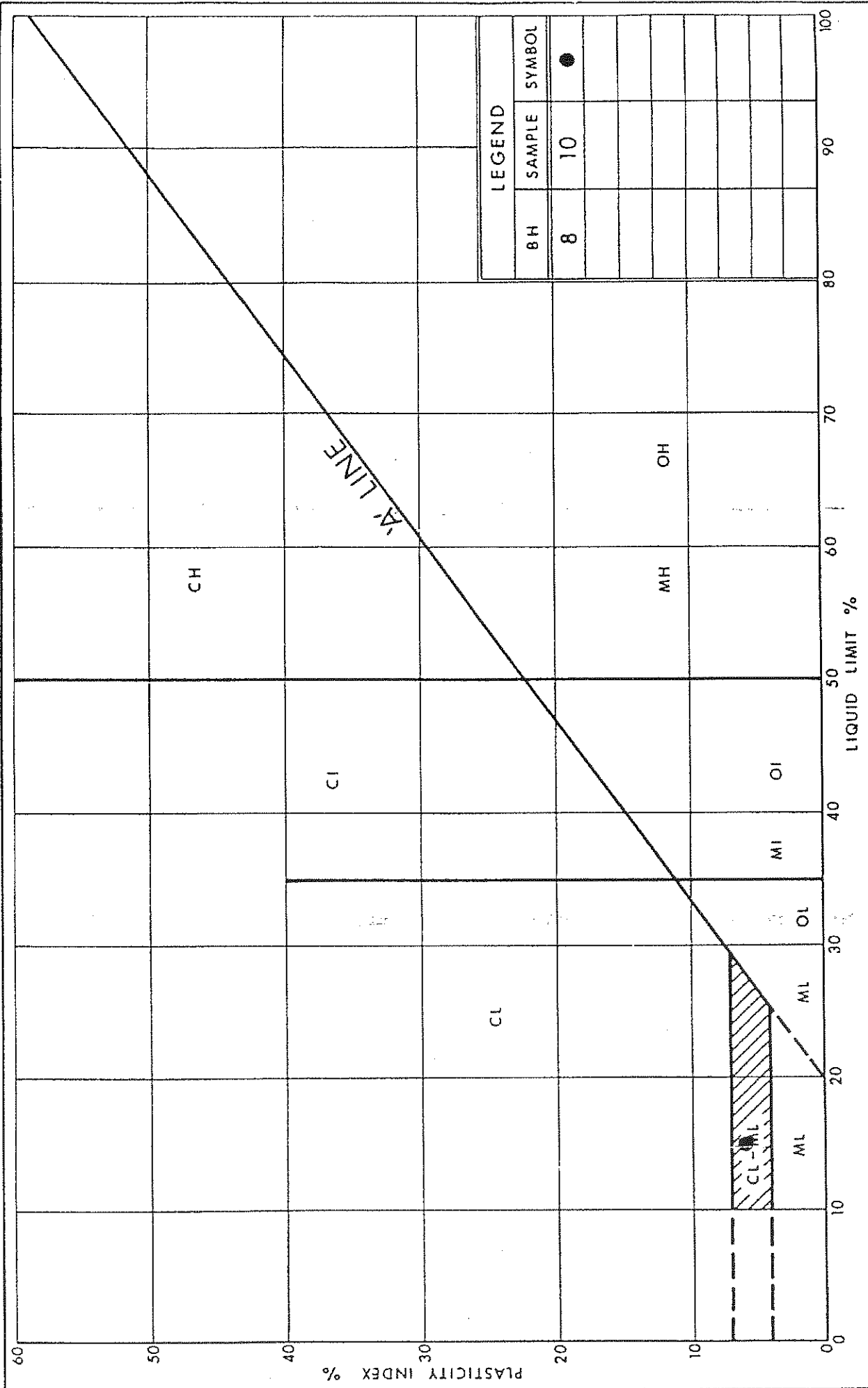


UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION  
HET MIXTURE OF SILT, SAND & GRAVEL  
(NON-COHESIVE GLACIAL TILL)

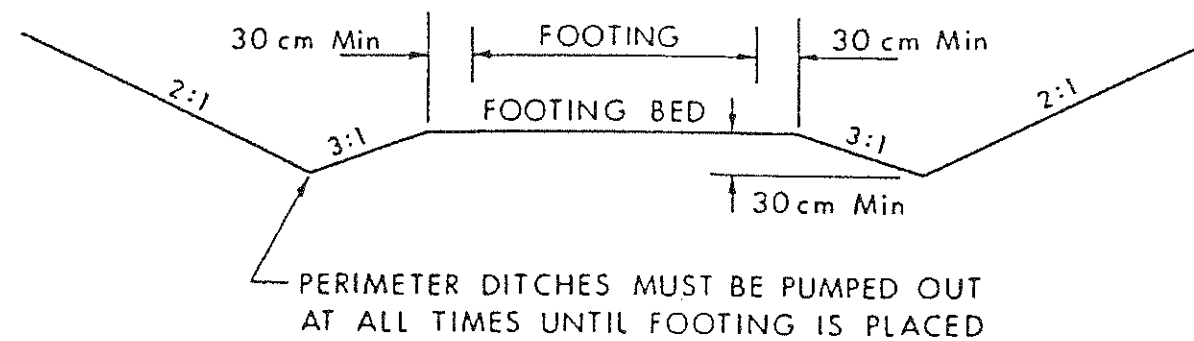
Oc1 75, FF.S-21



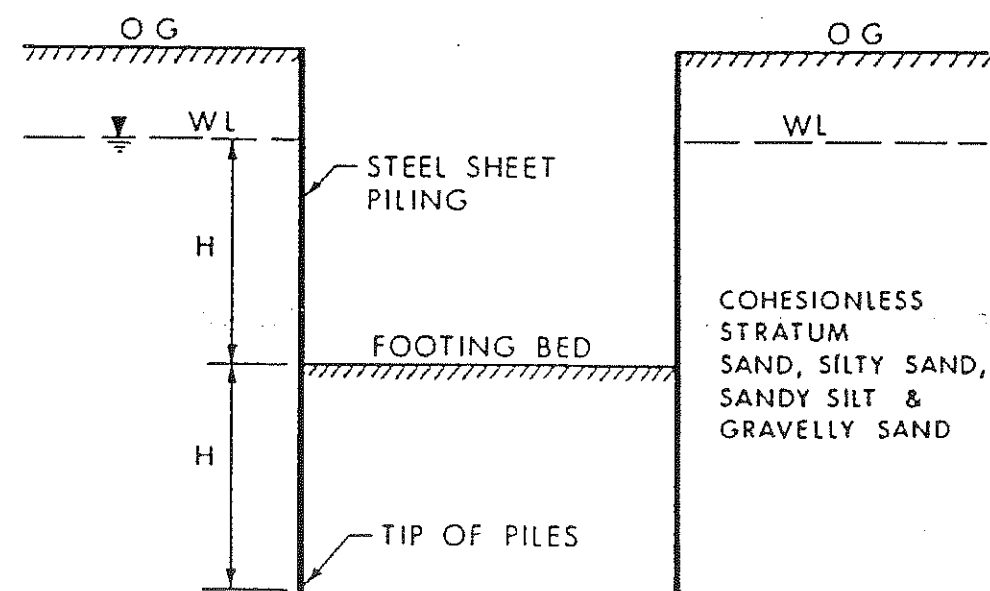
PLASTICITY CHART  
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL  
(COHESIVE GLACIAL TILL)

WP 663-89-00





## OVERSIZE EXCAVATION WITH PERIMETER DRAINS



STEEL SHEET PILING

FIG No 9

WP 663-89-00

RECORD OF BOREHOLE No 1						1 OF 1		METRIC				
W.P. 663 - 89 - 00		LOCATION Co-ords: N + 850 046.5 : E 384 817.7		ORIGINATED BY DO & TK								
DIST 6 HWY 401/407		BOREHOLE TYPE SOLID STEM AUGER		COMPILED BY D O								
DATUM GEODETIC		DATE 93 12 07		CHECKED BY T K								
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			N' VALUES	20 40 60 80 100				
104.5	Ground Surface											
0.0	Sand and Gravel (Fill) acc. STM layers		1	SS	34							
102.9	Organic Silt d. brown		2	SS	13							
1.8	d. brown grey		3	SS	38							
			4	SS	100							
					/15cm							
			5	SS	100							
					/15cm							
			6	SS	106							
					/20cm							
			7	SS	68							
			8	SS	17							
			9	SS	37							
			10	SS	75							
			11	SS	100							
					/15cm							
89.1			12	SS	125							
15.4	End of Borehole				/15cm							

+3, x5: Numbers refer to Sensitivity

+3. x<sup>5</sup>: Numbers refer to Sensitivity

+3. x<sup>3</sup>: Numbers refer to Sensitivity



RECORD OF BOREHOLE No 4															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 862 364.1 ; E 364 504.3			ORIGINATED BY T.K.												
DIST 8 HWY 401/407			BOREHOLE TYPE HOLLOW STEM AUGER			COMPILED BY O.O.												
DATUM GEODETIC			DATE 93.12.13			CHECKED BY T.K.												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80						100	W <sub>p</sub>
126.8	Ground Surface																	
0.0	Pavement Sand and Gravel (Fill), dense		1	SS	30													
125.4			2	SS	121													
1.4	Heterogeneous Mixture of Silt, Sand and Gravel, (Glacial Till), very dense		3	SS	103													
			4	SS	103													
121.2			5	SS	68													
5.8			6	SS	31													
			7	SS	31													
			8	SS	43													
115.8			9	SS	87													
113.2	Heterogeneous Mixture of Silt, Sand and Gravel, very dense		10	SS	104													
11.8	End of Borehole																	

+3, x<sup>3</sup>: Numbers refer to Sensitivity  
20 15-25 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 5															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 862 915.5 ; E 363 883.7			ORIGINATED BY O.O. & T.K.												
DIST 6 HWY 401/407			BOREHOLE TYPE SOLID STEM AUGER			COMPILED BY O.O.												
DATUM GEODETIC			DATE 93.12.08			CHECKED BY T.K.												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80						100	W <sub>p</sub>
134.0	Ground Surface																	
0.0	Top Soil																	
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till), dense to very dense		1	SS	45													
			2	SS	100													
			3	SS	120													
			4	SS	120													
129.8			5	SS	110													
4.1			6	SS	120													
			7	SS	120													
			8	SS	120													
125.5			9	SS	120													
8.5	End of Borehole at probable Boulders or Bedrock																	

+3, x<sup>3</sup>: Numbers refer to Sensitivity  
20 15-25 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 6															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 863 745.6 : E 384 092.7			ORIGINATED BY M V												
DIST 6 HWY 401/407			BOREHOLE TYPE HOLLOW STEM AUGER AND VANE TESTS			COMPILED BY M V												
DATUM GEODETIC			DATE 93 12 10			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES	20	40	60						80	100	WATER CONTENT (%)
138.8	Ground Surface																	
0.0	Sand and Gravel (Fill), dense		1	SS	43													
138.2	Organic silt, brown		2	SS	20													
1.4	Sandy Silt, compact		3	SS	11													
137.1			4	SS	38													
2.5	Clayey Silt, firm to very stiff		5	SS	27													
			6	SS	12													
			7	SS	3													
	trace of Gravel		8	SS	4													
129.5			9	SS	26													
10.1	Sand and Gravel, compact		10	SS	81													
127.6																		
12.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense																	
124.1																		
15.5	End of Borehole																	

+3, x5: Numbers refer to Sensitivity  
20  
15-5 (x) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 7															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 864 452.1 : E 383 821.5			ORIGINATED BY DO & TK												
DIST 6 HWY 401/407			BOREHOLE TYPE SOLID AND HOLLOW STEM AUGER, VANE TESTS			COMPILED BY D O												
DATUM GEODETIC			DATE 93 12 09			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES	20	40	60						80	100	WATER CONTENT (%)
140.4	Ground Surface																	
0.0	Pavement base material																	
139.3	Organic Silt, dark brown		1	SS	17													
1.1	Sandy Silt, compact		2	SS	29													
138.3			3	SS	20													
2.1			4	SS	26													
	Clayey Silt, trace of Gravel, firm to stiff		5	SS	4													
			6	SS	3													
			7	SS	3													
			8	SS	5													
			9	SS	6													
128.5																		
11.9	Sandy Silt, trace of Gravel, compact		10	SS	23													
127.2																		
13.2	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense		11	SS	106													
124.7			12	SS	120													
15.7	End of Borehole																	

+3, x5: Numbers refer to Sensitivity  
20  
15-5 (x) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 8															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 865 492.3 ; E 363 005.9			ORIGINATED BY M V												
DIST 6 HWY 401/407			BOREHOLE TYPE SOLID STEM AUGER			COMPILED BY M V												
DATUM GEODETIC			DATE 93 12 08 & 09			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					20	40	60	80	100	WATER CONTENT (%)	GR SA SI CL
153.3	Ground Surface																	
0.0	Sand and Gravel (Fill), compact		1	SS	21													
151.9			2	SS	60													
1.4			3	SS	128													
			4	SS	100													
			5	SS	100													
			6	SS	120													
			7	SS	128													
			8	SS	120													
			9	SS	100													
			10	SS	140													
			11	SS	131													
137.9			12	SS	130													
15.4	End of Borehole																	

+3, x<sup>3</sup>: Numbers refer to Sensitivity  
20  
15-20 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 9															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 866 233.5 ; E 382 482.8			ORIGINATED BY M V												
DIST 6 HWY 401/407			BOREHOLE TYPE HOLLOW STEM AUGER			COMPILED BY M V												
DATUM GEODETIC			DATE 93 12 07 & 08			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					20	40	60	80	100	WATER CONTENT (%)	GR SA SI CL
151.2	Ground Surface																	
0.0	Top Soil		1	SS	6													
			2	SS	15													
			3	SS	19													
			4	SS	26													
			5	SS	84													
			6	SS	33													
			7	SS	20													
142.4			8	SS	5													
8.8	Clayey Silt, firm		9	SS	6													
141.1			10	SS	12													
10.1			11	SS	14													
			12	SS	8													
			13	SS	31													
133.7			14	SS	48													
17.5			15	SS	37													
			16	SS	54													
			17	SS	58													
			18	SS	40													
			19	SS	33													
			20	SS	63													
121.8			21	SS	60													
29.4	End of Borehole																	

+3, x<sup>3</sup>: Numbers refer to Sensitivity  
20  
15-20 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 10															1 OF 1		METRIC	
W.P. 663 - B9 - 00			LOCATION Co-ords: N 4 866 651.9 : E 361 787.8			ORIGINATED BY M V												
DIST 6 HWY 401/407			BOREHOLE TYPE HOLLOW STEM AUGER			COMPILED BY M V												
DATUM GEODETIC			DATE 93.12.07			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES							20	40	60	80	100
152.6	Ground Surface																	
0.0	Organics																	
151.2	Silty Sand, trace of Gravel compact		1	SS	29													
1.4	Sand and Gravel, trace of Silt very dense		2	SS	68													
149.7			3	SS	95													
2.9	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense		4	SS	118													
			5	SS	121													
			6	SS	106													
			7	SS	126													
143.0			8	SS	108													
9.6	End of Borehole																	
	* Perched Water at 1.6 m																	

+3, x3: Numbers refer to Sensitivity  
20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 11															1 OF 1		METRIC	
W.P. 663 - B9 - 00			LOCATION Co-ords: N 4 868 176.4 : E 361 751.9			ORIGINATED BY M V												
DIST 6 HWY 401/407			BOREHOLE TYPE SOLID STEM AUGER			COMPILED BY M V												
DATUM GEODETIC			DATE 93.12.06			CHECKED BY T K												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES							20	40	60	80	100
180.3	Ground Surface																	
0.0	Organics																	
	Sandy Silt to Silty Sand, compact to dense		1	SS	15													
			2	SS	14													
			3	SS	10													
			4	SS	46													
178.1																		
4.2	Sand and Gravel, some Silt very dense		5	SS	91													
174.7																		
5.6	Heterogeneous Mixture of Silt, Sand and Gravel, occ. Clayey Silt layers, (Glacial Till) very dense		6	SS	121													
			7	SS	106													
			8	SS	153													
170.8																		
9.5	End of Borehole																	

+3, x3: Numbers refer to Sensitivity  
20  
15-5 (X) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 12															1 OF 1		METRIC	
W.P. 663 - 89 - 00			LOCATION Co-ords: N 4 869 492.6 ; E 361 267.6			ORIGINATED BY M V												
DIST 8 HWY 401/407			BOREHOLE TYPE SOLID STEM AUGER			COMPILED BY M V												
DATUM GEODETIC			DATE 93 12 06			CHECKED BY T K												
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
			NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa • UNCONFINED • QUICK TRIAXIAL	FIELD VANE • LAB VANE	20	40						60	80
214.3	Ground Surface					214												
0.0	Top Soil		1	SS	21													
			2	SS	39													
			3	SS	54													
			4	SS	64													
					15cm													
			5	SS	117													
					15cm													
			6	SS	121													
					15cm													
			7	SS	144													
					15cm													
			8	SS	114													
					15cm													
			9	SS	126													
					15cm													
			10	SS	113													
					15cm													
			11	SS	139													
					15cm													
198.8			12	SS	128													
					15cm													
15.4	End of Borehole																	
	Borehole dry on completion																	

+3, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-5 (X) STRAIN AT FAILURE  
10

## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 473 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING			MECHANICAL PROPERTIES OF SOIL		
SS	SPLIT SPOON	TP	THINWALL PISTON	$m_v$	kPa <sup>-1</sup> COEFFICIENT OF VOLUME CHANGE
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE	$C_c$	1 COMPRESSION INDEX
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE	$C_s$	1 SWELLING INDEX
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY	$C_a$	1 RATE OF SECONDARY CONSOLIDATION
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY	$C_v$	m <sup>2</sup> /s COEFFICIENT OF CONSOLIDATION
TW	THINWALL OPEN	FS	FOIL SAMPLE	H	m DRAINAGE PATH
				$T_v$	1 TIME FACTOR
				U	% DEGREE OF CONSOLIDATION
				$\sigma'_{vo}$	kPa EFFECTIVE OVERBURDEN PRESSURE
				$\sigma'_p$	kPa PRECONSOLIDATION PRESSURE
				$\tau_f$	kPa SHEAR STRENGTH
				$c'$	kPa EFFECTIVE COHESION INTERCEPT
				$\phi'$	° EFFECTIVE ANGLE OF INTERNAL FRICTION
				$c_u$	kPa APPARENT COHESION INTERCEPT
				$\phi_u$	° APPARENT ANGLE OF INTERNAL FRICTION
				$\tau_R$	kPa RESIDUAL SHEAR STRENGTH
				$\tau_r$	kPa REMOULDED SHEAR STRENGTH
				$S_l$	1 SENSITIVITY = $\frac{C_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL			PHYSICAL PROPERTIES OF SOIL		
$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL			
			$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
			$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
			D	mm	GRAIN DIAMETER
			$D_n$	mm	n PERCENT - DIAMETER
			$C_u$	1	UNIFORMITY COEFFICIENT
			h	m	HYDRAULIC HEAD OR POTENTIAL
			q	m <sup>3</sup> /s	RATE OF DISCHARGE
			v	m/s	DISCHARGE VELOCITY
			i	1	HYDRAULIC GRADIENT
			k	m/s	HYDRAULIC CONDUCTIVITY
			j	kN/m <sup>3</sup>	SEEPAGE FORCE

