

Ministry of Transportation Ontario

# Foundation Investigation Report For Environmental Assessment (Hydrogeology Specialty)

## HIGHWAY 407 EAST EXTENSION – EASTERN SECTION

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Prepared by:

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Project Number:

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February 19, 2009 Project Number: 107904 / 50613.20

Ms. Betty Bennett  
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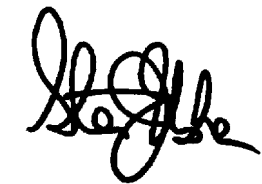
Dear Ms. Bennett:

**Re: Foundation Investigation Report For Environmental Assessment (Hydrogeology Specialty)**

We are pleased to convey this report on the Hydrogeological Investigations along the Eastern Mainline and East Durham Link of the Highway 407 East Extension to the Ministry of Transportation.

Shall you or any other technical reviewer have any questions please contact the undersigned.

Sincerely,  
AECOM Canada Ltd.



Steve Usher, B.Sc., M.Sc., P.Eng., P.Geo  
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SU:pc  
Attach.

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Signature Page

Report Prepared By:



Jason Cole, M.Sc.

Report Reviewed By:



Original Signed  
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Steve Usher, M.Sc., P.Eng, P.Geo





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# 1. Introduction

This report presents a summary of the Hydrogeological Investigations for the Foundation Investigation Report for the Eastern Mainline and Eastern Link of the Technically Preferred Route (TPR) of the Highway 407 East Extension. Gartner Lee Limited acting as AECOM was retained by McCormick Rankin Corporation (MRC) to carry out this study for the Ministry of Transportation (MTO). The purpose of this report is to provide a summary of the geological / hydrogeological information in support of the foundation design, structural design and highway design teams.

The study area of the hydrogeological investigations along the Eastern Mainline covers approximately 20 km between From Enfield Road / Courtice Road in the west to Highway 35/115 in the east (Figure 1). The East Durham Link covers approximately 10 km between Highway 401 and Highway 407. The majority of the field investigations were concentrated within one (1) km of the centreline of the TPR. An interpretation of the geological and hydrogeological conditions at each structure and at each deep cut location in this section is provided based upon existing information. A preliminary assessment has been made that highlights areas of risk, locations that require additional information, opportunities for potential avoidance, mitigation or compensation, and the priorities for detailed design. However, these assessments are not discussed in detail in this report. The companion Foundation Investigation and Design Report for Environmental Assessment – Hydrogeological Specialty, contains the results presented in this report as well as recommendations required for planning at the detailed design stage.

The information presented here may be used for planning and feasibility purposes. Additional, site-specific hydrogeologic data are required for preparation at the detailed design stage. Recommendations have been made for areas that require further investigations at the preliminary design stage, particularly the collection of geologic / hydrogeologic information at the deep cut locations.

# 2. Report Structure

The Eastern Mainline and Eastern Link have been divided into sub-sections based upon differences in geology / hydrogeology that exist within the larger East Section. The divisions were designed to be compatible with both the Foundation Investigation Report and the Impact Assessment Report. The study area was divided into two parts: *East 1* from Enfield Road / Courtice Road to Highway 35/115; and *East Link* from Highway 401 to Highway 407. *East 1* was further subdivided into *E1a* from east of Enfield Road to Solina Road; *E1b* from Holt Road to Liberty Street; *E1c* from Liberty Street to Nixon Road; and *E1d* from Nixon Road to Highway 35/155. *East Link* was further subdivided into *ELa* from Concession 6 road in the north to between Taunton Road and Nash Road; *ELb* from between Taunton Road and Nash Road to north of Bloor Street; and *ELc* from north of Bloor Street to Highway 401. These divisions are presented in Figure 2.

# 3. Sources

The following geological / hydrogeological conditions outlined in this report are based upon a comprehensive review of existing regional information and on investigative field activities. The information and conclusions presented herein were derived from, but not limited too, hydrogeological field investigations by Gartner Lee Limited acting as AECOM (AECOM), geotechnical field investigations by Thurber Engineering Limited (Thurber), and preliminary bridge and highway profile designs provided by MRC.

# 4. Geology and Hydrogeology

## 4.1 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 east portion of the Eastern Mainline is located within this region. The South Slope is a gently rolling till plain, characterized by numerous drumlins oriented upslope. The majority of the west and central portions of the Eastern Mainline are 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. This area is characterized 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. The majority of the East Link is found within this section.

## 4.2 Regional Geology and Hydrogeology

Only the upper most geological units are discussed below. Please refer to the Gartner Lee Limited Existing Conditions Report for a full description of the regional geology and hydrogeology (Gartner Lee Limited, 2006; Natural Environment Revised Draft Existing Conditions Technical Report).

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 overly 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 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 farther south inhibit both groundwater recharge and discharge.

4.3 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.

5. Hydrogeological Foundation Investigation

5.1 Hydrogeology Summary Tables

Hydrogeological Conditions Summary Tables were created for each subsection of the Eastern Mainline [*East 1 (E1a, E1b, E1c, and E1d)*] and Eastern Link [*East Link (ELa, ELb, and ELc)*]. The column on the left lists the associated tables and figures that accompany the summary table, the sources of field information used to draw conclusions, the engineering features of the subsection (structures, deep cuts, and high fills), and the general site physiography. The central column provides existing geological and hydrogeological conditions as interpreted from the desk top study,

borehole drilling, hydrogeology field investigations, water well surveys and water quality sampling. The column on the right provides a summary of the effects of groundwater on foundation design and construction, and the potential impacts to the natural environment. A summary of the avoidance/ mitigation/ compensation measures, and the recommended priorities for detailed design are included. Hydrogeological Condition Summaries are presented on Tables 1 to 7. Please refer to the companion report for a more detailed discussion of potential impacts and the avoidance/ mitigation/ compensation measures.

5.2 Structure Summary Tables

The Structure Summary Tables are modified versions of the Hydrogeology Foundation Design Tables that have been submitted monthly by AECOM to Thurber and MRC. They provide a summary at each structure along the Eastern Mainline and Eastern Link, including a discussion of the hydrogeologic conditions in its vicinity and hydrogeology site ranking (low, medium, high). They have been expanded to include information gathered from geotechnical boreholes and to include recommendations for watercourse crossings, based upon known or interpreted groundwater-surface water interactions at stream locations. Structure Summary Tables are shown on Tables 8 to 14.

5.3 Borehole Drilling

Hydrogeological field investigations included drilling a total of twelve (12) boreholes at 6 locations along the Eastern Mainline and ten (10) boreholes at 5 locations along the Eastern Link. The borehole logs are presented in Appendix A. Each hydrogeology borehole, with the exception of G9E, was completed as a groundwater monitor nest consisting of a shallow and a deep monitor. These nests were designed to estimate vertical hydraulic gradients, assess soil permeability, determine seasonal changes in water table depth and to identify the potential for future groundwater contamination.

Geotechnical field investigations conducted by Thurber included borehole drilling at individual structure locations. The geotechnical borehole logs were provided by Thurber and are presented in Appendix B. The location of all boreholes is presented on Figures 3 to 16.

5.4 Geological Cross-Sections

Geological Cross-Sections were created for Sections *East 1 (E1a and E1b)*, *East 2 (E1c and E1d)* and *East Link (ELa, ELb, and ELc)* using subsurface information collected from environmental borehole drilling by AECOM, geotechnical borehole drilling by Thurber, historic geotechnical boreholes, MOE water well records and surficial geological mapping (Figures 17, 18, and 19). Cross-Section locations are shown on Figures 3 to 16. In cases where the geology interpreted from borehole drilling differed from the provincial surficial geology mapping, the results of the borehole drilling were used. The central axis of the cross-section is the centre line of the highway corridor. A limit of ~500 m from the highway centre line was placed on MOE water wells and historic geotechnical boreholes to ensure accuracy, unless they were deep and continuous through multiple geological units. Wells were projected onto the cross-section at a 90° angle between the well and the highway centre line. Surface topography was determined from surface elevation

profiles along the centre line of the TPR using a digital elevation model (DEM) for the study area. The highway 407 Eastern Mainline and Eastern Link profiles were provided by MRC and were added to each cross-section. The profile used was provided to AECOM in October 2008 and may differ from the current profile. The final version of this report will include the final version of the Eastern Mainline and Eastern Link profiles.

5.5 Deep Cuts and High Fills

A Deep Highway Cut (deep cut) is defined herein as any excavation below original grade (OG) of greater than 5 m. Excavations below the water table related to deep cuts will permanently lower the water table elevation near the cut. The radius and extent of water table drawdown is dictated by the depth of the cut below the water table, the hydraulic conductivity of the subsurface material, and the lateral extent of the geologic unit. Permanent reductions in water table elevation have the potential to lower water levels in private wells and reduce baseflow to steams and wetlands. A technical memorandum on Deep Cut Analysis submitted by Gartner Lee Limited acting as AECOM on April 21, 2008 presented preliminary analysis of the deep cuts along the Central Mainline and the geologic / hydrogeologic conditions surrounding them. Recent geotechnical borehole drilling by Golder has provided additional subsurface information at or near many of the deep cut locations. The deep cut locations are presented on Figures 4, 6, 8, 10, 12, 14, and 16. A summary of the deep cut locations are presented on Table 15. Additional information on geology, seasonal water table fluctuations, hydraulic conductivity, and the presence/ absence of high permeability units within low permeability till soils, must be acquired prior to finalizing these ranges. The radius of water table drawdown was estimated based upon the principles of groundwater flow towards a linear cut or ditch (Wesseling, 1973 e.d.) for each deep cut location. The results are presented on Figures 20 to 29.

A High Fill (high fill) is defined as any placement of fill materials greater than 5.0 m above OG. Areas of high fill are typically found at bridge abutments, lengths of raised highway, valley fill, and fill for cross roads and ramps. The placement of large amounts of fill on the ground surface can have many different impacts related to groundwater. The placement of fill soils with a base material which is lower in hydraulic conductivity than that of the underlying geologic material can block groundwater discharge and can cause “wicking” of groundwater into the fill which can create slope stability problems. The weight of large amounts of fill can compress the underlying soils and decrease their ability to transmit groundwater, by artificially lowered their K value. This may reduce or eliminate groundwater discharge within localized areas or cause groundwater levels to rise on the upgradient side of the fill. Soils that are compressible and susceptible to frosh heave (silts and clays) may need to be removed prior to fill placement. The high fill locations are presented on Figures 4, 6, 8, 10, 12, 14, and 16. A summary of the high fill locations are presented on Table 16.

5.6 Residential Water Well Survey

A residential water well survey was undertaken in 2008. The study area for the water well survey was selected based upon the surficial geological conditions present along the TRR and was further refined to accommodate for changes between the Technically Recommended Route (TRR) and the Technically Preferred Route (TPR). It was assumed that areas underlain by low permeability till deposits were less sensitive to impacts than areas underlain by high permeability sand deposits. The water well survey was conducted within a one (1) km radius of the highway centreline where sand deposits are present at surface and within a 500 m radius of the highway centreline where till deposits are

present at surface. Water Quality samples were collected at twenty-seven (27) residences along the Eastern Mainline and twenty-three (23) residences along the Eastern Link between July and August 2008, to obtain a representative lateral and vertical distribution of the baseline water quality across the study area. The results of the water well survey and the water quality sampling are shown in Figures 30 and 31.

6. Miscellaneous

6.1 Numbering System

To maintain consistency with the engineering Design Teams, hydrogeological information is presented by structure location.

- EM - xx represents a structure along the Eastern Mainline
- EL - xx represents a structure along the Eastern Link

The structure summary tables present the drainage crossing identification numbers along side the structure locations, to aid the Drainage Teams in following the hydrogeological information presented along the Eastern Mainline and Eastern Link.

6.2 Acknowledgements

AECOM would like to thank Thurber Engineering Limited for their contribution to the hydrogeological investigations. The geotechnical borehole logs provided by Thurber aided AECOM in providing analysis of the geological / hydrogeologic conditions at each structure. Without these logs, the level of detail provided in this report would not have been possible.

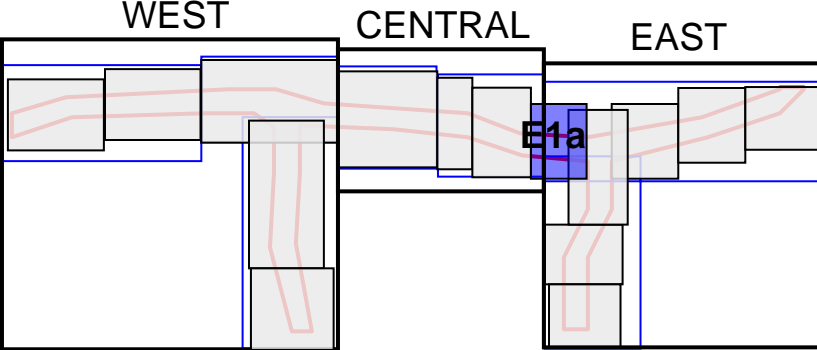
# Tables

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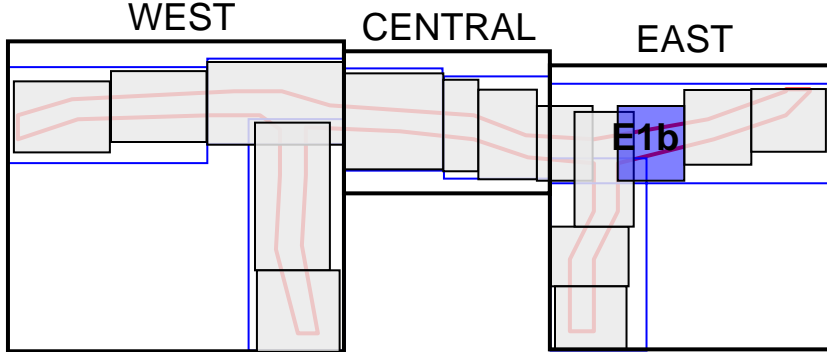
## 407 East Extension – Eastern Section

# Summary Table 1 (E1a) – Hydrogeological Conditions and Preliminary Recommendations

Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS:		POTENTIAL IMPACTS:
		East 1 (E1a) Section		<b>Groundwater Effects on Foundation Design and Construction:</b> <ul style="list-style-type: none"><li>Thick deposits of silty sand are present at or near the surface in the eastern part of this Section<ul style="list-style-type: none"><li>Dewatering is anticipated if excavating below the water table in this Section</li><li>From a hydrogeology perspective, deep foundations are desirable to minimize dewatering</li></ul></li><li>Shallow GWT (&lt;1 mBGS) may be encountered within till units because the unit is poorly drained.</li><li>No significant flowing artesian conditions are expected to be encountered in this section</li><li>Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term</li><li>High water table and permeable sediments at surface between 12+900 and 13+010<ul style="list-style-type: none"><li>Fill placement in this area has the potential for groundwater “wicking”</li></ul></li><li>Structure EM-1, EM-2, EM-4, EM-5 - Dewatering is anticipated for excavations in permeable sediments. A PTTW will be required</li><li>Structure EM-3 - Shallow dewatering may be required</li><li>Deep Cut DC-E1 (5 m deep cut) – additional information is required to estimate drawdown<ul style="list-style-type: none"><li>Will likely encounter the GWT at ~1.0 mBGS</li><li>Deep Cut in permeable surficial sand unit</li><li>Will require dewatering. Moderate potential to require a PTTW</li></ul></li></ul> <b>Surface Water Features:</b> <ul style="list-style-type: none"><li>The Solina Bog Wetland Complex is present south of the TPR<ul style="list-style-type: none"><li>Strong downwards hydraulic gradient measured in MP36 and G1E indicates the Solina Bog is not fed by deep groundwater discharge</li><li>Construction activities primarily occur in low permeability till units north of the Solina Bog and are not expected to affect this wetland</li><li>Erosion and sediment control around the wetland is a priority</li></ul></li><li>A hydraulic connection between Farewell Creek and the Solina Bog Wetland Complex is not anticipated due to differences in elevation and direction of groundwater flow. Hydraulic gradients suggest that the Solina Bog is perched on low permeability sediments restricting flow to depth</li><li>Temporary dewatering for construction of bridge abutments in the valley of Farewell Creek (EM-1/EM-2) and Black Creek is anticipated to reduce groundwater discharge into the creeks over the dewatering period<ul style="list-style-type: none"><li>A PTTW will be required</li><li>A site specific investigation will be required during detailed design</li></ul></li></ul> <b>Aquifer/Well Vulnerability:</b> <ul style="list-style-type: none"><li>Deep Cut DC-E1 (5 m deep cut) – Excavations estimated to be 4.0 m below the water table (figure 20)<ul style="list-style-type: none"><li>Radius of water table drawdown is estimated to be ~300 m</li><li>High potential to impact shallow dug wells within surficial sand unit</li><li>Potential to impact groundwater discharge into Farewell Creek and Black Creek</li></ul></li><li>Eastern Mainline (E1a) – Highway constructed primarily on low permeability till deposits<ul style="list-style-type: none"><li>Low potential for long-term impact to groundwater quality from de-icing compounds</li><li>No reduction in GW recharge due to the small surface area of the highway</li><li>Between 11+875 and 13+700 - potential for long-term impact to groundwater quality from de-icing compounds</li><li>SWM ponds, outlet channels and highway ditching will require lining to prevent infiltration</li></ul></li></ul> <b>Opportunities for Avoidance/ Mitigation/ Compensation:</b> <ul style="list-style-type: none"><li>Structures EM-1, EM-2, EM-4, EM-5 – dewatering required for construction of bridge footings. A PTTW will be required<ul style="list-style-type: none"><li>Deep foundations are recommended, where suitable, to minimize dewatering (high permeability units at surface)</li><li>Time the dewatering period to avoid fish spawning seasons (Oct – Mar)</li><li>Discharge water into receptor stream following temperature and clarity controls to maintain baseflow</li><li>Design valley fill with <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li></ul></li><li>Deep Cut DC-E1 – Estimated permanent lowering of water table within ~300 m of cut<ul style="list-style-type: none"><li>Potential to affect two (2) private wells (many other wells in the area, but will be decommissioned because are within highway right of way)</li><li>Establish GW monitoring program to monitor quality and quantity prior to, during and following construction</li><li>Compensate for impacts by: trucking in water (short-term), connecting to municipal supply (long-term), or drilling a new well to depth (short to long-term)</li><li>Mitigate the potential to impact groundwater discharge into Farewell Creek and Black Creek by reducing the depth of the cut</li></ul></li><li>Eastern Mainline (East 1 – E1a) – Low potential for reduction in groundwater quality from road run-off<ul style="list-style-type: none"><li>Low potential for long-term impact to groundwater quality from de-icing compounds</li><li>Most SWM ponds will not require lining because low permeability materials present at surface</li><li>No reduction in GW recharge due to the small surface area of the highway</li><li>Between 11+875 and 13+700 - Line ditching, SWM ponds, and outlet channels with clay</li></ul></li></ul> <b>PRIORITIES FOR DETAILED DESIGN:</b> <ul style="list-style-type: none"><li>A PTTW will be required for setting bridge foundations at EM-1/ EM-2 and EM-4/EM-5</li><li>Confirm depth of excavation for bridge abutments in the Farewell Creek and Black Creek river valleys so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts</li><li>The two (2) shallow dug wells near DC-E1 should be monitored for water level and quality for 1 month before construction, during construction and for 1 month following construction</li><li>Collection of geological and hydrogeological information along the length of and transverse to DC-E1 to confirm the depth of surficial sands and estimate the extent of local drawdown. Hydraulic testing will be required</li></ul>
<b>Map:</b> East 1 – E1a (see Figure 2 for location)		0 – 3 m	<b>Unit 1: Modern Alluvial Deposits</b> (surficial aquifer) – brown colour on figure 3 <ul style="list-style-type: none"><li>Silt, Sand and Gravel</li><li>Glacial Outwash deposits derived from modern, post-glacial rivers</li><li>modern alluvial sediments are present in modern river valleys</li></ul>	
<b>Section Boundaries:</b> Enfield Road to Solina Road		0 – 10 m	<b>Unit 2: Glaciolacustrine Deposits</b> (surficial aquifer) – yellow colour on figure 3 <ul style="list-style-type: none"><li>Fine to coarse sand and silty sand or sandy silt, moderately rounded, well sorted, compact</li><li>Utilized for potable water from shallow, dug wells.</li><li>Water table is often close to surface because till unit below restricts drainage to depth</li></ul>	
<b>Figure(s):</b> Figure 3 and Figure 4 (Section E1a)				
<b>Cross-section(s):</b> East 1 A – A' (Figure 17)				
<b>Proposed Structures:</b> Central and East Mainline – CM-28, CM-28B, CM-29, CM-29B, EM-1, EM-2, EM-3, EM-4, EM-5				
<b>Deep Cuts:</b> DC-E1 (12+175 to 12+850) – 5 m cut depth (drawdown curve – Figure 20)				
<b>High Fills:</b> HF-E1 (12+900 to 13+010) – 5.5 m fill height				
<b>Foundation Risk Assessment Hydrogeology Table:</b> Table 8 (Section E1a)				
<b>FIELD DATA SOURCES:</b>		0 – >30 m	<b>Unit 3: Newmarket Till</b> (aquitard) – light green on figure 3 <ul style="list-style-type: none"><li>Silty sand to sandy silt till, with gravel and occasional boulders, very dense</li><li>Ranges in thickness from 10 to &gt;30 m</li><li>Unit is mainly exposed at ground surface</li><li>Drumlinized surface, elongated hills oriented just west of north</li><li>Contains discontinuous sand lenses that are utilized as individual potable water sources</li><li>Water table is often close to surface (&lt;1 mBGS) because unit is poorly drained</li></ul>	
<b>Boreholes:</b> P27, P28, P29, BH12, EM03-1, EM03-2, EM03-3				
<b>Monitoring Wells:</b> G1E-1, G1E-2				
<b>Mini-Piezometers:</b> MP20s/d, MP21, MP36s/d				
<b>Stream Reconnaissance Sites:</b> SR27a,b				
<b>Residential Water Wells:</b> 72 private water wells. 18% dug, 17% drilled, 65% unknown Approximately 12 wells within the TPR boundary (will require decommissioning)				
<b>PHYSIOGRAPHIC SETTING:</b>		<b>GROUNDWATER FLOW:</b>		
<ul style="list-style-type: none"><li>Level to rolling till plain, with numerous drumlins oriented up slope (north), typical of the South Slope physiographic region (Chapman and Putman, 1984). Meltwater streams have cut sharp valleys in the till (e.g., Farewell Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys</li><li>The Solina Wetland Complex is located with in this Section, which has been designated as a Provincially Significant Wetland</li><li>This map sheet lies in the till plain, except east of Farewell Creek, which hosts overlying glaciolacustrine deposits</li></ul>		<b>Distribution &amp; Significance of Recharge/Discharge Areas:</b> <ul style="list-style-type: none"><li>Shallow groundwater flow directions typically mimic the surface topography. That is, shallow lateral groundwater flow is from high ground towards discharge areas in perennial river valley of Farewell Creek. Regional groundwater flow is primarily through the till. Lateral groundwater flow is minor</li><li>Low rates of groundwater recharge occur in upland till plains and surficial sand deposits, although surface runoff often exceeds recharge due to the presence of low permeability till deposits. Surficial clay deposits are suspected to exist along the north bank of Farewell Creek which cause significant ponding of water following rainfall events. Significant groundwater discharge occurs in Farewell Creek where coarse-textured glaciolacustrine sands are exposed at surface</li><li>Where present, surficial sand acts as a local recharge area and may have a high water table (&lt;1 mBGS) perched on dense till below</li></ul>		
<b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water Structures CM-28, CM-28B, CM-29 and CM-29B are also included in the Central Mainline Report		<b>Groundwater Use:</b> <ul style="list-style-type: none"><li>Private wells obtain potable water from thin, discontinuous sand lenses/ seams within till units</li><li>Dug wells are common where sands are exposed at surface</li><li>13 dug wells (~5 to ~12 m deep), 12 drilled wells (~10 to ~55 m deep), 47 other wells (unknown construction details)</li></ul>		

## 407 East Extension – Eastern Section

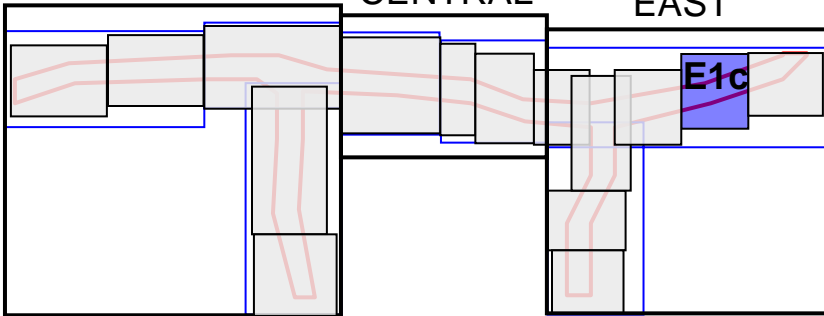
# Summary Table 2 (E1b) – Hydrogeological Conditions and Preliminary Recommendations

Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS:		POTENTIAL IMPACTS:
		East 1 (E1b) Section		<b>Groundwater Effects on Foundation Design and Construction:</b> <ul style="list-style-type: none"><li>► Deposits of silty sand are present at or near the surface in this Section between 14+700 to 17+900<ul style="list-style-type: none"><li>○ Shallow dewatering may be required if excavating below the water table</li></ul></li><li>► Deposits of soft silt and clay are also present at or near the surface in this Section<ul style="list-style-type: none"><li>○ Engineering measures to deal with settlement and frost heave will be required</li><li>○ These deposits are often present &gt;5 mBGS and are soft at depth</li></ul></li><li>► Organic soils (~0.5 m thick) are present on the west side of West Bowmanville Creek</li><li>► Significant flowing artesian conditions are expected to be encountered between 14+700 to 17+900<ul style="list-style-type: none"><li>○ Boreholes EM08-2, G5E-1, and G6E-1, as well as many domestic wells are flowing artesian</li><li>○ Anticipated to be encountered at or below 160 masl (~20 mbgs)</li><li>○ Foundation designs will need to address both shallow compressible soils and deep artesian pressure</li></ul></li><li>► Shallow GWT (&lt;1 mBGS) may be encountered within till units because the unit is poorly drained.</li><li>► Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term.</li><li>► High water table and permeable sediments at surface between 14+700 to 17+900<ul style="list-style-type: none"><li>○ Fill placement in this area has the potential for groundwater “wicking”</li></ul></li><li>► Structures EM-8/ EM-9, EM-19, EM-22/EM-23 - Dewatering is anticipated for excavations in permeable sediments. A PTTW will be required</li><li>► Structures EM-10, EM-11, EM-12, EM-13, EM-14, EM-15, EM-16, EM-17, EM-18, EM20, EM-21, EM-24 - Shallow dewatering may be required for excavations within surficial sandy sediments</li><li>► Deep Cut DC-E2 (9 m deep cut). Will likely encounter the GWT at &lt;6.0 mBGS. Low potential for dewatering</li><li>► Deep Cut DC-E3 (7.5 m deep cut). Will likely encounter the GWT at &lt;2.0 mBGS. Low potential for dewatering</li></ul> <b>Surface Water Features:</b> <ul style="list-style-type: none"><li>► Construction activities including temporary dewatering, fill placement (HF-E2), and deep highway cuts (DC-E2 – 14+730 to 14+800) at West Bowmanville Creek is anticipated to reduce groundwater discharge into the waterbody over the construction period (Structures EM-8/EM-9, EM-22/EM-23)<ul style="list-style-type: none"><li>○ Groundwater seepage was observed during a site visit along the western edge of the valley</li><li>○ A site specific investigation will be required during detailed design to ensure no long-term effects</li></ul></li><li>► Temporary dewatering for construction of bridge abutments at EM-13, EM-14, EM-16, EM-18, EM-20 is anticipated to reduce groundwater discharge into the creeks over the dewatering period<ul style="list-style-type: none"><li>○ A site specific investigation will be required during detailed design</li></ul></li></ul> <b>Aquifer/Well Vulnerability:</b> <ul style="list-style-type: none"><li>► Deep Cut DC-E2 (9 m deep cut) – Excavations estimated to be 3.0 m below the water table (figure 14)<ul style="list-style-type: none"><li>○ Radius of water table drawdown is estimated to be ~25 m</li><li>○ Low potential to impact wells/ aquifers unless continuous sand lenses are encountered</li></ul></li><li>► Deep Cut DC-E3 (11 m deep cut) – Excavations estimated to be 10.0 m below the water table (figure 15)<ul style="list-style-type: none"><li>○ Radius of water table drawdown is estimated to be ~50 m</li><li>○ Surficial sand unit appears too thin to be an aquifer</li><li>○ Low potential to impact wells/ aquifers unless continuous sand lenses are encountered</li></ul></li><li>► Eastern Mainline (E1b) – Highway constructed primarily on or near shallow high permeability aquifer deposits<ul style="list-style-type: none"><li>○ Potential for long-term impact to groundwater quality from de-icing compounds</li><li>○ No reduction in GW recharge due to the small surface area of the highway</li></ul></li></ul> <b>Opportunities for Avoidance/ Mitigation/ Compensation:</b> <ul style="list-style-type: none"><li>► Structures EM-8/ EM-9, EM-19, EM-22/EM-23 – dewatering required for excavations for bridge footings<ul style="list-style-type: none"><li>○ Deep foundations are recommended to minimize dewatering, but foundation design will need to address both shallow compressible soils and deep artesian pressure</li><li>○ Time the dewatering period to avoid fish spawning seasons (Oct – Mar)</li><li>○ Discharge water into receptor stream following temperature and clarity controls to maintain baseflow</li><li>○ Design valley fill with <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li></ul></li><li>► Deep Cut DC-E2 – Estimated permanent lowering of water table within ~25 m of cut<ul style="list-style-type: none"><li>○ No wells or waterbodies are anticipated to be affected</li></ul></li><li>► Deep Cut DC-E3 – Estimated permanent lowering of water table within ~50 m of cut<ul style="list-style-type: none"><li>○ No wells or waterbodies are anticipated to be affected</li></ul></li><li>► Eastern Mainline (East 1 – E1b) – Potential for reduction in groundwater quality from road run-off<ul style="list-style-type: none"><li>○ Between 14+700 to 17+900 - potential for long-term impact to groundwater quality from de-icing compounds</li><li>○ SWM ponds, outlet channels and highway ditching will require lining to prevent infiltration</li><li>○ No reduction in GW recharge due to the small surface area of the highway</li></ul></li></ul> <b>PRIORITIES FOR DETAILED DESIGN:</b> <ul style="list-style-type: none"><li>► The extent of sub-surface silt and clay and artesian pressure needs to be delineated between 14+700 to 17+900</li><li>► Engineering measures needed to address foundation design options for an area with both shallow compressible soils and deep artesian pressure</li><li>► Confirm depth of excavation for bridge abutments in the valleys East and West Bowmanville Creek so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts</li><li>► A PTTW will be required for setting bridge foundations at EM-8/ EM-9, EM-14, EM-16, EM-22/EM-23</li><li>► Collection of geological and hydrogeological information along the length of and transverse to the deep cut locations DC-E2 and DC-E3 to estimate the extent of local drawdown. Hydraulic testing of soils will be required</li><li>► A site specific investigation at West Bowmanville Creek (EM-8/ EM-9) to investigate organic soils, groundwater seeps and the impacts that construction will have on cold groundwater discharge</li></ul>
		0 – 5 m	<b>Unit 1: Modern and Older Alluvial Deposits</b> (surficial aquifer) <ul style="list-style-type: none"><li>– brown colour on figure 5</li><li>► Silt, Sand and Gravel</li><li>► Glacial Outwash deposits derived from modern and historical, post-glacial rivers</li><li>► Alluvial sediments are present in modern river valleys</li></ul>	
		0 – 5 m	<b>Unit 2: Coarse-textured Glaciolacustrine Deposits</b> (surficial aquifer) <ul style="list-style-type: none"><li>– yellow colour on figure 5</li><li>► Fine to coarse sand and silty sand or sandy silt, moderately rounded, well sorted, compact</li><li>► Utilized for potable water from shallow, dug wells.</li><li>► Water table is often close to surface because till unit below restricts drainage to depth</li></ul>	
		0 – 15 m	<b>Unit 3: Fine-textured Glaciolacustrine Sediments</b> (aquitard) <ul style="list-style-type: none"><li>– blue colour on figure 5 and figure 17 (cross-section)</li><li>► Clayey silt to silty clay interbedded with silty sand to sand, massive</li><li>► Soft to very dense</li><li>► Up 25 m in thickness</li><li>► Acts as a confining unit for fluvial sand and gravel deposits below which are commonly artesian</li></ul>	
		0 – >7.5	<b>Unit 4: Fluvial Sand and Gravel</b> (aquifer) <ul style="list-style-type: none"><li>- brown and yellow on figure 17 (cross-section)</li><li>► Sand and Gravel, loose, waterbering</li><li>► Potential confined fluvial aquifer deposits</li><li>► Flowing Artesian conditions common</li><li>► Encountered in boreholes between 14+700 to 17+900</li></ul>	
		>30 m	<b>Unit 5: Newmarket Till</b> (aquitard) <ul style="list-style-type: none"><li>– light green on figure 5 and figure 17 (cross-section)</li><li>► Silty sand to sandy silt till, with gravel and occasional boulders, very dense</li><li>► Ranges in thickness from 10 to &gt;30</li><li>► Unit is only exposed at surface along the east and west Section boundaries</li><li>► Contains discontinuous sand lenses that are utilized as individual potable water sources</li><li>► Water table is often close to surface (&lt;1 mBGS) because unit is poorly drained</li><li>► Overlying Halton Till may also be present in this Section although not encountered in boreholes</li></ul>	
		<b>GROUNDWATER FLOW:</b>		
		<b>Distribution &amp; Significance of Recharge/Discharge Areas:</b> <ul style="list-style-type: none"><li>► Shallow groundwater flow directions typically mimic the surface topography. That is, shallow lateral groundwater flow is from high ground towards discharge areas in perennial river valleys of East and West Bowmanville Creek. Regional groundwater flow is primarily through the till. Lateral groundwater flow is minor</li><li>► Low rates of groundwater recharge occur in upland till plains, although surface runoff often exceeds recharge due to the presence of low permeability till and glaciolacustrine deposits. Surficial clay and silt deposits exist within the TPR which restricts drainage and facilitates runoff. Significant groundwater discharge occurs in West Bowmanville Creek where coarse-textured glaciolacustrine sands are exposed at surface</li><li>► Where present, surficial sand acts as a local recharge area and may have a high water table (&lt;1 mBGS) perched on dense till or glaciolacustrine silts and clays below</li></ul>		
		<b>Groundwater Use:</b> <ul style="list-style-type: none"><li>► Private wells obtain potable water from surficial sand units or deep artesian aquifer unit</li><li>► 41 dug wells (~5 to ~12 m deep), 32 drilled wells (~10 to ~55 m deep), 165 other wells (unknown construction details), 1 commercial well (post office in Hampton)</li></ul>		
<b>Map:</b> East 1 – E1b (see Figure 2 for location) <b>Section Boundaries:</b> Holt Road to Liberty Street North (see note below) Chainage 12+500 to 14+250 of the Eastern Mainline shown on Table 5 (ELa) <b>Figure(s):</b> Figure 5 and Figure 6 (Section E1b)				
<b>Cross-section(s):</b> East 1 A – A' (Figure 18)				
<b>Proposed Structures:</b> Eastern Mainline – EM-6, EM-7, EM-8, EM-9, EM-10, EM-11, EM-12, EM-13, EM-14, EM-15, EM-16, EM-17, EM-18, EM-19, EM-20, EM-21, EM-22, EM-23, EM-24				
<b>Deep Cuts:</b> DC-E2 (14+050 to 14+650) – 9 m cut depth (drawdown curve – Figure 21) DC-E3 (17+875 to 18+425) – 7.5 m cut depth (drawdown curve – Figure 22) <b>High Fills:</b> HF-E2 (14+730 to 16+300) – 10 m fill height HF-E3 (16+760 to 17+080) – 5.5 m fill height				
<b>Foundation Risk Assessment Hydrogeology Table:</b> Table 9 (Section E1b)				
<b>FIELD DATA SOURCES:</b>				
<b>Boreholes:</b> P30, P31, P32, P33, P34, EM08-2, EM10-1, EM10-2, EM10-3, EM15-1, EM21-1, EM24-1				
<b>Monitoring Wells:</b> G5E-1, G5E-2, G6E-1, G6E-2				
<b>Mini-Piezometers:</b> MP29, MP30, MP31, MP37				
<b>Stream Reconnaissance Sites:</b> SR29a,b,c,d, SR30a,b, SR31a,b				
<b>Residential Water Wells:</b> 239 private water wells. 17% dug, 13% drilled, 70% unknown Approximately 14 wells within the TPR boundary (will require decommissioning)				
<b>PHYSIOGRAPHIC SETTING:</b>				
<ul style="list-style-type: none"><li>► Level to rolling till plain, with numerous drumlins oriented up slope (north), typical of the South Slope physiographic region (Chapman and Putman, 1984).</li><li>► This Section specifically consists of a wide (3.5 km), deep (&gt;20 m), flat-floored valley separating drumlinized upland areas (e.g., Barnett et al. 1998) and consisting of alternating layers of glaciofluvially derived sands and gravels and clayey silts.</li><li>► Meltwater streams have cut sharp valleys in the till (e.g., East and West Bowmanville Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys.</li></ul>				
<b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water				



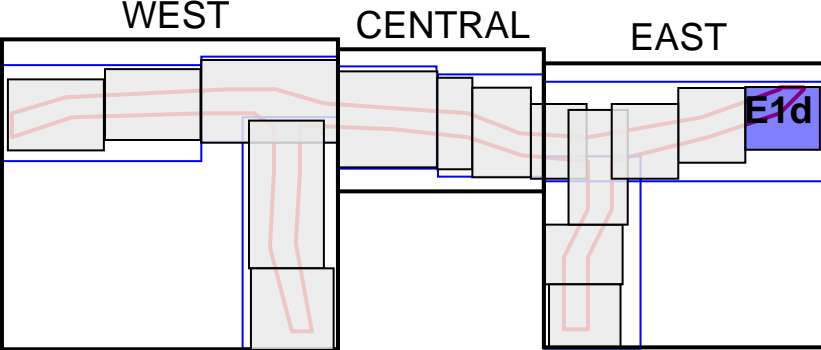
# 407 East Extension – Eastern Section

## Summary Table 3 (E1c) – Hydrogeological Conditions and Preliminary Recommendations

Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: East 1 (E1c) Section		POTENTIAL IMPACTS:
		<div>0 – 10 m</div>	<b>Unit 1: Modern Alluvial Deposits</b> (surficial aquifer) – brown colour on figure 7 ► Silt, Sand and Gravel ► Glacial Outwash deposits derived from modern, post-glacial rivers (19+500, 21+800) ► Alluvial sediments are present in modern river valleys	<b>Groundwater Effects on Foundation Design and Construction:</b> ► Deposits of silty sand are present at or near the surface in this Section ◦ Shallow dewatering may be required if excavating below the water table ► ORM Aquifer deposits may be present in this Section below Halton Till ◦ If encountered in excavation, significant dewatering is anticipated. A PTTW will be required ► Thorncliffe Aquifer unit present at depth in this Section. Not anticipated to be affected by highway construction ► Shallow GWT (<1 mBGS) may be encountered within till units because the unit is poorly drained. ► Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term. ► Structures EM-27/ EM-28, EM-32/EM-33 - Dewatering is anticipated for excavations in permeable sediments. A PTTW will be required ► Structure EM-26 - Shallow dewatering may be required for excavations within surficial sandy sediments ► Deep Cut DC-E4 (5 m deep cut). Will likely encounter the GWT at ~3.0 mBGS. Low potential for dewatering ► Deep Cut DC-E5 (10 m deep cut). Will likely encounter the GWT at ~6.0 mBGS. Low potential for dewatering ◦ Potential to encounter permeable units (ORM Aquifer) at the base of the cut
		<div>0 – 3 m</div>	<b>Unit 2: Coarse-textured Glaciolacustrine Deposits</b> (surficial aquifer) – yellow colour on figure 7 ► Fine to coarse sand and silty sand or sandy silt, moderately rounded, well sorted, compact ► Utilized for potable water from shallow, dug wells. ► Water table is often close to surface because till unit below restricts drainage to depth	
		<div>0 – 5 m</div>	<b>Unit 3: Halton Till</b> (aquitard) – dark green on figure 7 and figure 18 (cross-section) ► Clayey silt till, compact to very dense ► Ranges in thickness from 0 to 5 m ► Water table is often close to surface (<1 mBGS) because unit is poorly drained ► ORM sand and gravel deposits are encountered at the base of the Halton Till ► May be present over a greater extent than shown on figure 7 due to its similarity with the Newmarket Till below	
		<div>10 - &gt;30 m</div>	<b>Unit 5: Newmarket Till</b> (aquitard) – light green on figure 7 and figure 18 (cross-section) ► Silty sand to sandy silt till, with gravel and occasional boulders, very dense ► Ranges in thickness from 10 to >30 ► Unit is only exposed at surface in the central portion of the Section, although this may be Halton Till (requires additional investigations) ► Contains discontinuous sand lenses that are utilized as individual potable water sources ► Water table is often close to surface (<1 mBGS) because unit is poorly drained	
		<b>GROUNDWATER FLOW:</b>		
<b>Map:</b> East 1 – E1c (see Figure 2 for location)		<b>Distribution &amp; Significance of Recharge/Discharge Areas:</b> ► Shallow groundwater flow directions typically mimic the surface topography. That is, shallow lateral groundwater flow is from high ground towards discharge areas in perennial river valleys Mackie and Soper Creek. Regional groundwater flow is primarily through the till. Lateral GW flow is minor ► Low rates of groundwater recharge occur in upland till plains, although surface runoff often exceeds recharge due to the presence of low permeability till deposits. Significant groundwater discharge occurs in Soper Creek where coarse-textured glaciolacustrine sands are exposed at surface ► Where present, surficial sand acts as a local recharge area and may have a high water table (<1 mBGS) perched on dense till or glaciolacustrine silts and clays below		
<b>Section Boundaries:</b> Liberty Street North to Nixon Road				
<b>Figure(s):</b> Figure 7 and Figure 8 (Section E1c)				
<b>Cross-section(s):</b> East 2 B – B' (Figure 18)				
<b>Proposed Structures:</b> East Mainline – EM-25, EM-26, EM-27, EM-28, EM-29, EM-30, EM-31, EM-32, EM-33, EM-34				
<b>Deep Cuts:</b> DC-E4 (18+575 to 19+100) – 5 m cut depth (drawdown curve – Figure 23) DC-E5 (20+600 to 21+575) – 10 m cut depth (drawdown curve – Figure 24)				
<b>High Fills:</b> HF-E4 (19+170 to 19+590) – 8 m fill height HF-E5 (20+470 to 20+600) – 6 m fill height HF-E6 (21+590 to 22+010) – 16.5 m fill height HF-E7 (22+275 to 22+380) – 5.5 m fill height				
<b>Foundation Risk Assessment Hydrogeology Table:</b> Table 10 (Section E1c)				
<b>FIELD DATA SOURCES:</b>				
<b>Boreholes:</b> P34, P35, P36, P37, EM30-1				
<b>Monitoring Wells:</b> G7E-1, G7E-2				
<b>Mini-Piezometers:</b> MP32				
<b>Stream Reconnaissance Sites:</b> SR32a,b,c, SR33a,b				
<b>Residential Water Wells:</b> 27 private water wells. 2% dug, 30% drilled, 68% unknown Approximately 8 wells within the TPR boundary (will require decommissioning)				
<b>PHYSIOGRAPHIC SETTING:</b> ► Level to rolling till plain, with numerous drumlins oriented up slope (north), typical of the South Slope physiographic region (Chapman and Putman, 1984). Meltwater streams have cut sharp valleys in the till (e.g., Soper Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys. ► Surficial geological mapping indicates the presence of both Newmarket and Halton tills within E1c. The potential to encounter ORM deposits at the contact between the till units is high. ► The Iroquois Plain physiographic region is found south of the TPR in this Section and is characterized by flat lying deposits of coarse sand and gravel that are present along the shoreline bluff of Glacial Lake Iroquois. Glaciolacustrine sediments of sand, silt and clay overlie till to maximum depths of 20 m (Barnett, 1996). ► This map sheet lies on the South Slope of the ORM. The TPR encounters an area mapped as Lake Iroquois Shoreline sediments by Provincial Geological Mapping at 19+900 to 20+200.				
<b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water		<b>Groundwater Use:</b> ► Private wells obtain potable water from aquifer units present at depths ranging from 5 to 35 mBGS ► Private wells also obtain potable water from thin, discontinuous sand lenses/ seams within till units ► 2 dug wells (~5 to ~12 m deep), 8 drilled wells (~10 to ~35 m deep), 17 other wells (unknown construction details)		
		<b>PRIORITIES FOR DETAILED DESIGN:</b> ► Confirm depth of excavation for bridge abutments in the valleys of Mackie Creek and Soper Creek (Structures EM-27/ EM-28, EM-32/EM-33) so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts ► A PTTW will be required for setting bridge foundations at EM-27/ EM-28, EM-32/EM-33 ► Collection of geological and hydrogeological information along the length of and transverse to the deep cut locations DC-E4 and DC-E5 so the extent of local drawdown can be confirmed. Hydraulic testing of soils will be required to obtain a PTTW		

## 407 East Extension – Eastern Section

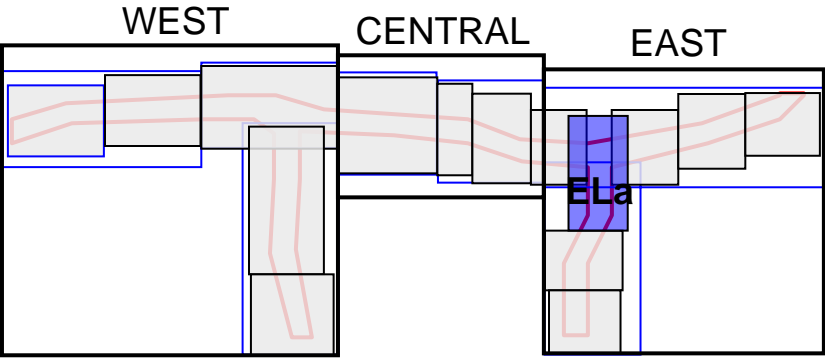
# Summary Table 4 (E1d) – Hydrogeological Conditions and Preliminary Recommendations

Key Map	TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: East 1 (E1d) Section		POTENTIAL IMPACTS:
	0 – 10 m	<b>Unit 1: Modern and Recent Alluvial Deposits</b> (surficial aquifer) – brown colour on figure 9 ▶ Silt, Sand and Gravel ▶ Glacial Outwash deposits derived from historical, post-glacial rivers ▶ Modern alluvial sediments are present in modern river valleys ▶ Often found as raised alluvial terraces (between 23+550 to 24+270) ◦ Sand and gravel deposits are typically loose and dry	<b>Groundwater Effects on Foundation Design and Construction:</b> ▶ Thick deposits of silty sand are present at or near the surface between 22+350 and 24+800 ◦ Dewatering is anticipated if excavating below the water table in this Section ◦ From a hydrogeology perspective, deep foundations are desirable to minimize dewatering ▶ ORM Aquifer deposits are present at ~10 – 20 mBGS between 23+000 to 27+750 ◦ If encountered in excavation, significant dewatering is anticipated. A PTTW will be required ▶ Shallow GWT (<1 mBGS) may be encountered within till units or surficial sand because of poor drainage below ▶ Potential high water table and permeable sediments at surface between 22+350 and 24+800 ◦ Fill placement in this area has the potential for groundwater “wicking” ▶ Structures EM-36/EM-37, EM-38/EM-39, EM-40 - Dewatering is anticipated. A PTTW will be required ▶ Deep Cut DC-E6 (5 m deep cut) – GWT at ~1.0 mBGS. Will require dewatering. Potential to require a PTTW ▶ Deep Cut DC-E7 (6 m deep cut) – Majority of cut though raised alluvial terrace. Conservative estimates put the GWT at ~1.0 mBGS, but there is a high potential that it will be deeper. Overall, will likely require dewatering and a PTTW ▶ Deep Cut DC-E8 (15 m deep cut) – GWT at ~8.0 mBGS. ORM aquifer interpreted to be present at ~20 mBGS ◦ Low potential for dewatering unless ORM aquifer deposits are encountered ▶ Deep Cut DC-E9 (10 m deep cut) – GWT at ~2.5 mBGS. Low potential for dewatering unless ORM is encountered <b>Surface Water Features:</b> ▶ Temporary dewatering for bridge abutments in the valley of Wilmot Creek and its tributaries is anticipated to reduce groundwater discharge into the waterbodies over the dewatering period (EM-36/EM-37, EM-38/EM-39) ◦ A site specific investigation will be required during detailed design to confirm impacts ▶ The headwaters of Orono Creek are found ~200 m south of the TPR between 26+300 and 26+900. The aquifer feeding the creek is likely present in the shallow subsurface below Structures EM-43 and EM-44 ◦ A site specific investigation will be required during detailed design to confirm impacts <b>Aquifer/Well Vulnerability:</b> ▶ Deep Cut DC-E6 (5 m deep cut) – Excavations estimated to be 4.0 m below the water table in sand (figure 25) ◦ Radius of water table drawdown is estimated to be ~100 m ◦ Low potential to impact wells due to separation distance and boundary condition of Wilmot Creek tributary ▶ Deep Cut DC-E7 (6 m deep cut) – Cut is within a raised terrace, and may be above the water table. Due to a lack of site specific information, excavations are conservatively estimated to be 5.0 m below the GWT in sand (figure 26) ◦ Radius of GWT drawdown is estimated to be ~ 300 m. May encounter ORM aquifer deposits ◦ Potential to impact two (2) private wells and groundwater discharge to Wilmot Creek ▶ Deep Cut DC-E8 (15 m deep cut) – Excavations estimated to be 7.0 m below the water table (figure 27) ◦ Radius of GWT drawdown is estimated to be ~50 m in till and ~500 m if ORM Aquifer deposits are encountered ◦ Low potential for impacts to wells or GW discharge because cut is likely in low permeability till deposits ▶ Deep Cut DC-E8 (10 m deep cut) – Excavations estimated to be 7.5 m below the water table (figure 28) ◦ Radius of GWT drawdown is estimated to be ~50 m in till and ~500 m if ORM Aquifer deposits are encountered ◦ Low potential for impacts to wells or GW discharge because cut is likely in low permeability till deposits ▶ Eastern Mainline (E1d) – Highway constructed on both high permeability sands and low permeability tills ◦ In till (24+800 to 27+750), low potential for long-term impact to GW quality from de-icing compounds ◦ In sands (22+350 and 24+800), high potential for long-term impact to GW quality from de-icing compounds ◦ No reduction in GW recharge for entire Section due to the small surface area of the highway <b>Opportunities for Avoidance/ Mitigation/ Compensation:</b> ▶ Structures EM-36/EM-37, EM-38/EM-39, EM-40 – dewatering required for excavations for bridge footings ◦ Deep foundations are recommended, where suitable, to minimize dewatering (high permeability units at surface) ◦ Time the dewatering period to avoid fish spawning seasons (Oct – Mar) ◦ Discharge water into receptor stream following temperature and clarity controls to maintain baseflow ◦ Design fill with K <sub>fill</sub> > 100K <sub>native</sub> to maintain GW flow and avoid “wicking” of GW into fill ▶ Structures EM-43 and EM-44 – keep Hwy on raised fill to avoid confined aquifer unit in excavation ▶ Deep Cut DC-E6 – Estimated permanent lowering of GWT within 100m of cut. No wells anticipated to be affected ▶ Deep Cut DC-E7 – Estimated permanent lowering of GWT within 300 m of cut. Potential to affect two (2) wells ◦ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction ◦ Compensate for impacts by: trucking in water (short-term) or drilling a new well to depth (short to long-term) ◦ Groundwater discharge into Wilmot Creek may be impacted. Construction monitoring required ▶ Deep Cut DC-E8 – Estimated permanent lowering of GWT within 50 m of cut. Potential to encounter ORM deposits ◦ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction ◦ Compensate for impacts by: trucking in water (short-term) or drilling a new well (long-term) ▶ Deep Cut DC-E9 – Estimated permanent lowering of GWT within 50 m of cut. Potential to encounter ORM deposits ◦ No wells anticipated to be affected ▶ Eastern Mainline (East 1 – E1d) – Between 22+350 and 24+800, potential for reduction in GW quality from run-off ◦ Collect storm water in SWM ponds with passive treatment and vegetative polishing ◦ Line ditching, SWM ponds, and outlet channels with clay between 22+350 and 24+800 to prevent infiltration ◦ Compensate for impacts by: trucking in water (short-term) or deepening well (long-term)
	0 – 10 m	<b>Unit 2: Coarse-textured Glaciolacustrine Deposits</b> (surficial aquifer) – yellow colour on figure 9 ▶ Fine to coarse sand and silty sand or sandy silt, moderately rounded particles, well sorted, compact ▶ Utilized for potable water from shallow, dug wells. ▶ Water table is often close to surface because till unit below restricts drainage to depth ▶ May directly overlie ORM aquifer deposits in the Wilmot Creek Valley	
	0 – 20 m	<b>Unit 3: Halton Till</b> (aquitard) – dark green on figure 9 and figure 18 ▶ Clayey silt till, compact to very dense ▶ Ranges in thickness from 0 to 20 m ▶ Water table is often close to surface (<1 mBGS) because unit is poorly drained ▶ ORM sand and gravel deposits are encountered at the base of the Halton Till ▶ Wilmot Creek valley may have eroded through the Halton Till exposing ORM aquifer sediments below	
	0 – 10 m	<b>Unit 4: Oak Ridges Moraine (ORM) Sand and Gravel</b> (aquifer) - hatched brown and yellow on figure 18 ▶ Sand and Gravel, loose, waterbering ▶ ORM aquifer deposits found at the base of the Halton Till ▶ Potential for flowing Artesian conditions ▶ ORM aquifer deposits may be unconfined (i.e. direct hydraulic connection to surface) within the Wilmot Creek valley	
	10 - >60 m	<b>Unit 5: Newmarket Till</b> (aquitard) – light green on figure 9 and figure 18 ▶ Silty sand to sandy silt till, with gravel and occasional boulders, very dense ▶ Ranges in thickness from 10 to >60 ▶ Unit is not well exposed at surface and along the TPR. Its presence is interpreted from borehole logs ▶ Contains discontinuous sand lenses that are utilized as individual potable water sources	
GROUNDWATER FLOW:			
<b>Distribution &amp; Significance of Recharge/Discharge Areas:</b> ▶ Shallow groundwater flow directions typically mimic the surface topography. That is, shallow lateral groundwater flow is from high ground towards discharge areas in perennial river valley of Wilmot Creek. Regional groundwater flow is primarily through the till. Lateral GW flow is minor ▶ Low rates of groundwater recharge occur in upland till plains, although surface runoff often exceeds recharge due to the presence of low permeability till deposits. Significant groundwater discharge occurs in Wilmot Creek where coarse-textured glaciolacustrine sands are exposed at surface and where the river valley may intersect ORM aquifer deposits ▶ Where present, surficial sand acts as a local recharge area and may have a high water table (<1 mBGS) perched on dense till below. The greater Wilmot Creek valley is a significant recharge area			
<b>Groundwater Use:</b> ▶ Private wells primarily obtain potable water the ORM aquifer located at ~10 - 20 mBGS ▶ Dug wells are common where alluvial and glaciolacustrine sands are exposed at surface (i.e. within the Wilmot Creek valley) ▶ 10 dug wells (~5 to ~12 m deep), 3 drilled wells (~10 to ~55 m deep), 25 other wells (unknown construction details)			
POTENTIAL IMPACTS:			
<b>PRIORITIES FOR DETAILED DESIGN:</b> ▶ DC-E7 and DC-E8 require sub-surface investigations prior to detailed design to confirm hydrogeological conditions ▶ Confirm depth of excavation for bridge footings in Wilmot Creek valley (EM-36/EM-37, EM-38/EM-39, EM-40) so dewatering rates can be estimated for the PTTW. Hydraulic testing will be required to establish potential impacts ▶ Collection of geological and hydrogeological information along the length of and transverse to the deep cut locations DC-E6, DC-E7, DC-E8, DC-E9 so the extent of local drawdown can be confirmed. Investigations should confirm the absence/ presence of Halton Till and underlying ORM aquifer deposits. Hydraulic testing of soils will be required ▶ Site specific investigation at EM-43/ EM-44 to determine impact of Hwy construction on headwaters of Orono Creek			
<b>Map:</b> East 1 – E1d (see Figure 2 for location)			
<b>Section Boundaries:</b> Brown Road to Highway 35/155			
<b>Figure(s):</b> Figure 9 and Figure 10 (Section E1d)			
<b>Cross-section(s):</b> East 2 B – B' (Figure 18)			
<b>Proposed Structures:</b> East Mainline – EM-36, EM37, EM-38, EM-39, EM-40, EM-41, EM-42, EM-43, EM-44, EM-45, EM-46, EM-47, EM-48 (EM-49, EM-50, EM-51 shown on figure 6 but are no longer required for the 407 TPR)			
<b>Deep Cuts:</b> DC-E6 (23+175 to 23+350) – 5 m cut depth (drawdown curve – Figure 25) DC-E7 (23+780 to 24+000) – 6 m cut depth (drawdown curve – Figure 26) DC-E8 (24+825 to 25+300) – 15 m cut depth (drawdown curve – Figure 27) DC-E9 (25+700 to 28+300) – 10 m cut depth (drawdown curve – Figure 28)			
<b>High Fills:</b> HF-E8 (23+350 to 23+510) – 11 m fill height HF-E9 (23+350 to 23+510) – 18 m fill height HF-E10 (23+350 to 23+510) – 6 m fill height HF-E11 (23+350 to 23+510) – 8.5 m fill height HF-E12 (23+350 to 23+510) – 11 m fill height			
<b>Foundation Risk Assessment Hydrogeology Table:</b> Table 11 (Section E1d)			
FIELD DATA SOURCES:			
<b>Boreholes:</b> P38, P39, P40, EM35-1, EM35-2, EM40-1			
<b>Monitoring Wells:</b> G8E-1, G8E-2 (G9E-1 is located approx. 500 to the north of Section E1d)			
<b>Mini-Piezometers:</b> MP33, MP34s/d, MP35s/d			
<b>Stream Reconnaissance Sites:</b> SR34, SR35a,b,c, SR36			
<b>Residential Water Wells:</b> 38 private water wells. 26% dug, 8% drilled, 66% unknown Approximately 2 wells within the TPR boundary (will require decommissioning)			
PHYSIOGRAPHIC SETTING:			
▶ Level to rolling till plain, with numerous drumlins oriented up slope (north), typical of the South Slope physiographic region (Chapman and Putman, 1984). Meltwater streams have cut sharp valleys in the till (e.g., Wilmot Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys. ▶ The Oak Ridges Moraine (ORM) was deposited about 13,000 years ago on the surface of the Newmarket Till in a deep glacial lake. The peak and the core of the ORM is largely the result of glaciofluvial deposition, whereas the flanks better reflect glaciolacustrine sedimentation. Section E1d is located on the southern flank of the ORM and laminated silts and clays are present at ground surface. High permeability ORM sediments were identified north of the TPR and are exposed due to non-deposition of Halton Till in this area. ▶ Surficial geological mapping indicates the presence of both Newmarket and Halton tills within E1d. The potential to encounter ORM deposits at the contact between the till units is high.			
<b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water			



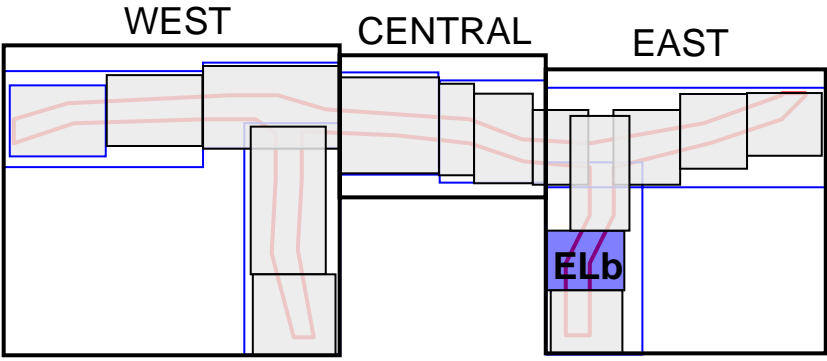
## 407 East Extension – East Section

# Summary Table 5 (ELa) – Hydrogeological Conditions and Preliminary Recommendations

Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: East Link (ELa) Section	POTENTIAL IMPACTS:
		<div>0 – 10 m</div> <p><b>Unit 1: Coarse-textured Glaciolacustrine</b> (surficial aquifer) - yellow on figure 11</p> <ul style="list-style-type: none"><li>▶ Fine to coarse sand and silty sand or sandy silt, well rounded, well sorted, compact</li><li>▶ Form the unconfined Iroquois Plain Shallow Aquifer</li><li>▶ Utilized for potable water from shallow dug wells</li><li>▶ Water table is often close to surface because till unit below restricts drainage to depth</li><li>▶ Unit is typically considered a recharge area, but local groundwater discharge can occur in the Lake Iroquois deposits along breaks in slope and in watercourses</li><li>▶ Alluvial sediments are present in modern river valleys</li></ul>	<p><b>Groundwater Effects on Foundation Design and Construction:</b></p> <ul style="list-style-type: none"><li>▶ Thick deposits of glaciolacustrine sands and silts are present over most of the East Durham Link<ul style="list-style-type: none"><li>○ Local dewatering will be required for excavations in glaciolacustrine materials, probably at low rates</li><li>○ From a hydrogeology perspective, deep foundations are desirable to minimize dewatering</li></ul></li><li>▶ Shallow GWT (&lt;1 mBGS) may be encountered within till units or surficial sand because of poor drainage below</li><li>▶ Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term</li><li>▶ High water table and permeable sediments at surface between 12+700 to 18+050<ul style="list-style-type: none"><li>○ Fill placement in this area has the potential for groundwater “wicking”</li></ul></li><li>▶ Structures EL-23, EL-24, EL-31 - Dewatering is anticipated for excavations. A PTTW will be required</li><li>▶ Structure EL-25 - Shallow dewatering may be required for excavations within surficial sandy sediments</li><li>▶ Deep Cut DC-E10 (5.5 m deep cut) – additional information is required to estimate drawdown<ul style="list-style-type: none"><li>○ Will likely encounter the GWT at ~1.0 mBGS in a surficial sand unit</li><li>○ Will require dewatering. Moderate potential to require a PTTW</li></ul></li></ul>
<p><b>Map:</b> East Link – ELa (see Figure 2 for location)</p> <p><b>Section Boundaries:</b> Concession 6 Road to midway between Taunton Road and Nash Road between Solina Road and Rundle Road.</p> <p><b>Figure(s):</b> Figure 11 and Figure 12 (Section ELa)</p> <p><b>Cross-section(s):</b> East Link: C – C' (Figure 19)</p>		<div>50 m</div> <p><b>Unit 2: Newmarket Till</b> (aquitard) – light green in figure 11</p> <ul style="list-style-type: none"><li>▶ Silty sand to sandy silt till, with gravel and occasional boulders, very dense</li><li>▶ Approximately 50 m thick and underlies all surficial deposits</li><li>▶ Unit is exposed at ground surface in many places</li><li>▶ Contains discontinuous sand lenses that are utilized as individual potable water sources</li><li>▶ Water table is often close to surface (&lt;1 mBGS) because unit is poorly drained</li></ul>	<p><b>Surface Water Features:</b></p> <ul style="list-style-type: none"><li>▶ The Harmony-Farewell Iroquois Beach Wetland Complex is present to the east and west of the TPR between 14+500 and 18+050 and is a provincially significant wetland (PSW)<ul style="list-style-type: none"><li>○ The TPR avoids crossing the wetland except between 16+800 and 17+100</li><li>○ Over this area (16+800 and 17+100) mini-piezometers and groundwater monitor nests indicate that groundwater discharge is occurring (upwards hydraulic gradients).</li></ul></li><li>▶ AECOM Ecology teams noted Brook Trout spawning habitat in Black Creek, ~500 east of the TPR and east of Rundle Road (16+300 to 17+500). Mini-piezometer data shows both upwards and downwards hydraulic gradients over this area<ul style="list-style-type: none"><li>○ Dewatering for the placement of bridge footings (EL-23, EL-24) has the potential to temporarily impact groundwater discharge into Black Creek over the duration of water taking</li><li>○ Stream flow and wetland monitoring prior to, during and following construction will be required to confirm</li></ul></li></ul>
<p><b>Proposed Structures:</b> East Link – EL-23, EL-24, EL-25, EL-26, EL-27, EL-28, EL-29, EL-30, EL-31, EL-32, EL-33, EL-34, EL-35 (EM-4, EM-5 are shown, but discussed in Section E1a)</p> <p><b>Deep Cuts:</b> DC-E10 (16+125 to 16+650) – 5.5 m cut depth (drawdown curve – Figure 29)</p> <p><b>High Fills:</b> HF-E14 (16+750 to 17+250) – 8 m fill height HF-E15 (17+800 to 18+000) – 5 m fill height</p> <p><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 12 (Section ELa)</p>		<div>&gt; 50 m</div> <p><b>Unit 3: Bedrock</b> (aquifer) – figure 19</p> <ul style="list-style-type: none"><li>▶ Flat-lying Paleozoic (Upper Ordovician) limestone and shale</li><li>▶ Lindsay Formation Limestone and Blue Mountain (locally Whitby Formation) Shale<ul style="list-style-type: none"><li>○ Present at an elevation of approximately 100 masl</li></ul></li><li>▶ No outcrops present in study area</li><li>▶ Utilized as a source of potable water by deep drilled wells, but is known to contain high concentrations of iron, manganese, iron reducing bacteria, and methane</li></ul>	<p><b>Aquifer/Well Vulnerability:</b></p> <ul style="list-style-type: none"><li>▶ Deep Cut DC-E10 (5.5 m deep cut) – Excavations estimated to be 4.5 m below the water table (figure 29)<ul style="list-style-type: none"><li>○ Radius of water table drawdown is estimated to be ~275 m</li><li>○ High potential to impact shallow dug wells within surficial sand unit</li><li>○ Potential to impact groundwater discharge into Black Creek</li></ul></li><li>▶ Eastern Mainline (ELa) – Highway constructed on both high permeability sands and low permeability tills<ul style="list-style-type: none"><li>○ In till (18+050 to Mainline), low potential for long-term impact to GW quality from de-icing compounds</li><li>○ In sands (12+700 to 18+050), high potential for long-term impact to GW quality from de-icing compounds</li></ul></li><li>▶ No reduction in GW recharge for entire Section due to the small surface area of the highway</li><li>▶ The TPR crosses the Harmony-Farewell Iroquois Beach Wetland Complex at 16+800 to 17+100 (East Link)<ul style="list-style-type: none"><li>○ This wetland is fed by groundwater discharge</li><li>○ The placement of high fills near this area has the potential to impact groundwater flow within the surficial sand aquifer and may affect groundwater discharge into the wetland</li></ul></li></ul>
<p><b>FIELD DATA SOURCES:</b></p> <p><b>Boreholes:</b> BH9, BH10, BH11, P29, EM04-1, EM04-2, EM05-1, EM05-2, EM06-1, EL27-1, EL27-2, EL27-3, EL23-4, EL24-4</p> <p><b>Monitoring Wells:</b> ∓ G10E-1, G10E-2</p> <p><b>Mini-Piezometers:</b> MP22, MP23, MP25s/d, MP39S/d, MP40, MP41s/d</p>		GROUNDWATER FLOW:	
<p><b>Stream Reconnaissance Sites:</b> SR28d,e,f</p> <p><b>Residential Water Wells:</b> 106 private water wells. 18% dug, 10% drilled, 72% unknown. Approximately 26 wells within the TPR boundary (will require decommissioning)</p> <p><b>PHYSIOGRAPHIC SETTING:</b></p> <ul style="list-style-type: none"><li>▶ The northern part of the Section is characterized by level to rolling till plain, with numerous drumlins oriented up slope (north), typical of the South Slope physiographic region (Chapman and Putman, 1984). Meltwater streams have cut sharp valleys in the surficial Newmarket Till (e.g., Farewell Creek and Black Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys</li><li>▶ The southern part of the Section is part of the Iroquois Plain physiographic region (Chapman and Putman, 1984). Boulder pavements and sand and gravel beach deposits characterize the shoreline of Glacial Lake Iroquois, which is found south of Taunton Road. Nearshore deposits of sand, that grade to silts and clays characterize the area between the glacial shoreline and Lake Ontario. These shallow deposits overlie the Newmarket Till, which is found below surficial sand deposits. Modern alluvial silts, sands and gravels can be found in recent alluvial valley of Farewell Creek, Black Creek and their tributaries</li></ul>		<p><b>Distribution &amp; Significance of Recharge/Discharge Areas:</b></p> <ul style="list-style-type: none"><li>▶ Shallow groundwater flow directions typically mimic the surface topography. Groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal, due to low permeability till sediments restricting flow below, and flows to the southeast or southwest towards perennial river valleys of Black Creek and its tributaries. Deep groundwater flow within the bedrock aquifer is south towards Lake Ontario</li><li>▶ Groundwater recharge occurs locally within areas of the Iroquois Sand Plain Aquifer. Minor groundwater recharge also occurs on upland till deposits, although run-off exceeds recharge in these areas. Localized groundwater discharge is predominant along the Lake Iroquois shoreline deposits and where incised river valleys intercept the water table in the surficial Iroquois Plain Aquifer</li></ul>	<p><b>Opportunities for Avoidance/ Mitigation/ Compensation:</b></p> <ul style="list-style-type: none"><li>▶ Structures EL-23, EL-24, EL-31 – dewatering required for excavations for bridge footings<ul style="list-style-type: none"><li>○ Deep foundations are recommended, where suitable, to minimize dewatering (high permeability units at surface)</li><li>○ Time the dewatering period to avoid fish spawning seasons (Oct – Mar)</li><li>○ Discharge water into receptor stream following temperature and clarity controls to maintain baseflow</li><li>○ Design fill with <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li><li>○ Monitor stream flow and groundwater discharge into adjacent wetlands</li></ul></li><li>▶ High Fill (HF-E14) – Design fill base with level (0% slope) perforated pipes and <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li><li>▶ Deep Cut DC-E10 – Estimated permanent lowering of water table within 275 m of the cut<ul style="list-style-type: none"><li>○ Potential to affect three (3) private wells and GW discharge to Black Creek</li><li>○ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction</li><li>○ Compensate for impacts by: trucking in water (short-term), connecting to municipal supply (long-term), or drilling a new well (short to long-term)</li><li>○ Monitor Black Creek at Rundle Road to determine impacts to stream flow, stream temperature and GW discharge</li></ul></li><li>▶ East Link (East Link – ELa) – Between 12+700 to 18+050, potential for reduction in GW quality from run-off<ul style="list-style-type: none"><li>○ Collect storm water in SWM ponds with passive treatment and vegetative polishing</li><li>○ Line ditching, SWM ponds, and outlet channels with clay between 12+700 to 18+050 to prevent infiltration</li><li>○ Compensate for impacts by: trucking in water (short-term), connecting to municipal supply (long-term), or deepening well (long-term)</li></ul></li></ul>
<p><b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water</p>		<p><b>Groundwater Use:</b></p> <ul style="list-style-type: none"><li>▶ Majority of private wells obtain potable water either from unconfined glaciolacustrine sand aquifers</li><li>▶ Some private wells obtain potable water from thin, discontinuous sand lenses/ seams within the Newmarket Till</li><li>▶ 19 dug wells (~5 to ~12 m deep), 11 drilled wells (~10 to ~55 m deep), 76 other wells (unknown construction details)</li></ul>	<p><b>PRIORITIES FOR DETAILED DESIGN:</b></p> <ul style="list-style-type: none"><li>▶ The Harmony-Farewell Iroquois Beach Wetland Complex located between 16+300 and 17+500 east and west of the TPR and should be instrumented with additional mini-piezometers and monitored for 1 month before construction, during construction and for 1 month following construction for GW water level, surface water flow, and GW discharge</li><li>▶ Confirm depth of excavation for bridge abutments near Black Creek (EL-24, EL-24) so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts and obtain a PTTW</li><li>▶ Collection of geological and hydrogeological information along the length of and transverse to the deep cut location DC-E10 to confirm the presence of glaciolacustrine aquifer unit and estimate the extent of local drawdown. Hydraulic testing will be required to establish potential impacts, which may be permanent</li><li>▶ Three (3) private wells and Black Creek to the east of DC-E10 should be monitored for water level and quality for 1 month before construction, during construction and for 1 month following construction</li><li>▶ Engineering design of permeable sub-base and GW equalization drains for HF-E14 to maintain GW flow in wetland</li></ul>

## 407 East Extension – East Section

# Summary Table 6 (ELb) – Hydrogeological Conditions and Preliminary Recommendations

Key Map	TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: East Link (ELb) Section	POTENTIAL IMPACTS:
	<p><b>0 – 20 m</b></p> <p><b>Unit 1: Coarse-textured Glaciolacustrine Deposits including Glacial Lake Iroquois Shoreline</b> (surficial aquifer) - yellow and hatched yellow on figure 13</p> <ul style="list-style-type: none"> <li>Sand and Gravel, loose (Nearshore Lake Iroquois deposits) – hatched yellow <ul style="list-style-type: none"> <li>Up to 20 m in thickness</li> <li>Present from 14+700 to 16+100</li> <li>Borehole G11E-1 indicates that Lake Iroquois deposits may be present as far south as 14+700 and that the till unit (green) should be marked as Iroquois sand and gravel (observation is further detailed in Primary Hydrogeological Report)</li> </ul> </li> <li>Sand and silty sand or sandy silt, well rounded, well sorted, compact – yellow</li> <li>Unit becomes finer grained with depth, often grading to clay – blue on figure 19</li> <li>Forms the unconfined Iroquois Plain Shallow Aquifer. Utilized for potable water</li> <li>Water table is often close to surface because till unit below restricts drainage</li> <li>Unit is typically considered a recharge Area, but local groundwater discharge can occur in the Lake Iroquois deposits along breaks in slope and in watercourses</li> </ul>	<p><b>Groundwater Effects on Foundation Design and Construction:</b></p> <ul style="list-style-type: none"> <li>Thick deposits of glaciolacustrine sands and silts are present over most of the East Durham Link <ul style="list-style-type: none"> <li>Local dewatering will be required for excavations in glaciolacustrine materials, probably at low rates</li> <li>From a hydrogeology perspective, deep foundations are desirable to minimize dewatering</li> </ul> </li> <li>Shallow GWT (&lt;1 mBGS) may be encountered within till units or surficial sand because of poor drainage below</li> <li>Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term</li> <li>High water table and permeable sediments at surface between 12+700 to 18+050 <ul style="list-style-type: none"> <li>Fill placement in this area has the potential for groundwater “wicking”</li> </ul> </li> <li>Structures EL-17, EL-18, EL-19 - Dewatering is anticipated for excavations. A PTTW will be required</li> <li>Structure EL-10, EL-11, EL-12, EL-13, EL-14, EL-15, EL-22 - Shallow dewatering may be required for excavations within surficial sandy sediments</li> <li>The TPR crossed the Lake Iroquois Shoreline sand and gravel sediments from 15+600 to 16+100 (East Link). These deposits are highly permeable and any excavations will required dewatering and a PTTW if saturated</li> <li>Although Newmarket Till is shown by Provincial Mapping on figure 13, drilling at G11E has confirmed that this unit is not present at surface between 14+700 and 15+600 as shown <ul style="list-style-type: none"> <li>Foundation design should prepare for sands and gravels at surface rather than till</li> <li>This observation is further expanded upon in the Primary Hydrogeological Report (Report B)</li> </ul> </li> </ul>
<p><b>Map:</b> East Link – ELb (see Figure 2 for location)</p> <p><b>Section Boundaries:</b> Midway between Taunton Road and Nash Road to north of Bloor Street between Courtice Road and Rundle Road.</p> <p><b>Figure(s):</b> Figure 13 and Figure 14 (Section ELb)</p>	<p><b>50 m</b></p> <p><b>Unit 2: Newmarket Till</b> (aquitard) – light green in figure 13</p> <ul style="list-style-type: none"> <li>Silty sand to sandy silt till, with gravel and occasional boulders, very dense</li> <li>Approximately 50 m thick and underlies the entire area</li> <li>Unit is exposed at ground surface in many places</li> <li>Although shown by Provincial Mapping on figure 13, drilling at G11E has confirmed that this unit is not present at surface between 14+700 and 15+600 as shown</li> <li>Contains discontinuous sand lenses that are utilized as individual potable water sources</li> <li>Water table is often close to surface (&lt;1 mBGS) because unit is poorly drained</li> </ul>	<p><b>Surface Water Features:</b></p> <ul style="list-style-type: none"> <li>The Harmony-Farewell Iroquois Beach Wetland Complex is present to the east and west of the TPR between 14+500 and 18+050 and is a provincially significant wetland (PSW) <ul style="list-style-type: none"> <li>The TPR avoids crossing this wetland</li> <li>Mini-piezometers and groundwater monitor nests indicate that in most of this Section, groundwater discharge is occurring in the wetland areas and within Black Creek</li> </ul> </li> <li>The Maple Grove Wetland Complex is present between 13+800 and 14+200 and is a PSW <ul style="list-style-type: none"> <li>The TPR crosses a small portion of the wetland with an interchange at EL-13, EL-14, EL-15</li> <li>Mini-piezometers and groundwater monitor nests indicate some minor groundwater discharge, but overall the predominantly downwards hydraulic gradients indicate groundwater recharge and not discharge</li> </ul> </li> <li>Pond located at 15+400 was historically excavated as a sand and gravel pit. Supported by shallow GW inputs</li> <li>AECOM Ecology teams noted Brook Trout and Brook Trout spawning habitat in Black Creek, east of the TPR and east of Rundle Road (14+800 to 17+900) <ul style="list-style-type: none"> <li>Dewatering for the placement of bridge footings (EL-17, EL-18, EL-19, EL-22) has the potential to temporarily impact groundwater discharge into Black Creek over the duration of water taking</li> <li>Stream flow and wetland monitoring prior to, during and following construction will be required to confirm</li> </ul> </li> </ul>
<p><b>Cross-section(s):</b> East Link: C – C' (Figure 19)</p> <p><b>Proposed Structures:</b> East Link – EL-10, EL-11, EL-12, EL-13, EL-14, EL-15, EL-16, EL-17, EL-18, EL-19, EL-20, EL-21, EL-22</p> <p><b>Deep Cuts:</b> None</p> <p><b>High Fills:</b> HF-E13 (14+125 to 14+480) – 9 m fill height HF-E17 (13+810 to 14+170) – 9 m fill height (Cross road and ramp) HF-E18 (14+230 to 14+400) – 8.5 m fill height (Cross road and ramp) HF-E19 (14+200 to 14+460) – 8.5 m fill height (Cross road and ramp)</p>	<p><b>&gt; 50 m</b></p> <p><b>Unit 3: Bedrock</b> (aquifer) – figure 19</p> <ul style="list-style-type: none"> <li>Flat-lying Paleozoic (Upper Ordovician) limestone and shale</li> <li>Lindsay Formation Limestone and Blue Mountain (locally Whitby Formation) Shale</li> <li>Present at an elevation of approximately 100 masl at the north end of the Section, dipping to &lt;80 masl south of 13+900</li> <li>No outcrops present in study area</li> <li>Utilized as a source of potable water by deep drilled wells, but is known to contain high concentrations of iron, manganese, iron reducing bacteria, and methane.</li> </ul>	<p><b>Aquifer/Well Vulnerability:</b></p> <ul style="list-style-type: none"> <li>The TPR crossed Glacial Lake Iroquois Shoreline sediments at 14+700 to 16+100 (East Link). <ul style="list-style-type: none"> <li>Aquifer unit is highly sensitive to surficial contamination due to high permeability</li> </ul> </li> <li>East Link (ELb) – Highway constructed primarily on or near shallow high permeability aquifer deposits <ul style="list-style-type: none"> <li>Potential for long-term impact to groundwater quality from de-icing compounds</li> <li>No reduction in GW recharge due to the small surface area of the highway</li> </ul> </li> <li>The TPR crosses the Maple Grove Wetland Complex at 13+800 and 14+200 (East Link) <ul style="list-style-type: none"> <li>The GWT is perched (&lt; 1mBGS) in surficial sand deposits due to poor drainage though silty clay deposits below</li> <li>Some evidence of shallow GW discharge, but generally GW flow is downwards (recharge)</li> </ul> </li> <li>The placement of high fills between 13+800 and 14+200 has the potential to impact groundwater flow within the surficial sand aquifer and may affect the minor groundwater discharge into the wetland</li> </ul>
<p><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 13 (Section ELb)</p>		
<p><b>FIELD DATA SOURCES:</b></p>		
<p><b>Boreholes:</b> BH5, BH6, BH7, BH8, EL12-1, EL12-2, EL12-3, EL17-1, EL17-2, EL17-3, EL22-1, EL22-2</p>		
<p><b>Monitoring Wells:</b> G2E-1, G2E-2, G3E-1, G3E-2, G11E-1, G11E-2</p>		
<p><b>Mini-Piezometers:</b> MP26, MP42, MP44s/d, MP45</p>		
<p><b>Stream Reconnaissance Sites:</b> SR28a,b,c</p>		
<p><b>Residential Water Wells:</b> 224 private water wells. 32% dug, 8% drilled, 60% unknown. Approximately 22 wells within the TPR boundary (will require decommissioning)</p>		
<p><b>PHYSIOGRAPHIC SETTING:</b></p>	<p><b>GROUNDWATER FLOW:</b></p>	
<p>► This Section is part of the Iroquois Plain physiographic region (Chapman and Putman, 1984). Boulder pavements and sand and gravel beach deposits characterize the shoreline of Glacial Lake Iroquois, which is found between 15+400 and 16+100. Nearshore deposits of sand, that grade to silts and clays with depth and with southward distance, characterize the area between the glacial shoreline and Lake Ontario. These shallow deposits overlie the Newmarket Till, which is found below surficial sand deposits. Modern alluvial silts, sands and gravels can be found in recent alluvial valley Black Creek</p>	<p><b>Distribution &amp; Significance of Recharge/Discharge Areas:</b></p> <ul style="list-style-type: none"> <li>Shallow groundwater flow directions typically mimic the surface topography. Groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal, due to low permeability till sediments restricting flow below, and flows to the southeast or southwest towards perennial river valleys of Black Creek and Tooley Creek. Deep groundwater flow within the bedrock aquifer is south towards Lake Ontario</li> <li>Groundwater recharge occurs locally within areas of the Iroquois Sand Plain Aquifer. Minor groundwater recharge also occurs on upland till deposits, although run-off exceeds recharge in these areas. Groundwater discharge is predominant along the Lake Iroquois shoreline deposits particularly where incised river valleys intercept the water table in the surficial Iroquois Plain Aquifer</li> </ul>	<p><b>Opportunities for Avoidance/ Mitigation/ Compensation:</b></p> <ul style="list-style-type: none"> <li>For structures EL-17, EL-18, EL-19 – Temporary dewatering will be required for excavations in permeable sediments. A PTTW will likely be required <ul style="list-style-type: none"> <li>Deep foundations are recommended, where suitable, to minimize dewatering (high permeability units at surface)</li> <li>Time the dewatering period to avoid fish spawning seasons (Oct – Mar)</li> <li>Discharge water into receptor stream following temperature and clarity controls to maintain baseflow</li> <li>Design fill with <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li> <li>Monitor stream flow and groundwater discharge into adjacent wetlands</li> </ul> </li> <li>High Fills (HF-E13, HF-E17, HF-E18, HF-E19) – Design fill base with level (0% slope) perforated pipes and <math>K_{fill} &gt; 100K_{native}</math> to maintain GW flow and avoid “wicking” of GW into fill</li> <li>East Link (East Link – ELb) – Potential for reduction in groundwater quality from road run-off <ul style="list-style-type: none"> <li>Collect storm water in SWM ponds with passive treatment and vegetative polishing</li> <li>Line ditching, SWM ponds, and outlet channels with clay between 12+700 to 18+050 to prevent infiltration</li> <li>Compensate for impacts by: trucking in water (short-term), connecting to municipal supply (long-term), or deepening well (long-term)</li> </ul> </li> </ul>
<p><b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water</p>	<p><b>Groundwater Use:</b></p> <ul style="list-style-type: none"> <li>Majority of private wells obtain potable water from unconfined glaciolacustrine sand aquifers</li> <li>Some wells obtain potable water from thin, discontinuous sand lenses/ seams within the Newmarket Till</li> <li>71 dug wells (~5 to ~12 m deep), 18 drilled wells (~10 to ~55 m deep), 134 other wells (unknown construction details), 2 commercial wells both located along Highway 2</li> </ul>	<p><b>PRIORITIES FOR DETAILED DESIGN:</b></p> <ul style="list-style-type: none"> <li>The Harmony-Farewell Iroquois Beach Wetland Complex and the Maple Grove Wetland Complex should be instrumented with additional mini-piezometers and monitored for 1 month before construction, during construction and for 1 month following construction for GW water level, surface water flow, and GW discharge</li> <li>Confirm depth of excavation for bridge abutments near Black Creek (EL-17, EL-18, EL-19) so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts and obtain a PTTW</li> <li>Collection of geological and hydrogeological information along the TPR where it crosses the Lake Iroquois Shoreline. The implications of crossing this unit need to be understood</li> <li>Engineering design of permeable sub-base and GW equalization drains for HF-E13, HF-E17, HF-E18, HF-E19, to maintain GW flow in wetland</li> </ul>



## 407 East Extension – Eastern Section

# Summary Table 7 (ELc) – Hydrogeological Conditions and Preliminary Recommendations

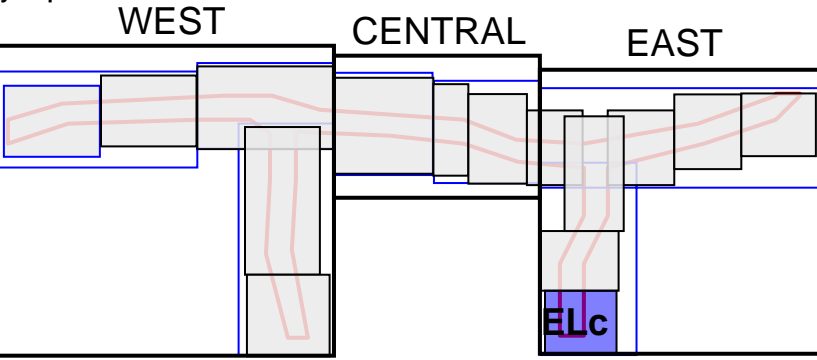
Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: East Link (ELc) Section	POTENTIAL IMPACTS:
		<p><b>0 – 5 m</b></p> <p><b>Unit 1: Fine-textured Glaciolacustrine Sediments</b> (surficial aquitard) – blue on figure 15</p> <ul style="list-style-type: none"> <li>► Silt and clay, massive, well laminated</li> <li>► Derived from glaciolacustrine sedimentation in calm offshore waters of Glacial Lake Iroquois</li> <li>► May contain interbedded fine sand layers</li> <li>► Minor glaciolacustrine silt and sand present at surface</li> </ul>	<p><b>Groundwater Effects on Foundation Design and Construction:</b></p> <ul style="list-style-type: none"> <li>► Thin deposits of glaciolacustrine silts and clays are present over most of this Section <ul style="list-style-type: none"> <li>○ Engineering measures to deal with settlement and frost heave will be required</li> <li>○ From a hydrogeology perspective, deep foundations are desirable to minimize dewatering</li> <li>○ Bedrock is generally within 30 m of surface</li> </ul> </li> <li>► Shallow ground water table (&lt;1 mBGS) may be encountered within till units because the unit is poorly drained</li> <li>► Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term</li> <li>► Flowing artesian conditions encountered in Borehole EL9-1 at Structure EL-9</li> <li>► Significant dewatering is not anticipated at any Structure in this Section</li> </ul>
<p><b>Map:</b> East Link – ELc (see Figure 2 for location)</p> <p><b>Section Boundaries:</b> North of Bloor Street to Highway 401</p> <p><b>Figure(s):</b> Figure 15 and Figure 16 (Section ELc)</p> <p><b>Cross-section(s):</b> West Link: C – C' (Figure 19)</p> <p><b>Proposed Structures:</b> East Link – EL-1, EL-2, EL-3, EL-3, EL-4, EL-5, EL-6, EL-7, EL-8, EL-9</p>		<p><b>0 – 30 m</b></p> <p><b>Unit 2: Newmarket Till</b> (aquitard) – light green on figure 15</p> <ul style="list-style-type: none"> <li>► Silty sand to sandy silt till, with gravel and occasional boulders, very dense</li> <li>► Ranges in thickness from 25 to 35 m</li> <li>► Unit is exposed at ground surface in places</li> <li>► Contains discontinuous sand lenses that are utilized as individual potable water sources</li> <li>► Water table is often close to surface (&lt;1 mBGS) because unit is poorly drained</li> </ul>	<p><b>Surface Water Features:</b></p> <ul style="list-style-type: none"> <li>► Some seepage areas may be present at the contact between the surficial silts and clays and the underlying till</li> <li>► Tooley Creek is present in this Section and construction activities will cross this creek at 3 locations that do not have Structures associated with them: 1 – Tooley Creek at Bloor St, 2 – Tooley Creek at Courtice Rd, 3 – Tooley Creek at Hwy 401 <ul style="list-style-type: none"> <li>○ Additional investigations are required</li> </ul> </li> <li>► Darlington Creek is present in this Section and construction activities will cross this creek at 1 location that does not have a Structure associated with it: 1 – Darlington Creek at Bloor St <ul style="list-style-type: none"> <li>○ Additional investigations are required</li> </ul> </li> </ul>
<p><b>Deep Cuts:</b> None</p> <p><b>High Fills:</b> HF-E16 (9+500 to 10+200) – 9 m fill height (Cross road and ramp)</p> <p><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 14 (Section ELc)</p>		<p><b>&gt;12 m</b></p> <p><b>Unit 3: Bedrock</b> (aquifer) – figure 19</p> <ul style="list-style-type: none"> <li>► Flat-lying Paleozoic (Upper Ordovician) limestone and shale</li> <li>► Lindsay Formation Limestone and Blue Mountain (locally Whitby Formation) Shale</li> <li>► Present at an elevation of ~80 masl dropping down towards Lake Ontario</li> <li>► No outcrops present in study area</li> <li>► Utilized as a source of potable water by deep drilled wells, but is known to contain high concentrations of iron, manganese, iron reducing bacteria, and methane.</li> </ul>	<p><b>Aquifer/Well Vulnerability:</b></p> <ul style="list-style-type: none"> <li>► No impacts to local water wells or aquifer units is anticipated</li> <li>► East Link (ELc) – Highway constructed primarily on low permeability till and glaciolacustrine deposits <ul style="list-style-type: none"> <li>○ Low potential for long-term impact to groundwater quality from de-icing compounds</li> <li>○ SWM ponds will not require lining because low permeability materials present at surface</li> <li>○ No reduction in GW recharge due to the small surface area of the highway</li> </ul> </li> </ul>
<p><b>FIELD DATA SOURCES:</b></p> <p><b>Boreholes:</b> BH1, BH2, BH4, EL01-1, EL02-1, EL02-2, EL02-3, EL02-4, EL03-3, EL03-4, EL04-1, EL04-2, EL05-1, EL05-2, EL05-3, EL05-4, EL06-1, EL06-2, EL07-2, EL08-2, EL09-1, EL09-2</p> <p><b>Monitoring Wells:</b> G4E-1, G4E-2</p> <p><b>Mini-Piezometers:</b> MP28s/d</p> <p><b>Stream Reconnaissance Sites:</b> None (Tooley and Darlington creeks are not crossed)</p> <p><b>Residential Water Wells:</b> 91 private water wells. 26% dug, 11% drilled, 63% unknown. Approximately 14 wells within the TPR boundary (will require decommissioning)</p>		<p><b>GROUNDWATER FLOW:</b></p> <p><b>Distribution &amp; Significance of Recharge/Discharge Areas:</b></p> <ul style="list-style-type: none"> <li>► Shallow groundwater flow directions typically mimic the surface topography. Groundwater flow in the Iroquois Plain Shallow Aquifer is predominantly horizontal, due to low permeability till sediments restricting flow below, and flows to the southeast or southwest towards perennial river valleys of Darlington Creek and its tributaries. Deep groundwater flow within the bedrock aquifer is south towards Lake Ontario.</li> </ul>	<p><b>Opportunities for Avoidance/ Mitigation/ Compensation:</b></p> <ul style="list-style-type: none"> <li>► Structure EL-9 – artesian pressure encountered at depth within a confined sand and gravel aquifer unit <ul style="list-style-type: none"> <li>○ To avoid this aquifer unit, the option for shallow footings should be explored by engineering design teams</li> </ul> </li> <li>► East Link (East Link = ELc) – Low potential for reduction in groundwater quality from road run-off <ul style="list-style-type: none"> <li>○ Collect storm water in SWM ponds with passive treatment and vegetative polishing</li> <li>○ Compensate for any impacts by: trucking in water (short-term) or deepening well (long-term)</li> </ul> </li> </ul>
<p><b>PHYSIOGRAPHIC SETTING:</b></p> <ul style="list-style-type: none"> <li>► Gently sloping southward from the South Slope physiographic region to Lake Ontario is the Iroquois Plain physiographic region (Chapman and Putman, 1984). Offshore deposits of silts and clays characterize the area and overlie the stony, sandy, silty Newmarket Till (formerly called the Bowmanville Till). Below the Newmarket Till, shale and limestone bedrock of the Lindsay formation</li> </ul> <p><b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water</p>		<p><b>Groundwater Use:</b></p> <ul style="list-style-type: none"> <li>► Majority of private wells obtain potable water either from unconfined glaciolacustrine sand aquifers or from sand layers with the Newmarket Till.</li> <li>► 24 dug wells (~5 to ~12 m deep), 10 drilled wells (~10 to ~55 m deep), 57 other wells (unknown construction details). 38 commercial/ industrial wells (numbered as a subset of the number of total wells) are found primarily along Baseline Road between Trulls Road and Rundle Road</li> </ul>	<p><b>PRIORITIES FOR DETAILED DESIGN:</b></p> <ul style="list-style-type: none"> <li>► Site specific investigations at the three Tooley Creek crossings that as of Feb, 2009 do not have structures associated with them (1 – Tooley Creek at Bloor St, 2 – Tooley Creek at Courtice Rd, 3 – Tooley Creek at Hwy 401)</li> <li>► Site specific investigations at the Darlington Creek crossings that as of Feb, 2009 does not have a structure associated with it (1 – Darlington Creek at Bloor St)</li> <li>► Engineering design teams should explore designs for shallow footings at EL-9 to avoid artesian pressure</li> <li>► Confirm highway design for Interchange Ramps connecting Hwy 407 with Hwy 401. New deep cut and high fill locations are anticipated</li> <li>► Engineering measures to deal with settlement and frost heave for construction activities on glaciolacustrine clayey silt will need to be determined</li> </ul>

TABLE 8  
Highway 407 East Extension  
Eastern Section (Sub-section E1a) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
CENTRAL SECTION - Subsection C2a	CM - 28	-	Bridge	Underpass	Concession Rd. 6	P26	Surficial sandy silt glaciolacustrine plain. Surficial silty sand to sandy silt till (Newmarket Till) to 9.8 mBGS.	Cannot confirm groundwater conditions. Depth to water table is expected to be <7.0 mBGS.	Low	No Watercourse (Street Crossing)				100
	CM - 28b	-	Bridge	Underpass	Concession Rd. 6	P26	Surficial sandy silt glaciolacustrine plain. Surficial silty sand to sandy silt till (Newmarket Till) to 9.8 mBGS.	Cannot confirm groundwater conditions. Depth to water table is expected to be <7.0 mBGS.	Low	No Watercourse (Street Crossing)				100
	CM - 29	-	Bridge	Overpass	Enfield Road	CM29-1, CM29-2	Surficial silty clay glaciolacustrine plain to 2.1 mBGS. Surficial silty sand to sandy silt till (Newmarket Till) to at least 20.7 mBGS.	Cannot confirm groundwater conditions. Depth to water table is expected to be <3.0 mBGS.	Low	No Watercourse (Street Crossing)				95
	CM - 29b	-	Bridge	Overpass	Enfield Road	CM29-1, CM29-2	Surficial silty clay glaciolacustrine plain to 2.1 mBGS. Surficial silty sand to sandy silt till (Newmarket Till) to at least 20.7 mBGS.	Cannot confirm groundwater conditions. Depth to water table is expected to be <3.0 mBGS.	Low	No Watercourse (Street Crossing)				95
EASTERN SECTION - Subsection E1a	EM - 1	EM-58	Bridge	Overpass	Farewell Creek	MP21	Surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS). PSW within study area. Upward hydraulic gradient measured in creek indicating groundwater discharge. Stream temperature records suggest year round groundwater inputs.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	Moderately wide, deep valley with locally steep valleysides; potential for undercutting where meandering channel impinges on valleyeside	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	EM-58	Bridge	Overpass	Farewell Creek	MP21	Surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS). PSW within study area. Upward hydraulic gradient measured in creek indicating groundwater discharge. Stream temperature records suggest year round groundwater inputs.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	Moderately wide, deep valley with locally steep valleysides; potential for undercutting where meandering channel impinges on valleyeside	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.	EM03-1, EM03-2, EM03-3, P29	Surficial silty sand to sand glaciolacustrine aquifer deposits to a depth of 8.5 mBGS. Underlain by sandy silt till (Newmarket Till) aquitard.	Water table at ~4.6 mBGS and surficial sand aquifer. Deep cut at this location is 5 m below OG and therefore, the water table after excavations will be <1.0 mBGS. Dewatering will be required for excavations below the water table for foundations	High	No Watercourse (Street Crossing)				70

TABLE 9  
Highway 407 East Extension  
Eastern Section (Sub-section E1b) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS						
EASTERN SECTION - Subsection E1b	EM - 4	EM-59	Bridge	Overpass	Black Creek	EM04-1, EM04-2, EM05-1, EM05-2, MP39s/d, MP40	Surficial silty sand aquifer with alluvial materials (sand and gravel) in river valley to a depth of 8.5 mBGS. Underlain by sandy silt till (Newmarket Till) aquitard. Downwards hydraulic gradient measured in creek and small wetland area, indicating groundwater recharge.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	10-20	60
	EM - 5	EM-59	Bridge	Overpass	Black Creek	EM04-1, EM04-2, EM05-1, EM05-2, MP39s/d, MP40	Surficial silty sand aquifer with alluvial materials (sand and gravel) in river valley to a depth of 8.5 mBGS. Underlain by sandy silt till (Newmarket Till) aquitard. Downwards hydraulic gradient measured in creek and small wetland area, indicating groundwater recharge.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	10-20	60
	EM - 6	-	Bridge	Flyover	Holt Rd.	EM06-1, P30	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Depth to water table estimated to be <6.0 mBGS.	Low	No Watercourse (Street Crossing)				70
	EM - 7	EM-60	Culvert	Overpass	Drainage Swale	EM06-1, P30	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Depth to water table estimated to be <6.0 mBGS.	Low	Closed Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	70
	EM - 8	EM-61	Bridge	Overpass	West Bowmanville Creek	EM08-2, MP29	Surficial aquifer consisting of alluvial sand and gravel to a depth of 2.1 m. Underlain by soft to stiff, silty clay deposits (lacustrine) to depth of 19.2 mBGS. Below, a gravel aquifer deposit was encountered to a depth of 20.4 mBGS. The gravel aquifer exhibited flowing artesian groundwater conditions. The water level was estimated to be >1.0 m above ground surface. The shallow water table is estimated to be <1.0 mBGS.	Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. The shallow water table is estimated to be <1.0 mBGS. Groundwater seepage was observed along the west valley slope. Artesian pressure at a depth of 19.2 mBGS is anticipated within the West Bowmanville Creek valley. Many private wells in the area encountered artesian conditions at depth >15.0 mBGS.	High	Span Bridge	Wide, shallow valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valleyside 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	EM-61	Bridge	Overpass	West Bowmanville Creek	EM08-2, MP29	Surficial aquifer consisting of alluvial sand and gravel to a depth of 2.1 m. Underlain by soft to stiff, silty clay deposits (lacustrine) to depth of 19.2 mBGS. Below, a gravel aquifer deposit was encountered to a depth of 20.4 mBGS. The gravel aquifer exhibited flowing artesian groundwater conditions. The water level was estimated to be >1.0 m above ground surface. The shallow water table is estimated to be <1.0 mBGS.	Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. The shallow water table is estimated to be <1.0 mBGS. Groundwater seepage was observed along the west valley slope. Artesian pressure at a depth of 19.2 mBGS is anticipated within the West Bowmanville Creek valley. Many private wells in the area encountered artesian conditions at depth >15.0 mBGS.	High	Span Bridge	Wide, shallow valley (old glacial meltwater spillway and early post-glacial river valley) with no geomorphic evidence of significant valleyside 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.	G5E-1, G5E-2, EM10-1, EM10-2, EM10-3, P31	Thin veneer of glaciolacustrine silty sand, underlain by clayey silt to a depth of 6.1 mBGS. Sand seems were encountered at 2.3 and 2.9 mBGS. A sand deposit was encountered between 6.1 and 8.8 mBGS, which is underlain by silty clay to a depth of 12.7 mBGS. The water level at G5E is <1.0 mBGS and G5E-2 is often flowing artesian.	Water table is at or above ground surface (0.0 mBGS) and sand seems encountered at 2.3 and 2.9 mBGS exhibit flowing artesian conditions suggesting that they are continuous laterally. Potential for dewatering if excavating for foundations. Many private wells in the area encountered artesian conditions at depth >15.0 mBGS.	High	No Watercourse (Street Crossing)		Early post-glacial alluvium dominantly gravelly sand, with localized silt layers		50
	EM - 11	EM-62	Culvert	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Surficial silty clay (lacustrine) to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for shallow dewatering if surficial sand deposits are encountered.	Medium	Open Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	55
	EM - 12	-	Culvert	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Surficial silty clay (lacustrine) to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for shallow dewatering if surficial sand deposits are encountered.	Medium	Open Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
	EM - 13	EM-63	Culvert	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Assumed alluvial sediments in river valley. Silty clay (lacustrine) deposits to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for dewatering if excavating in alluvial sediments in valley.	High	Open Bottom Culvert	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	10-20	55
	EM - 14	EM-63	Culvert	Overpass	Bowmanville Creek tributary	MP30 (EM15-1, P32)	Assumed alluvial sediments in river valley. Silty clay (lacustrine) deposits to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for dewatering if excavating in alluvial sediments in valley.	High	Open Bottom Culvert	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	10-20	50
	EM - 15	-	Bridge	Flyover	Regional Road 57	EM15-1, P32	Surficial silty clay (lacustrine) to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for shallow dewatering if surficial sand deposits are encountered.	Medium	No Watercourse (Street Crossing)				50
	EM - 16	EM-63	Bridge	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Assumed alluvial sediments in river valley. Silty clay (lacustrine) deposits to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for dewatering if excavating in alluvial sediments in valley.	High	Open Bottom Culvert	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	10-20	50
	EM - 17	EM-64	Culvert	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Surficial silty clay (lacustrine) to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for shallow dewatering if surficial sand deposits are encountered.	Medium	Open Bottom Culvert	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	10-20	50
	EM - 18	EM-65	Culvert	Overpass	Bowmanville Creek tributary	None (EM15-1, P32)	Assumed alluvial sediments in river valley. Silty clay (lacustrine) deposits to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Potential for dewatering if excavating in alluvial sediments in valley.	Medium	Open Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
	EM - 19	EM-67	Bridge	Overpass	Bowmanville Creek tributary	MP31	Assumed alluvial sediments in river valley. Silty clay (lacustrine) deposits to a depth of 13.1 mBGS underlain by clayey silt to sandy silt till (Newmarket Till) to a depth 22.9 mBGS. GWT near surface in river valley. Upward hydraulic gradient measured in creek indicating groundwater discharge.	Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside 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

TABLE 9  
Highway 407 East Extension  
Eastern Section (Sub-section E1b) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EASTERN SECTION - Subsection E1b	EM - 20	EM-68	Culvert	Overpass	Bowmanville Creek tributary	None	Silty sand to silty clay with organics at surface, to a depth of 2.2 mBGS. Silty sand till (Newmarket Till) aquitard encountered below to a depth of 21.4 mBGS. GWT near surface in river valley.	Mapping indicates intermittent watercourse. Construction activities should take place when the stream bed is dry. Depth to water table estimated to be <3.0 mBGS. Potential to encounter flowing artesian conditions at depth.	Medium	Span Bridge	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	60
	EM - 21	-	-	Cul de Sac	Middle Rd.	G6E-1, G6E-2, EM21-1, P33, MP37	Silty sand to silty clay with organics at surface, to a depth of 2.2 mBGS. Silty sand till (Newmarket Till) aquitard encountered below to a depth of 7.6 mBGS. Clayey silt was found below to a depth of 10.9 mBGS. G6E-1 encountered flowing artesian groundwater conditions at 10.9 mBGS in a sand unit. Domestic wells in the area between 10 and 24 m deep, are commonly artesian. Downwards hydraulic gradient measured at stream indicating groundwater recharge in the shallow subsurface.	Potential for dewatering if excavating alluvial sediments in valley. Shallow GWT at G6E (1.65 mBGS). Artesian pressure at a depth of 10.9 mBGS is anticipated within the East Bowmanville Creek valley.	High	No Watercourse (Street Crossing)				60
	EM - 22	EM-69	Bridge	Overpass	East Bowmanville Creek	G6E-1, G6E-2, MP37	Silty sand to silty clay with organics at surface, to a depth of 2.2 mBGS. Silty sand till (Newmarket Till) aquitard encountered below to a depth of 7.6 mBGS. Clayey silt was found below to a depth of 10.9 mBGS. G6E-1 encountered flowing artesian groundwater conditions at 10.9 mBGS in a sand unit. Domestic wells in the area between 10 and 24 m deep, are commonly artesian. Downwards hydraulic gradient measured at stream indicating groundwater recharge in the shallow subsurface.	Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. Shallow GWT at G6E (1.65 mBGS). Artesian pressure at a depth of 10.9 mBGS is anticipated within the East Bowmanville Creek valley.	High	Span Bridge	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside instability	Valley bottom sediments >0.5 m deep and dominantly silty gravelly sand alluvium, overlying glaciolacustrine sandy silt	20-50	60
	EM - 23	EM-69	Bridge	Overpass	East Bowmanville Creek	G6E-1, G6E-2, MP37	Silty sand to silty clay with organics at surface, to a depth of 2.2 mBGS. Silty sand till (Newmarket Till) aquitard encountered below to a depth of 7.6 mBGS. Clayey silt was found below to a depth of 10.9 mBGS. G6E-1 encountered flowing artesian groundwater conditions at 10.9 mBGS in a sand unit. Domestic wells in the area between 10 and 24 m deep, are commonly artesian. Downwards hydraulic gradient measured at stream indicating groundwater recharge in the shallow subsurface.	Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. Shallow GWT at G6E (1.65 mBGS). Artesian pressure at a depth of 10.9 mBGS is anticipated within the East Bowmanville Creek valley.	High	Span Bridge	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside 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.	EM24-1, P34	Surficial silty sand to silty clay till (Newmarket Till) aquitard to a depth of 12.2 mBGS. Sand aquifer units present between 12.2 and 18.6 mBGS. GWT expected to be <3.0 mBGS.	Water table perched on till unit. Depth to water table is anticipated to be <3.0 mBGS. Surficial geology indicates silty sand deposits at surface, although were not encountered in borehole. If these units are encountered, shallow dewatering may be required.	Low	No Watercourse (Street Crossing)				70



TABLE 10  
Highway 407 East Extension  
Eastern Section (Sub-section E1c) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EASTERN SECTION - Subsection E1c	EM - 25	EM-70	Culvert	Overpass	Mackie Creek tributary	EM24-1, P34	Surficial silty sand to silty clay till (Newmarket Till) aquitard to a depth of 12.2 mBGS. Sand aquifer units present between 12.2 and 18.6 mBGS. GWT expected to be <3.0 mBGS.	Water table perched on till unit. Depth to water table is anticipated to be <3.0 mBGS. Surficial geology indicates silty sand deposits at surface, although were not encountered in borehole. If these units are encountered, shallow dewatering may be required. Culvert installation should occur when stream bed is dry	Low	Closed Bottom Culvert	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	EM-71	Bridge	Overpass	Mackie Creek tributary	None	Anticipate to encounter surficial silty sand to silty clay till (Newmarket Till) aquitard to a depth of 12.2 mBGS. A surficial silty sand aquifer unit may be present at surface as indicated in the surficial geology mapping.	Water table perched on till unit. Depth to water table is anticipated to be <3.0 mBGS. Culvert installation should occur when stream bed is dry	Medium	Span Bridge	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	EM-72	Bridge	Overpass	WB freeway bridge over Mackie Creek	None	Anticipate to encounter surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS). Stream reconnaissance work shows an increase in flow between upstream and downstream of the ROW, suggesting groundwater inputs.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	EM-72	Bridge	Overpass	EB freeway bridge over Mackie Creek	None	Anticipate to encounter surficial silt till with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS). Stream reconnaissance work shows an increase in flow between upstream and downstream of the ROW, suggesting groundwater inputs.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	EM-73	Culvert	Overpass	Drainage Swale	None	Anticipate to encounter surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Culvert	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	EM30-1, P35	Surficial geology shows area of Glacial Lake Iroquois Shoreline sand and gravel deposits present at surface. Borehole drilling encountered silty sand till (Newmarket Till) to a depth of 7.0 mBGS. A sand and gravel aquifer unit underlie the till. GWT at 2.1 mbgs and perched on till.	Low potential to encounter shallow Lake Iroquois sand and gravel sediments. Any excavations within these sediments would require dewatering and potentially a PTTW. Depth to water table is likely <3.0 mBGS. Watercourse perched on till.	Low	No Watercourse (Street Crossing)				50
	EM - 31	EM-74	Culvert	Overpass	Mackie Creek tributary	None	Anticipate to encounter surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Culvert	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	EM-75	Bridge	Overpass	WB freeway bridge over Soper Creek	G7E-1, G7E-2, P36	Surficial sandy silt with silty sand organic alluvial plain in river valley. Upland areas around valley are underlain by clayey silt till (Halton Till) and sandy silt till (Newmarket Till) to a depth of 10.7 mBGS. Below lacustrine silt was encountered to a depth of 14.3 mBGS. Water table is found at 8.5 mBGS outside the valley. Water table near surface in valley (<1.0 mBGS) with an upward hydraulic gradient measured in the stream indicating groundwater discharge.	Significant groundwater discharge noted at this stream crossing and springs along the western valley slopes. Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	EM-75	Bridge	Overpass	EB freeway bridge over Soper Creek	G7E-1, G7E-2, P36	Surficial sandy silt with silty sand organic alluvial plain in river valley. Upland areas around valley are underlain by clayey silt till (Halton Till) and sandy silt till (Newmarket Till) to a depth of 10.7 mBGS. Below lacustrine silt was encountered to a depth of 14.3 mBGS. Water table is found at 8.5 mBGS outside the valley. Water table near surface in valley (<1.0 mBGS) with an upward hydraulic gradient measured in the stream indicating groundwater discharge.	Significant groundwater discharge noted at this stream crossing and springs along the western valley slopes. Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	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	EM-77	Culvert	Overpass	Drainage Swale	None	Anticipate to encounter surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Culvert	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

Site ranking for Hydrogeology: Low/Medium/High risk -in terms of sensitivity of the environment to construction, e.g. High risk - highly sensitive environment.

TABLE 11  
Highway 407 East Extension  
Eastern Section (Sub-section E1d) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EASTERN SECTION - Subsection E1d	EM - 35	-	-	Cul de Sac	Brown Rd.	EM35-1, EM35-2	Surficial silty sand aquifer (glaciolacustrine) with some sand and gravel to a depth of 9.4 mBGS. Water table at 6.1 mBGS. Potential to encounter ORM aquifer deposits at depth.	Depth to water table is 6.1 mBGS. Potential for dewatering if excavating below the water table. A PTTW will be required.	Medium	No Watercourse (Street Crossing)				80
	EM - 36	EM-78	Bridge	Overpass	WB freeway bridge over Wilmot Creek tributary	MP33 (EM35-1, EM35-2)	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Upward gradient measured at stream indicating groundwater discharge. Potential to encounter ORM aquifer deposits at depth.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	Narrow, moderately deep valley; potential for undercutting of relatively steep valleysides 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	EM-78	Bridge	Overpass	EB freeway bridge over Wilmot Creek tributary	MP33 (EM35-1, EM35-2)	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Upward gradient measured at stream indicating groundwater discharge. Potential to encounter ORM aquifer deposits at depth.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	High	Span Bridge	Narrow, moderately deep valley; potential for undercutting of relatively steep valleysides 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	EM-79	Bridge	Overpass	WB freeway bridge over Wilmot Creek	G8E-1, G8E-2	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Upward gradient measured at stream indicating groundwater discharge. Potential to encounter ORM aquifer deposits at depth.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. Spring seepage on lower east valleyside, at toe of terrace scarps	High	Span Bridge	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	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	EM-79	Bridge	Overpass	EB freeway bridge over Wilmot Creek	G8E-1, G8E-2	Surficial sandy silt with silty sand alluvial plain in river valley. GWT near surface in river valley. Upward gradient measured at stream indicating groundwater discharge. Potential to encounter ORM aquifer deposits at depth.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering. Spring seepage on lower east valleyside, at toe of terrace scarps	High	Span Bridge	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	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.	G8E-1, G8E-2, EM40-1P38, MP34s/d	Surficial silt deposit to a depth of 3.1 mBGS, underlain by sand and gravel to a depth of 6.8 mBGS. Silty sand till (Newmarket Till) is encountered at 6.8m. GWT ranges between 4.5 and 6.8 mbgs. Hydraulic gradients measured in monitors suggest a downwards gradient indicating that groundwater recharge is occurring in upland areas.	Surficial silt and sand and gravel aquifer units. Dewatering is anticipated for excavations below the water table at 4.5 mBGS. Potential to require a PTTW.	Low	No Watercourse (Street Crossing)	Steep valleyside comprising fine sand susceptible to ravelling if cut too steep			85
	EM - 41	EM-80	Culvert	Overpass	Wilmot Creek tributary	None	Anticipate to encounter surficial silt till (Halton Till) with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS).	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. Potential to require a PTTW.	Low	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	105
	EM - 42	EM-81	Culvert	Overpass	Wilmot Creek tributary	None	Anticipate to encounter surficial silt till (Halton Till) with silty sand/organic alluvial plain in the river valley. GWT near surface (<1.0 mBGS).	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. Potential to require a PTTW.	Low	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	105
	EM - 43	EM-82	Culvert	Overpass	Orono Creek	None	Anticipate to encounter surficial silt and clay deposits (lacustrine). Sandy aquifer materials may be confined beneath the surficial clay. Significant groundwater discharge occurs at the head waters of the Orono Creek tributary approximately 200 m south of the TPR. Water table likely >5.0 mBGS due to drainage by the aquifer below.	Water table likely >2.5 mBGS due to drainage by the aquifer below. Dewatering may be required if underlying sandy aquifer materials are encountered if excavating for foundations. Potential to impact groundwater discharge downstream of the TPR.	High	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	110
	EM - 44	EM-83	Culvert	Overpass	Orono Creek	None	Anticipate to encounter surficial silt and clay deposits (lacustrine). Sandy aquifer materials may be confined beneath the surficial clay. Significant groundwater discharge occurs at the head waters of the Orono Creek tributary approximately 200 m south of the TPR. Water table likely >5.0 mBGS due to drainage by the aquifer below.	Water table likely >2.5 mBGS due to drainage by the aquifer below. Dewatering may be required if underlying sandy aquifer materials are encountered if excavating for foundations. Potential to impact groundwater discharge downstream of the TPR.	High	Closed Bottom Culvert	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	<10	110
	EM - 45	EM-84	Culvert	Overpass	Orono Creek tributary	None	Surficial silt till (Halton Till). GWT near surface in river valley and is likely perched within low permeability till.	Nil	Low	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside 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)	None	Surficial silt till (Halton Till). GWT is likely perched within low permeability till.	Nil	Low	No Watercourse (Street Crossing)				130
	EM - 47	-	Bridge	Overpass - Ramp	407/Hwy 35/115 S-W Ramp (south connection)	None	Surficial silt till (Halton Till). GWT is likely perched within low permeability till.	Nil	Low	No Watercourse (Street Crossing)				130
	EM - 48	EM-85	Culvert	Cancelled	Orono Creek tributary	None	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.	Depth to water table is likely <1.0 mBGS in river valley. Culvert installation should occur when stream bed is dry.	Medium	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	125

TABLE 12  
Highway 407 East Extension  
Eastern Link Section (Sub-section ELA) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EAST LINK SECTION - Subsection ELA	EL - 23	EL-89	Bridge	Overpass	SB freeway bridge over Black Creek tributary	G10E-1, G10E-2, EL23-4, EL24-4, MP25s/d, MP41s/d	Surficial silty sand aquifer (glaciolacustrine) to a depth of 8.2 mBGS. Below, silty sand till (Newmarket Till) is encountered to a depth of 13.0 mBGS. Water table at <2.0 mBGS. Upwards hydraulic gradient measured indicating groundwater discharge.	Shallow water table (<2.0 mBGS) within high permeability materials. Surficial aquifer will require dewatering if excavating for foundations. A PTTW will be required. A PSW is present near this structure.	High	Span Bridge	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	EL-89	Bridge	Overpass	NB freeway bridge over Black Creek tributary	G10E-1, G10E-2, EL23-4, EL24-4, MP25s/d, MP41s/d	Surficial silty sand aquifer (glaciolacustrine) to a depth of 8.2 mBGS. Below, silty sand till (Newmarket Till) is encountered to a depth of 13.0 mBGS. Water table at <2.0 mBGS. Upwards hydraulic gradient measured indicating groundwater discharge.	Shallow water table (<2.0 mBGS) within high permeability materials. Surficial aquifer will require dewatering if excavating for foundations. A PTTW will be required. A PSW is present near this structure.	High	Span Bridge	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	EL-88	Bridge	Overpass	Black Creek	MP23	Surficial sandy silt with silty sand alluvial sediments in river valley. Upwards hydraulic gradient measured in Black Creek to the east, indicating groundwater discharge. Water table is estimated to be <2.0 mBGS.	Shallow water table (<2.0 mBGS). Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Medium	Open Bottom Culvert	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	Overpass	Drainage Swale	None	Surficial silty sand till (Newmarket Till) aquitard to a depth of 33.6 mBGS. Water table at <2.0 mBGS.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Low	Closed Bottom Culvert	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	EL27-1, EL27-2, EL27-3, MP22	Surficial silty sand till (Newmarket Till) aquitard to a depth of 33.6 mBGS. Water table at <2.0 mBGS.	Shallow water table (<2.0 mBGS) perched on till materials.	Low	No Watercourse (Street Crossing)				60
	EL - 28	-	Culvert	Overpass	Drainage Swale	EL27-1, EL27-2, EL27-3, MP22	Surficial silty sand till (Newmarket Till) aquitard to a depth of 33.6 mBGS. Water table at <2.0 mBGS.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Low	Closed Bottom Culvert	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	Overpass	Drainage Swale	EL27-1, EL27-2, EL27-3, MP22	Surficial silty sand till (Newmarket Till) aquitard to a depth of 33.6 mBGS. Water table at <2.0 mBGS.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Low	Closed Bottom Culvert	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	None	Surficial silty sand till (Newmarket Till) aquitard to a depth of 33.6 mBGS. Water table at <2.0 mBGS.	Shallow water table (<2.0 mBGS) perched on till materials.	Low	No Watercourse (Street Crossing)				65
	EL - 31	-	Bridge	Overpass - Ramp	East Link/407 W-S Ramp	None	Surficial silty sand aquifer with alluvial materials (sand and gravel) in river valley to a depth of 8.5 mBGS. Underlain by sandy silt till (Newmarket Till) aquitard. Downwards hydraulic gradient measured in creek and small wetland area, indicating groundwater recharge.	Shallow water table (<1.0 mBGS) and surficial sand aquifer. Dewatering will be required if excavating in alluvial sediments for foundations. PTTW will be required for dewatering.	Medium	No Watercourse (Street Crossing)				65
	EL - 32	-	Bridge	Overpass - Ramp	East Link/407 S-W Ramp	None	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Depth to water table estimated to be <6.0 mBGS.	Low	No Watercourse (Street Crossing)				65
	EL - 33	-	Bridge	Overpass - Ramp	East Link/407 E-S Ramp	None	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Depth to water table estimated to be <6.0 mBGS.	Low	No Watercourse (Street Crossing)				70
	EL - 34	EM-60	Culvert	Overpass	Drainage Swale	None	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Low	Closed Bottom Culvert	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	EM-60	Culvert	Overpass	Drainage Swale	None	Surficial sandy silt till (Newmarket Till) aquitard to a depth of 15.5 mBGS.	Mapping indicates intermittent watercourse. Culvert installation should occur when the stream bed is dry.	Low	Closed Bottom Culvert	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

TABLE 13  
Highway 407 East Extension  
Eastern Link Section (Sub-section ELb) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EAST LINK SECTION - Subsection ELb	EL - 10	EL-95	Culvert	Overpass	Tooley Creek tributary	None	Surficial sand with silty sand alluvial plain, underlain by silty sand till to a depth of 4.1 mBGS. Fine to medium sand is encountered below to a depth of 8.5 mBGS. Water table at <1.0 mBGS.	Shallow water table (<1.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering.	Medium	Closed Bottom Culvert	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	<10	50
	EL - 11	EL-94	Culvert	Overpass	Tooley Creek tributary	None (G3E-1, G3E-2, EL12-1, EL12-2, EL12-3, BH6)	Surficial sand and silty sand aquifer (glaciolacustrine) to a depth of 3.1 mBGS. This is underlain by clay and silt (glaciolacustrine) to a depth of 12.2 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.2 mBGS. Water table depth ranges from 0.3 to 2.0 mBGS. Groundwater monitors and minipiezometers show a downwards hydraulic gradient indicating a recharge area	Shallow water table (<2.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering.	Medium	Closed Bottom Culvert	Narrow, shallow swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
	EL - 12	-	Bridge	Underpass	Highway 2	G3E-1, G3E-2, EL12-1, EL12-2, EL12-3, BH6	Surficial sand and silty sand aquifer (glaciolacustrine) to a depth of 3.1 mBGS. This is underlain by clay and silt (glaciolacustrine) to a depth of 12.2 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.2 mBGS. Water table depth ranges from 0.3 to 2.0 mBGS. PSW near structure. Groundwater monitors and minipiezometers show a downwards hydraulic gradient indicating a recharge area	Shallow water table (<2.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering. PSW present near structure.	High	No Watercourse (Street Crossing)				50
	EL - 13	EL-93	Culvert	Overpass	Tooley Creek	G3E-1, G3E-2, MP45	Surficial sand and silty sand aquifer (glaciolacustrine) to a depth of 3.1 mBGS. This is underlain by clay and silt (glaciolacustrine) to a depth of 12.2 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.2 mBGS. Water table depth ranges from 0.3 to 2.0 mBGS. PSW near structure. Groundwater monitors and minipiezometers show a downwards hydraulic gradient indicating a recharge area	Shallow water table (<2.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering. PSW present near structure.	High	Closed Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
	EL - 14	-	Bridge	Overpass	SB freeway bridge	G3E-1, G3E-2, MP44s/d	Surficial sand and silty sand aquifer (glaciolacustrine) to a depth of 3.1 mBGS. This is underlain by clay and silt (glaciolacustrine) to a depth of 12.2 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.2 mBGS. Water table depth ranges from 0.3 to 2.0 mBGS. PSW near structure. Groundwater monitors and minipiezometers show an upwards hydraulic gradient indicating a discharge area	Shallow water table (<2.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering. PSW present near structure.	High	Span Bridge	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 - 15	-	Bridge	Overpass	NB freeway bridge	G3E-1, G3E-2, MP44s/d	Surficial sand and silty sand aquifer (glaciolacustrine) to a depth of 3.1 mBGS. This is underlain by clay and silt (glaciolacustrine) to a depth of 12.2 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.2 mBGS. Water table depth ranges from 0.3 to 2.0 mBGS. PSW near structure. Groundwater monitors and minipiezometers show an upwards hydraulic gradient indicating a discharge area	Shallow water table (<2.0 mBGS) perched on low permeability materials. Thin surficial aquifer may require shallow dewatering. PSW present near structure.	High	Span Bridge	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 - 16	-	Bridge	Cancelled	Solina Rd.	None	Not clear what feature this structure refers to	Not clear what feature this structure refers to	Unknown	No Watercourse (Street Crossing)	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	EL-92	Bridge	Overpass	Nash Rd.	EL17-1, EL17-2, EL17-3, BH7, MP26	Surficial clay and silt (glaciolacustrine) aquitard to a depth of between 5.5 and 11.0 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.4mBGS. Water table depth <1.0 mBGS. PSW near structure. Minipiezometer data suggests a downwards gradient, but many groundwater discharge indicators are present in the area (water cress, seeps, etc.). A small dam downstream may have created an artificial pool and created an isolated area recharge within a larger discharge area	Shallow water table (<1.0 mBGS) perched on low permeability materials. Surficial aquifer will require dewatering and a PTTW. PSW present near structure. Removal of the downstream dam may promote additional groundwater discharge into Black Creek.	High	Span Bridge				50

TABLE 13  
Highway 407 East Extension  
Eastern Link Section (Sub-section ELb) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EAST LINK SECTION - Subsection ELb	EL - 18	EL-92	Bridge	Overpass	SB freeway bridge	EL17-1, EL17-2, EL17-3, BH7, MP26	Surficial clay and silt (glaciolacustrine) aquitard to a depth of between 5.5 and 11.0 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.4mBGS. Water table depth <1.0 mBGS. PSW near structure. Minipiezometer data suggests a downwards gradient, but many groundwater discharge indicators are present in the area (water cress, seeps, etc.). A small dam downstream may have created an artificial pool and created an isolated area recharge within a larger discharge area.	Shallow water table (<1.0 mBGS) perched on low permeability materials. Surficial aquifer will require dewatering and a PTTW. PSW present near structure. Removal of the downstream dam may promote additional groundwater discharge into Black Creek.	High	Span Bridge	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside 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	EL-92	Bridge	Overpass	NB freeway bridge	EL17-1, EL17-2, EL17-3, BH7, MP26	Surficial clay and silt (glaciolacustrine) aquitard to a depth of between 5.5 and 11.0 mBGS. Below, silty sand till (Newmarket Till) aquitard is present to a depth of 15.4mBGS. Water table depth <1.0 mBGS. PSW near structure. Minipiezometer data suggests a downwards gradient, but many groundwater discharge indicators are present in the area (water cress, seeps, etc.). A small dam downstream may have created an artificial pool and created an isolated area recharge within a larger discharge area.	Shallow water table (<1.0 mBGS) perched on low permeability materials. Surficial aquifer will require dewatering and a PTTW. PSW present near structure. Removal of the downstream dam may promote additional groundwater discharge into Black Creek.	High	Span Bridge	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside 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	Overpass	Drainage Swale	EL17-1, EL17-2, EL17-3, BH7, MP26	Fill unit shown on Provincial surficial geology map is not present. Area is underlain by silt, sand and gravel. At EL-20, surficial sandy silt (glaciolacustrine) is present to a depth of 2.1 mBGS. Below, silty clay aquitard materials (glaciolacustrine) are present to a depth of between 5.5 and 11.0 mBGS. Below this, silty sand till (Newmarket Till) aquitard is present to a depth of 15.4mBGS. Water table depth <1.0 mBGS. PSW near structure.	Depth to water table is likely <1.0 mBGS. Watercourse is intermittent. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Culvert	Narrow, shallow, channelized swale with no geomorphic evidence of significant valleyside instability	Likely no appreciable alluvial deposits, based on field checks of similar swales	<10	50
	EL - 21	-	Bridge	Cancelled	Black Creek	None	Not clear what feature this structure refers to	Not clear what feature this structure refers to	Medium	No Structure Required with TPR Route	Moderately wide, shallow valley with no geomorphic evidence of significant valleyside 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	Underpass	Solina Rd.	G2E-1, G2E-2, G11E-1, G11E-2, EL22-1, EL22-2	Surficial silty sand and sand and gravel aquifer at surface, with till encountered at 10.0 mBGS. Surficial aquifer is Glacial Lake Iroquois Shore sediments. Water table at 1.2 mbgs. Downward hydraulic gradient measured between shallow and deep boreholes, indicating groundwater recharge.	Shallow water table (1.2 mBGS) within high permeability materials. Surficial aquifer will require dewatering if excavating for foundations. A PTTW will be required. A PSW is present near this structure.	High	No Watercourse (Street Crossing)				55

TABLE 14  
Highway 407 East Extension  
Eastern Link Section (Sub-section ELC) - Foundations Risk Assessment Hydrogeology Table

SECTION	Structures		Type	Category	Name	Data Source(s) at Structure	Groundwater Comments		SITE RANKING	Recommended Watercourse Crossing	Valley Geomorphology	Valley Sediments & Wetlands	Approx. Meander Belt Width (m)	Approx. Overburden Thickness (m), based on interpolation from geotechnical borehole and water well records
	ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
EAST LINK SECTION - Subsection ELC	EL - 1	-	Bridge	Overpass - Ramp	401/Courtice Rd. E- N/S Ramp	EL01-1, BH1, BH2	Surficial clayey silt (glaciolacustrine) to a depth of 1.4 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 13.8 mBGS. Water table at <1.0 mBGS.	Shallow water table (<1.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				30
	EL - 2	-	Bridge	Overpass - Ramp	401/Courtice N/S-E & Holt Rd. W-N/S Ramps	EL02-1, EL02-2, EL02-3, EL02-4	Surficial clayey silt (glaciolacustrine) to a depth of 1.2 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 7.8 mBGS. Water table at 2.1 mBGS.	Shallow water table (2.1 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				35
	EL - 3	-	Bridge	Overpass	East Link/401 N-W Ramp	EL03-3, EL03-4	Surficial sandy fill to a depth of 2.0 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 6.3 mBGS. Water table at <4.0 mBGS.	Shallow water table (<4.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				35
	EL - 4	-	Bridge	Overpass	East Link/401 W-N Ramp	EL04-1, EL04-2	Surficial clayey silt (glaciolacustrine) to a depth of 2.2 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 8.0 mBGS. Water table at <4.0mBGS.	Shallow water table (<4.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				35
	EL - 5	-	Bridge	Overpass	East Link/401 N-E Ramp	EL05-1, EL05-2, EL05-3, EL05-4	Surficial sandy silt (glaciolacustrine) to a depth of 1.4 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 7.7 mBGS. Water table at 1.4 mBGS.	Shallow water table (1.4 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				35
	EL - 6	-	Bridge	Overpass	East Link/401 E-N Ramp	EL06-1, EL06-2	Surficial silty clay (glaciolacustrine) to a depth of 1.4 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 13.8 mBGS. Water table at <4.0 mBGS.	Shallow water table (<4.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				35
	EL - 7	-	Bridge	Underpass/O verpass	Baseline Rd. - West Side (over/under?)	EL07-2	Surficial sandy silt (glaciolacustrine) to a depth of 0.7 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 6.4 mBGS. Water table at <1.0 mBGS.	Shallow water table (<1.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				40
	EL - 8	-	Bridge	Underpass/O verpass	Baseline Rd. - East Side (over/under?)	EL08-2	Surficial sandy silt (glaciolacustrine) to a depth of 0.7 mBGS, underlain by sand and silt till (Newmarket Till) to a depth of 7.0mBGS. Water table at <1.0 mBGS.	Shallow water table (<1.0 mBGS) perched in low permeability materials.	Low	No Watercourse (Street Crossing)				40
	EL - 9	-	Bridge	Overpass	Bloor St.	G4E-1, G4E-2, EL09-1, BH4, MP28s/d	Surficial silty sand till (Newmarket Till) aquitard to a depth of 11.3 mBGS. Gravelly sand unit from 11.4 to 12.1 in G4E. Sand unit encountered between 9.0 and 12.0 mBGS in EL09-1.	Water table ranges between -0.3 and 1.0 mBGS. Shallow water table and weak flowing artesian conditions. Gravelly sand unit at 11.4 m is confined.	Medium	No Watercourse (Street Crossing)				45

AECOM Name	Location	Chainage	Maximum Depth of Cut	Data Sources	Geology	Depth to Groundwater	Estimated Maximum Drawdown (m)	Estimated Hydraulic Conductivity K (m/s)	Estimated Radius of Influence (m)	Potentially Affected Private Wells	Proposed Mitigation/ Compensation Measures	Comments
DC-E1	Solina Road	12+175 to 12+850	5 m	EM03-1, EM03-2, EM03-3, P29	Surficial glaciolacustrine silt and sand to a depth of ~7.5 mBGS. Underlain by silty sand till (Newmarket Till)	1.0 m	4.0 m	1.0E-05	300 m	Two (2) shallow, dug wells anticipated to be affected by cut. Many others in the area, but will be decommissioned as part of highway construction.	Two (2) wells require monitoring prior to, during and following excavations for both water quality and quantity. Raising highway grade would reduce the estimated radius of drawdown.	Site specific data is required to confirm analysis. Potential to impact groundwater discharge into Black Creek and Farewell Creek. Monitoring of the watercourses will be required.
DC-E2	Holt Road	14+050 to 14+650	9 m	EM06-1, P30	Newmarket Till Aquitard -sandy silt till	6.0 m	3.0 m	1.0E-07	25 m	No wells are anticipated to be affected by deep cut	None	Site specific data is required to confirm analysis. Estimation does not account for potential sand lenses/ seems. Encountering these features will significantly increase the radius of influence.
DC-E3	East of Middle Road to Liberty Road	17+875 to 18+425	7.5 m	EM24-1, P34	Surficial glaciolacustrine silt and sand to an estimated depth of 1.5 mBGS. Underlain by clayey silt till (Halton Till) to an estimated depth of 6.5 mBGS. Silty sand till (Newmarket Till) is present below. Potential to encounter ORM aquifer units between the Halton and Newmarket till units.	<2.0 m	6.5 m	1.0E-07	~50 m	No wells are anticipated to be affected by deep cut	None	Surficial silt and sand unit too thin to be an aquifer unit but may contribute groundwater to East Bowmanville Creek. Site specific data is required to confirm the presence/ absence of ORM aquifer units at the base of the Halton Till. Encountering these will significantly increase the radius of impact.
DC-E4	East of Liberty Road	18+700 to 18+975	5 m	MOE well# 1904530, EM24-1, EM30-1, P30, P35,	Newmarket Till Aquitard -sandy silt till	3.0 m	2.0 m	1.0E-07	25 m	No wells are anticipated to be affected by deep cut.	None	Site specific data is required to confirm analysis. Estimation does not account for potential sand lenses/ seems. Encountering these features will significantly increase the radius of influence.
DC-E5	Between Bethesda Road and Cole Road	20+700 to 21+525	10 m	MOE well# 1904100, EM30-1, P35, P36	Newmarket Till Aquitard (sandy silt till) or Halton Till Aquitard (clayey silt till). Sand aquifer unit present at ~25 mBGS. Potential ORM aquifer unit	6.0 m	4.0 m	1.0E-07	30 m	No wells are anticipated to be affected by deep cut.	None	Site specific data is required to confirm the presence/ absence of ORM aquifer units at the base of the Halton Till. Encountering these will significantly increase the radius of impact. May also impact groundwater discharge into Soper Creek.
DC-E6	Brown Road	23+175 to 23+350	5 m	EM35-1, EM35-2	Surficial silty sand underlain by Halton Till to a depth of ~10.0 mBGS.	1.0 m	4.0 m	1.0E-05	100 m	No wells are anticipated to be affected by deep cut due to the separation distance.	None	Site specific data is required to confirm analysis. Potential to impact groundwater discharge into Wilmot Creek tributary. Monitoring of the watercourse will be required.
DC-E7	Between Brown Road and Leaskard Road	23+780 to 24+000	6 m	MOE well# 1902913, 1902624, EM35-1, EM35-2	Raised alluvial terrace consisting of sand and gravel aquifer deposits. Potentially underlain by unconfined ORM Aquifer deposits.	1.0 m	5.0 m	1.0E-05	~300 m	Two (2) wells are anticipated to be impacted by construction activities. Are located south of the TPR along Concession Road 7.	Five (5) wells near the deep require monitoring prior to, during and following excavations for both water quality and quantity. Raising highway grade would reduce the estimated radius of drawdown and would reduce the chance of impacting wells.	Site specific data is required to confirm water table depth and location of ORM aquifer. If this unit is breached, significant dewatering will be required.
DC-E8	East of Leaskard Road	24+825 to 25+300	15 m	EM40-1, P38	Silt till at surface (Halton Till), with thin surficial sand and at west edge of cut and sandy silt at east edge of cut. Silty sand till (Newmarket Till) underlies the Halton Till. ORM aquifer deposits may be present at the base of the Halton Till.	8.0 m	7.0 m	1.0E-07 (1.0E-05)	50 m in till / 500 m if ORM aquifer unit is encountered	No wells are anticipated to be affected by deep cut.	None	Not anticipated to encounter significant aquifer units. Site specific data is required to confirm the presence/ absence of ORM aquifer units at the base of the Halton Till. Encountering these will significantly increase the radius of impact.
DC-E9	Best Road	25+700 to 28+300	10 m	EM40-1, P38, MOE well# 1903885	Silt till at surface (Halton Till), with thin surficial sand at west edge of cut. Silty sand till (Newmarket Till) underlies the Halton Till. ORM aquifer deposits may be present at the base of the Halton Till.	~2.5 m	7.5 m	1.0E-07 (1.0E-05)	50 m in till / 500 m if ORM aquifer unit is encountered	No wells are anticipated to be affected by deep cut.	None	Not anticipated to encounter significant aquifer units. Site specific data is required to confirm the presence/ absence of ORM aquifer units at the base of the Halton Till. Encountering these will significantly increase the radius of impact.
DC-E10	East of Solina Road between Taunton Road and Nash Road	16+125 to 16+650 (East Link)	5.5 m	G2E-1, G2E-2, G10E-1, G10E-2, G11E-1, G11E-2, MOE Well# 1903000, 1903602	Glacial Lake Iroquois Shoreline sand and gravel sediments at surface to a depth of ~12 mBGS. Silty sand till (Newmarket Till) is found below.	<1.0 m	4.5 m	1.0E-05	275 m	Three (3) wells within 275 m of excavation. Potential to affect groundwater inputs to Black Creek to the east which is known for Brook Trout habitat. Additional information is required to determine the full extent of impacts.	Raise highway grade to reduce the depth of the cut. Additional, site specific data is required to recommend potential mitigation measures. Three (3) wells require monitoring prior to, during and following excavations for both water quality and quantity.	Site specific data is required to confirm analysis. Potential to impact groundwater discharge into Black Creek. Monitoring of the watercourse will be required.

Profile Reviewed: Provided by MRC (December 2008)

**Table 16**  
High Fills Analysis  
Hwy 407 - Eastern Section

Name (Map)	Location	Chainage	Description of Fill Placement	Maximum Height of Fill	Data Sources	Geology	Hydrogeology	Potential Issues	Proposed Mitigation Measures
HF-E1 (E1a)	Solina Road (Black Creek)	12+900 to 13+010	EM-4/5 Bridge Abutments	5.5 m	EM04-1, EM04-2, EM05-1, EM05-2, MP39s/d, geologic map	Surficial glaciolacustrine silt and sand to a depth of >7.6 mBGS. Underlain by silty sand till (Newmarket Till). Small wetland area is present on the east side of Black Creek at MP39s/d.	Water table at 1.1 mBGS. Estimated groundwater flow direction is southeast- southwest towards Black Creek	1) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-E2 (E1b)	West Bowmanville Creek to West Bowmanville Creek tributary	14+730 to 16+300	Continuous Fill for Raised Alignment	10.0 m	G5E-1, G5E-2, EM08-2, EM10-1, EM10-2, EM10-3, EM15-1, P31, P32, geologic map	Surficial glaciolacustrine silt and sand to a depth ~2.0 mBGS. Unconsolidated. Glaciolacustrine silty clay present to a depth of >10.0 mBGS. Below, silty sand till (Newmarket Till) is present.	Water table estimated to be <3.0 mBGS due to poor drainage through the silty clay. Groundwater flow direction is predominantly downward, but some lateral flow is anticipated towards river valleys.	1) Potential for "wicking" of groundwater into fill due to shallow water table. 2) Compressible and frost susceptible silt and clay deposits present at or near surface, becoming finer grained with depth.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Engineering measures to deal with settlement and frost will be required.
HF-E3 (E1b)	East Bowmanville Creek tributary	16+760 to 17+080	EM-19 Bridge Abutments	5.5 m	MP31, geologic map, (EM15-1)	Surficial glaciolacustrine silt and sand to a depth ~2.0 mBGS. Unconsolidated. Glaciolacustrine silty clay present to a depth of >10.0 mBGS. Below, silty sand till (Newmarket Till) is present.	Water table estimated to be <3.0 mBGS due to poor drainage through the silty clay. Shallow groundwater flow is east-west towards East Bowmanville Creek tributary	1) Potential for "wicking" of groundwater into fill due to shallow water table. 2) Compressible and frost susceptible silt and clay deposits present at or near surface, becoming finer grained with depth.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Engineering measures to deal with settlement and frost will be required.
HF-E4 (E1c)	Mackie Creek	19+170 to 19+590	EM-26/27 Bridge Abutments	8.0 m	geologic map	Surficial glaciolacustrine silt and sand to a depth of ~2.5 mBGS. Alluvial sand and gravel anticipated in Mackie Creek valley. Underlain by silty sand till (Newmarket Till).	Water table anticipated to be at or near ground surface in river valley (<1.0 mBGS). Shallow groundwater flow is east- west towards Mackie Creek.	1) Some evidence of groundwater discharge in river valley. 2) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge to Mackie Creek and to prevent a perched water table from forming ( $K_{fill}$ >100 $K_{native}$ ).
HF-E5 (E1c)	Between Bethesda Road and Acres Road	20+470 to 20+600	EM-31 Culvert Fill	6.0 m	No direct borehole (closest borehole - EM30-1, 400m to the west). Geologic Map	Surficial sandy silt till or clayey silt till (Newmarket Till or Halton Till).	Water table at 2.0 mBGS due to poorly drained soils. Groundwater flow direction is downwards.	None. Consolidated till soils at surface	None
HF-E6 (E1c)	Soper Creek to East of Cole Road	21+590 to 22+010	Fill for Raised Alignment and for EM-32 /33 Bridge Abutments	16.5 m	G7E-1, G7E-2, P36, geologic map	Surficial sandy silt to a depth of 2.1 mBGS. Underlain by clayey silt till (Halton Till) to a depth of 4.5 mBGS. Silty sand till (Newmarket Till) is present below. Soper Creek valley will contain alluvial sand and gravel at surface.	Water table at >7.0 mBGS on valley slopes. Water table at <1.0 mBGS in river valley. Groundwater flow is towards Soper Creek. Significant groundwater seepage observed at the base of the slope on the west side of Soper Creek.	1) Potential for "wicking" of groundwater into fill due to shallow water table in river valley. 2) Compressible and frost susceptible silt and clay deposits present at or near surface, becoming finer grained with depth.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Engineering measures to deal with settlement and frost will be required.
HF-E7 (E1c)	West of Darlington Clark Townline	22+275 to 22+380	EM-34 Culvert Fill	5.5 m	No direct borehole (closest borehole - P37, 250m to the east). Geologic Map	Surficial silty clay till (Halton Till).	Water table estimated to be <3.0 mBGS due to poor drainage through the silty clay. Groundwater flow direction is downward.	None. Consolidated till soils at surface	None
HF-E8 (E1d)	Wilmot Creek tributary east of Brown Road	23+350 to 23+510	EM-36/37 Bridge Abutments	11.0 m	EM35-1, EM35-2, geologic map	Surficial silt and sand (glaciolacustrine) to a depth of 4.3 mBGS. Underlain by silty sand and sand and gravel ORM aquifer deposits. Aluvial sand and gravel at surface in river valley.	Water table estimated at ~6.0 mBGS in valley slopes. Water table at <1.0 mBGS in river valley. Shallow groundwater flow direction is towards Wilmot Creek tributary.	1) Some evidence of groundwater discharge in river valley. 2) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge to Wilmot Creek tributary and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-E9 (E1d)	Wilmot Creek Valley	24+280 to 24+800	Fill for Raised Alignment (24+280 to 24+540). EM- 38/39 Bridge Abutments (24+540 to 24+800)	18.0 m	EM40-1, P38, MOE well# 1904280, 1902670	Older and modern alluvial deposits of sand and gravel present at surface.	Water table estimated to be <1.0 mBGS. Surficial sediments are highly permeable. Groundwater flow direction is to the east towards Wilmot Creek.	Borehole Drilling is required at this location to confirm. 1) Evidence of groundwater discharge in river valley. 2) Potential for "wicking" of groundwater into fill due to shallow water table. 3) Potential for interception of recharge that may reduce subsequent stream baseflow.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge to Wilmot Creek and to prevent a perched water table from forming ( $K_{fill}$ >100 $K_{native}$ ). 2) Deflect clean run-off to native soils to maintain recharge. 3) Borehole drilling will be required at Detailed Design.
HF-E10 (E1d)	Wilmot Creek tributary east of Leskard Road	25+340 to 25+430	Culvert Fill (EM41?)	6.0 m	No direct borehole information. Geologic Map	Surficial silty clay till (Halton Till) on valley slopes. Thin sand deposits are anticipated in the river valley.	Water table estimated at <5.0 mBGS in valley slopes. Water table at <1.0 mBGS in river valley. Groundwater flow direction is downward.	No significant groundwater issues related to fill placement on valley slopes.	None
HF-E11 (E1d)	Orono Creek between Best Road and Hwy 35/115	26+380 to 26+700	EM-43 Culvert Fill and Fill for Raised Alignment	8.5 m	No direct borehole information. Geologic Map	Surficial silt and clay (glaciolacustrine). Potentially underlain by a sand aquifer.	Water table estimated to be <1.0 mBGS due to poor drainage through the silty clay. Groundwater flow direction is predominantly downward.	Borehole Drilling is required at this location to confirm. 1) Compressible and frost susceptible silt and clay deposits present at or near surface, becoming finer grained with depth. 2) If underlain by a sand aquifer, there is a risk that it may be exposed.	1) Engineering measures to deal with settlement and frost will be required. 2) Stripping of surface soils may expose confined sand aquifer below. 3) Borehole drilling will be required at Detailed Design.



Table 16  
High Fills Analysis  
Hwy 407 - Eastern Section

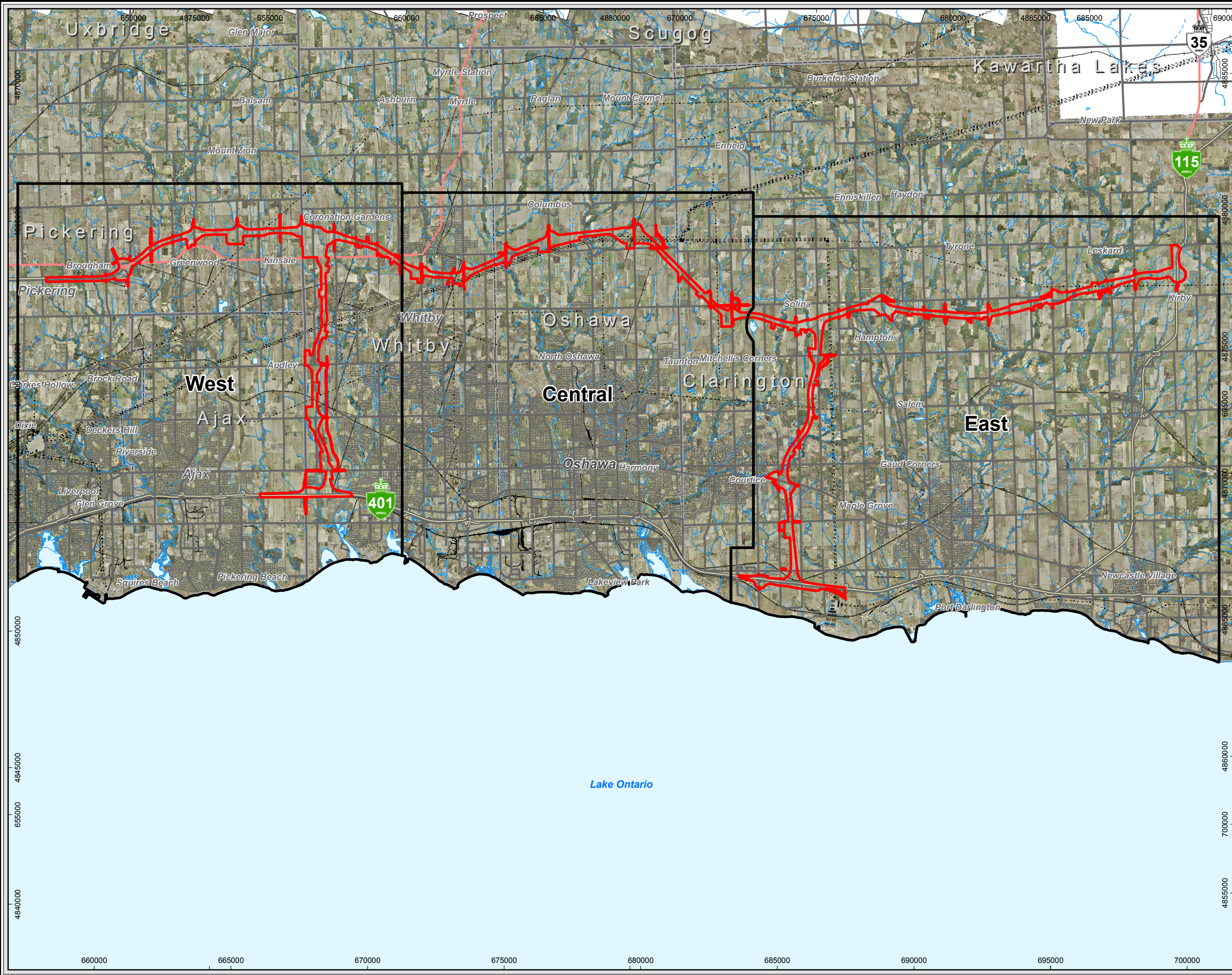
Name (Map)	Location	Chainage	Description of Fill Placement	Maximum Height of Fill	Data Sources	Geology	Hydrogeology	Potential Issues	Proposed Mitigation Measures
HF-E12 (E1d)	Orono Creek between Best Road and Hwy 35/115	26+760 to 26+920	EM-44 Culvert Fill	11.0 m	No direct borehole information. Geologic Map	Surficial silt and clay (glaciolacustrine). Potentially underlain by a sand aquifer.	Water table estimated to be <1.0 mBGS due to poor drainage through the silty clay. Groundwater flow direction is predominantly downward.	Borehole Drilling is required at this location to confirm. 1) Compressible and frost susceptable silt and clay deposits present at or near surface, becoming finer grained with depth. 2) If underlain by a sand aquifer, there is a risk that it may be exposed.	1) Engineering measures to deal with settlement and frost will be required. 2) Stripping of surface soils may expose confined sand aquifer below. 3) Borehole drilling will be required at Detailed Design.
HF-13 (ELb)	Maple Grove Wetland Complex between Highway 2 and Nash Road	(East Link) 14+125 to 14+480	Fill for Raised Alignment and for EL-14/15 Bridge Abutments	9.0 m	G3E-1, G3E-2, EL12-1, EL17-1, EL17-2, EL17-3, BH6, MP44s/d	Surficial silty sand aquifer to a depth of 3.0 mBGS. Underlain by clay and silt to a depth of 12.0 mBGS. Silty sand till (Newmarket Till) is present below.	Water table ranges from 0.3 to 2.0 mBGS. Permeable sand deposits present at surface. Upward hydraulic gradient measured (i.e., groundwater discharge).	1) Fill placement within wetland area will require lateral groundwater pressure equalization to avoid ponding. 2) Some evidence of groundwater discharge in wetland. 3) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Fill should be designed with a granular sub-base with level (0% slope), perforated pipes, placed in line with groundwater flow (~NW-SE), and covered with a geotextile filter to prevent intrusion of fine particles.
HF-14 (ELa)	Black Creek tributary and wetland between Solina Road and Rundle Road north of Nash Road	(East Link) 16+750 to 17+250	EL-23/24 Bridge Abutments	8.0 m	G10E-1, G10E-2, EL23-4, EL24-4	Surficial silty sand aquifer to a depth of 8.2 mBGS. Underlain by silty sand till (Newmarket Till).	Water table at <2.0 mBGS. Permeable sand deposits present at surface. Upward hydraulic gradient measured (i.e., groundwater discharge).	1) Fill placement within wetland area will require lateral groundwater pressure equalization to avoid ponding. 2) Some evidence of groundwater discharge in wetland. 3) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Fill should be designed with a granular sub-base with level (0% slope), perforated pipes, placed in line with groundwater flow (TBD at Detailed Design), and covered with a geotextile filter to prevent intrusion of fine particles.
HF-15 (ELa)	Black Creek between Solina Road and Rundle Road south of Taunton Road	(East Link) 17+800 to 18+000	EL-25 Bridge Abutments	5.0 m	No direct borehole information. Geologic Map	Surficial silty sand aquifer underlain by silty sand till (Newmarket Till).	Water table at <2.0 mBGS. Groundwater flow direction is lateral towards Black Creek	1) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
Cross Roads and Ramps									
HF-16 (ELc)	Ramp for EDL and Highway 401 ramp	(East Link) 9+500+10+200	EL-4 and EL-5 Bridge Abutments for Ramps Over Hwy 401	8.5 m	EL02-1, EL02-2, EL02-3, EL04-1, EL04-2, EL05-1, EL05-2, EL05-3	Fill material consiting of silty clay to sand present at surface to a depth of ~1.5 mBGS. Underlain by silty sand till (Newmarket Till).	Water table at ~1.5 mBGS due to poor drainage though till unit. Groundwater flow direction is downwards.	None. Consolidated soils at surface. Fill materials at surface are likely recompacted till soils.	None
HF-17 (ELb)	Maple Grove Wetland Complex. Highway 2 cross road and ramp	(East Link - Hwy 2 cross road and ramp) 13+810 to 14+170	EL12 Bridge Abutments for Hwy 2 Cross Road	9.0 m	G3E-1, G3E-2, EL12-1, BH6, MP44s/d	Surficial silty sand aquifer to a depth of 3.0 mBGS. Underlain by clay and silt to a depth of 12.0 mBGS. Silty sand till (Newmarket Till) is present below.	Water table ranges from 0.3 to 2.0 mBGS. Permeable sand deposits present at surface. Upward hydraulic gradient measured (i.e., groundwater discharge).	Additional informaiton on flili placement location is required. 1) Fill placement within wetland area will require lateral groundwater pressure equalization to avoid ponding. 2) Some evidence of groundwater discharge in wetland. 3) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Fill should be designed with a granular sub-base with level (0% slope), perforated pipes, placed in line with groundwater flow (TBD during Detailed Design), and covered with a geotextile filter to prevent intrusion of fine particles.
HF-18 (ELb)	Maple Grove Wetland Complex. Highway 2 cross road and ramp	(East Link - Hwy 2 cross road and ramp) 14+230 to 14+400	Bridge Abutments for Northbound EDL Entrance Ramp from Westbound Hwy 2 (EL-16 - although this structure is not accuratly placed on the figures)	8.5 m	G3E-1, G3E-2, EL12-1, BH6, MP44s/d	Surficial silty sand aquifer to a depth of 3.0 mBGS. Underlain by clay and silt to a depth of 12.0 mBGS. Silty sand till (Newmarket Till) is present below.	Water table ranges from 0.3 to 2.0 mBGS. Permeable sand deposits present at surface. Upward hydraulic gradient measured (i.e., groundwater discharge).	Additional informaiton on flili placement location is required. 1) Fill placement within wetland area will require lateral groundwater pressure equalization to avoid ponding. 2) Some evidence of groundwater discharge in wetland. 3) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Fill should be designed with a granular sub-base with level (0% slope), perforated pipes, placed in line with groundwater flow (TBD during Detailed Design), and covered with a geotextile filter to prevent intrusion of fine particles.
HF-19 (ELb)	Maple Grove Wetland Complex. Highway 2 cross road and ramp	(East Link - Hwy 2 cross road and ramp) 14+200 to 14+460	Bridge Abutments for Southbound EDL Exit Ramp to Hwy 2 (EL-13 - although this structure is not accuratly placed on the figures)	8.5 m	G3E-1, G3E-2, EL12-1, BH6, MP44s/d	Surficial silty sand aquifer to a depth of 3.0 mBGS. Underlain by clay and silt to a depth of 12.0 mBGS. Silty sand till (Newmarket Till) is present below.	Water table ranges from 0.3 to 2.0 mBGS. Permeable sand deposits present at surface. Upward hydraulic gradient measured (i.e., groundwater discharge).	Additional informaiton on flili placement location is required. 1) Fill placement within wetland area will require lateral groundwater pressure equalization to avoid ponding. 2) Some evidence of groundwater discharge in wetland. 3) Potential for "wicking" of groundwater into fill due to shallow water table.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Fill should be designed with a granular sub-base with level (0% slope), perforated pipes, placed in line with groundwater flow (TBD during Detailed Design), and covered with a geotextile filter to prevent intrusion of fine particles.

# Figures

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Map Document: (N:\Projects\2005\50613\2009\Final\GIS\patial\MXDs\Report\MXD\Hydrogeology\January2009\50613\Hydrogeology\_TPR\_11x17.mxd)  
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**Legend**

- Intermittent Stream
- Permanent Stream
- Transmission Line
- Railway
- Freeway
- Highway
- Major Road
- Local Road
- Technically Preferred Route
- Municipal Division
- Waterbody
- Cartographic Wetland

Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50,000

0 0.5 1 2 3 4 5  
Km  
1:140,000  
UTM Zone 17N, NAD 83

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407 Environmental Assessment

**Technically Preferred Route**

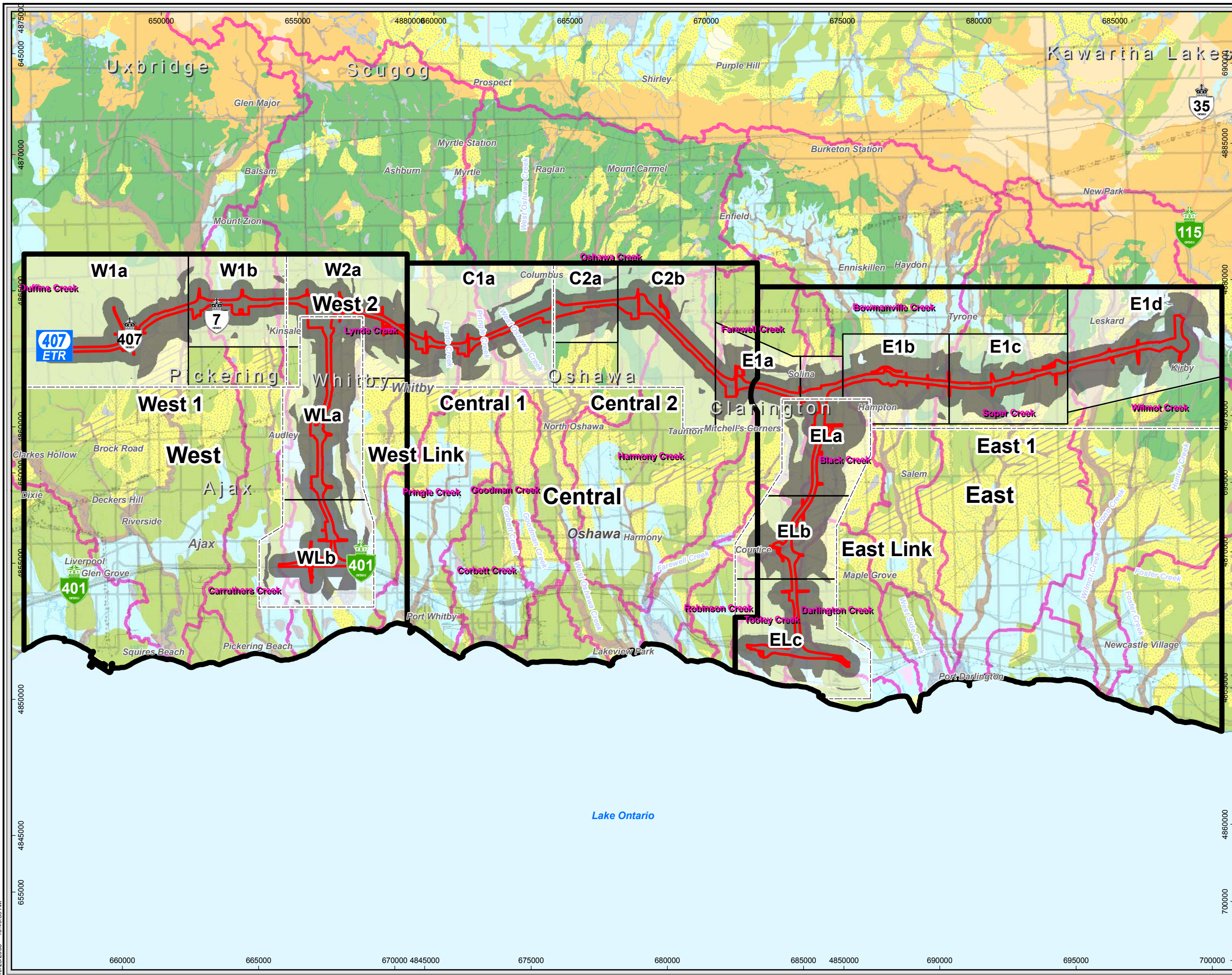
January 2009  
Project 50613

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**Figure 1**



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**Legend**

- Intermittent Stream
- Permanent Stream
- Transmission Line
- Railway
- Freeway
- Highway
- Major Road
- Local Road
- Technically Preferred Route
- Watershed
- Municipal Division
- Water Well Survey Study Area
- Waterbody
- Cartographic Wetland

Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000

0 1 2 4 6 Km  
1:140,000

UTM Zone 17N, NAD 83

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407 Environmental Assessment

**Hydrogeological Conditions Location Map**

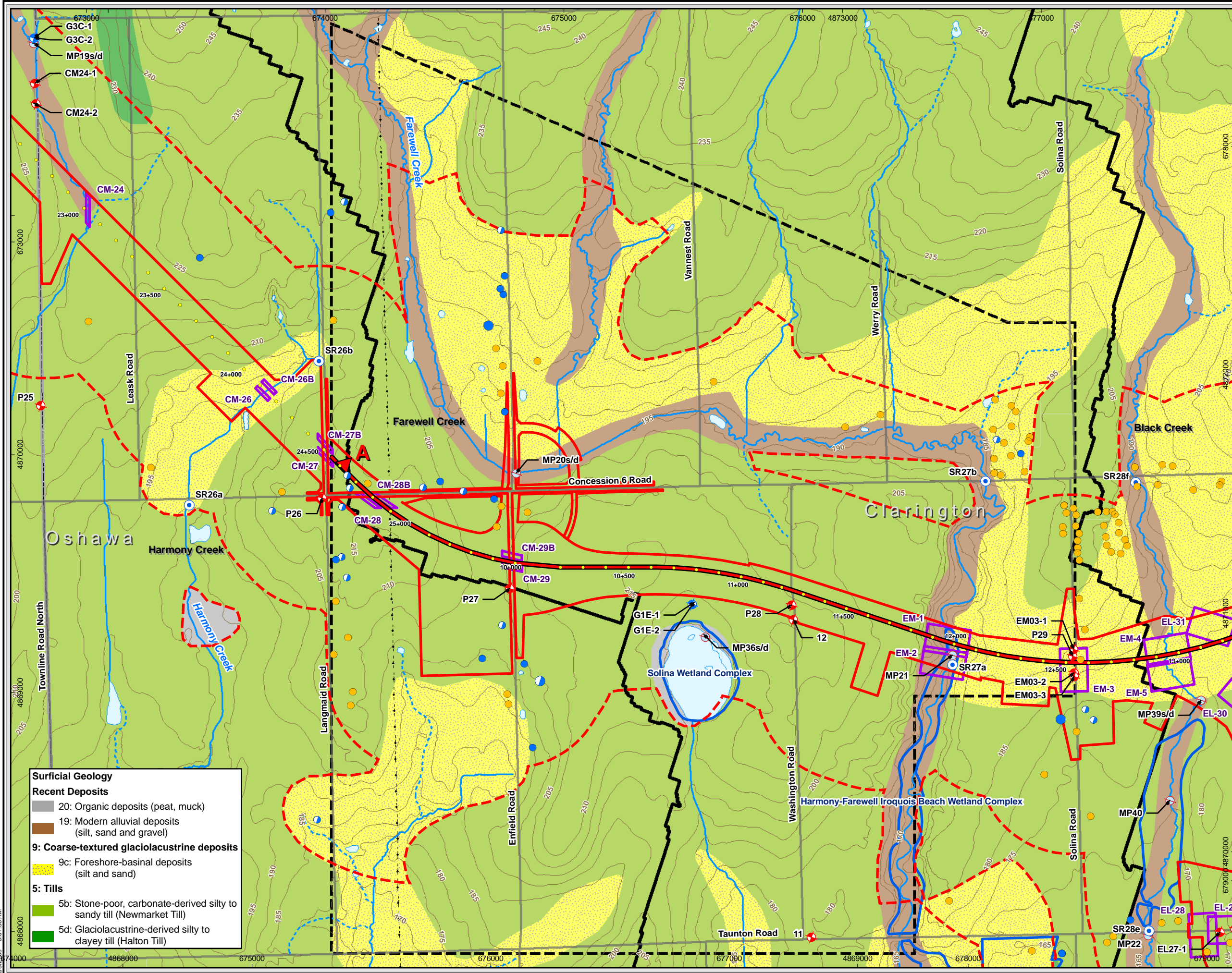
October 2008  
Project 50613

**AECOM**

Figure 2

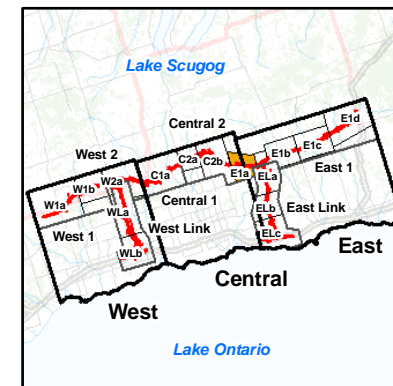


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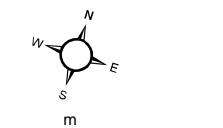


- Surficial Geology**
- Recent Deposits**
- 20: Organic deposits (peat, muck)
  - 19: Modern alluvial deposits (silt, sand and gravel)
- 9: Coarse-textured glaciolacustrine deposits**
- 9c: Foreshore-basinal deposits (silt and sand)
- 5: Tills**
- 5b: Stone-poor, carbonate-derived silty to sandy till (Newmarket Till)
  - 5d: Glaciolacustrine-derived silty to clayey till (Halton Till)

- Legend**
- Dug Wells**
- Sampled
  - Not Sampled
- Drilled Wells**
- Sampled
  - Not Sampled
- Other Wells**
- No Data
- Engineering Station**
- Surface Water Monitor
  - Mini-piezometer
- Boreholes**
- Geotechnical
  - Groundwater Monitor
- Contour (5m)
- Intermittent Stream
- Permanent Stream
- Cross-section (East 1)
- Water Well Survey Study Area
- Technically Preferred Route
- Proposed Structure
- Provincially Significant Wetland
- Watershed
- Municipal Division
- Waterbody
- Cartographic Wetland



Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000



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407 Environmental Assessment  
**Instrumentation (Hydrogeology,  
Geotechnical, Water Wells)**  
**East Mainline  
Section E1a**

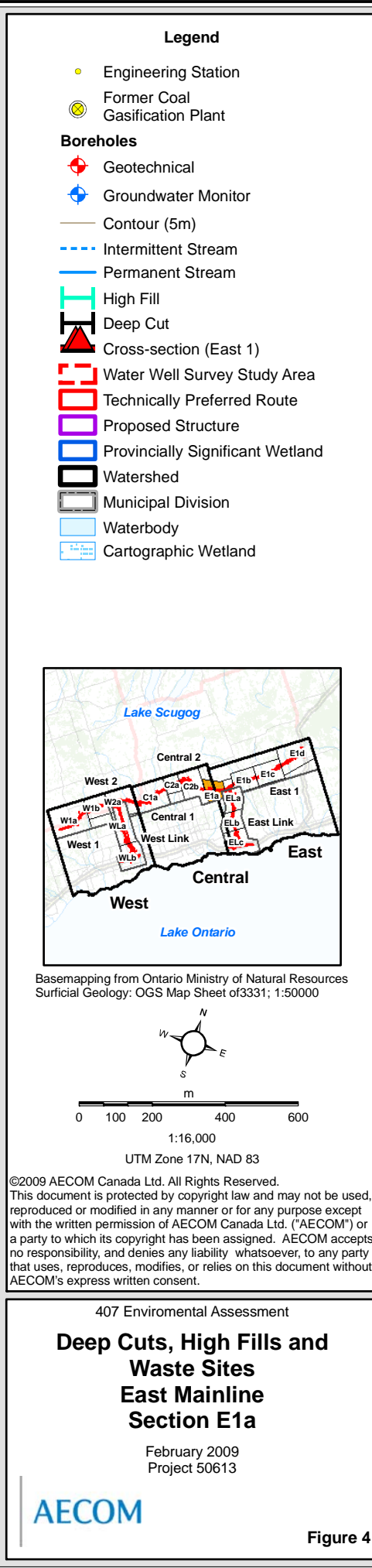
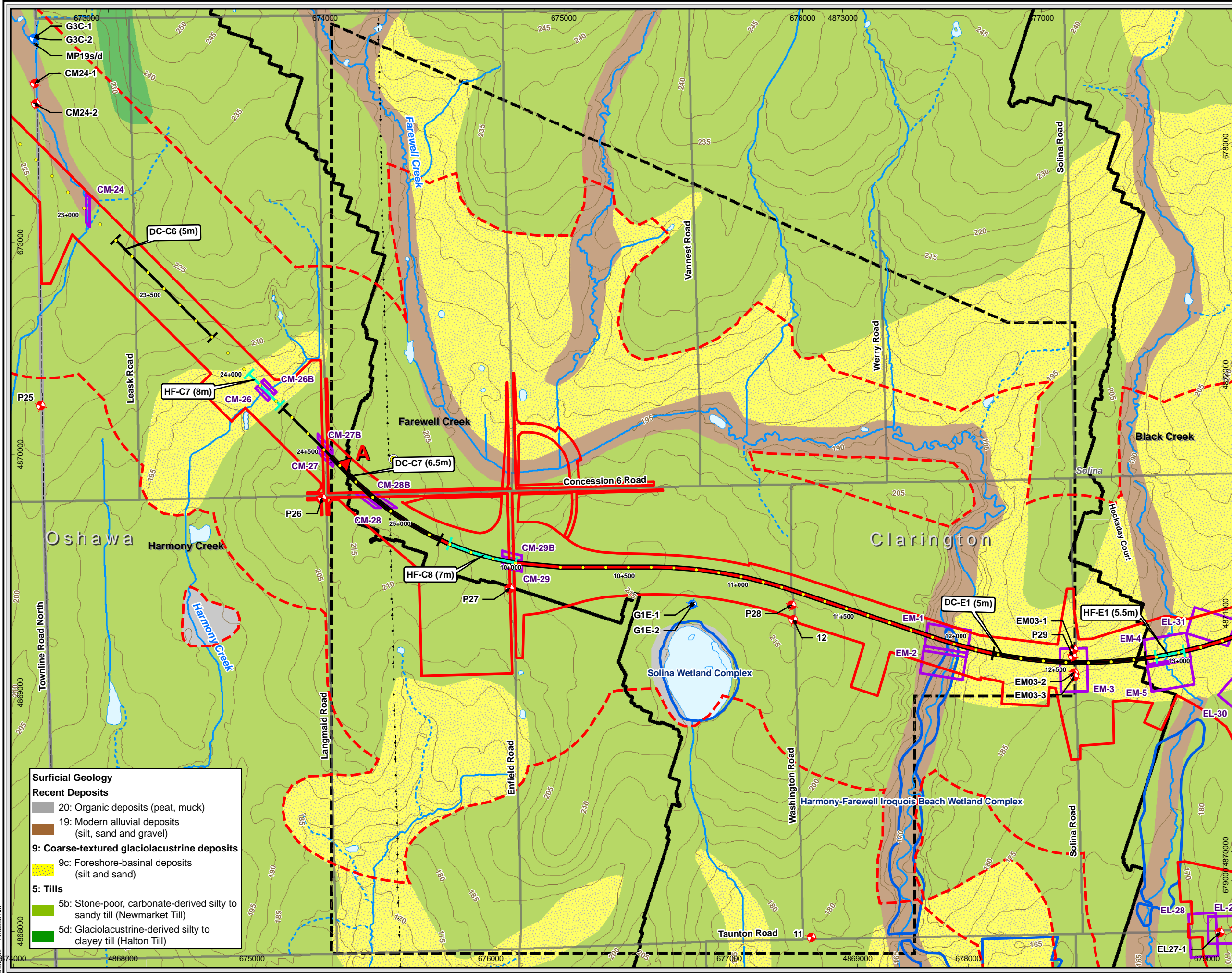
February 2009  
Project 50613

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Figure 3

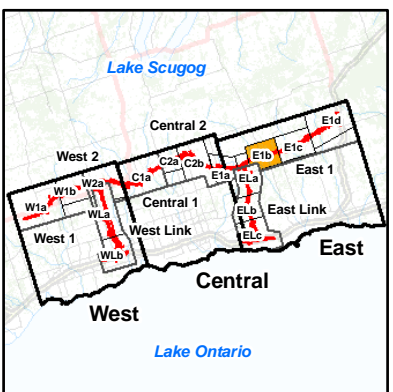
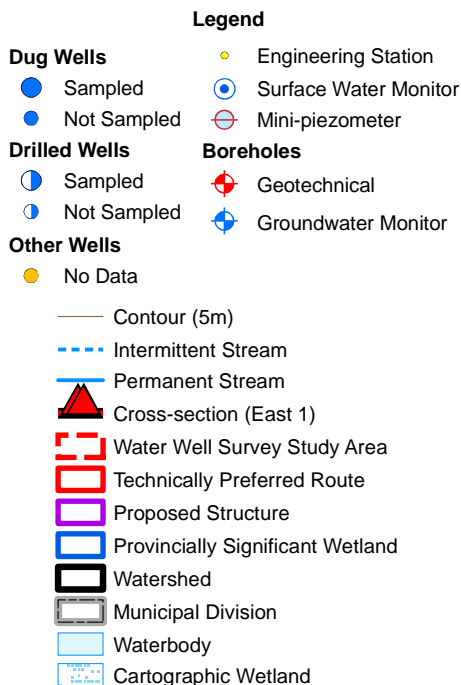
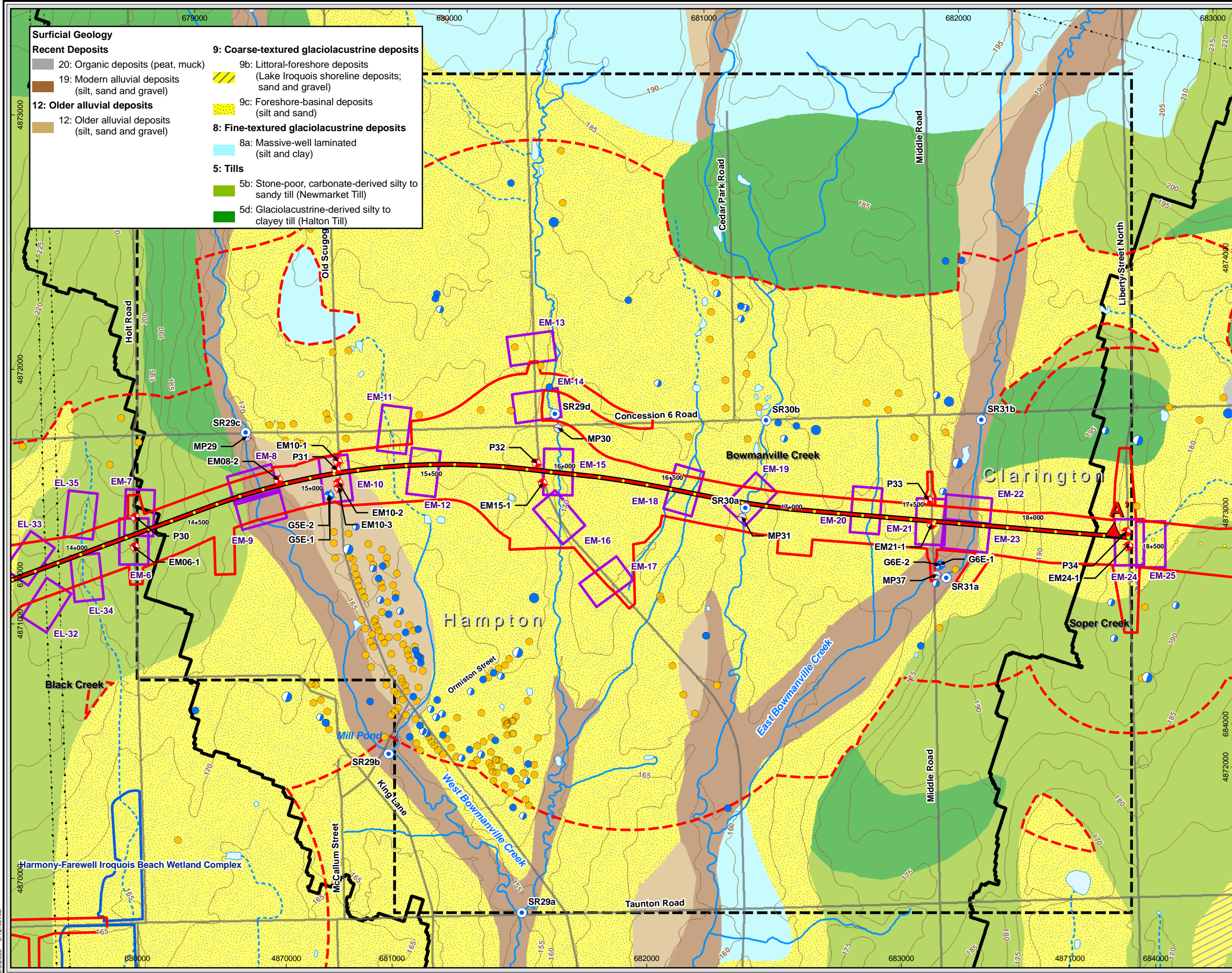


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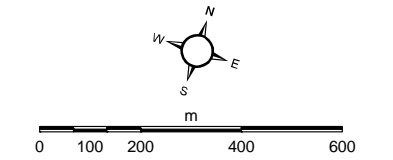




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Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000



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UTM Zone 17N, NAD 83

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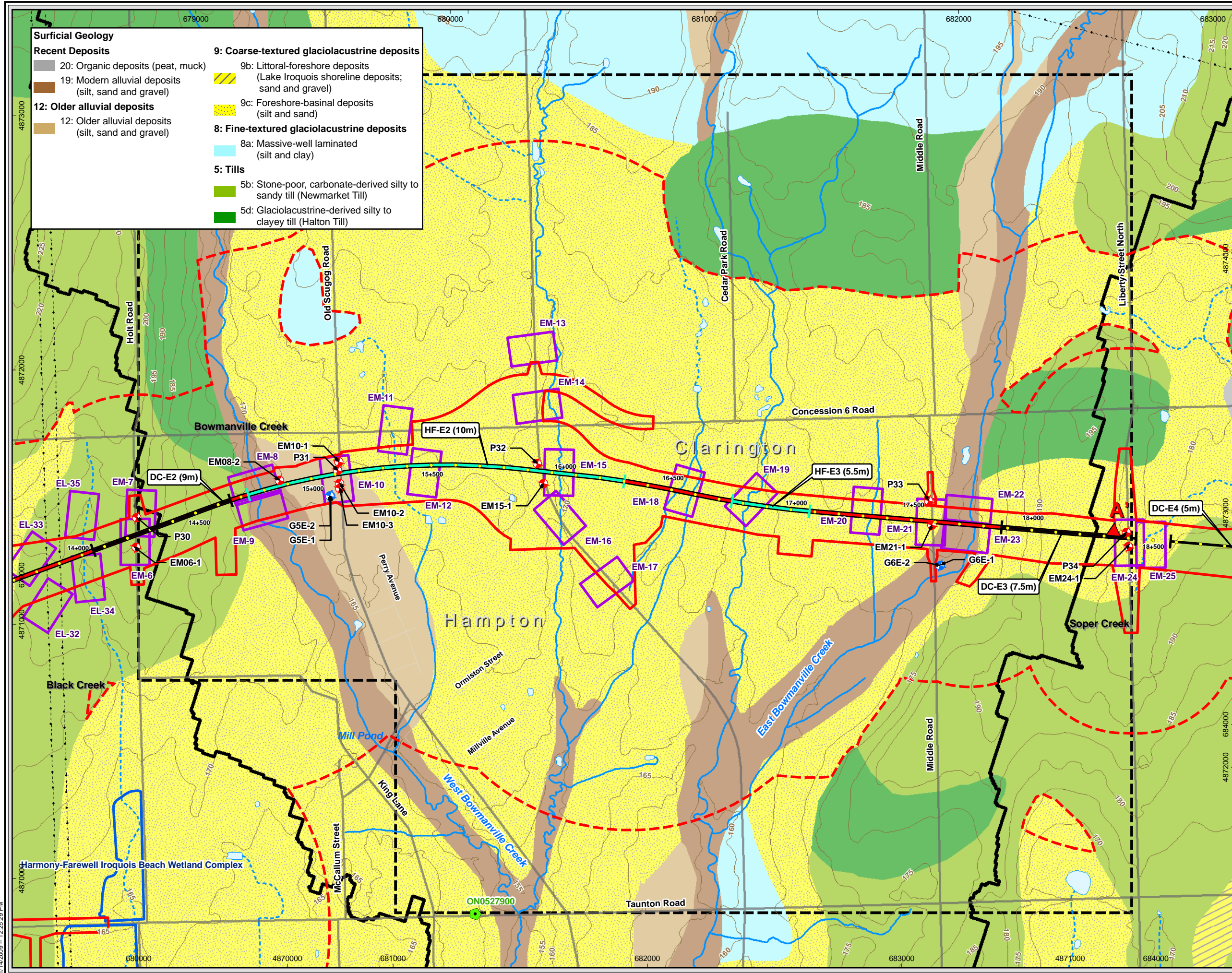
407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Mainline Section E1b**  
February 2009  
Project 50613

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Figure 5



Map Document (N:\Projects\2005\50613\008\Final\GIS\Spatial\IM\XDis\Report\MDa\Hydrology\January2009\50613\HydrologicalConditions\_Set2-E1b-11x17.mxd)  
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#### Surficial Geology

##### Recent Deposits

- 20: Organic deposits (peat, muck)
- 19: Modern alluvial deposits (silt, sand and gravel)

##### 12: Older alluvial deposits

- 12: Older alluvial deposits (silt, sand and gravel)

##### 9: Coarse-textured glaciolacustrine deposits

- 9b: Littoral-foreshore deposits (Lake Iroquois shoreline deposits; sand and gravel)
- 9c: Foreshore-basinal deposits (silt and sand)

##### 8: Fine-textured glaciolacustrine deposits

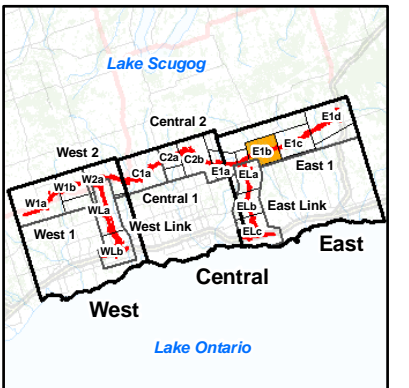
- 8a: Massive-well laminated (silt and clay)

##### 5: Tills

- 5b: Stone-poor, carbonate-derived silty to sandy till (Newmarket Till)
- 5d: Glaciolacustrine-derived silty to clayey till (Halton Till)

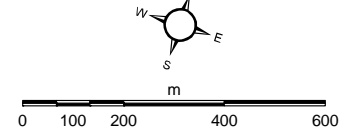
#### Legend

- Engineering Station
- Waste Generator Site
- Boreholes**
  - Geotechnical
  - Groundwater Monitor
- Contour (5m)
- Intermittent Stream
- Permanent Stream
- Deep Cut
- Cross-section (East 1)
- Water Well Survey Study Area
- Technically Preferred Route
- Proposed Structure
- Provincially Significant Wetland
- Watershed
- Municipal Division
- Waterbody
- Cartographic Wetland



Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000

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#### 407 Environmental Assessment Deep Cuts, High Fills and Waste Sites East Mainline Section E1b

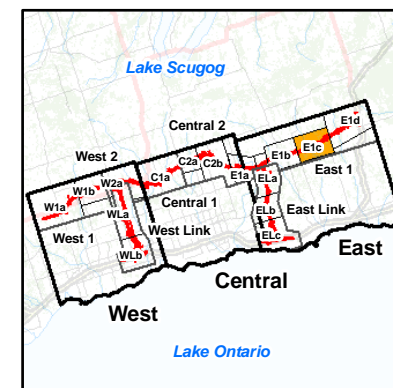
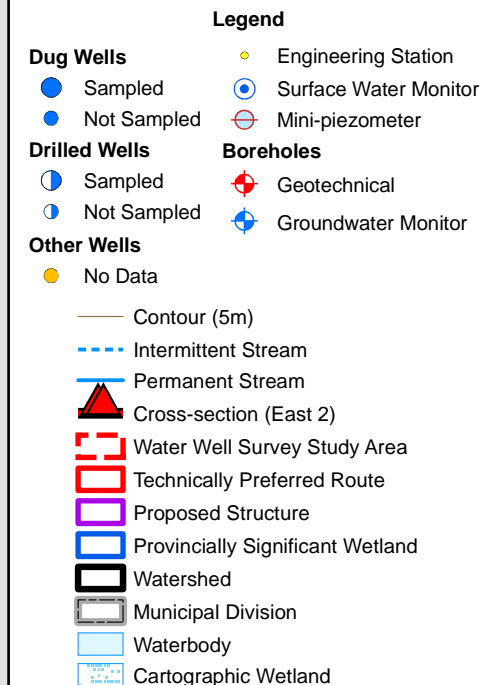
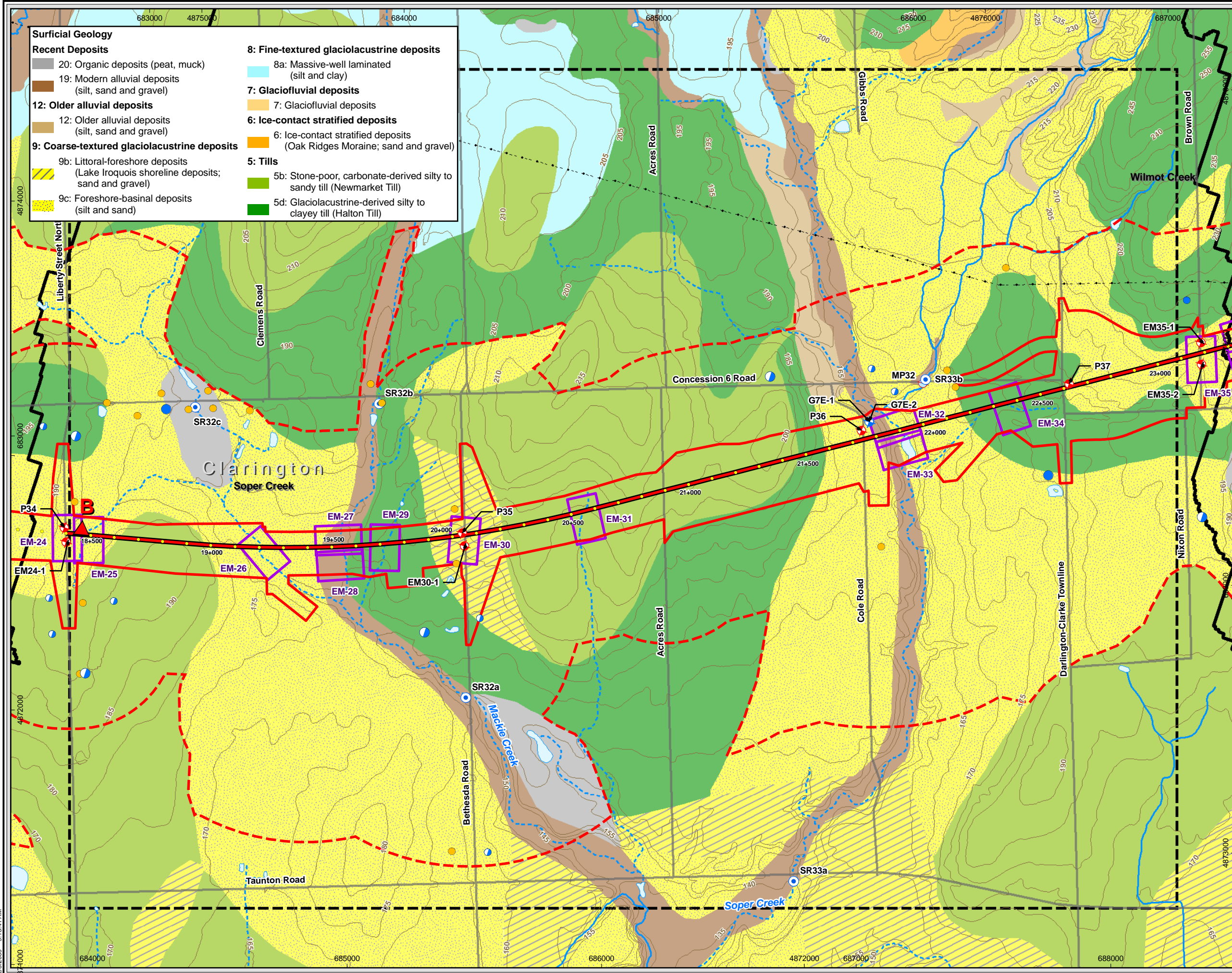
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Figure 6



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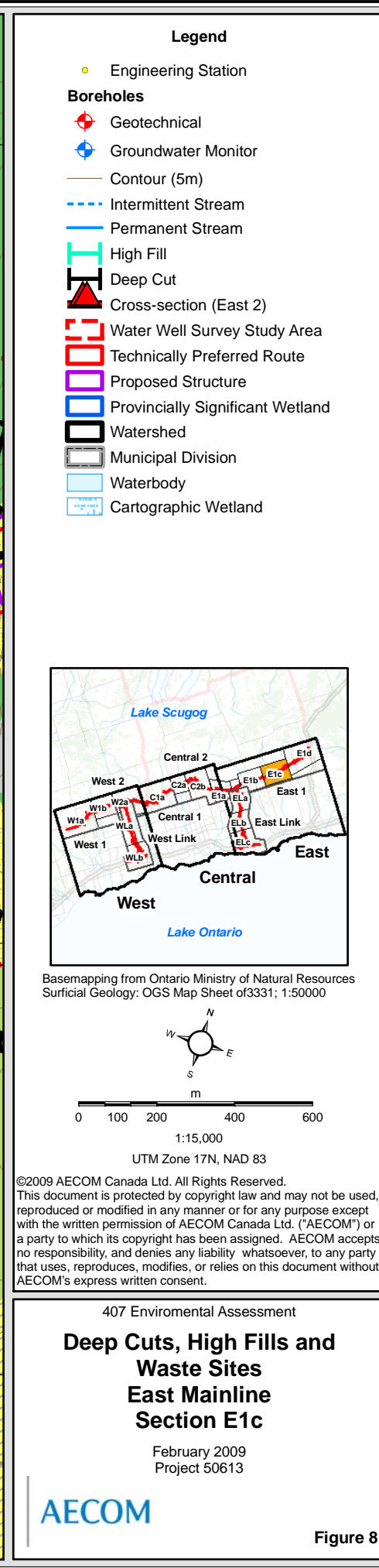
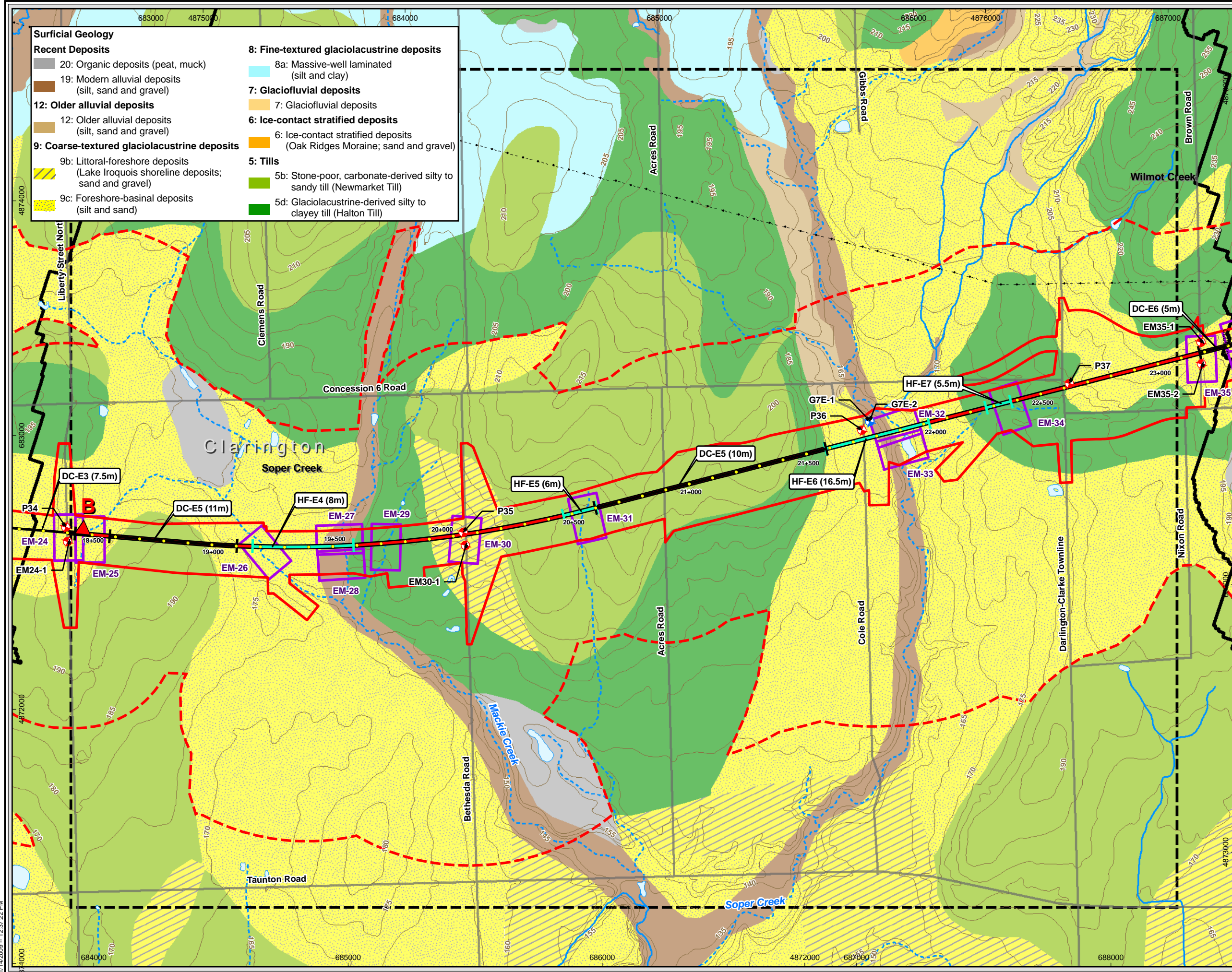
407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Mainline Section E1c**  
February 2009  
Project 50613

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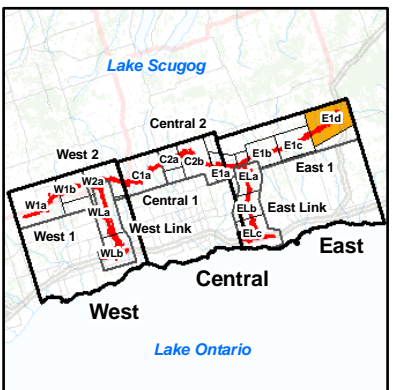
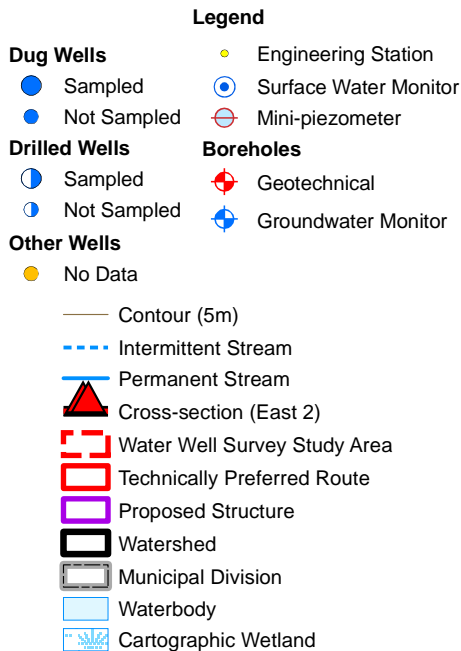
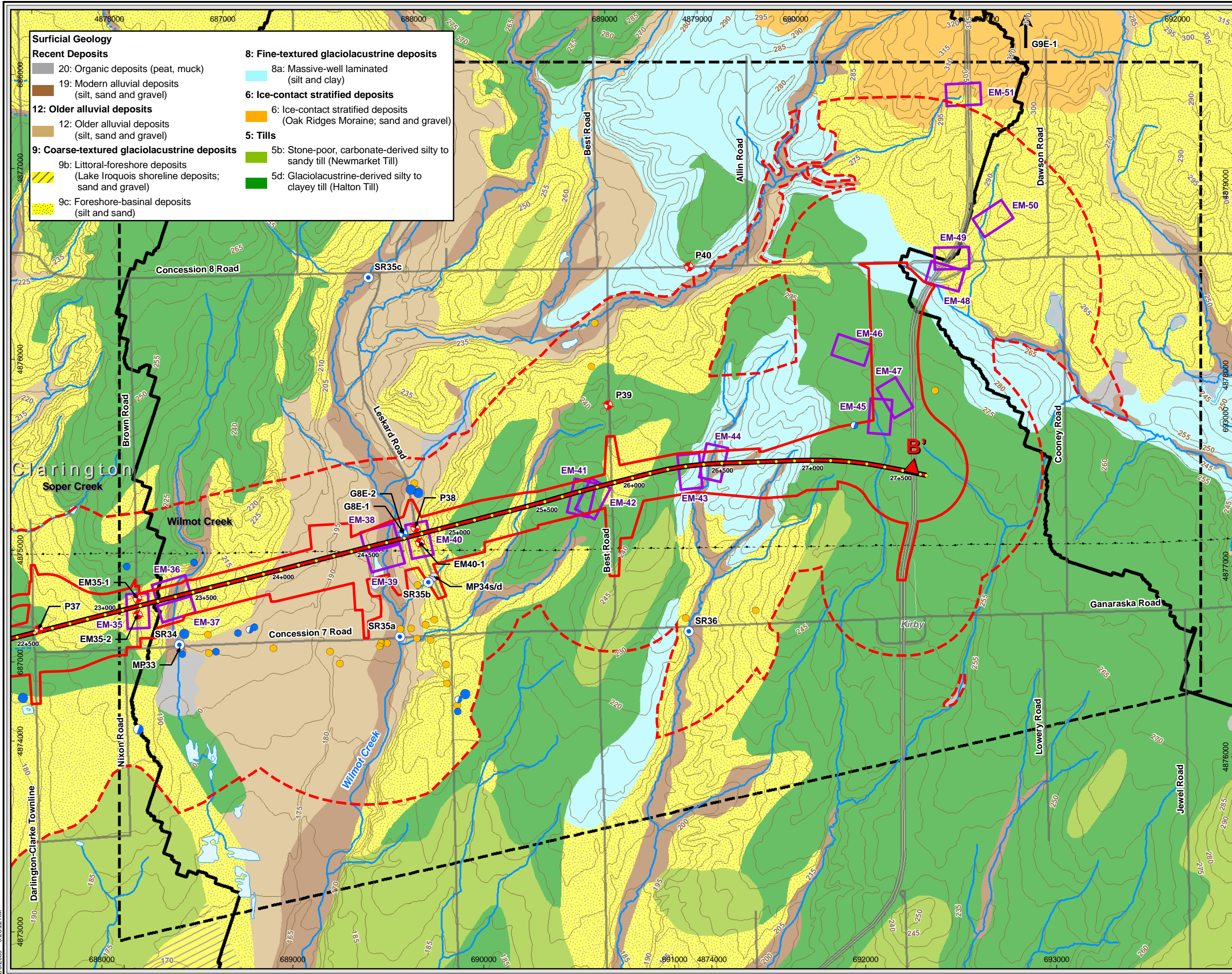
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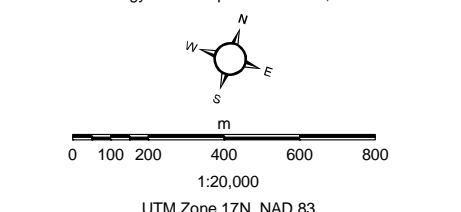
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Surficial Geology: OGS Map Sheet of 3331; 1:50000



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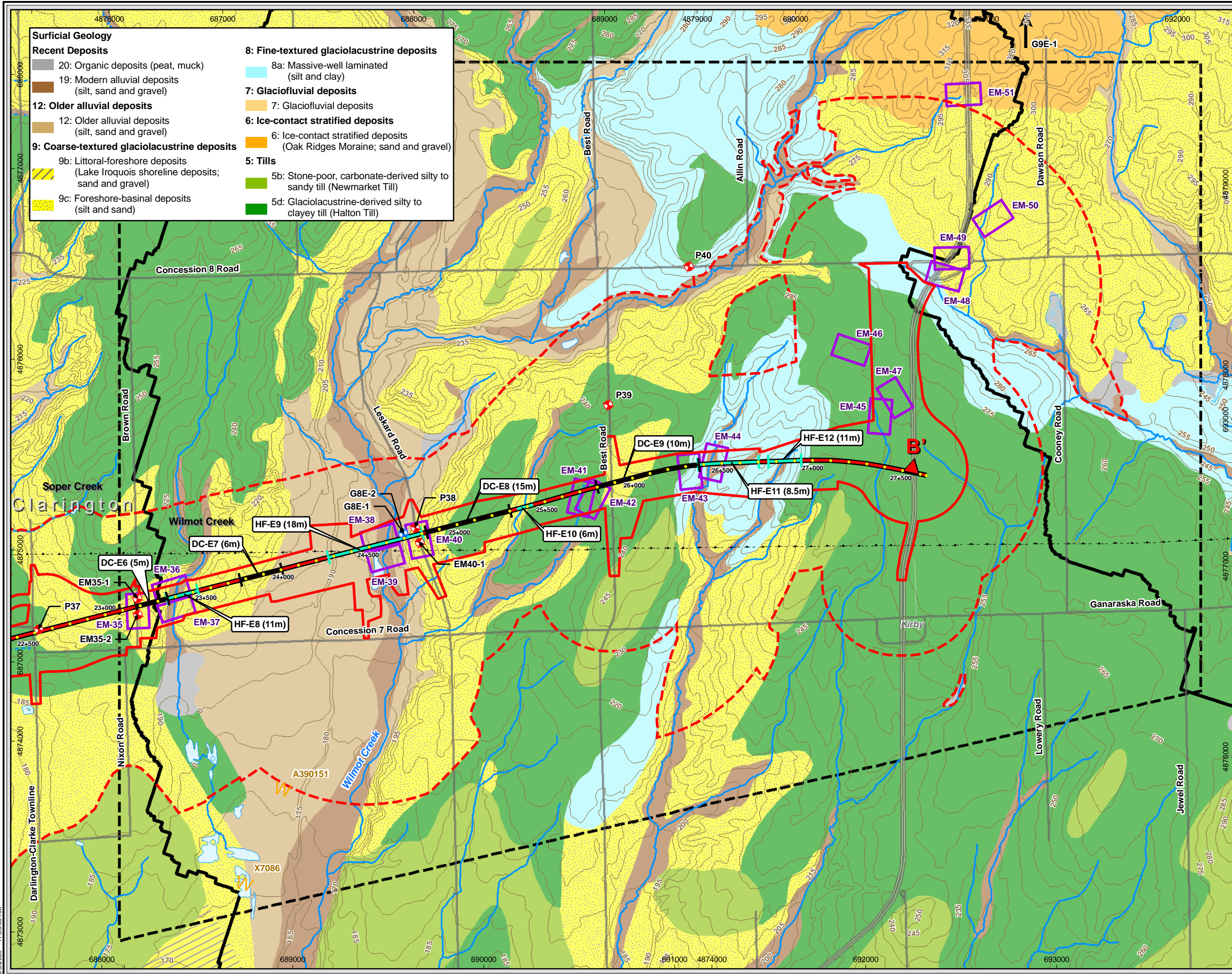
407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Mainline Section E1d**  
February 2009  
Project 50613

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Figure 9



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#### Surficial Geology

##### Recent Deposits

- 20: Organic deposits (peat, muck)
- 19: Modern alluvial deposits (silt, sand and gravel)

##### 12: Older alluvial deposits

- 12: Older alluvial deposits (silt, sand and gravel)

##### 9: Coarse-textured glaciolacustrine deposits

- 9b: Littoral-foreshore deposits (Lake Iroquois shoreline deposits; sand and gravel)
- 9c: Foreshore-basinal deposits (silt and sand)

##### 8: Fine-textured glaciolacustrine deposits

- 8a: Massive-well laminated (silt and clay)

##### 7: Glaciofluvial deposits

- 7: Glaciofluvial deposits

##### 6: Ice-contact stratified deposits

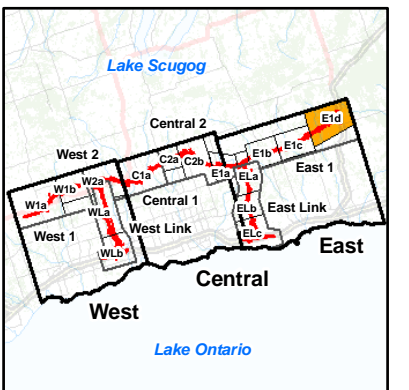
- 6: Ice-contact stratified deposits (Oak Ridges Moraine; sand and gravel)

##### 5: Tills

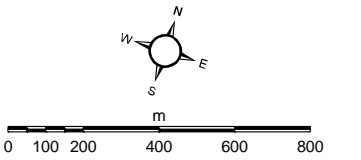
- 5b: Stone-poor, carbonate-derived silty to sandy till (Newmarket Till)
- 5d: Glaciolacustrine-derived silty to clayey till (Halton Till)

#### Legend

- Engineering Station
- Waste Disposal Site
- Boreholes**
  - Geotechnical
  - Groundwater Monitor
- Contour (5m)
- Intermittent Stream
- Permanent Stream
- High Fill
- Deep Cut
- Cross-section (East 2)
- Water Well Survey Study Area
- Technically Preferred Route
- Proposed Structure
- Watershed
- Municipal Division
- Waterbody
- Cartographic Wetland



Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000



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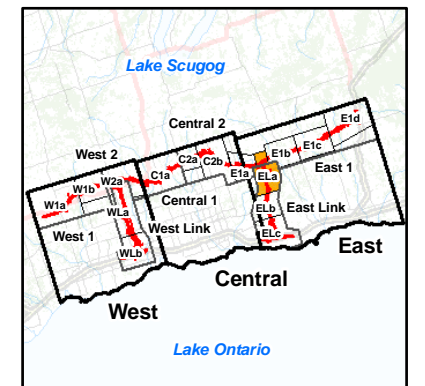
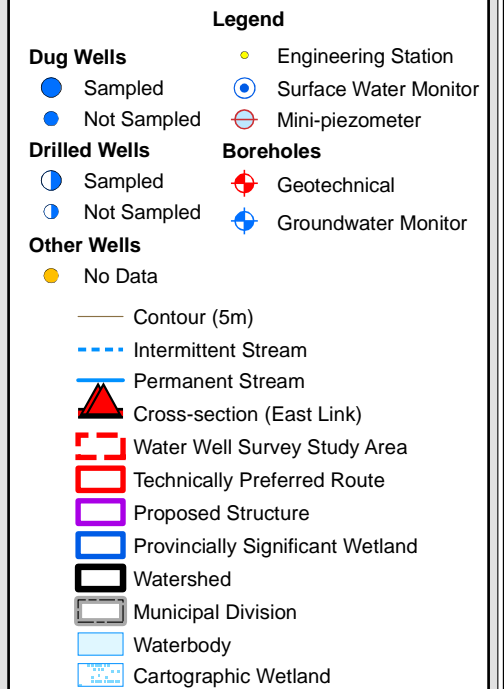
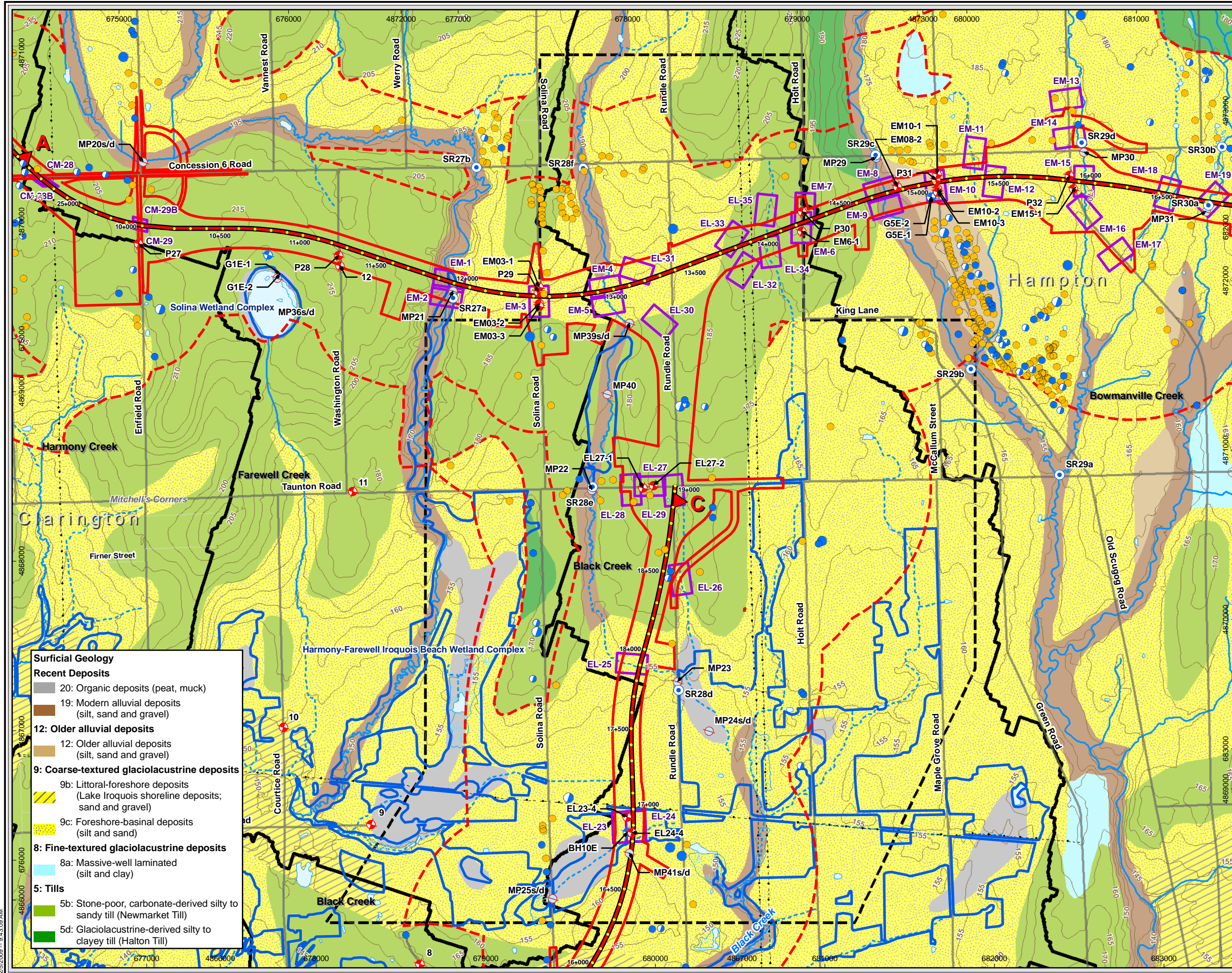
#### 407 Environmental Assessment Deep Cuts, High Fills and Waste Sites East Mainline Section E1d

February 2009  
Project 50613

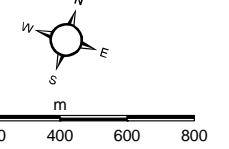
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Figure 10





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Surficial Geology: OGS Map Sheet of 3331; 1:50000



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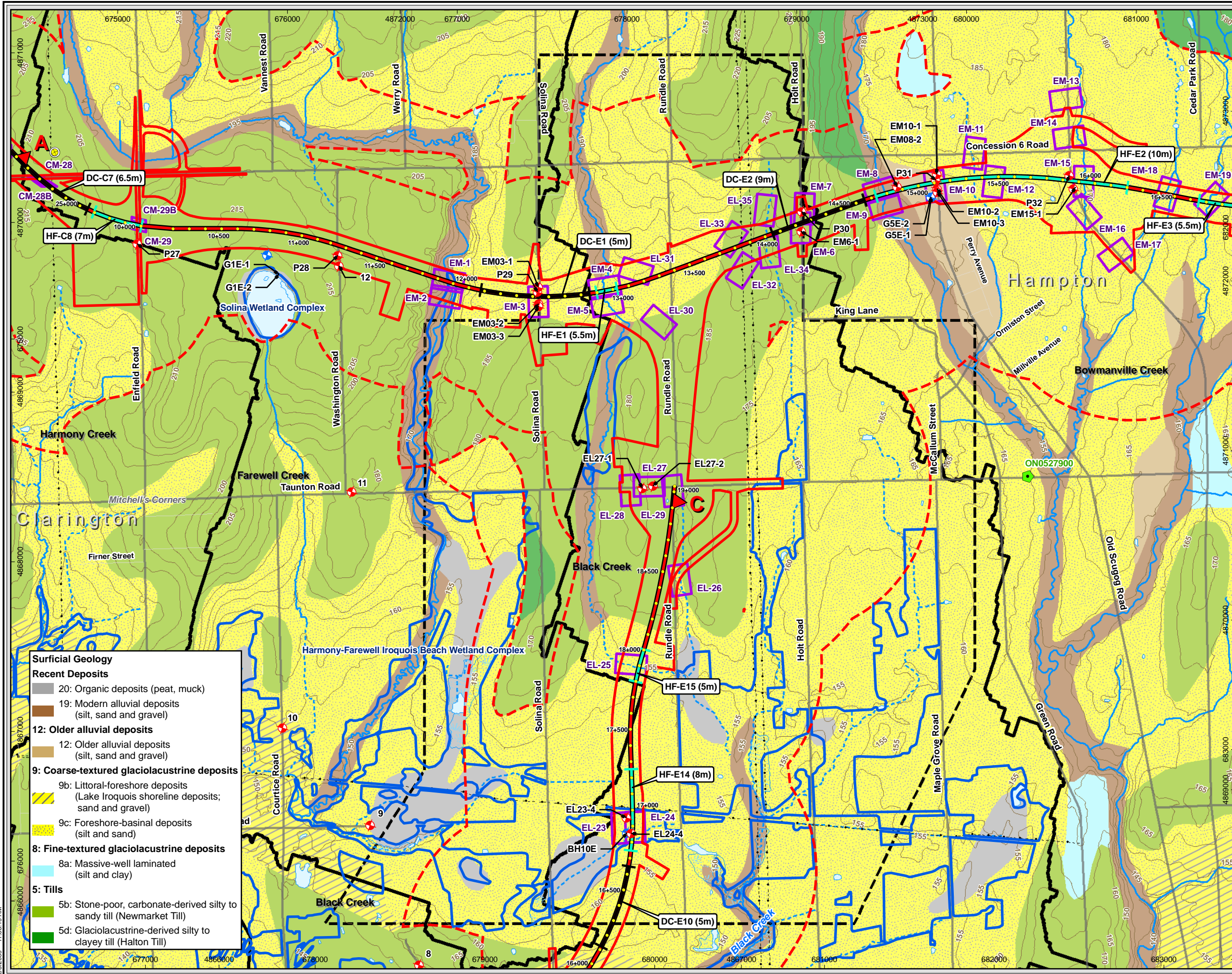
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407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Link Section ELA**  
February 2009  
Project 50613

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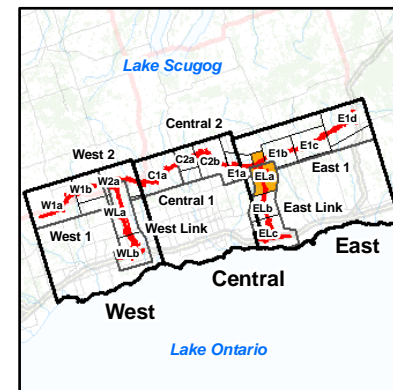
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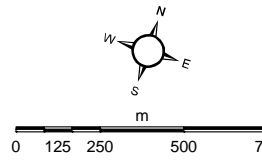


- Surficial Geology**
- Recent Deposits**
- 20: Organic deposits (peat, muck)
  - 19: Modern alluvial deposits (silt, sand and gravel)
- 12: Older alluvial deposits**
- 12: Older alluvial deposits (silt, sand and gravel)
- 9: Coarse-textured glaciolacustrine deposits**
- 9b: Littoral-foreshore deposits (Lake Iroquois shoreline deposits; sand and gravel)
  - 9c: Foreshore-basinal deposits (silt and sand)
- 8: Fine-textured glaciolacustrine deposits**
- 8a: Massive-well laminated (silt and clay)
- 5: Tills**
- 5b: Stone-poor, carbonate-derived silty to sandy till (Newmarket Till)
  - 5d: Glaciolacustrine-derived silty to clayey till (Halton Till)

- Legend**
- Engineering Station
  - Former Coal Gasification Plant
  - Waste Generator Site
- Boreholes**
- Geotechnical
  - Groundwater Monitor
  - Contour (5m)
  - Intermittent Stream
  - Permanent Stream
  - High Fill
  - Deep Cut
  - Cross-section (East Link)
  - Water Well Survey Study Area
  - Technically Preferred Route
  - Proposed Structure
  - Provincially Significant Wetland
  - Watershed
  - Municipal Division
  - Waterbody
  - Cartographic Wetland



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Surficial Geology: OGS Map Sheet of 3331; 1:50000



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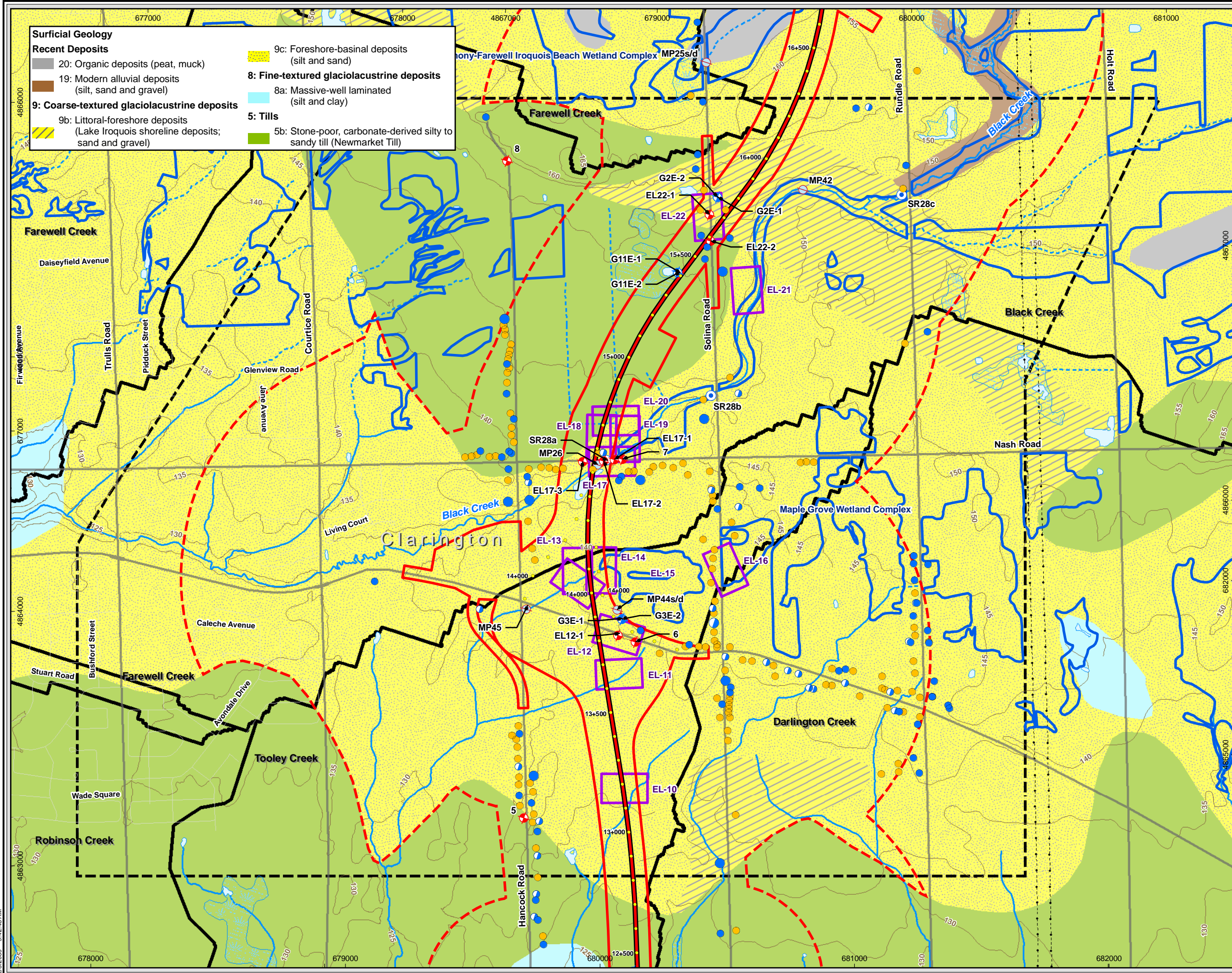
407 Environmental Assessment  
**Deep Cuts, High Fills and  
Waste Sites  
East Link  
Section ELa**

February 2009  
Project 50613

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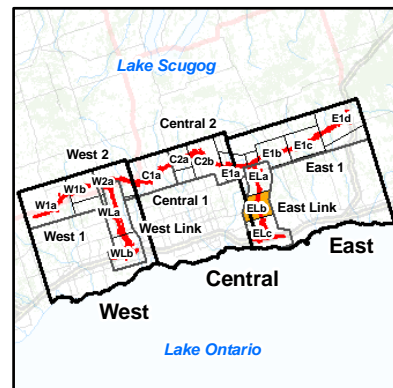


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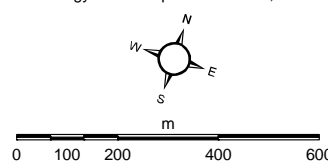


- Dug Wells**
- Sampled (Blue circle with dot)
  - Not Sampled (Blue circle)
- Drilled Wells**
- Sampled (Blue circle with dot)
  - Not Sampled (Blue circle)
- Other Wells**
- No Data (Yellow circle)
- Legend**
- Engineering Station**
- Surface Water Monitor (Blue circle with cross)
  - Mini-piezometer (Red circle with cross)
- Boreholes**
- Geotechnical (Red circle with cross)
  - Groundwater Monitor (Blue circle with cross)

- Contour (5m) (Black line)
- Intermittent Stream (Blue dashed line)
- Permanent Stream (Blue solid line)
- Cross-section (East Link) (Red triangle)
- Water Well Survey Study Area (Red dashed line)
- Technically Preferred Route (Red dashed line)
- Proposed Structure (Purple outline)
- Provincially Significant Wetland (Blue outline)
- Watershed (Black outline)
- Municipal Division (Grey outline)
- Waterbody (Blue fill)
- Cartographic Wetland (Blue hatched area)



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Surficial Geology: OGS Map Sheet of 3331; 1:50000



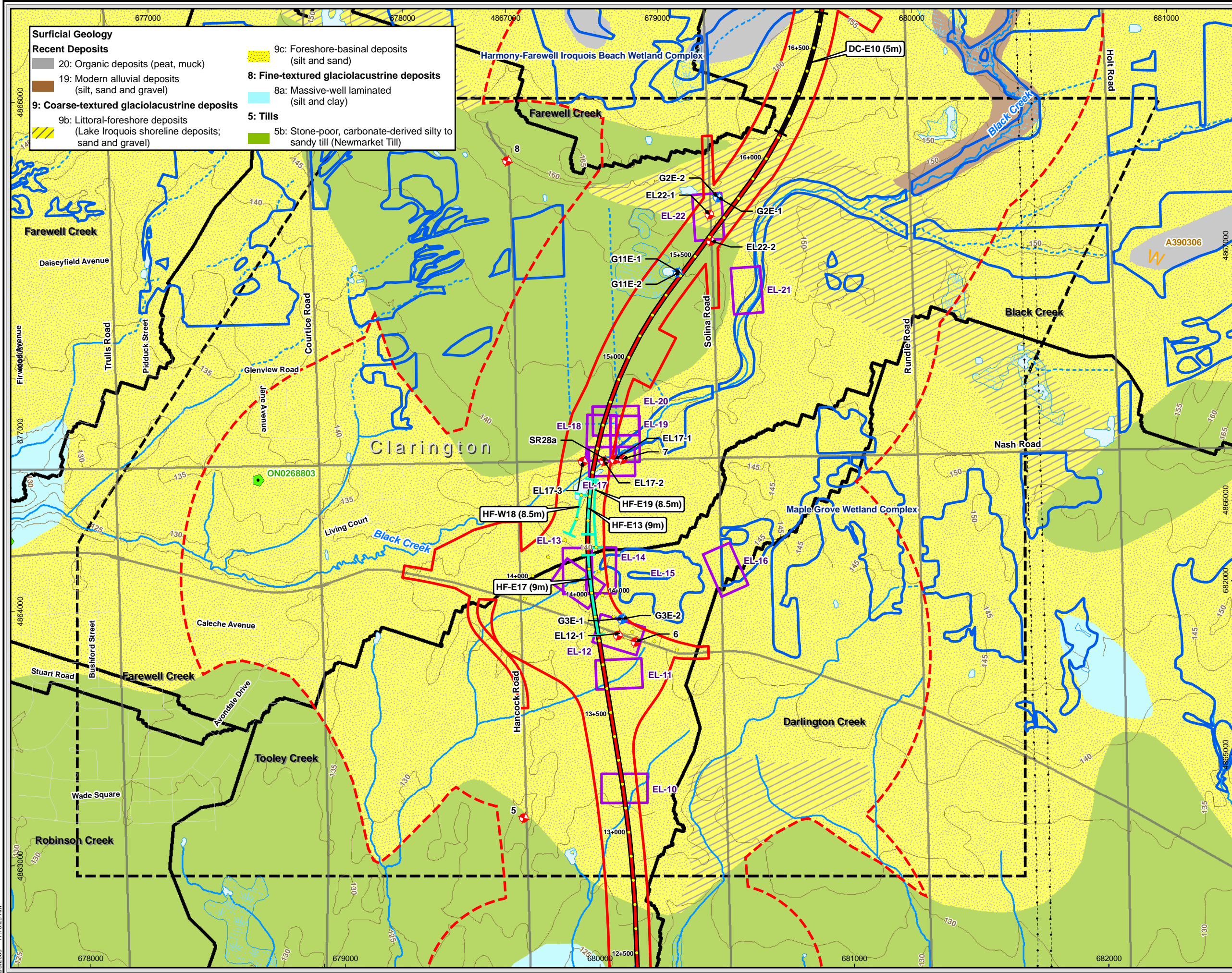
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407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Link**  
**Section ELb**  
February 2009  
Project 50613

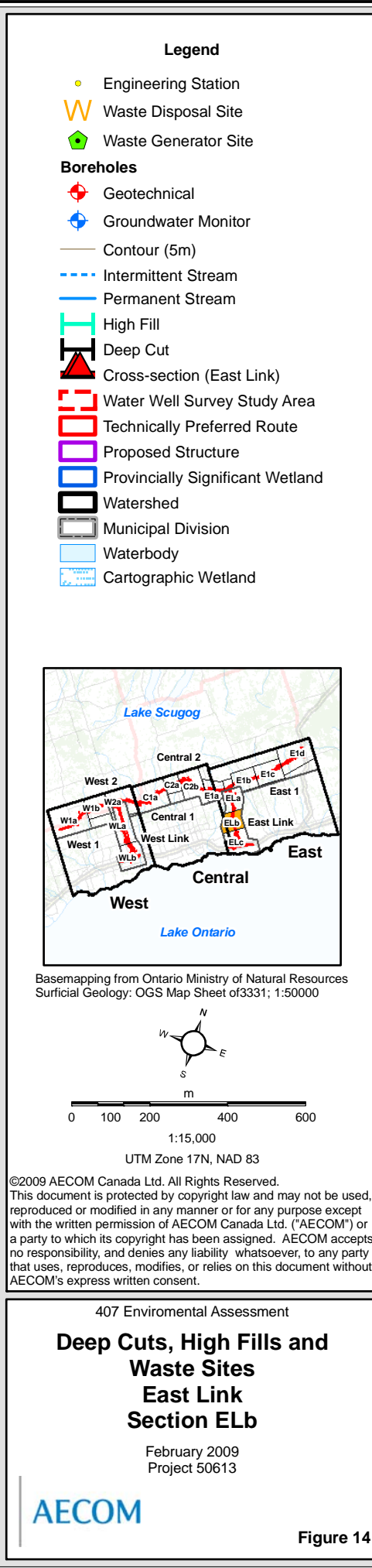
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Figure 13



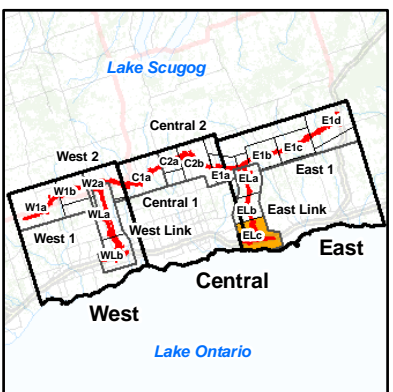
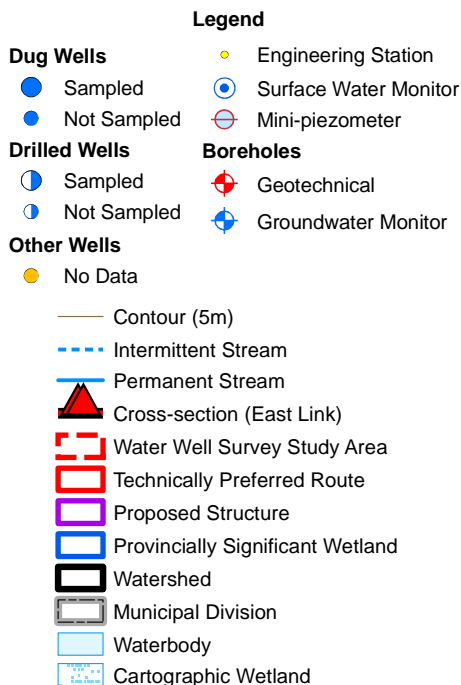
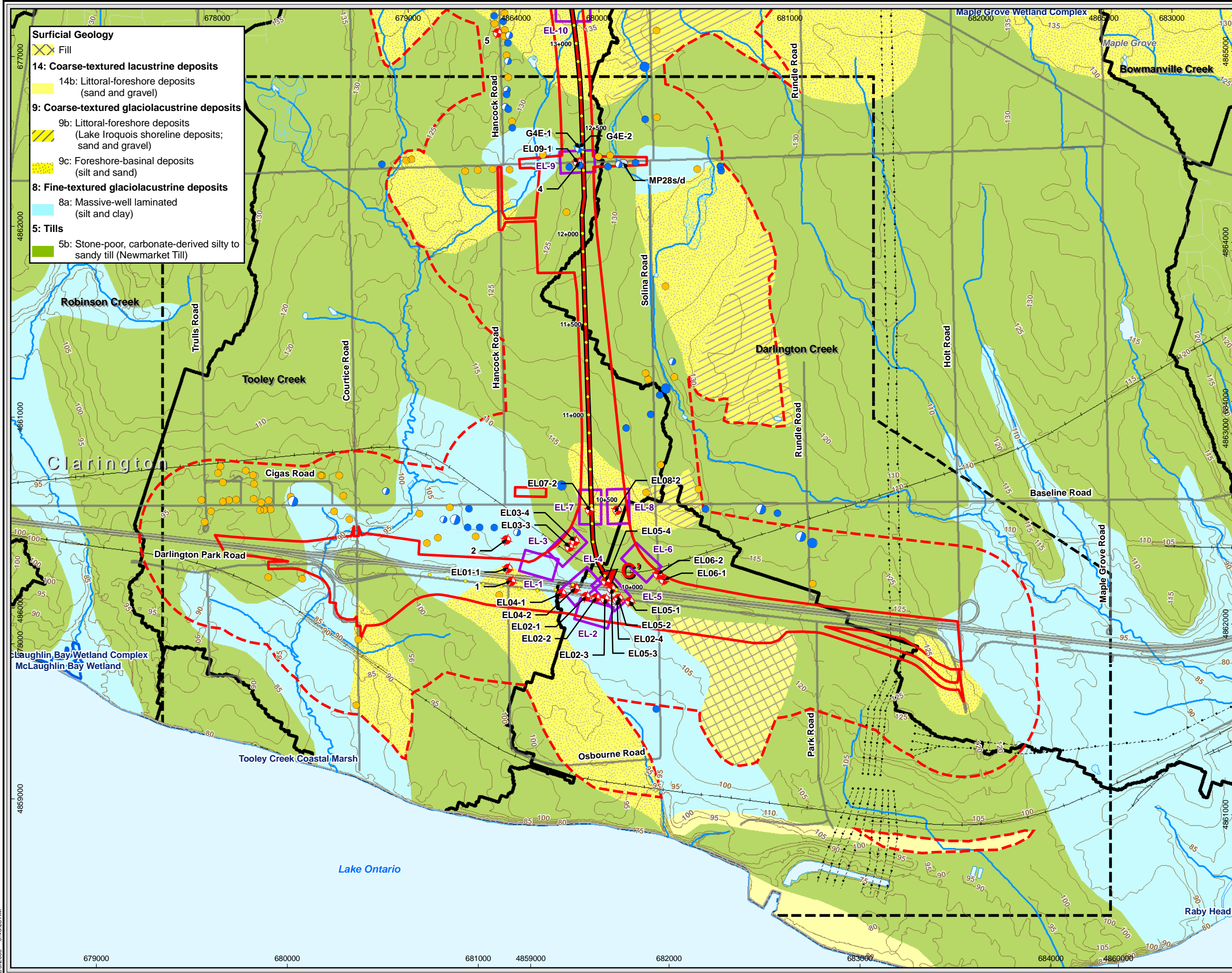


- Surficial Geology**
- Recent Deposits**
- 20: Organic deposits (peat, muck)
  - 19: Modern alluvial deposits (silt, sand and gravel)
- 9: Coarse-textured glaciolacustrine deposits**
- 9b: Littoral-foreshore deposits (Lake Iroquois shoreline deposits; sand and gravel)
- 9c: Foreshore-basinal deposits (silt and sand)
- 8: Fine-textured glaciolacustrine deposits**
- 8a: Massive-well laminated (silt and clay)
- 5: Tills**
- 5b: Stone-poor, carbonate-derived silty to sandy till (Newmarket Till)

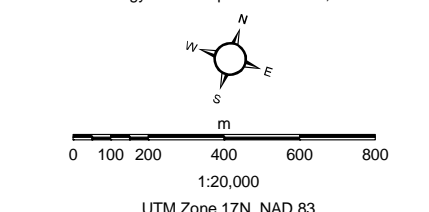




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Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000



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407 Environmental Assessment  
**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**  
**East Link Section ELC**  
February 2009  
Project 50613

AECOM

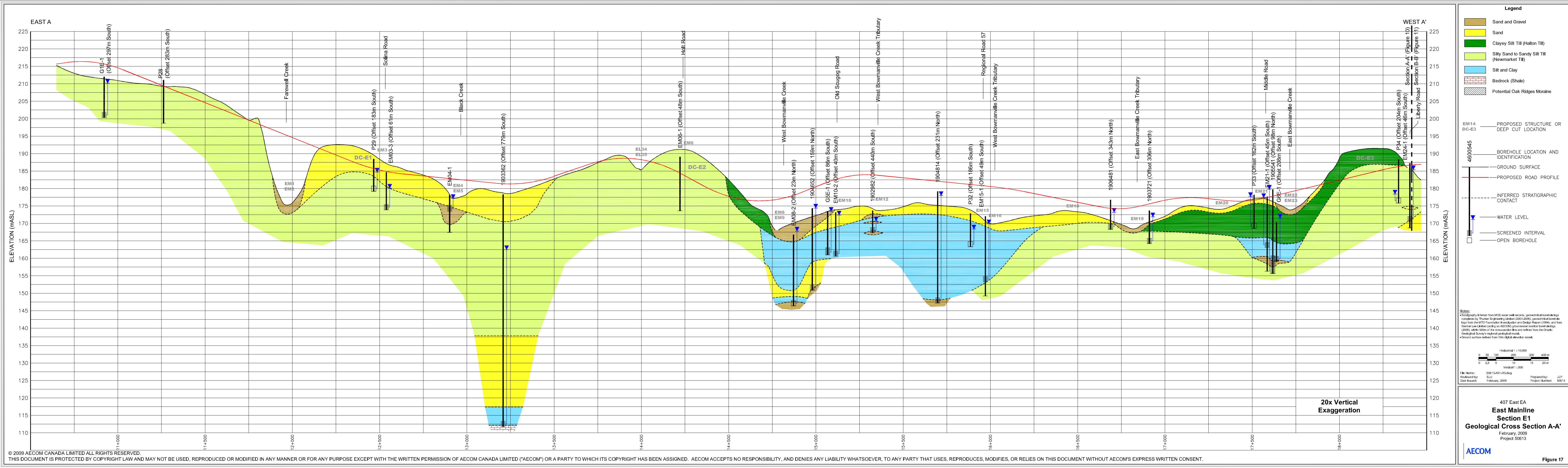
Figure 15



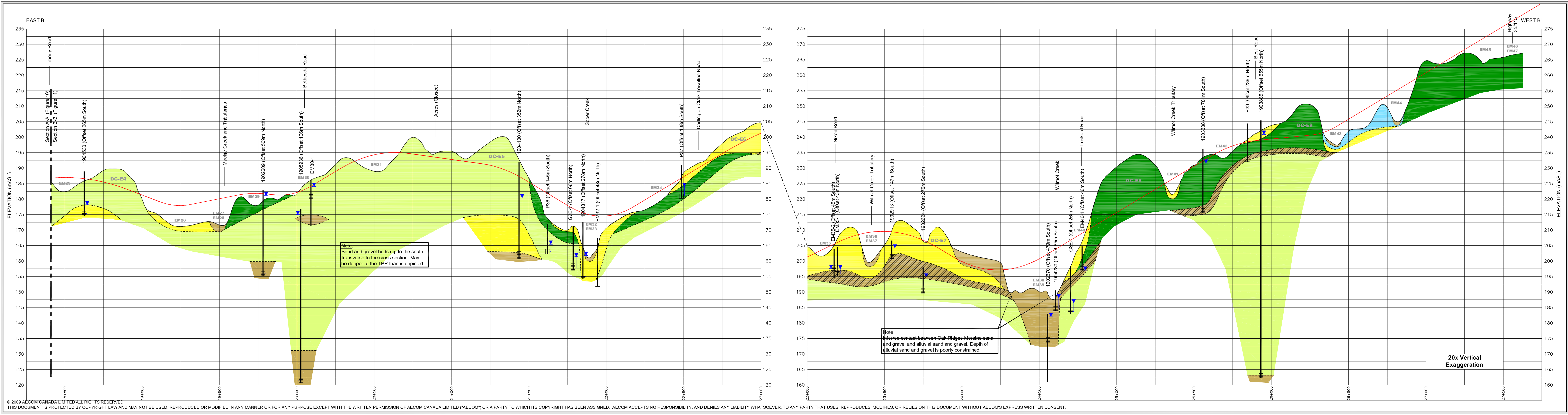




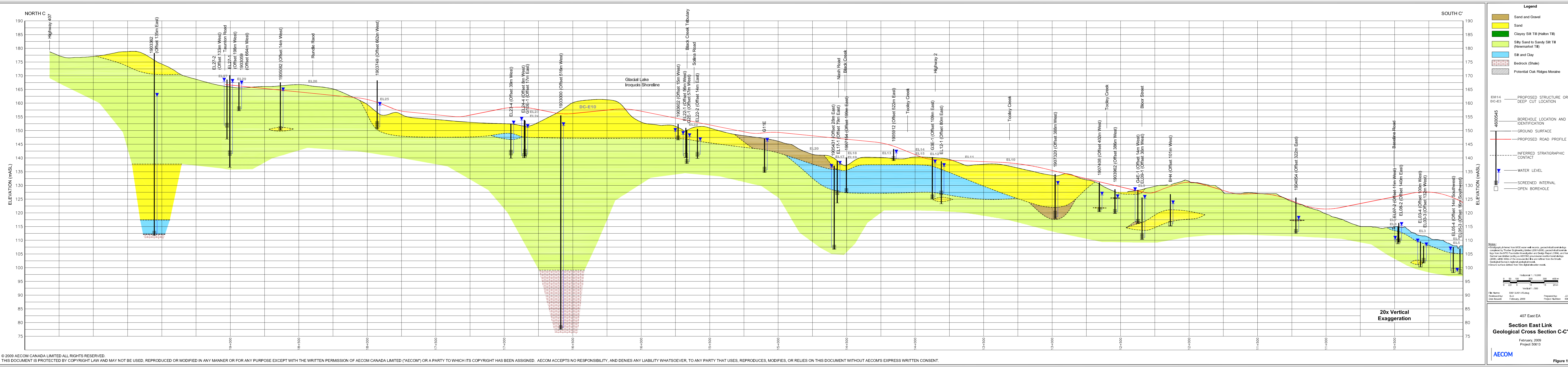
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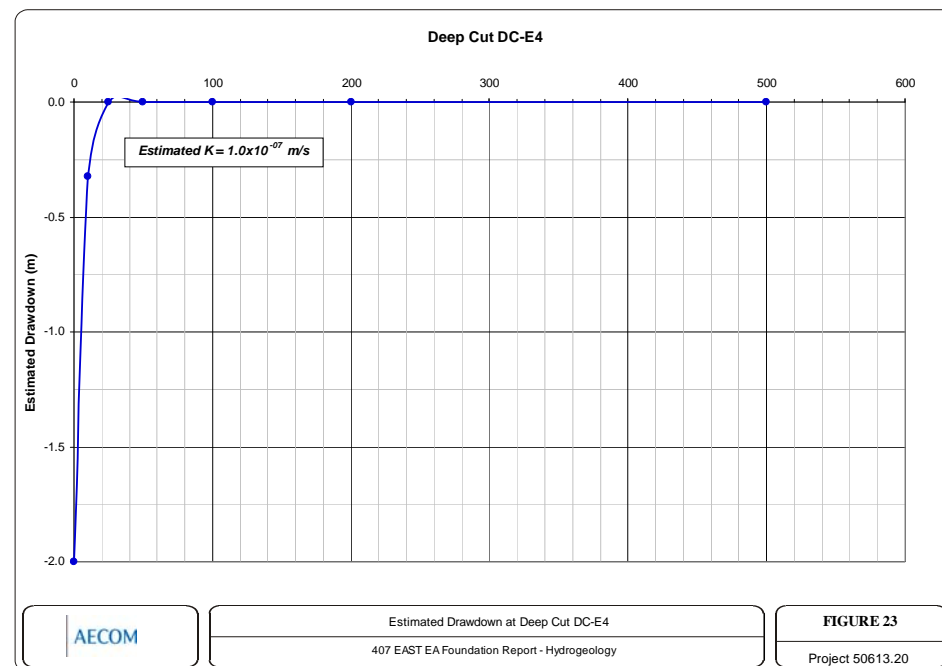
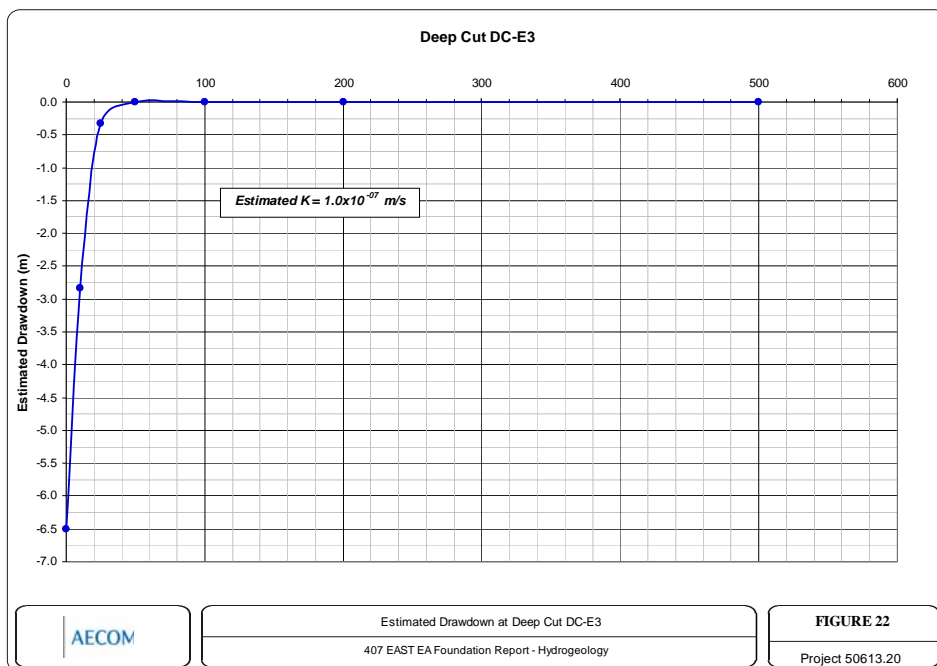
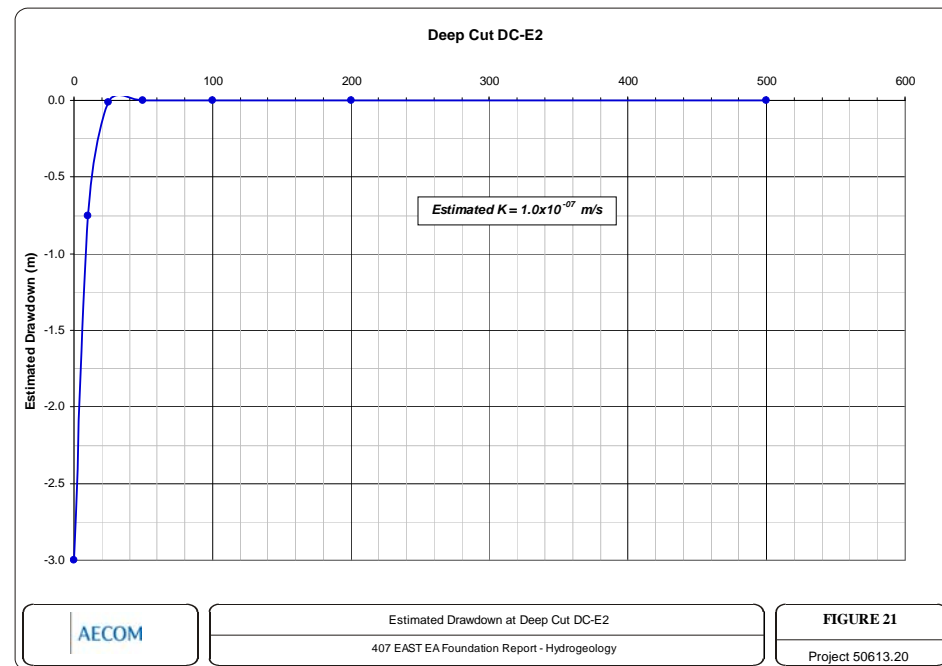
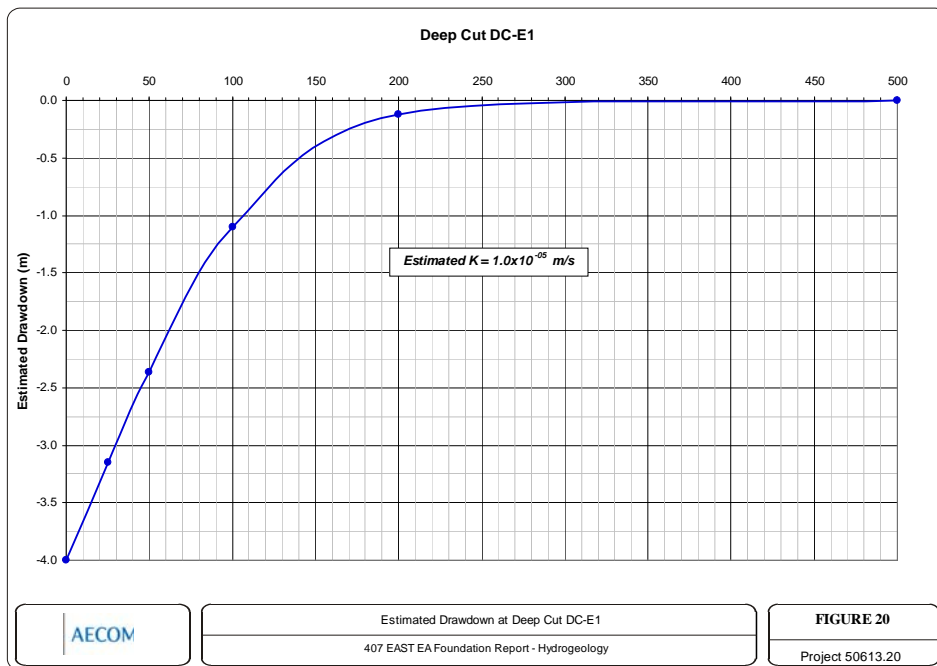
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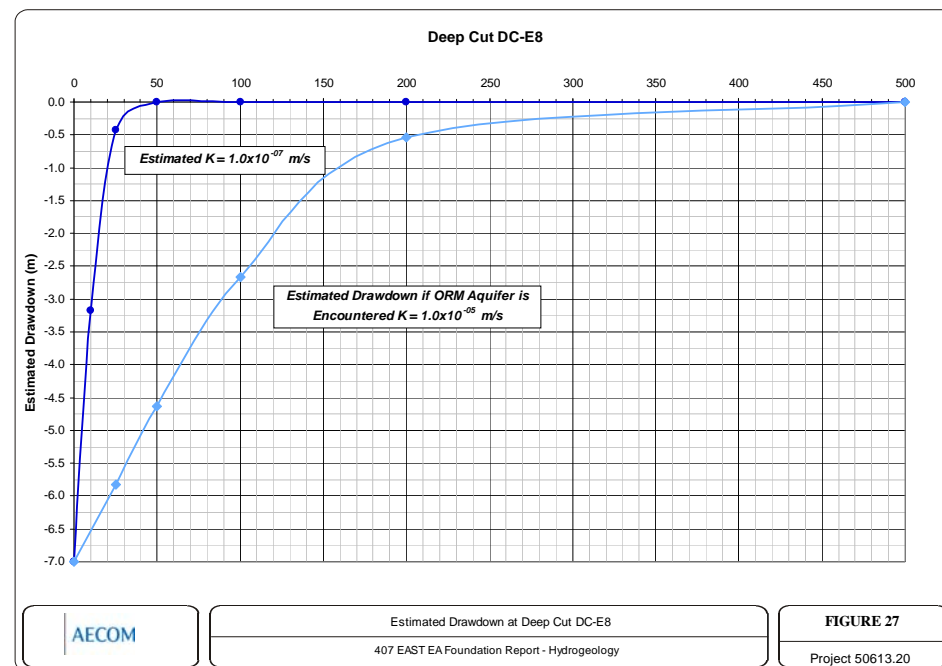
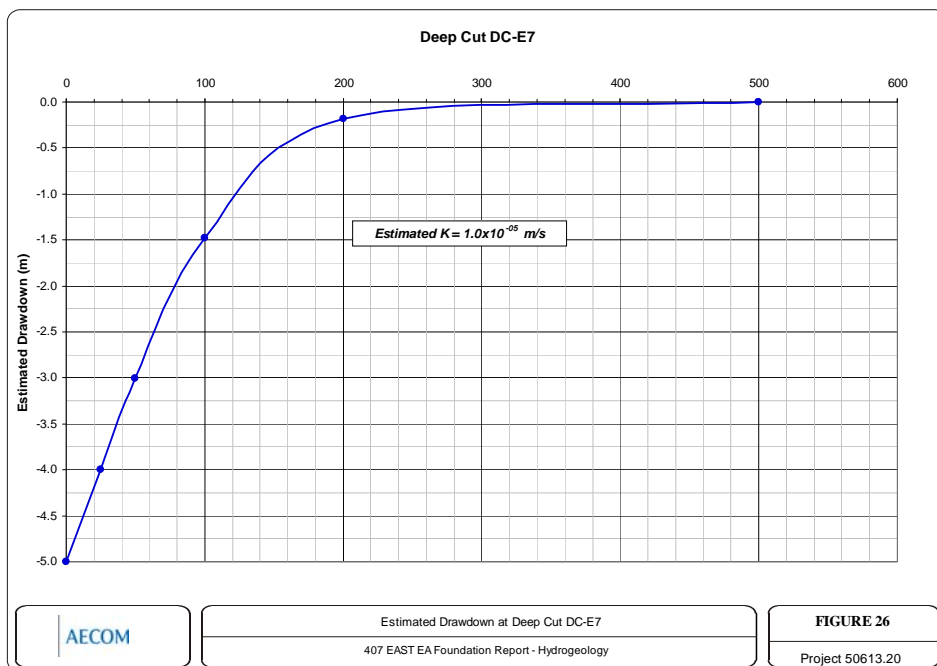
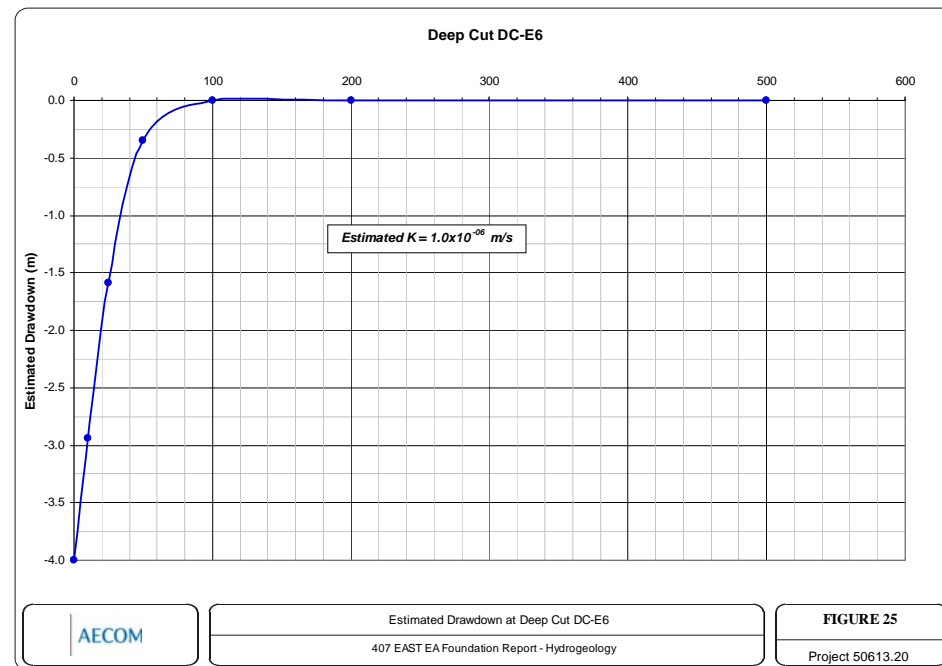
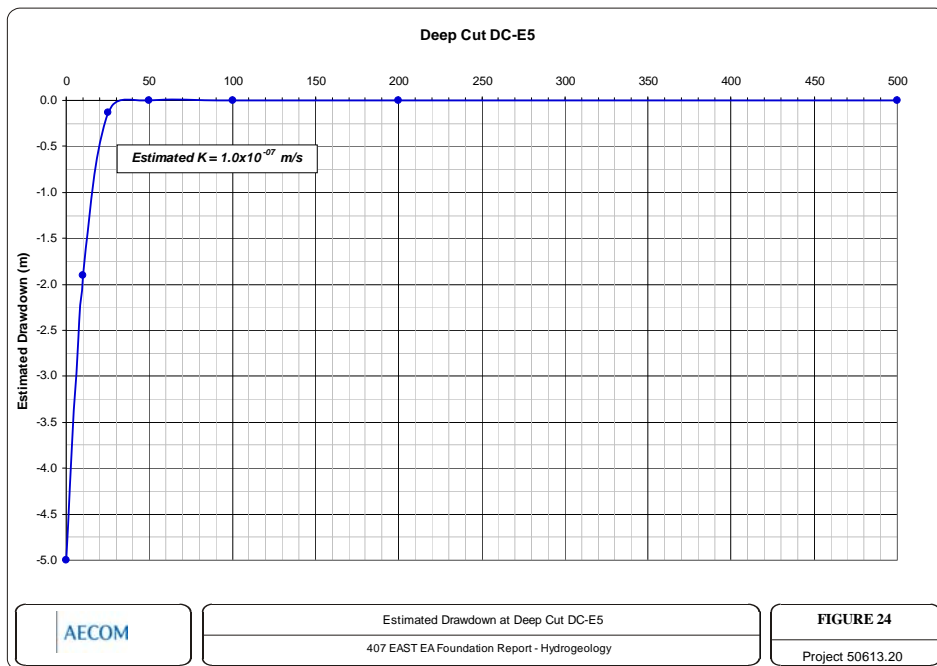




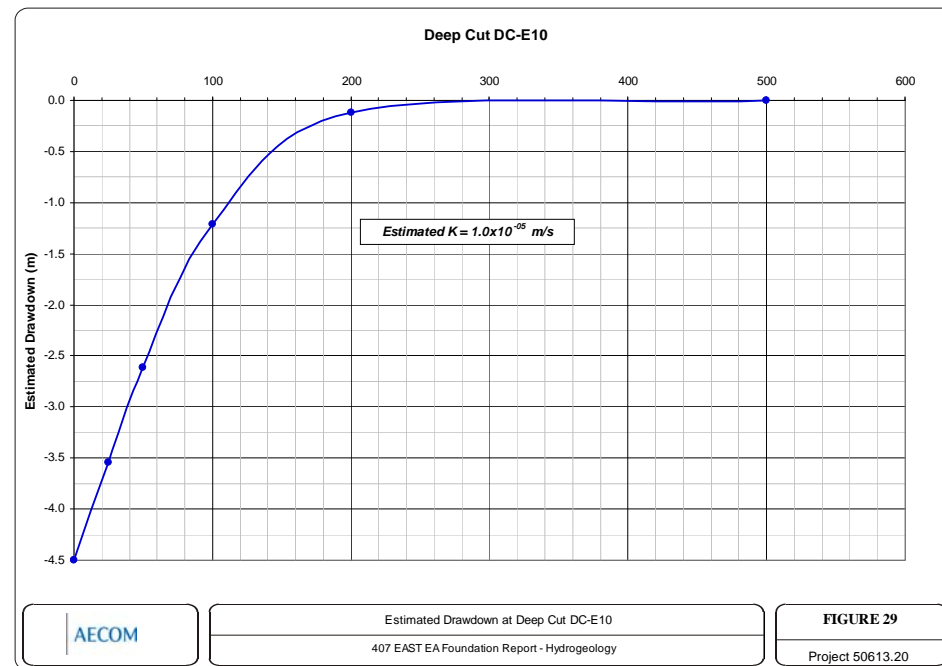
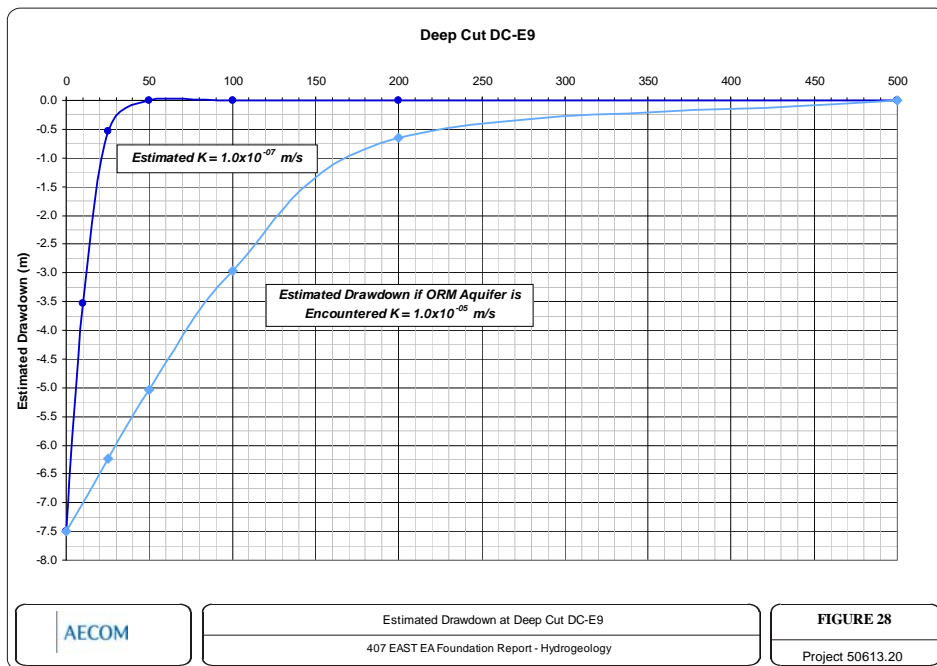






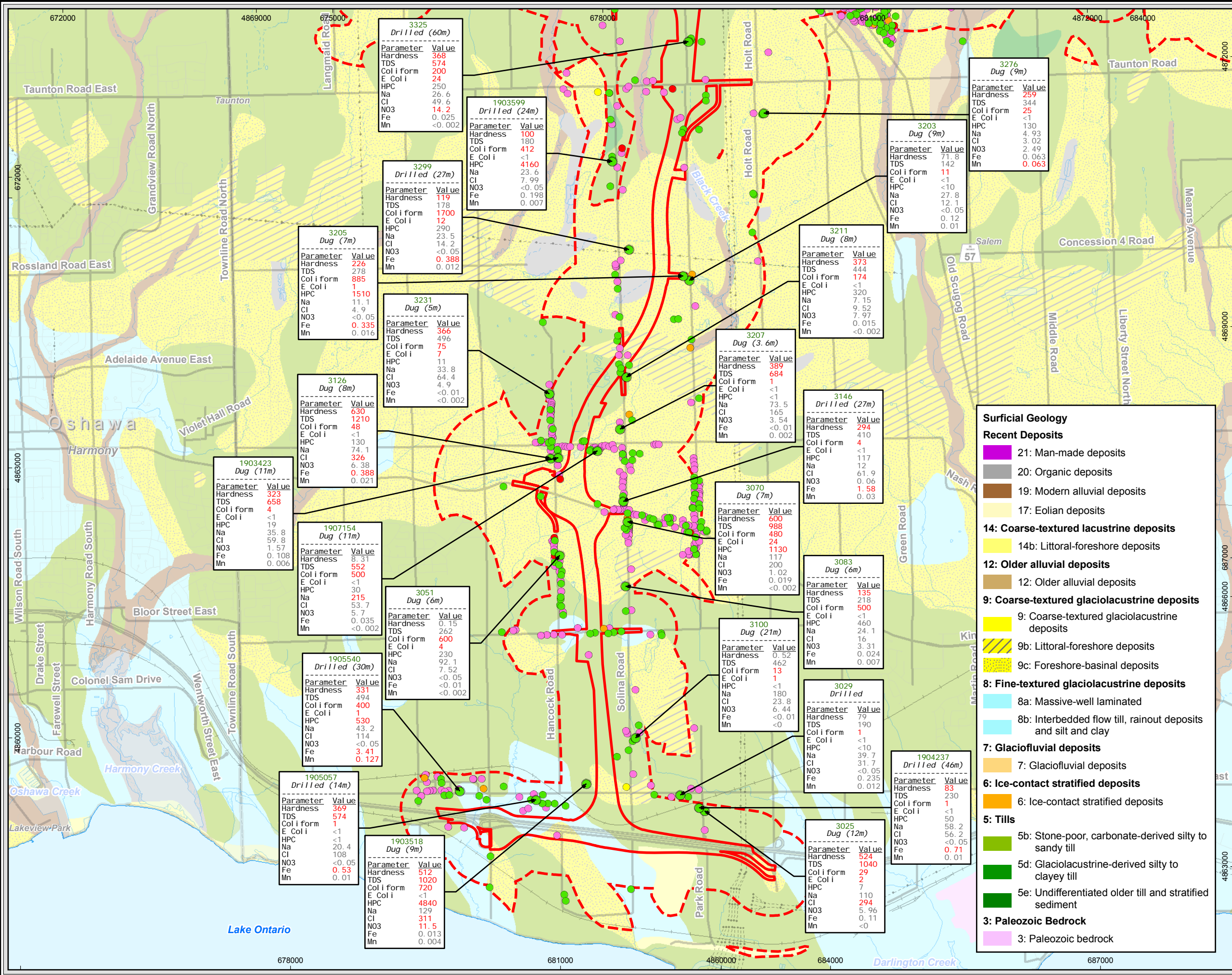












### Legend

500m Buffer from Centreline (in surficial tills/clay/silts) and 1000m Buffer from Centreline (in surficial sand & gravels)

Technically Preferred Route

Waterbody

Cartographic Wetland

### Well Survey Status

- Survey Complete/Sampled
- Survey Complete
- Survey Declined
- Survey Left
- Not Home
- No Survey
- Unable to Confirm
- Municipal Address/ Well Not Visited

GLL/MOE ID  
Well Type (depth)  
Parameter Value  
Water quality compared to ODWS

### Well Status - East Section

Status	East Section	%
Survey Complete	322	40.4
Survey Declined	9	1.1
Survey Left	31	3.9
Not Home	431	54.1
No Survey	2	0.3
Well Not Found	2	0.3
<b>Sampled</b>	<b>46</b>	<b>5.8</b>

### Well Statistics - East Section

Section	Total # of Wells	# of Wells in MOE Database	Wells Added
East	797	180	617

**Note:**  
The data frame has been rotated 18 degrees from north.  
Basemapping from Ontario Ministry of Natural Resources  
Surficial Geology: OGS Map Sheet of 3331; 1:50000

UTM Zone 17N, NAD 83

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### Surficial Geology

#### Recent Deposits

- 21: Man-made deposits
- 20: Organic deposits
- 19: Modern alluvial deposits
- 17: Eolian deposits

#### 14: Coarse-textured lacustrine deposits

- 14b: Littoral-foreshore deposits

#### 12: Older alluvial deposits

- 12: Older alluvial deposits

#### 9: Coarse-textured glaciolacustrine deposits

- 9: Coarse-textured glaciolacustrine deposits
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits

#### 8: Fine-textured glaciolacustrine deposits

- 8a: Massive-well laminated
- 8b: Interbedded flow till, rainout deposits and silt and clay

#### 7: Glaciofluvial deposits

- 7: Glaciofluvial deposits

#### 6: Ice-contact stratified deposits

- 6: Ice-contact stratified deposits

#### 5: Tills

- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 5e: Undifferentiated older till and stratified sediment

#### 3: Paleozoic Bedrock

- 3: Paleozoic bedrock

### 407 Environmental Assessment

## Water Well Survey

### East Link Section - Hydrogeology

February 2009  
Project 50613

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Figure 31

# Appendix A

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## Hydrogeology Borehole Logs











<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3E-1 1 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> December 12, 2007 <b>LOGGED BY</b> RBC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
		<b>TOPSOIL</b> Brown silt, trace fine sand, some rootlets, moist, dense.			1		SS	35	11	66									
0.9					2		SS	11	22	56									
1.6		<b>SAND</b> Dark brown fine sand, some medium sand, trace coarse sand, trace clay, compact, moist to saturated, compact.			3		SS	42	14	75									
		Increasing silt content below about 1.1 m																	
2		<b>SILTY SAND</b> Brown to grey silty sand, trace to some clay, wet, compact to dense. -Becoming saturated below about 2.3 m.			4		SS	20	20	75									
3.1					5		SS	26	14	96									
		<b>CLAYEY SILT</b> Grey clayey silt, trace sand, wet, very stiff.			6		SS	22	14	88									
4					7		SS	22	14	92									
5.0																			
		<b>CLAY AND SILT</b> Grey clay and silt, trace sand, saturated, soft to very soft.			8		SS	6	25	100									
6																			
7																			
8					9		SS	6	28	81									
9																			
					10		SS	4	27	100									

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3E-1 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> December 12, 2007 <b>LOGGED BY</b> RBC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
					11		SS	0	28	100									
11																			
12.2					12		SS	27	9	71									
		<b>SILTY SAND TILL</b> (Newmarket Till) Grey silty sand till, some fine gravel, trace clay, compact to very dense, saturated.																	
13																			
					13		SS	39	10	25									
14																			
					14		SS	55	8	100									
15.2																			
		Borehole terminated at 15.24 m in silty sand till.																	
		Water level: 2.50 metres below ground measured June, 2008.																	

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Path: C:\Users\GartnerLee\Documents\Projects\50-613\G3E-1\Borehole Logs\G3E-1\Borehole Log 2 of 2.dwg



BOREHOLE LOG		PROJECT: 50-613		BOREHOLE: G3E-2		1 of 1													
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation				DATE: December 12, 2007 LOGGED BY RBC GROUND ELEV m ASL															
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40	
0.9		TOPSOIL Brown silt, trace fine sand, some rootlets, moist, dense.																	
1.6		SAND Dark brown fine sand, some medium sand, trace coarse sand, trace clay, compact, moist to saturated, compact.																	
2		Increasing silt content below about 1.1 m																	
3.1		SILTY SAND Brown to grey silty sand, trace to some clay, wet, compact to dense. -Becoming saturated below about 2.3 m.																	
4		CLAYEY SILT Grey clayey silt, trace sand, wet, very stiff.																	
4.6		Borehole terminated at 4.57 m in clayey silt.																	
		Water level: 1.49 metres below ground measured June, 2008.																	
		Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G3E-1.																	



BOREHOLE LOG		PROJECT: 50-613		BOREHOLE: G4E-1 1 of 2														
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation				DATE: March 31, 2008 LOGGED BY HSA GROUND ELEV m ASL														
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE				WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40
0.2		TOPSOIL Brown sandy silt, rootlets, loose, moist.			1		SS	11	57	50								
		SAND AND SILT TILL (Newmarket Till) Dark brown sand and silt till, some clay, trace gravel, massive, moist, compact to dense.		▽	2		SS	68	9	100			>>					
1.5		SILTY SAND TILL (Newmarket Till) Grey silty sand till, some gravel, trace clay, massive, moist, very dense.			3		SS	15/ 0.13m	10	100								
					4		SS	50/ 0.13m	10	100								
					5		SS	50/ 0.13m	10	100								
					6		CS	0.13m	8									
										12								
					7		CS		9									
					8		CS		11									
					9		CS		14									
7.7		SANDY SILT Grey sandy silt, trace clay, saturated, compact to dense. -Silt content increasing below about 8.0 m.																
8.1		SILTY SAND TILL (Newmarket Till) Grey silty sand till, some clay, trace gravel, massive, saturated, very dense.			10		CS		17									



BOREHOLE LOG		PROJECT: 50-613		BOREHOLE: G4E-1		2 of 2														
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation				DATE: March 31, 2008 LOGGED BY HSA GROUND ELEV m ASL																
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE				WATER CONTENT (%)						
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40		
11 11.3					11		CS	21												
12.1 12		GRAVELLY SAND TILL (Newmarket Till) Grey gravelly sand till, some silt, trace clay, massive, saturated, very dense.																		
		Borehole terminated at 12.09 m in gravelly sand till.																		
		Water level: 0.80 metres below ground measured June, 2008.																		

BOREHOLE LOG			PROJECT: 50-613			BOREHOLE: G4E-2			1 of 1										
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation						DATE: April 1, 2008 LOGGED BY HSA GROUND ELEV m ASL													
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE				WATER CONTENT (%)					
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	1	5	30	45	60	10	20	30	40
0.2		TOPSOIL Brown sandy silt, rootlets, loose, moist.																	
1		SAND AND SILT TILL (Newmarket Till) Dark brown sand and silt till, some clay, trace gravel, massive, moist, compact to dense.		▽															
1.5		SILTY SAND TILL (Newmarket Till) Grey silty sand till, some gravel, trace clay, massive, moist, very dense.																	
2																			
3																			
4																			
5																			
6.1		Borehole terminated at 6.10 m in silty sand till.  Water level: 0.97 metres below ground measured June, 2008.  <i>Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G4E-1.</i>																	





<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G5E-2 1 of 1
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 11, 2008 <b>LOGGED BY:</b> CRC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
0.1		<b>TOPSOIL</b> Dark brown clayey silt, trace sand, rootlets, wet, loose.																	
0.8		<b>SILTY SAND</b> Brown silty sand, trace clay, wet, loose to compact.																	
1		<b>CLAYEY SILT</b> Grey clayey silt interbedded with silty sand to sand, trace fine sand, trace fine gravel, wet, compact to dense.																	
2.3		- silty sand encountered from about 2.3 to 2.5 m.																	
2.5																			
2.9		- sand encountered from about 2.9 to 3.4 m.																	
3.4																			
4.4		<b>CLAYEY SILT TILL (Halton Till)</b> Grey clayey silt till, trace sand, trace fine gravel angular, massive, moist, very dense.																	
6.1		Borehole terminated at 6.10 m in clayey silt till.																	
		Water level: 0.51 metres below ground measured June, 2008.																	
		Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G5E-1.																	

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G6E-1 1 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 14, 2007 <b>LOGGED BY:</b> RBC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
		<b>TOPSOIL</b> Brown clayey silt, some sand, some organic material, some rootlets, saturated, loose.			1		SS	14	37	17									
1					2		SS	7	17	21									
1.5		<b>FILL</b> Brown silt fill, trace to some fine to coarse sand, trace fine to coarse gravel, saturated, compact.			3		SS	16	21	38									
2					4		SS	43	11	83									
2.7		<b>CLAY AND SILT TILL (Halton Till)</b> Grey clay and silt till, some fine to coarse sand, trace fine sub-angular gravel, saturated, very dense to compact. Thin fine to coarse sand and gravel layer at upper till contact.			5		SS	16	22	67									
3					6		SS	55	13	83									
4					7		SS	40	17	100									
5																			
6					8		SS	15	22	100									
7																			
7.6		<b>CLAYEY SILT</b> Grey clayey silt, trace to some fine sand, firm to very stiff, saturated.			9		SS	8	26	100									
8																			
9					10		SS	30	11	83									



<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G6E-1 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> December 14, 2007 <b>LOGGED BY</b> RBC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
10.9					11	SS	9	15	52										
11.3		<b>SAND</b> Grey fine sand, trace silt, saturated, loose.  Borehole terminated at 11.28 m in sand.  Water level: 1.09 metres above ground measured June, 2008.																	

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G6E-2 1 of 1
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> December 14, 2007 <b>LOGGED BY</b> RBC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
1		<b>TOPSOIL</b> Brown clayey silt, some sand, some organic material, some rootlets, saturated, loose.																	
1.5		<b>FILL</b> Brown silt fill, trace to some fine to coarse sand, trace fine to coarse gravel, saturated, compact.																	
2.7		<b>CLAY AND SILT TILL (Halton Till)</b> Grey clay and silt till, some fine to coarse sand, trace fine sub-angular gravel, saturated, very dense to compact. Thin fine to coarse sand and gravel layer at upper till contact.																	
4.6		Borehole terminated at 4.57 m in clay and silt till.  Water level: 2.8 metres below ground measured June, 2008.  <i>Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G6E-1.</i>																	

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G7E-1 1 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 10, 2008 <b>LOGGED BY:</b> CRC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
0.1		<b>TOPSOIL</b> Brown clayey silt, trace sand rootlets, moist, firm.			1		SS	5	38	38									
		<b>SANDY SILT</b> Dark to light brown sandy silt, trace to some clay, moist, loose to compact.			2		SS	6	22	100									
		- 0.01 m thick fine sand seam at about 1.5 m.			3		SS	12	24	83									
2.1		<b>CLAYEY SILT TILL (Horton Till)</b> Brown clayey silt till, with sand, trace fine gravel rounded to sub-angular, moist, compact to dense.			4		SS	17	12	83									
					5		SS	23	10										
					6		SS	34	11	100									
4.5		<b>SANDY SILT TILL (Newmarket Till)</b> Light brown sandy silt till, trace to some clay, trace iron staining, saturated, compact to dense. -Trace of iron staining observed between about 4.6 and 5.2 m.			7		SS	35	10	100									
		-Cobbles (angular) encountered between about 6.1 and 7.9 m.			8		SS	35	12	83									
		-Becoming saturated below about 8.2 m.			9		SS	65/ 0.25 m	13	100									
		-Minor iron staining noted below about 9.1 m.			10		SS	31	15	100									

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G7E-1 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 10, 2008 <b>LOGGED BY:</b> CRC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
10.7		<b>SANDY SILT</b> Light brown to grey sandy silt, trace clay, trace iron staining, saturated, loose to compact.			11		SS	15	18	75									
					12		SS	89	19	100									
13.7		<b>SILT</b> Grey silt, trace to some clay, trace sand, saturated, very dense.			13		SS	71/ 0.28 m	20										
14.3		Borehole terminated at 14.33 m in Silt.																	
		Water level: 9.17 metres below ground measured June, 2008.																	

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BOREHOLE LOG		PROJECT: 50-613		BOREHOLE: G7E-2		1 of 2													
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation				DATE: January 10, 2008 LOGGED BY CRC GROUND ELEV m ASL															
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40	
0.1		TOPSOIL Brown clayey silt, trace sand rootlets, moist, firm.																	
1		SANDY SILT Dark to light brown sandy silt, trace to some clay, moist, loose to compact.  - 0.01 m thick fine sand seam at about 1.5 m.																	
2.1		CLAYEY SILT TILL (Halton Till) Brown clayey silt till, with sand, trace fine gravel rounded to sub-angular, moist, compact to dense.																	
3																			
4																			
4.5		SANDY SILT TILL (Newmarket Till) Light brown sandy silt till, trace to some clay, trace iron staining, saturated, compact to dense. -Trace of iron staining observed between about 4.6 and 5.2 m.																	
5																			
6		-Cobbles (angular) encountered between about 6.1 and 7.9 m.																	
7																			
8		-Becoming saturated below about 8.2 m.																	
9		-Minor iron staining noted below about 9.1 m.																	

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BOREHOLE LOG			PROJECT: 50-613			BOREHOLE: G7E-2			2 of 2										
407 East Extension East Mainline and East Link FOR: Ontario Ministry of Transportation						DATE: January 10, 2008 LOGGED BY CRC GROUND ELEV m ASL													
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE				WATER CONTENT (%)					
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40	
10.1		Borehole terminated at 10.06 m in sandy silt.  Water level: 8.77 metres below ground measured June, 2008.  <i>Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G7E-1.</i>																	

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G9E-2 1 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 17, 2008 <b>LOGGED BY</b> HSA <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)					
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC										
											15	30	45	60	10	20	30	40		
0.1		<b>TOPSOIL</b> Dark brown silty sand, moist, loose.			1		SS	3	44	74	■									▲
1		<b>SAND</b> Brown fine to medium sand, trace silt, trace clay, moist, loose to compact.			2		SS	6	14	70	■									▲
					3		SS	5	10	100	■									▲
2.4		<b>SANDY GRAVEL TO GRAVELLY SAND</b> Brown to grey sandy gravel to gravelly sand, trace silt, trace clay, trace to some cobbles rounded to sub-rounded, moist, very dense.			4		SS	23	2	57	■							▲		
3		5				SS	50/ 0.11m	2	52								▲			
		6				SS	82/ 0.25m	3	51									▲		
4		7				SS	50/ 0.13m	3	41									▲		
5		8				SS	50/ 0.08m	2	36									▲		
6		9				SS	50/ 0.13m	2	28									▲		
7		10				SS	50/ 0.13m	2	56									▲		
8		11				SS	50/ 0.09m	2	34										▲	
9		12				SS	50/ 0.11m		5											▲
		13				SS	50/ 0.05m	3	26											▲

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G9E-2 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 17, 2008 <b>LOGGED BY</b> HSA <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)			
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	N VALUE				WATER CONTENT (%)			
											15	30	45	60	10	20	30	40
10.7		BOREHOLE ABANDONED AND GROUTED WITH BENTONITE TO SURFACE SEE BH9E-1 FOR REMAINDER OF PROFILE.			14		SS	50/ 0.09m	6	0								



<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G10E-1 1 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> August 15, 2008 <b>LOGGED BY:</b> CRC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
1		<b>SILTY SAND FILL</b> Dark brown silty sand fill, some clay, trace to some organics, concrete fragments and asphalt moist becoming wet at about 1.7 m, loose to compact.			1		SS	9	18	100									
					2		SS	27	9	100									
2					3		SS	14	11	100									
2.4		<b>SILTY SAND</b> Grey silty fine sand, trace clay, trace gravel, saturated, loose to compact.			4		SS	18	16	100									
3					5		SS	18	17	100									
4					6		SS	16	17	100									
5					7		SS	29	13	100									
6					8		SS	4	8	100									
7					9		SS	59	7	100									
8.2		<b>SILTY SAND TILL (Newmarket Till)</b> Grey silty sand till, some gravel sub-angular, trace cobbles, trace clay, saturated.			10		SS	102	9	100									
9																			

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G10E-1 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> August 15, 2008 <b>LOGGED BY:</b> CRC <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)				
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC									
11					11		SS	00/0.109	109	100									
12					12		SS	00/0.151	151	100									
13.0		Borehole terminated at 12.96 m in silty sand till.  Water level: 2.35 metres below ground measured October, 2008.																	








<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G11E-1 2 of 2
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> October 20, 2008 <b>LOGGED BY</b> CRC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)			
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	N VALUE				WATER CONTENT (%)			
											15	30	45	60	10	20	30	40
11					11		SS	18	18	100	■					▲		
12.4					12		SS	18	11	100	■					▲		
		Borehole terminated at 12.42 m in silty sand.  Water level: 0.8 metres below ground measured October, 2008.																

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G11E-2 1 of 1
407 East Extension East Mainline and East Link <b>FOR:</b> Ontario Ministry of Transportation		<b>DATE:</b> October 20, 2008 <b>LOGGED BY</b> CRC <b>GROUND ELEV</b> m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE						N VALUE				WATER CONTENT (%)					
					NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	15	30	45	60	10	20	30	40		
0.1		<b>TOPSOIL.</b> Dark brown silty sand, trace gravel, some rootlets, moist, very loose.		▽																
1		<b>SAND</b> Brown sand (medium to coarse), trace gravel, saturated, loose.																		
1.6																				
1.9			<b>GRAVEL.</b> Brown gravel (medium to coarse), trace medium sand, saturated, loose.																	
2	<b>SAND AND GRAVEL.</b> Brown sand and gravel (fine to medium), trace to some silt, saturated, compact.																			
3																				
4.0		Borehole terminated at 3.96 m in sand and gravel.  Water Level : 0.79 mBGS, measured October, 2008  <i>Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G11E-1.</i>																		

# Appendix B

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## Geotechnical Borehole Logs





RECORD OF BOREHOLE No EM03-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 859 948.6 E 352 496.1 Solina Road				ORIGINATED BY TG							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-12 - 2007-12-12				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
						20 40 60 80 100	20 40 60 80 100						
188.8	ASPHALT (100mm)												
0.0	Sandy SILT, mixed with topsoil		1	SS	9								
0.1	Loose to Compact		2	SS	23								
	Dark brown (FILL)												
187.3	SAND, trace silt, trace gravel		3	SS	16								
1.5	Compact												
	Brown												
	Moist												
186.4	SILT, some sand, trace gravel, trace clay		4	SS	39								
2.4	Dense to Very Dense												
	Brown												
	Moist												
			5	SS	90/								
					275								
184.4	Silty SAND, trace gravel, trace clay		6	SS	50/								
4.4	Very Dense				125								
	Brown												
	Moist												
	some gravel		7	SS	100/								
					200								
			8	SS	100/								
					125								
180.2	Sandy SILT, some clay, trace gravel		9	SS	100/								
8.5	Very Dense				100								
	Brown												
	Moist												
	(FILL)												
179.0	END OF BOREHOLE AT 9.75m												
9.8													

Continued Next Page

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



RECORD OF BOREHOLE No EM03-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 859 948.6 E 352 496.1 Solina Road				ORIGINATED BY TG							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-12 - 2007-12-12				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
						20 40 60 80 100	20 40 60 80 100						
	Continued From Previous Page												
	UPON AUGER REFUSAL.												
	BOREHOLE BACKFILLED WITH												
	BENTONITE TO 0.15m AND												
	ASPHALT TO SURFACE												

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



RECORD OF BOREHOLE No EM03-2												1 OF 2		METRIC							
G.W.P. W.O. 07-20017		LOCATION N 4 869 949.4 E 362 529.0 Soina Road				ORIGINATED BY TG															
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES															
DATUM Goodale		DATE 2007-12-12 - 2007-12-12				CHECKED BY AEG															
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	40	60	20
185.1	ASPHALT (100mm)		1	SS	15																
184.3	SAND, gravelly, some topsoil Compact Dark Brown Moist (FILL)		2	SS	23																
	Clayey SILT, some sand, trace gravel, occasional black staining Very Stiff to Hard Brown		3	SS	15																
			4	SS	44																
182.1	Clayey SILT, with sand, trace gravel, occasional oxide lenses Hard Brown (TILL)(CL)		5	SS	88																
180.8	SAND and SILT, trace gravel, trace clay Very Dense Grey Moist (TILL)		6	SS	100/200																
179.0	Silty SAND, some gravel, trace clay Very Dense Brown Moist		7	SS	50/125																
			8	SS	55/100																
176.4	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/125																

Continued Next Page

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

ONTM14S 1140 G.P.J. 8/12/08



RECORD OF BOREHOLE No EM03-2												2 OF 2		METRIC							
G.W.P. W.O. 07-20017		LOCATION N 4 869 949.4 E 362 529.0 Soina Road				ORIGINATED BY TG															
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES															
DATUM Goodale		DATE 2007-12-12 - 2007-12-12				CHECKED BY AEG															
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	40	60	20
	Continued From Previous Page																				
174.3			10	SS	100/125																
10.0	END OF BOREHOLE AT 10.80m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.15m AND ASPHALT TO SURFACE																				

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

ONTM14S 1140 G.P.J. 8/12/08



ONTM4S 1140.GPJ 8/12/05

+<sup>3</sup>, ×<sup>3</sup>. Numbers refer to Sensitivity

CONTINUED ON GPJ 5/17/88

+ 3, X 3; Numbers refer to Sensitivity



RECORD OF BOREHOLE No EM04-1															1 OF 2		METRIC		
G.W.P. W.O. 07-20017		LOCATION					ORIGINATED BY W.B.												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2008.05.30 - 2008.05.30					CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	IN VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)		GR	SA
0.0	TOPSOIL Brown Moist		1	AS															
0.8	Silty SAND, trace gravel Loose Brown Moist		1	SS	7														
1.2	SAND and SILT, some clay, trace gravel Compact Brown Moist		2	SS	18														
2.3	SAND, some gravel, trace silt Compact Brown Moist		3	SS	25														
3.4	Sandy GRAVEL, some cobbles, trace silt Dense Grey Moist to Wet		4	SS	45														
4.3	Gravelly SAND, trace silt, trace cobbles Very Dense Brown Moist		5	SS	68														
			6	SS	57														
			7	SS	100N 275														
8.5	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		8	SS	100N 125														

Continued Next Page

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

ONTMFS 1142.GPJ 8/12/08



RECORD OF BOREHOLE No EM04-1															2 OF 2		METRIC		
G.W.P. W.O. 07-20017		LOCATION					ORIGINATED BY W.B.												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2008.05.30 - 2008.05.30					CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	IN VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)		GR	SA
	Continued From Previous Page																		
	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100														
10.8	END OF BOREHOLE AT 10.77m. WATER LEVEL AT 1.83m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m skirted screen																		
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV (m)																		

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

ONTMFS 1142.GPJ 8/12/08





RECORD OF BOREHOLE No EM04-2															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION					ORIGINATED BY W8											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.05.03 - 2008.06.03					CHECKED BY AEG											
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	GR
0.0	TOPSOIL, some silt Dark Brown Moist		1	AS														
			1	SS														
1.4	Sandy SILT, some clay, trace gravel Light Brown Moist		2	SS														
2.3	SAND, trace silt, trace gravel Compact to Dense Brown Moist		3	SS														
			4	SS														
4.0	Gravelly SAND, trace silt, trace clay Dense Brown Moist to Wet		5	SS														
6.1	SILT, some clay, trace gravel Hard Brown		6	SS														
6.4	SAND, some silt, trace gravel Very Dense Brown Damp																	
7.3	Sandy GRAVEL, trace silt, trace clay Very Dense Brown Damp		7	SS														
9.2	END OF BOREHOLE AT 9.24m WATER LEVEL AT 4.57m UPON COMPLETION BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.6m THEN AUGER		8	SS														

Continued Next Page

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



RECORD OF BOREHOLE No EM04-2															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION					ORIGINATED BY W8											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.05.03 - 2008.06.03					CHECKED BY AEG											
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	GR
	Continued From Previous Page CUTTINGS TO SURFACE																	

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

ONTARIOS 1140.GPJ 8/12/08

+ 3, X 3. Numbers refer to Sensitivity

ONTARIO 110 GPJ 8/12/88

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

CONTENTS : 140.GPJ 8/12/08

+<sup>3</sup>, ×<sup>3</sup>. Numbers refer to Sensitivity

00NTMT4S 1140.GPJ 8/12/08

+3, x3 Numbers refer to Sensitivity





RECORD OF BOREHOLE No EM06-1										1 OF 2	METRIC							
G.W.P. W.O. 07-20017		LOCATION N 4 870 754.3 E 363 855.4 Holt Road				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-13 - 2007-12-13				CHECKED BY AEG												
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	WATER CONTENT (%)
189.1	SAND, some gravel, trace silt Brown Moist (FILL)																	
188.6	SANDY SILT, trace gravel, trace clay Dense to Very Dense Brown Moist (TILL)		1	SS	44													
			2	SS	53													
			3	SS	64													
			4	SS	100/275							0 26 69 6						
			5	SS	100/200													
			6	SS	100/175													
182.0	Silty SAND, some clay, trace gravel Very Dense Brown Moist to Wet (TILL)		7	SS	70													
			8	SS	67							1 53 30 16						

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity  
20  
15-0-5  
10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM06-1										2 OF 2	METRIC							
G.W.P. W.O. 07-20017		LOCATION N 4 870 754.3 E 363 855.4 Holt Road				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-13 - 2007-12-13				CHECKED BY AEG												
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	WATER CONTENT (%)
	Continued From Previous Page																	
	Silty SAND, some clay, trace gravel Dense Gray Moist to Wet (TILL)		9	SS	33													
	Becoming Very Dense		10	SS	100/150													
			11	SS	100/150							3 50 33 15						
			12	SS	100/250													
173.6	END OF BOREHOLE AT 15.4m Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen  WATER LEVEL READINGS DATE DEPTH (m) ELEV (m)																	

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity  
20  
15-0-5  
10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM08-2 1 OF 3 METRIC																		
G.W.P. W.O. 07-20017		LOCATION N 4 871 191.9 E 364 441.8 (Eastside of Bowmanville Creek)					ORIGINATED BY WB											
HWY 407		BOREHOLE TYPE Hollow Stem Augers					COMPILED BY VM											
DATUM Geodetic		DATE 2008.05.04 - 2008.06.05					CHECKED BY AEG											
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			20	40					60	80	100	20	40	60
166.8	TOPSOIL Dark Brown Wet		1	AS														
166.2	Gravelly SAND, trace clay, trace silt Compact Brown Moist		1	SS	24													
165.1	SILT and SAND, trace clay, trace gravel, occasional oxide staining Compact Brown Moist		2	SS	24													
164.6	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		3	SS	56									1	10	57	32	
162.5	Silty CLAY, trace sand Hard Grey		5	SS	56/125													
162.5	becoming Very Stiff		6	SS	37									0	1	56	43	
150.6	SAND and SILT, trace clay Compact Grey Moist		13	SS	16													
149.1	Silty CLAY, trace sand Very Stiff Grey		14	SS	29													
147.8	GRAVEL, some sand, trace silt Compact Grey Wet		8	SS	15													

Continued Next Page

+ 3. X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE)

ONTM-T4S 1140.GPJ 8/12/08



RECORD OF BOREHOLE No EM08-2 2 OF 3 METRIC																		
G.W.P. W.O. 07-20017		LOCATION N 4 871 191.9 E 364 441.8 (Eastside of Bowmanville Creek)					ORIGINATED BY WB											
HWY 407		BOREHOLE TYPE Hollow Stem Augers					COMPILED BY VM											
DATUM Geodetic		DATE 2008.05.04 - 2008.06.05					CHECKED BY AEG											
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			20	40					60	80	100	20	40	60
	Continued From Previous Page																	
	Silty CLAY, trace sand Hard Grey		9	SS	12													
	becoming Firm		10	SS	5													
			11	SS	6													
			12	SS	5													
150.6	SAND and SILT, trace clay Compact Grey Moist		13	SS	16													
149.1	Silty CLAY, trace sand Very Stiff Grey		14	SS	29													
147.8	GRAVEL, some sand, trace silt Compact Grey Wet		8	SS	15													

Continued Next Page

+ 3. X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE)

ONTM-T4S 1140.GPJ 8/12/08

Continued Next Page

+3, x3 Numbers refer to Sensitivity

+ 3, X 3 Numbers refer to Sensitivity

0976-1821





RECORD OF BOREHOLE No EM08-2															3 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 191.9 E 354 441.8 (Eastside of Bowmanville Creek)					ORIGINATED BY WB											
HWY 407		BOREHOLE TYPE Hollow Stem Augers					COMPILED BY WM											
DATUM Geodetic		DATE 2008.06.04 - 2008.05.05					CHECKED BY AEG											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID			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	W P W W L	WATER CONTENT (%)	UNIT WEIGHT Y	GR SA SI CL					
	Continued From Previous Page																	
140.4	GRAVEL, some sand, trace silt Compact Grey Wet		15	SS	18													
20.4	END OF BOREHOLE AT 20.42 m ARTESIAN PRESSURE WAS ENCOUNTERED DURING DRILLING AT 19.20 m BOREHOLE SEALED WITH BENTONITE AND CEMENT.						146											

4 3 X 3 Numbers refer to Sensitivity  
20 15 10 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM10-1															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 337.1 E 354 653.9 Old Scugog Road					ORIGINATED BY TG											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2007-12-14 - 2007-12-14					CHECKED BY AEG											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID			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	W P W W L	WATER CONTENT (%)	UNIT WEIGHT Y	GR SA SI CL					
174.2	ASPHALT (150mm)																	
0.2	SAND, gravelly, some silt Very Dense to Compact Brown Moist (FILL)		1	SS	56													
			2	SS	25													
			3	SS	45													
171.9	Silty CLAY, some sand Very Silty Brown		4	SS	20													
171.3	SILT, some clay, trace sand Compact Grey		5	SS	29													
170.2	Silty CLAY, some sand Hard Grey		6	SS	100/225													
168.1	SAND, some silt, trace gravel Very Dense to Compact Brown Wet		7	SS	100/200													
			8	SS	24													
165.5	Silty CLAY, some sand, trace gravel Hard Brown (FILL)		9	SS	100/225													

Continued Next Page

4 3 X 3 Numbers refer to Sensitivity  
20 15 10 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM10-1															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 671 337.1 E 364 653.9 Old Scugog Road					ORIGINATED BY TG											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2007-12-14 - 2007-12-14					CHECKED BY AEG											
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	SHEAR STRENGTH kPa								WATER CONTENT (%)		
							20	40	60	80	100							
							UNCONFINED + FIELD VANE				QUICK TRIAXIAL X LAB VANE							
							20	40	60	80	100							
							WATER CONTENT (%)											
							20	40	60	80	100							
							WATER CONTENT (%)											
							20	40	60	80	100							
							WATER CONTENT (%)											
							20	40	60	80	100							
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							WATER CONTENT (%)											
							20	40	60	80	100							



RECORD OF BOREHOLE No EM10-2															2 OF 2		METRIC		
G.W.P. W.O. 07-20017		LOCATION N 4 871 252.3 E 354 683.0 Old Scugog Road					ORIGINATED BY TG												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-14 - 2007-12-14					CHECKED BY AEG												
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	T <sub>N</sub> VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	20 40 60	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	Y	GR SA SI CL				
162.8	Continued From Previous Page																		
10.4	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		10	SS	100/		163												
	SILT, some clay, trace sand Very Dense Grey (TILL)				225		162												
161.6																			
11.6	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		11	SS	100/		161												
160.6					250														
12.6	END OF BOREHOLE AT 12.60m. BOREHOLE OPEN UPON COMPLETION. Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.01.08 0.75 172.4 2008.03.20 0.13 173.02																		

+ 3, x 3 Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM10-3															1 OF 2		METRIC		
G.W.P. W.O. 07-20017		LOCATION N 4 871 233.3 E 354 683.5 Old Scugog Road					ORIGINATED BY TG												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-13 - 2007-12-13					CHECKED BY AEG												
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	T <sub>N</sub> VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	20 40 60	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	Y	GR SA SI CL				
173.0																			
0.1	ASPHALT (100mm)		1	SS	64/		173												
	SAND, gravelly, trace to some silt Very Dense to Compact Brown Moist (FILL)		2	SS	26		172												
			3	SS	15		171												
170.9																			
2.2	Silty CLAY, trace to some sand Stiff Grey (CL)		4	SS	13		170												
			5	SS	20														
169.0																			
4.0	Hard						169												
			6	SS	90		168												
			7	SS	100/		167												
					250														
165.7							166												
7.3	SAND and SILT, trace clay, trace gravel Dense to Very Dense Brown Moist (TILL)		8	SS	48		165												
			9	SS	100/		164												
					225														
163.0																			

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+ 3, x 3 Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE



ONTM4S 1:40.GPJ 8:12/08

Continued Next Page

 $4^3 \times 3$ 

Numbers refer to  
Sensitivity

15-20 5 (% STRAIN AT FAILURE)

INTEGRALS: 140.GPJ 8/12/08 $+^3, \times$ 

Numbers refer to  
Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EM10-3															2 OF 2		METRIC			
G.W.P. W.O. 07-20017			LOCATION N 4 871 233.3 E 364 689.5 Old Scugog Road					ORIGINATED BY TG												
HWY 407			BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic			DATE 2007-12-13 - 2007-12-13					CHECKED BY AEG												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			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	W.P.	W	W.L.	Y	GR	SA	SI	CL
10.0	Continued From Previous Page SILT, some clay, trace sand Very Dense Brown Moist		10	SS	100/		163													
					250		162													
							161													
160.4	END OF BOREHOLE AT 12.57m BOREHOLE BACKFILLED WITH BENTONITE TO 0.15m AND ASPHALT TO SURFACE.		11	SS	100/															
12.6					225															

Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No EM15-1															1 OF 3		METRIC			
G.W.P. W.O. 07-20017			LOCATION N 4 871 497.8 E 355 489.7 Regional Road 57					ORIGINATED BY HL												
HWY 407			BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic			DATE 2007-12-21 - 2008-01-09					CHECKED BY AEG												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			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	W.P.	W	W.L.	Y	GR	SA	SI	CL
172.1	SAND and GRAVEL, trace silt Brown Moist (FILL)		1	GS			172													
171.3	SAND and SILT, some clay, trace gravel Dense Brown Moist (TILL)		1	SS	41		171													
			2	SS	41		170													
			3	SS	35		169													
169.2	Silty CLAY, trace to some sand, trace gravel Hard Brown		4	SS	68		168													
	becoming Very Stiff Grey		5	SS	41		167													
			6	SS	17		166													
	becoming Stiff		7	SS	11		165													
			8	SS	13		164													
							163													

Continued Next Page

Numbers refer to Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM21-1										1 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 802.2 E 367 075.1				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-18 - 2007-12-20				CHECKED BY AEG							
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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES						SHEAR STRENGTH kPa
177.7	ASPHALT (50mm)		1	GS									
177.1	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	7								
176.4	Silty CLAY, with peat (fibrous) and wood fragments Firm Dark Brown		2	SS	4								
175.6	Silty SAND Loose Brown Moist		3	SS	6								
174.4	Silty CLAY Firm Brown		4	SS	4								
173.4	Silty SAND, some clay to clayey, trace gravel Loose Brown Wet (TILL)(CL+ML)		5	SS	9								
172.4	becoming Compact		6	SS	10								
171.4			7	SS	16								
169.0	Silty CLAY, some sand, trace gravel Silt Grey (TILL)(CL)		8	SS	14								

Continued Next Page

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

ONTM4S 1140.GPJ B1203



RECORD OF BOREHOLE No EM21-1										2 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 802.2 E 367 075.1				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-18 - 2007-12-20				CHECKED BY AEG							
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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES						SHEAR STRENGTH kPa
	Continued From Previous Page												
167.9	Silty CLAY, some sand, trace gravel Silt Grey (TILL)		9	SS	13								
165.9	Silty CLAY, trace sand Firm Grey (CL)		10	SS	7								
164.9			11	SS	8								
163.9	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		12	SS	51								
160.4	SAND, some silt, trace gravel Grey		13	SS	100								
157.5	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		14	SS	100								

Continued Next Page

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

ONTM4S 1140.GPJ B1203





RECORD OF BOREHOLE No EM21-1															3 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 802.2 E 357 075.1				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-18 - 2007-12-20				CHECKED BY AEG												
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT. PILOT	NUMBER	TYPE			% VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)						
	Continued From Previous Page																	
	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)				125													
156.2			15	SS	106.9													
21.4	END OF BOREHOLE AT 21.44m. Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1/2" slot screen				100													
WATER LEVEL READINGS.																		
DATE DEPTH(m) ELEV.(m)																		
2007.12.21 12.75 164.9																		
2008.01.09 10.10 167.6																		
2008.03.20 Frozen																		

+ 3, X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

ONTMT45 1140.GPJ 8/12/08



RECORD OF BOREHOLE No EM24-1															1 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 871 953.3 E 367 878.5				ORIGINATED BY HL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-01-08 - 2008-01-09				CHECKED BY AEG												
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT. PILOT	NUMBER	TYPE			% VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)						
187.3																		
0.0	SAND and GRAVEL, silty, some topsoil Brown Moist (FILL)		1	GS														
186.6																		
0.7	Sandy SILT, some clay, trace gravel Loose Brown Moist (TILL)		2	SS	8													
185.9																		
1.4	Silty CLAY, some sand, trace gravel Very Stiff to Stiff Brown (TILL)		3	SS	17													
			4	SS	11													
184.1																		
3.2	Silty SAND, some clay, trace gravel Compact to Dense Brown Moist (TILL)		5	SS	20													
			6	SS	41									1 51 31 16				
181.8																		
5.5	Silty CLAY, trace sand Hard to Very Stiff Grey (TILL)(CL)		7	SS	30													
			8	SS	29									0 7 64 29				
178.8																		
8.5	Silty SAND, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	52													

Continued Next Page

+ 3, X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

ONTMT45 1140.GPJ 8/12/08

ONTM14\$ 1140 GPJ 2/12/08

+ 3, X 3 Numbers refer to Sensitivity

ONTARIO 1140 GPJ 8/12/03

+ 3, X 3: Numbers refer to Sensitivity



RECORD OF BOREHOLE No EM30-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 872 417.4 E 359 456.8				ORIGINATED BY HL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008-01-09 - 2008-01-09				CHECKED BY AEG							
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
180.8	ASPHALT (50mm)		1	AS									
180.4	SAND, some gravel, trace silt; Brown Moist (FILL)		2	SS	45								
179.9	TOPSOIL, silty, sandy Dark Brown Moist		3	SS	85								
179.9	Silty SAND, trace to some gravel, trace clay Dense to Very Dense Brown Moist (T.R.L.)		4	SS	90								
			5	SS	104								
			6	SS	100/276								
			7	SS	100/150								
173.0	SAND and GRAVEL, some silt Very Dense Brown Wet		8	SS	100/200								
172.3	SAND, some gravel, some silt Very Dense Brown Wet		9	SS	100/								
171.5	END OF BOREHOLE AT 9.30m. BOREHOLE OPEN TO 6.10m AND WATER LEVEL AT 0.91m UPON COMPLETION. Piezometer installation records at				150								
9.3													

+ 3 . X 3 Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EM30-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 872 417.4 E 359 456.8				ORIGINATED BY HL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008-01-09 - 2008-01-09				CHECKED BY AEG							
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
	Continued From Previous Page												
	19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV (m) 2008.01.10 2.14 178.7 2008.03.20 Frozen												

+ 3 . X 3 Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE



ONTARIO: 140 GFJ - 072008

Numbers refer to Sensitivity

NEWTS : 40 GS : 22208

$\sigma_1, \sigma_2$	Numbers refer to Sensitivity	$\frac{\sigma_1}{\sigma_2}$	(%) STRAIN AT FAILURE
10, 10	10	1.0	10
10, 20	15	2.0	15
10, 30	20	3.0	20
10, 40	25	4.0	25
10, 50	30	5.0	30
10, 60	35	6.0	35
10, 70	40	7.0	40
10, 80	45	8.0	45
10, 90	50	9.0	50
20, 20	55	1.0	55
20, 30	60	1.5	60
20, 40	65	2.0	65
20, 50	70	2.5	70
20, 60	75	3.0	75
20, 70	80	3.5	80
20, 80	85	4.0	85
20, 90	90	4.5	90
30, 30	95	1.0	95
30, 40	100	1.33	100
30, 50	105	1.67	105
30, 60	110	2.0	110
30, 70	115	2.33	115
30, 80	120	2.67	120
30, 90	125	3.0	125
40, 40	130	1.0	130
40, 50	135	1.25	135
40, 60	140	1.5	140
40, 70	145	1.75	145
40, 80	150	2.0	150
40, 90	155	2.25	155
50, 50	160	1.0	160
50, 60	165	1.2	165
50, 70	170	1.4	170
50, 80	175	1.6	175
50, 90	180	1.8	180
60, 60	185	1.0	185
60, 70	190	1.17	190
60, 80	195	1.33	195
60, 90	200	1.5	200
70, 70	205	1.0	205
70, 80	210	1.14	210
70, 90	215	1.29	215
80, 80	220	1.0	220
80, 90	225	1.11	225
90, 90	230	1.0	230



RECORD OF BOREHOLE No EM33-1															1 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 873 422.0 E 370 880.34				ORIGINATED BY WB												
HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-08-28 - 2008-08-29				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT			UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	N <sup>o</sup> VALUES	20	40	60	80	100			W <sub>p</sub>	W <sub>L</sub>		
171.9	SAND, some gravel, mixed with topsoil Brown Damp		1	AS														
171.3	Silty CLAY with sand, trace gravel Firm to Hard Brown Moist (TILL)(CL)		1	SS	5													
			2	SS	9													
			3	SS	12													
			4	SS	15													
			5	SS	50													
			6	SS	45													
164.9	SAND and SILT, trace clay Very dense to Dense Brown Moist		7	SS	67													
			8	SS	37													

Continued Next Page

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



RECORD OF BOREHOLE No EM33-1															2 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 873 422.0 E 370 880.34				ORIGINATED BY WB												
HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-08-28 - 2008-08-29				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT			UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	N <sup>o</sup> VALUES	20	40	60	80	100			W <sub>p</sub>	W <sub>L</sub>		
	Continued From Previous Page																	
			9	SS	42													
			10	SS	25													
			11	SS	35													
167.3	SILT, some clay, trace sand, laminated Stiff to Hard Grey Moist		12	SS	10													
14.6			13	SS	50													
			14	SS	16													
	Becoming Very Stiff																	
152.1	Sandy SILT, trace clay																	
15.0																		

Continued Next Page

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



RECORD OF BOREHOLE No EM33-1															3 OF 3		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 873 422.0 E 370 880.34										ORIGINATED BY WB						
HWY 407		BOREHOLE TYPE Hollow Stem Augers										COMPILED BY ES						
DATUM Geodetic		DATE 2008-08-28 - 2008-08-29										CHECKED BY AEG						
SOIL PROFILE		SAMPLES		ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL MOISTURE LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER		TYPE	"N" VALUES	GROUND WATER CONDITIONS	20 40 60 80 100			W P W L							
Continued From Previous Page																		
	Very Loose to Compact Grey Wet		15	SS	0						0 31 66 3							
			16	SS	24													
148.2																		
23.8	Silly SAND Very Dense Grey Moist		17	SS	100/-175													
			18	SS	100/275						5 64 31 (SI+CL)							
145.4																		
26.5	Sandy GRAVEL, trace silt Very Dense Grey Moist																	
			19	SS	100/335													
144.1																		
27.8	END OF BOREHOLE AT 27.81m. Piezometer installation consists of 15mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct.10/08 7.6 164.3																	

4 3 x 3 Numbers refer to Sensitivity 30 15 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL12-2															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 863 972.087 E 363 977.595										ORIGINATED BY WB						
HWY 407		BOREHOLE TYPE Solid Stem Augers										COMPILED BY ES						
DATUM Geodetic		DATE 2008-08-21 - 2008-08-21										CHECKED BY AEG						
SOIL PROFILE		SAMPLES		ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL MOISTURE LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER		TYPE	"N" VALUES	GROUND WATER CONDITIONS	20 40 60 80 100			W P W L							
139.3																		
0.0	SAND, some gravel Loose to Compact Brown Moist (FILL)		1	AS														
			1	SS	8													
137.5			2	SS	11													
1.8	SAND and SILT, trace clay lenses Compact to Dense Brown Moist																	
135.5			3	SS	45					0 34 57 8								
2.7	Silly CLAY, trace sand Hard Grey (CL)																	
			4	SS	50													
	becoming soft to very soft		5	SS	20					0 3 61 36								
			6	SS	3													
			7	SS	1					0 5 50 44								
			8	SS	2													

Continued Next Page

4 3 x 3 Numbers refer to Sensitivity 30 15 10 (% STRAIN AT FAILURE)



ONTMT4S 1:40.GPJ 8/12/08

4, 3, X 3: Numbers refer to Sensitivity

ONTARIO 140 GPJ 8/12/09 80718

+<sup>2</sup> × 3. Numbers refer to Sensitivity



RECORD OF BOREHOLE No EM35-2										1 OF 2		METRIC					
G.W.P. W.O. 07-20017		LOCATION N 4 874 023.0 E 372 149.3				ORIGINATED BY HL											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-01-10 - 2008-01-10				CHECKED BY AEG											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	W <sub>p</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>L</sub>	Y	GR	SA	SI	CL
203.6																	
0.0	SAND and GRAVEL		1	AS													
0.1	Brown (FILL)		2	AS													
	Sandy SILT, trace gravel, trace clay, some organics																
	Compact																
	Brown																
	Moist																
202.5			1	SS	22												
1.4	SAND and SILT, trace to some clay, trace gravel																
	Dense to Very Dense																
	Brown																
	Moist																
	(TILL)																
			2	SS	41												
			3	SS	46												
			4	SS	83												
			5	SS	100												
197.9																	
5.9	SAND, gravelly, trace silt		6	SS	100/275												
	Very Dense																
	Brown																
	Wet																
			7	SS	100/150												
			8	SS	100/200												
194.5																	
9.3	END OF BOREHOLE AT 9.35m. BOREHOLE OPEN TO 6.71m UPON COMPLETION. Piezometer installation consists of																

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Continued Next Page

+ 3 . X 3 Numbers refer to Sensitivity 15 20 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EM35-2										2 OF 2		METRIC					
G.W.P. W.O. 07-20017		LOCATION N 4 874 023.0 E 372 149.3				ORIGINATED BY HL											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-01-10 - 2008-01-10				CHECKED BY AEG											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	W <sub>p</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>L</sub>	Y	GR	SA	SI	CL
	Continued From Previous Page																
	30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen																
	WATER LEVEL READINGS:																
	DATE DEPTH(m) ELEV.(m)																
	2008.01.10 6.12 197.7																
	2008.03.20 Dry																

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+ 3 . X 3 Numbers refer to Sensitivity 15 20 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EM40-1															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 874 856.0 E 373 519.0		ORIGINATED BY JHL														
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES														
DATUM Geodetic		DATE 2008-01-10 - 2008-01-10		CHECKED BY AEG														
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
			NUMBER	TYPE	N° VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
								○ UNCONFINED + FIELD VANE	○ UNCONFINED + FIELD VANE	○ UNCONFINED + FIELD VANE	○ UNCONFINED + FIELD VANE	○ UNCONFINED + FIELD VANE	○ UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL X LAB VANE	● QUICK TRIAXIAL X LAB VANE	● QUICK TRIAXIAL X LAB VANE	● QUICK TRIAXIAL X LAB VANE	● QUICK TRIAXIAL X LAB VANE	● QUICK TRIAXIAL X LAB VANE					
204.7	ASPHALT (50mm)																	
204.1	SAND and GRAVEL Brown (FILL)		1	AS														
204.1	SAND, some silt to silty, trace gravel Dense to Very Dense Brown Moist		1	SS	46										0 78 22 (SI+CL)			
			2	SS	51													
			3	SS	53													
201.7	SAND and SILT, trace to some clay, trace gravel Dense to Very Dense Brown Moist (FILL)		4	SS	32										1 52 39 6			
			5	SS	100													
	cobble at 5.2 to 5.5m																	
			6	SS	100										5 55 28 11			
197.9	cobble at 6.7 to 6.8m																	
197.9	SAND and GRAVEL, trace silt Very Dense Grey Wet		7	SS	102													
197.0	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN TO 7.31m AND WATER LEVEL DRY UPON COMPLETION. Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.01.11 DRY - 2008.01.11 DRY -				125													

+ 3, x 3 Numbers refer to  
Sensitivity 20  
15 10 (%) STRAIN AT FAILURE





RECORD OF BOREHOLE No EL01-1												1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 331.0 E 364 789.0				ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES									
DATUM Geodetic		DATE 2008-01-16 - 2008-01-17				CHECKED BY AEG									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT (%)			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	W.P. W. L.	W.P. W. L.	Y	GR SA SI CL		
102.6	SAND, some gravel, trace gr. Brown Moist		1	AS											
101.9	Clayey SILT, some sand, trace gravel Hard Brown		1	SS	33										
101.1	SAND and SILT, some clay, trace gravel, occasional cobbles Dense to Very Dense Brown Moist (TILL)		2	SS	38								5	44	36 15
			3	SS	100/200										
			4	SS	100/200										
			5	SS	100/150										
			6	SS	100								6	43	37 14
			7	SS	36										
			8	SS	77										

Continued Next Page

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

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RECORD OF BOREHOLE No EL01-1												2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 331.0 E 364 789.0				ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES									
DATUM Geodetic		DATE 2008-01-16 - 2008-01-17				CHECKED BY AEG									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT (%)			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	W.P. W. L.	W.P. W. L.	Y	GR SA SI CL		
	Continued From Previous Page														
	SAND and SILT, some clay, trace gravel, occasional cobbles Dense to Very Dense Brown Moist (TILL)		9	SS	100/225									2	42 47 10
			10	SS	100/125										
88.7	END OF BOREHOLE AT 13.84m. BOREHOLE OPEN TO 13.11m AND WATER LEVEL AT 4.11m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.02.10 0.68 101.89 2008.03.20 0.48 102.09		11	SS	100/125										

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

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RECORD OF BOREHOLE No EL02-1															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 860 308.0 E 365 246.3				ORIGINATED BY SLI												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-01-16 - 2008-01-16				CHECKED BY MRA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	W VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W P	W	W L	W	W L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
104.5	ASPHALT: (90mm)		1	AS														
0.1	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	27													
104.0	Silty CLAY, trace sand, trace gravel, occasional black staining Very Silty Brown (FILL)		1	SS	27													
0.6	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		2	SS	24													
103.4			3	SS	42													
1.2			4	SS	100/													
			5	SS	100/													
			6	SS	100/													
			7	SS	100/													
99.8	END OF BOREHOLE AT 7.77m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 1.5m THEN AUGER CUTTINGS TO SURFACE.																	

+ 3, x 3; Numbers refer to Sensitivity 15-20 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL02-2															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 860 318.1 E 365 300.9				ORIGINATED BY SLI												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-01-16 - 2008-01-16				CHECKED BY MRA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	W VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W P	W	W L	W	W L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
105.0	ASPHALT: (75mm)		1	AS														
0.1	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	28													
104.4	Silty CLAY, trace sand, trace gravel Very Silty Dark Brown to Brown Moist		1	SS	28													
0.6			2	SS	20													
102.8	SAND and SILT, trace to some clay, trace gravel Very dense Brown Moist (TILL)		3	SS	100/													
2.2			4	SS	100/													
			5	SS	100/													
	becoming Grey occasional cobbles and sand pockets		6	SS	100/													
			6	SS	100/													
			7	SS	100/													
97.3	END OF BOREHOLE AT 7.77m. BOREHOLE OPEN TO 7.16m AND WATER LEVEL AT 4.19m UPON COMPLETION BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.																	

+ 3, x 3; Numbers refer to Sensitivity 15-20 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL02-3										1 OF 1		METRIC			
G.W.P. W.O. 07-20017		LOCATION N 4 860 326.8 E 365 348.8				ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES									
DATUM Geodetic		DATE 2008-01-15 - 2008-01-15				CHECKED BY MRA									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)
105.3	ASPHALT (75mm)		1	AS											
104.7	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	23										
104.5	SAND and SILT, trace to some clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	86										
			3	SS	100/										
			4	SS	100/										
			5	SS	100/										
			6	SS	100/										
			7	SS	100/										
97.5	END OF BOREHOLE AT 7.7m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008 01 16 3.72 101.55 2008 03 20 2.14 103.13														

+ 3 x 3: Numbers refer to  
Sensitivity 15 20 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL02-4										1 OF 1		METRIC			
G.W.P. W.O. 07-20017		LOCATION N 4 860 339.6 E 365 415.0				ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES									
DATUM Geodetic		DATE 2008-01-15 - 2008-01-15				CHECKED BY MRA									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)	WATER CONTENT (%)
106.1	ASPHALT (50mm)		1	AS											
105.4	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	21										
	Silty CLAY, some sand, trace gravel, topsoil stained Very Silty Dark Brown to Brown		2	SS	24										
103.9	SAND and SILT, some clay, trace gravel Very Dense Brown Moist (TILL)		3	SS	88										
			4	SS	100/										
			5	SS	100/										
			6	SS	100/										
			7	SS	100/										
98.4	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN AND DRY UPON COMPLETION BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m THEN AUGER CUTTINGS TO SURFACE.														

+ 3 x 3: Numbers refer to  
Sensitivity 15 20 10 (% STRAIN AT FAILURE)





RECORD OF BOREHOLE No EL03-3															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 542.9 E 355 079.0					ORIGINATED BY JM											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008-03-20 - 2008-03-20					CHECKED BY AEG											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	W.P.	W	W.L.	W.P.	W	W.L.	GR SA SI CL		
108.0	TOPSOIL: with roots and rootlets (150mm)						108											
0.0	SAND, some gravel, trace silt, occasional cobbles		1	SS	78/		107											
0.2	Very Dense		2	SS	100/		106											
	Brown						105											
	Moist (FILL)						104											
	Cobbles at 1.12 to 1.24m						103											
105.0	SAND and SILT, some clay, trace gravel		3	SS	50/		105									3 43 42 12		
2.0	Very Dense		4	SS	100/		104											
	Brown						103											
	Moist (TILL)						102											
			5	SS	100/		101									5 47 37 12		
							100											
101.9	Sandy SILT, trace gravel		6	SS	50/		102											
101.7	Very Dense						101											
6.3	Grey						100											
	Moist (TILL)						99											
	END OF BOREHOLE AT 6.27m						98											
	Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.						97											
	WATER LEVEL READINGS:						96											
	DATE DEPTH (m) ELEV. (m)						95											

± 3, X 3: Numbers refer to Sensitivity  
20 15 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL03-4															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 581.7 E 355 097.6					ORIGINATED BY JM											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008-03-20 - 2008-03-20					CHECKED BY AEG											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	W.P.	W	W.L.	W.P.	W	W.L.	GR SA SI CL		
109.6	TOPSOIL: roots (150mm)						109											
0.0	Dark Brown						108											
0.2	SAND and SILT, some clay, trace gravel		1	SS	28		107											
	Compact to Very Dense						106											
	Brown		2	SS	36		105											
	Moist (TILL)						104											
			3	SS	57/		103									3 46 39 12		
							102											
			4	SS	50/		101											
							100											
	Grey						99											
			5	SS	60		98									8 46 40 6		
							97											
103.5	SILT, trace sand, trace gravel		6	SS	100/		96											
6.1	Very Dense						95											
	Grey						94											
	Moist (TILL)						93											
102.7	SAND, fine grained, trace to some silt, trace gravel						92											
	Very Dense						91											
	Grey		7	SS	60/		90											
	Moist						89											
							88											
101.0	Clayey SILT, some sand, trace gravel						87											
8.5	Hard						86											
	Grey						85											
	Moist (TILL)		8	SS	100/		84									1 19 56 24		
100.3							83											
9.3	END OF BOREHOLE AT 9.27m.						82											
	BOREHOLE OPEN TO 7.62m AND WATER LEVEL AT 0.20m UPON COMPLETION						81											

Continued Next Page

± 3, X 3: Numbers refer to Sensitivity  
20 15 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL03-4														2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 581.7 E 365 097.6				ORIGINATED BY JM											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-03-20 - 2008-03-20				CHECKED BY AEG											
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	GROUND WATER	ELEVATION	20 40 60 80 100	20 40 60 80 100	20 40 60	W P W L	UNIT WEIGHT	GR SA SI CL				
Continued From Previous Page																	
	BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.30m THEN AUGER CUTTINGS TO SURFACE																

+ 3, x 3 Numbers refer to Sensitivity 15 20 10 (% STRAIN AT FAILURE

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RECORD OF BOREHOLE No EL04-1														1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 284.7 E 365 112.4				ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-01-16 - 2008-01-16				CHECKED BY AEG											
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	GROUND WATER	ELEVATION	20 40 60 80 100	20 40 60 80 100	20 40 60	W P W L	UNIT WEIGHT	GR SA SI CL				
104.2							104										
0.0	SAND, some gravel, trace silt Brown Moist (FILL)		1	AS													
103.6																	
0.6	Silty CLAY, some sand Brown (FILL)		1	SS	20												
103.3																	
0.9	Silty CLAY, some sand, trace gravel; topsoil stained, trace rootlets Very Silty to Hard Dark Brown Moist		2	SS	33												
102.0																	
2.2	SAND and SILT, trace to some clay; trace gravel; Compact to Very Dense (FILL) Brown (CL-ML)		3	SS	17												
			4	SS	29												
	becoming Groy																
			5	SS	100/												
					100												
			6	SS	100/												
					175												
			7	SS	100/												
					200												
95.2																	
8.0	END OF BOREHOLE AT 7.98m BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.15m AND ASPHALT TO SURFACE																

+ 3, x 3 Numbers refer to Sensitivity 15 20 10 (% STRAIN AT FAILURE

ONTM14S 1140.GPJ 8/12/08

ONTMT4S 1140.GPJ 8/12/03

+ 3, X 3. Numbers refer to Sensitivity

ONTM:T4S 114C.GPJ 8/12/03

+ 3, X 3; Numbers refer to Sensitivity





RECORD OF BOREHOLE No EL05-1															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 350.6 E 365 483.6				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-01-15 - 2008-01-15				CHECKED BY MRA												
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 <sub>L</sub>	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE			20	40	60	80						100	20	40
107.0	ASPHALT (75mm)		1	AS		107												
106.3	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	31	106												
104.6	SANDY SILT, trace gravel, some topsoil staining, trace rootlets Dense to Compact Brown Moist (FILL)		2	SS	26	105												
104.6	SAND and SILT, some clay, trace gravel Very Dense Brown Moist (FILL)		3	SS	63	104										3 44 38 15		
			4	SS	100	104												
			5	SS	100	102												
			6	SS	100	101										2 31 52 15		
99.2	END OF BOREHOLE AT 7.72m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.		7	SS	100	100												

4 3 X 3 Numbers refer to  
Sensitivity 15 10 5 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL05-2															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 350.6 E 365 420.6				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-01-14 - 2008-01-14				CHECKED BY MRA												
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 <sub>L</sub>	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE			20	40	60	80						100	20	40
106.6	SAND, some gravel, trace silt Brown Moist (FILL)		1	AS		106												
105.9	SANDY SILT, trace gravel Compact Brown Moist (FILL)		1	SS	10	106												
105.1	SAND and SILT, some clay, trace gravel Compact to Very Dense Grey Moist (FILL)		2	SS	12	105												
			3	SS	41	104										2 46 38 13		
			4	SS	100	104												
			5	SS	100	103												
			6	SS	100	102												
			7	SS	100	101										1 39 42 18		
99.8	END OF BOREHOLE AT 7.72m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV(m) 2008.01.16 DRY - 2008.03.20 1.40 105.16		7	SS	100	100												

4 3 X 3 Numbers refer to  
Sensitivity 15 10 5 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL05-3														1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 390.3 E 365 367.1				ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-01-19 - 2008-01-19				CHECKED BY MRA											
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	GR
107.0	ASPHALT (150mm)																
0.2	SAND, some gravel, trace silt Brown Moist		1	AS													
106.3	(FILL)																
0.7	Silty CLAY, some sand, trace gravel, topsoil stained Very Silt Brown		1	SS	25												
105.6	SAND and SILT, some clay to clayey, trace gravel Dense to Very Dense Brown Moist (TILL)		2	SS	40												
			3	SS	100/ 225							5	42	39	14		
			4	SS	63												
			5	SS	100/ 150												
			6	SS	100/ 150							2	31	43	26		
			7	SS	100/ 175												
97.8	END OF BOREHOLE AT 9.24m BOREHOLE OPEN TO 8.43m AND WATER LEVEL AT 8.33m UPON COMPLETION. BOREHOLE BACKFILLED WITH		8	SS	100/ 100												

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+ 3 . X 3 Numbers refer to  
Sensitivity 15-20 5 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL05-3														2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 850 390.3 E 365 367.1				ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES											
DATUM Geodetic		DATE 2008-01-19 - 2008-01-19				CHECKED BY MRA											
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	GR
	Continued From Previous Page																
	BENTONITE TO 0.15m THEN ASPHALT TO SURFACE.																

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+ 3 . X 3 Numbers refer to  
Sensitivity 15-20 5 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL05-4															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 860 419.8 E 365 325.1				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-02-04 - 2008-02-04				CHECKED BY MRA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	
107.6	TOP SOIL; trace rootlets (150mm) Brown Moist																	
105.8	Silty SAND, trace gravel, trace rootlets Dark Brown Wet (FILL)		1	SS	13													
105.0	Silty SAND, trace gravel, trace rootlets Compacted Dark Brown Wet		2	SS	63													
	SAND and SILT, some clay, trace gravel, occasional cobbles Very Dense Brown Moist (TILL)		3	SS	71													
			4	SS	100/175													
103.5	Silty CLAY, sandy Hard Grey (TILL)(CL)		5	SS	60													
102.0	SAND and SILT, some clay to clayey, trace gravel, occasional cobbles Very Dense Grey Moist (TILL)		6	SS	100/150													
			7	SS	100/175													
96.2	END OF BOREHOLE AT 9.27m BOREHOLE OPEN AND WATER LEVEL AT 0.97m UPON COMPLETION BOREHOLE BACKFILLED WITH		8	SS	100/125													

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+ 3 x 3 Numbers refer to Sensitivity 15 20 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL05-4															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 860 419.8 E 365 325.1				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-02-04 - 2008-02-04				CHECKED BY MRA												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	
	Continued From Previous Page																	
	BENTONITE TO SURFACE																	

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+ 3 x 3 Numbers refer to Sensitivity 15 20 10 (%) STRAIN AT FAILURE





RECORD OF BOREHOLE No EL06-1															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 890 520.5 E 355 628.8				ORIGINATED BY SL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-02-06 - 2008-02-06				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES				20 40 60 80 100	Wp	W	WL	Y	GR SA SI CL				
112.3	TOPSOIL: trace rootlets (175mm) Brown Moist																	
0.0																		
0.2	Silty CLAY, some sand, trace rootlets, trace gravel Very Silty Brown		1	SS	28													
110.8																		
1.4	SAND and SILT, some clay, trace gravel Dense to Very Dense Brown Moist (TILL) (CL-ML)		2	SS	42									3 41 30 18				
			3	SS	84													
			4	SS	100													
					.175													
109.2																		
4.1	Silty CLAY, sandy Very Silty Gray (CL)		5	SS	23									0 33 42 25				
105.5																		
5.8	SAND and SILT, trace to some clay, trace gravel Dense to Very Dense Gray Moist (TILL) becoming Loose		6	SS	62													
			7	SS	40									1 50 44 5				
			8	SS	7													

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4 3 X 3: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No EL06-1															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 890 520.5 E 355 628.8				ORIGINATED BY SL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-02-06 - 2008-02-06				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES				20 40 60 80 100	Wp	W	WL	Y	GR SA SI CL				
	Continued From Previous Page																	
	SAND and SILT, trace to some clay, trace gravel Very Dense Gray Moist (TILL)		9	SS	100													
					.125													
	occasional cobbles		10	SS	100													
					.075													
96.5			11	SS	100													
13.8	END OF BOREHOLE AT 13.79m. BOREHOLE OPEN AND WATER LEVEL AT 4.95m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG MIXED WITH AUGER CUTTINGS TO SURFACE.				.075													

4 3 X 3: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No EL06-2										1 OF 2	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 860 540.3 E 365 588.7				ORIGINATED BY SLI					
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES					
DATUM Geodetic		DATE 2008-02-04 - 2008-02-04				CHECKED BY AEG					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	20 40 60 80 100	W.P. W. W.L.	W.P. W. W.L.	UNIT WEIGHT	GR SA SI CL
111.8	SAND, some gravel, trace silt										
111.5	Brown Moist (FILL)										
0.4	Silty CLAY, some sand, trace gravel										
	Very Stiff Brown										
109.6			1	SS	16						
			2	SS	21						
2.2	SAND and SILT, some clay, trace gravel		3	SS	24					2 40 36 20	
	Compact to Very Dense Brown Moist (TILL) (CL-ML)		4	SS	25						
107.9			5	SS	100					2 47 36 15	
4.0			6	SS	29					1 46 40 13	
			7	SS	100						
			8	SS	100					0 46 44 8	

Continued Next Page

+ 3 x 3 Numbers refer to Sensitivity 15 10 5 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No EL06-2										2 OF 2	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 860 540.3 E 365 588.7				ORIGINATED BY SLI					
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES					
DATUM Geodetic		DATE 2008-02-04 - 2008-02-04				CHECKED BY AEG					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID UNIT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	20 40 60 80 100	W.P. W. W.L.	W.P. W. W.L.	UNIT WEIGHT	GR SA SI CL
	Continued From Previous Page										
	SAND and SILT, some clay, trace gravel										
	Compact to Very Dense Brown Moist (TILL) (CL-ML)		9	SS	100						
	END OF BOREHOLE AT 10.80m. BOREHOLE OPEN AND WATER LEVEL AT 3.66m UPON COMPLETION										
	Pneumometer installation consists of 19mm diameter scheduled 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS:										
	DATE DEPTH (m) ELEV. (m)										
	2008.03.20 0.65 111.15										

+ 3 x 3 Numbers refer to Sensitivity 15 10 5 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No EL07-2										1 OF 1	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 850 770.0 E 365 126.0		ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES							
DATUM Goodetic		DATE 2008-03-19 - 2008-03-19		CHECKED BY AEG							
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W.P. W L	GR SA SI CL
115.1	TOPSOIL: with roots and rootlets (175mm)						115				
0.2	Sandy SILT, brown, moist										
114.4	Brown Moist										
0.7	SAND and SILT, some clay, trace gravel		1	SS	100/						
	Very Dense										
	Brown		2	SS	104/						
	Moist to Wet (TILL)										
			3	SS	100/						
			4	SS	102/						
			5	SS	105/						
			6	SS	100/						
109.7	Grey										
0.4	END OF BOREHOLE AT 6.38m BOREHOLE OPEN TO 2.13m AND WATER LEVEL AT 4.72m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.76m THEN AUGER CUTTINGS TO SURFACE.										

+ 3 X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE)

ONTM14S 1140.GPJ 8/12/08



RECORD OF BOREHOLE No EL08-2										1 OF 1	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 850 813.0 E 355 271.0		ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES							
DATUM Goodetic		DATE 2008-03-17 - 2008-03-17		CHECKED BY AEG							
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W.P. W L	GR SA SI CL
116.3	TOPSOIL: with roots and rootlets (125mm)						116				
0.1	Sandy SILT, some clay, trace gravel										
115.6	Brown Moist										
0.7	SAND and SILT, trace clay, trace gravel		1	SS	29						
	Compact to Very Dense										
	Brown to Grey		2	SS	104						
	Moist (TILL)										
	occasional cobbles		3	SS	97						
			4	SS	100/						
			5	SS	52/						
			6	SS	100/						
112.2	Clayey SILT, some sand, with thin clay seams, trace gravel										
4.1	Hard Grey (TILL)		5	SS	52/						
			6	SS	100/						
109.3	END OF BOREHOLE AT 7.01m. BOREHOLE OPEN AND WATER LEVEL AT 0.91m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen										
7.0	WATER LEVEL READINGS: DATE DEPTH (m) ELEV (m)										

+ 3 X 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE)

ONTM14S 1145.GPJ 8/12/08





RECORD OF BOREHOLE No EL09-1															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 062 582.3 E 364 504.3				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-18 - 2007-12-18				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		STRAT PLOT	NUMBER	TYPE	"N" VALUES	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	20	40							60	80	100	W P					
125.6 0.0 0.1	ASPHALT (75mm)				1	GS												
125.0 0.6	SAND, some gravel, trace silt Brown Moist (FILL)				1	SS	13											
	SAND and SILT, some clay, trace gravel, occasional cobbles Compact to Very Dense Brown Moist (TILL)				2	SS	67											
	becoming Grey				3	SS	100/ 0/5											
					4	SS	100											
					5	SS	25											
					6	SS	30											
					7	SS	41											
115.6 9.0	SAND, trace silt, trace gravel Dense Grey Wet				8	SS	33											

Continued Next Page

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



RECORD OF BOREHOLE No EL09-1															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 062 582.3 E 364 504.3				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2007-12-18 - 2007-12-18				CHECKED BY AEG												
SOIL PROFILE		SAMPLES		STRAT PLOT	NUMBER	TYPE	"N" VALUES	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	20	40							60	80	100	W P					
	Continued From Previous Page																	
	SAND, trace silt, trace gravel Dense Grey Wet				9	SS	100/ 275											
113.6 12.0	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)				10	SS	100/ 050											
					11	SS	100/ 075											
110.2 15.3	END OF BOREHOLE AT 15.34m. BOREHOLE OPEN TO 13.11m UPON COMPLETION. Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007.12.21 7.65 117.93 2008.01.16 1.30 124.28 2008.03.20 0.34 125.24				12	SS	100											

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

ONTMYS 1149.GPJ 3/12/08

+3, X3. Numbers refer to Sensitivity

Q10141278 4340 CQ1 8/13/2028

Continued Next Page

+ 5. X 3. Numbers refer to Sensitivity

+3, X3. Numbers refer to Sensitivity

+ 3. X 3. Numbers refer to Sensitivity





RECORD OF BOREHOLE No EL12-3															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION			ORIGINATED BY VMB													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES													
DATUM Geodetic		DATE 2008.06.12 - 2008.06.12			CHECKED BY AEG													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	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
0.0	SAND, trace gravel, occasional black staining Loose Brown Moist (FILL)		1	AS														
			1	SS	8													
1.4	SAND, some silt, trace gravel Compact Brown Moist		2	SS	19													
2.1	Sand and SILT, trace clay Dense Grey Damp		3	SS	41													
			4	SS	50													
	Becoming Compact		5	SS	10													
5.0	Silty CLAY, trace sand, trace gravel Stiff to Firm Grey		6	SS	3													
			7	SS	49													
8.5	Sandy SILT, trace gravel Dense Grey Moist (TILL)		7	SS	49													

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+ 3, x 3 Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

ONTM-TAS 1143.GPJ 8/12/08



RECORD OF BOREHOLE No EL12-3															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION			ORIGINATED BY VMB													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES													
DATUM Geodetic		DATE 2008.06.12 - 2008.06.12			CHECKED BY AEG													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	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
	Continued From Previous Page																	
	Sandy SILT, trace gravel Dense Grey Moist (TILL)		8	SS	100/300													
			5	SS	52													
12.8	END OF BOREHOLE AT 12.80m																	

+ 3, x 3 Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

ONTM-TAS 1143.GPJ 8/12/08



RECORD OF BOREHOLE No EL17-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 854 661.9 E 363 800.5				ORIGINATED BY SLI							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-14 - 2007-12-14				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
128.5	ASPHALT (75mm)												
138.3	SAND and GRAVEL, some silt Brown Moist (FILL)												
137.5	TOPSOIL, sandy, some silt, occasional rootlets Soft Dark Brown Moist (FILL)		1	SS	4								
136.8	Silty CLAY, trace sand Very Silty (FILL)		2	SS	19							0 2 62 36	
135.1	SILT, trace clay, trace sand Very Dense to Dense Grey Moist		3	SS	51								
135.1	Silty CLAY, trace sand Very Soft to Soft Brown		4	SS	37							0 7 83 9	
134.0			5	SS	4								
133.0			6	SS	1								
131.0			7	SS	1							0 2 45 52	
130.0			8	SS	1								

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+ 3, x 3 Numbers refer to Sensitivity 15 20 10 (%) STRAIN AT FAILURE

ONTM145 1145.GPJ 8/12/08



RECORD OF BOREHOLE No EL17-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 854 661.9 E 363 800.5				ORIGINATED BY SLI							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-14 - 2007-12-14				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
	Continued From Previous Page												
128.0	Silty CLAY, trace sand Very Soft to Soft Brown		9	SS	18								
11.0	SILT, trace clay, trace gravel Very Dense Grey Wet (FILL)		10	SS	100/150							4 45 41 10	
123.7			11	SS	100/100								
15.3	END OF BOREHOLE AT 15.29m BOREHOLE OPEN TO 12.19m UPON COMPLETION Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV (m) 2007.12.21 0.73 135.22 2008.01.16 1.20 138.75 2008.03.04 Frozen -		12	SS	100/050								

+ 3, x 3 Numbers refer to Sensitivity 15 20 10 (%) STRAIN AT FAILURE

ONTM145 1145.GPJ 8/12/08

ONTN:T4S 114C GFJ 8/12/08

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

ONTM4S 1:40.GPJ ENT2/C5

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



ONTM4S 1140.GPJ 2/12/08

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

ONTIMT4S 1140.GPJ 8/12/06

+ 3. X 3. Numbers refer to Sensitivity



RECORD OF BOREHOLE No EL22-1										1 OF 2		METRIC				
G.W.P. W.O. 07-20017		LOCATION N 4 865 745.3 E 383 880.0				ORIGINATED BY SLL										
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES										
DATUM Geodetic		DATE 2008-01-11 - 2008-01-11				CHECKED BY AEG										
SOIL PROFILE		SAMPLES		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	20 40 60 80 100	20 40 60 80 100	W P	W	W L	KN/m <sup>3</sup>	GR	SA	SI	CL
151.0	ASPHALT (50mm)															
0.2	SAND, trace silt Brown Moist (FILL)		1	AS												
	SAND, some silt, trace gravel Compact Brown Moist		1	SS	11											
			2	SS	26											
			3	SS	20											
	becoming Wet		4	SS	13											
	becoming Dense to Very Dense		5	SS	59											
			6	SS	41											
			7	SS	100/											
					175											
142.7	SAND and SILT, trace clay Very Dense Brown Wet (FILL)		8	SS	100/											
8.4					200											

Continued Next Page

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



RECORD OF BOREHOLE No EL22-1										2 OF 2		METRIC				
G.W.P. W.O. 07-20017		LOCATION N 4 865 745.3 E 383 880.0				ORIGINATED BY SLL										
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES										
DATUM Geodetic		DATE 2008-01-11 - 2008-01-11				CHECKED BY AEG										
SOIL PROFILE		SAMPLES		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	20 40 60 80 100	20 40 60 80 100	W P	W	W L	KN/m <sup>3</sup>	GR	SA	SI	CL
	Continued From Previous Page															
	SAND and SILT, trace clay Very Dense Brown Wet (FILL)		9	SS	100/											
140.2																
10.8	END OF BOREHOLE AT 10.82m. BOREHOLE OPEN TO 8.38m AND WATER LEVEL AT 2.44m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE AND AUGER CUTTINGS TO 0.15m AND ASPHALT TO SURFACE.															

ONTM745 1140 GPJ 8/12/08

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



RECORD OF BOREHOLE No EL22-2										1 OF 2	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 855 641.9 E 363 917.0				ORIGINATED BY SLL					
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES					
DATUM Geodetic		DATE 2008-01-14 - 2008-01-14				CHECKED BY AEG					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER			TYPE	"N" VALUES				
150.6	ASPHALT (90mm)		1	AS							
0.0	SAND, some gravel, trace silt. Loose Brown Moist (FILL)		1	SS	7						
149.1	SAND, some silt, trace gravel Compact Brown Moist to Wet		2	SS	22						7 78 14 (SI+CL)
147.6	SILT, some clay, with thin sand seams Compact to Very Dense Grey Moist		3	SS	28						
3.0			4	SS	13						
144.8	Silty SAND, some gravel, trace clay Very Dense Grey Moist (FILL)		5	SS	60						
5.6			6	SS	100/125						10 65 21 5
			7	SS	100/125						
			8	SS	100/125						

Continued Next Page

+ 3 X 3: Numbers refer to Sensitivity  
15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140.GPJ 8/12/08



RECORD OF BOREHOLE No EL22-2										2 OF 2	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 855 641.9 E 363 917.0				ORIGINATED BY SLL					
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES					
DATUM Geodetic		DATE 2008-01-14 - 2008-01-14				CHECKED BY AEG					
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER			TYPE	"N" VALUES				
	Continued From Previous Page										
139.8	Silty SAND, some gravel, trace clay Very Dense Grey Moist (FILL)		9	SS	100/125						
10.8	END OF BOREHOLE AT 10.80m. BOREHOLE OPEN TO 9.91m AND WATER LEVEL AT 1.75m UPON COMPLETION. Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a .52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV(m) 2008.01.16 4.32 146.25										

+ 3 X 3: Numbers refer to Sensitivity  
15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140.GPJ 8/12/08





RECORD OF BOREHOLE No EL23-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 666 777.95 E 364 045.66		ORIGINATED BY W8									
HWY 407		BOREHOLE TYPE Hollow Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2008-08-19 - 2008-08-20		CHECKED BY AEG									
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT			
ELEV. (m)	DEPTH (m)	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	% VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>		
153.4	0.0	TOPSOIL, clayey Brown Moist											
152.8	0.6	Silty SAND, trace clay Compact Brown Moist		1	SS	14							
				2	SS	16							
				3	SS	26							
150.5	3.0	Silty CLAY, sandy, trace gravel Firm Brown (CL)		4	SS	6							
149.1	4.3	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		5	SS	66							
				6	SS	100/250							
				7	SS	100/075							
144.1	9.2	END OF BOREHOLE AT 9.22m. Piezometer installation consists of 18mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS:		11	SS	100/075							

Continued Next Page

20 15 10 5 0  
x 3  
Numbers refer to Sensitivity  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL23-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 666 777.95 E 364 045.66		ORIGINATED BY W8									
HWY 407		BOREHOLE TYPE Hollow Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2008-08-19 - 2008-08-20		CHECKED BY AEG									
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT			
ELEV. (m)	DEPTH (m)	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	% VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>		
		Continued From Previous Page											
		DATE Oct.10/08											
		DEPTH (m) 0.72											
		ELEV. (m) 152.7											

20 15 10 5 0  
x 3  
Numbers refer to Sensitivity  
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL23-2															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 8/1.22 E 354 026.08		ORIGINATED BY WB		HWY 407		BOREHOLE TYPE Hollow Stem Augers		COMPILED BY ES		DATUM Geodetic		DATE 2008-08-15 - 2008-08-15		CHECKED BY AEG		
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	TM VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	Wp W WL	UNCONFINED + FIELD VANE	QUICK TRIAXIAL X LAB VANE	20 40 60 80 100	20 40 60	Y	GR SA SI CL			
153.4	TOPSOIL, clayey Soft Brown Damp		1	SS	9		153											
152.8	Sandy SILT, trace clay, trace gravel Compact Brown Moist (FRL)		2	SS	27		152											
			3	SS	14		151											
151.3	Silty SAND, trace clay and gravel Compact Grey Wet		4	SS	16		150											
			5	SS	18		149											
			6	SS	16		148											
			7	SS	29		147											
	Beccoming Loose		8	SS	5		146											
146.1	SAND and SILT, some clay, trace gravel Very dense Grey Moist (TILL)		9	SS	66		145											
7.3			10	SS	100/250		144											

Continued Next Page

1 3 X 3 Numbers refer to Sensitivity  
20 15 10 5 0 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL23-2															2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 8/1.22 E 354 026.08		ORIGINATED BY WB		HWY 407		BOREHOLE TYPE Hollow Stem Augers		COMPILED BY ES		DATUM Geodetic		DATE 2008-08-15 - 2008-08-15		CHECKED BY AEG		
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	TM VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	Wp W WL	UNCONFINED + FIELD VANE	QUICK TRIAXIAL X LAB VANE	20 40 60 80 100	20 40 60	Y	GR SA SI CL			
	Continued From Previous Page																	
			11	SS	100/100		143											
							142											
141.1			12	SS	100/150													
12.3	END OF BOREHOLE AT 12.34m. Monitoring well installation consists of 50.8mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS. DATE DEPTH (m) ELEV. (m)																	

1 3 X 3 Numbers refer to Sensitivity  
20 15 10 5 0 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL23-4										1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 952.2 E 353 978.5				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008-03-14 - 2008-03-14				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
							20 40 60 80 100						
							20 40 60 80 100						
152.5	TOPSOIL, peat, amorphous with roots												
152.2	Black Frozen												
0.3	Silty SAND, trace clay		1	SS	15								
	Compact												
	Brown to Grey												
	Wet												
			2	SS	25							0 72 24 4	
			3	SS	24								
			4a	SS	11								
149.0	SILT, some sand to sandy		4b	SS									
3.5	Compact												
	Grey												
	Wet												
148.2	Clayey SILT, with thin sandy silt seams		5	SS	12								
4.3	Silt												
	Grey												
146.7	SAND and SILT, some clay, trace gravel		6	SS	3							5 41 35 19	
5.8	Loose to Very Dense												
	Grey												
	Wet												
			7	SS	109/250								
			8	SS	100/275								

Continue Next Page

+ 3 X 3 Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140 GPJ 8/12/08



RECORD OF BOREHOLE No EL23-4										2 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 952.2 E 353 978.5				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008-03-14 - 2008-03-14				CHECKED BY AEG							
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						SHEAR STRENGTH kPa
							20 40 60 80 100						
							20 40 60 80 100						
	Continued From Previous Page												
	SAND and SILT, some clay, trace gravel		9	SS	100/225							5 53 32 10	
	Very Dense												
	Grey												
	Wet												
			10	SS	100/275								
139.8	END OF BOREHOLE AT 12.62m												
12.6	BOREHOLE OPEN TO 9.14m AND WATER LEVEL AT SURFACE UPON COMPLETION												
	Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.												
	WATER LEVEL READINGS.												
	DATE DEPTH (m) ELEV. (m)												

+ 3 X 3 Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140 GPJ 8/12/08



RECORD OF BOREHOLE No EL24-1															1 OF 1		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 780.69 E 354 051.31				ORIGINATED BY WB												
HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-08-19 - 2008-08-19				CHECKED BY AEG												
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE			WATER CONTENT (%)	WATER CONTENT (%)										
152.7	TOPSOIL mixed with clayey, trace sand, trace plant matter Brown Moist		1	AS														
152.1	Silty SAND, trace clay, trace gravel Compact Brown Moist to wet		1	SS	15													
150.6	Silty CLAY, trace sand Soft Brown (CL)		2	SS	16										1 72 24 2			
149.5	SAND and SILT, some clay, trace gravel Very Dense Brown to Grey Wet (TILL)		3	SS	4										0 17 40 43			
148.4			4	SS	15													
147.5			5	SS	84										0 49 36 14			
146.5			6	SS	100/125													
145.5			7	SS	163/125										5 35 44 16			
143.5	END OF BOREHOLE AT 9.20m. WATER LEVEL AT 6.30m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.		8	SS	100/225													

+ 3 x 3 Numbers refer to Sensitivity  
20 15 10 (% STRAIN AT FAILURE)



RECORD OF BOREHOLE No EL24-2															1 OF 2		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 866 076.94 E 354 060.00				ORIGINATED BY WB												
HWY 407		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY ES												
DATUM Geodetic		DATE 2008-08-19 - 2008-08-19				CHECKED BY AEG												
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE			WATER CONTENT (%)	WATER CONTENT (%)										
153.6	TOPSOIL, mixed with silty clay Brown damp		1	AS														
153.2	Silty SAND, some clay, trace gravel, trace topsoil Compact Brown Moist (FILL)		1	SS	28													
152.1	Sandy SILT, trace clay, trace gravel Loose Brown Moist		2	SS	13													
151.6	Silty CLAY, some sand, trace gravel Brown (CL)		3	SS	4										5 36 31 27			
150.6	SAND, fine grained, some silt Compact Grey Wet		4	SS	15										0 87 13 (SI+CL)			
149.4	Silty CLAY, some sand, trace gravel Stiff Grey		5	SS	10													
147.5	SAND and SILT, some clay, trace gravel Loose to Very Dense Grey Wet (TILL)		6	SS	5										5 43 34 17			
146.5			7	SS	58													
145.5			8	SS	100/225													
144.5			9	SS	100/225										1 51 35 12			

Continued Next Page

+ 3 x 3 Numbers refer to Sensitivity  
20 15 10 (% STRAIN AT FAILURE)



+  $3 \times 3$  Numbers refer to Sensitivity

ONTM14S 1140.GPJ 8/12/08
$$-1.3 \times 10^3$$

Numbers refer to Sensitivity

ONTM4S 1145.GPJ 8/12/05 $4^3 \times 3^3$ 

Numbers refer to Sensitivity



RECORD OF BOREHOLE No EL27-1										1 OF 4		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 858 943.8 E 363 477.0		ORIGINATED BY TG									
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2007-12-18 - 2007-12-19		CHECKED BY AEG									
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	W P W L	Y	GR SA SI CL		
170.2	SAND, some gravel, trace silt; Brown Moist (FILL)												
169.9	Silty SAND, some clay, trace gravel Dense to Very Dense Brown Moist (TILL)		1	SS	33								
169.4			2	SS	51								
			3	SS	38								
			4	SS	42								
			5	SS	49								
			6	SS	41								
			7	SS	54								
			8	SS	72								

Continued Next Page

+ 3 . x 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM4S 1:60 GPJ B1208



RECORD OF BOREHOLE No EL27-1										2 OF 4		METRIC	
G.W.P. W.O. 07-20017		LOCATION N 4 858 943.8 E 363 477.0		ORIGINATED BY TG									
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2007-12-18 - 2007-12-19		CHECKED BY AEG									
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	W P W L	Y	GR SA SI CL		
	Continued From Previous Page												
	Silty SAND, some clay, trace gravel Very Dense Brown Moist (TILL)		9	SS	100/ 275								
			10	SS	100/ 275								
			11	SS	26								
	becoming Compact		12	SS	27								
			13	SS	26								
			14	SS	13								

Continued Next Page

+ 3 . x 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM4S 1:60 GPJ B1208



RECORD OF BOREHOLE No EL27-1										3 OF 4	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 858 943.8 E 363 477.0		ORIGINATED BY TG							
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-18 - 2007-12-19		CHECKED BY AEG							
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		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	W <sub>p</sub> W <sub>N</sub> W <sub>L</sub>	GR SA SI CL
Continued From Previous Page											
	Silty SAND, some clay, trace gravel Dense to Compact Brown Wet (TILL)		15	SS	35		150				
			16	SS	17		149				
							148				
							147				
145.9							146				
24.4	SAND and SILT, trace clay, trace gravel Very Dense Grey Wet (TILL)		17	SS	55		145				
							144				
							143				
			18	SS	65		142				
							141				
2 41 51 6											

Continued Next Page

+ 3, x 3, Numbers refer to Sensitivity  
20 15 10 5 0 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No EL27-1										4 OF 4	METRIC
G.W.P. W.O. 07-20017		LOCATION N 4 858 943.8 E 363 477.0		ORIGINATED BY TG							
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES							
DATUM Geodetic		DATE 2007-12-18 - 2007-12-19		CHECKED BY AEG							
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		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	W <sub>p</sub> W <sub>N</sub> W <sub>L</sub>	GR SA SI CL
Continued From Previous Page											
	SAND and SILT, trace clay, trace gravel Very Dense Grey Wet (TILL)		19	SS	100		140				
							139				
			20	SS	100		138				
							137				
136.6			21	SS	100		136				
33.6	END OF BOREHOLE AT 33.63m BOREHOLE OPEN TO 28.41m UPON COMPLETION Piezometer installation consists of 30mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008.01.11 2.58 167.66 2008.03.20 Frozen				100						

ONTM48 1140.GPJ 8/12/08

+ 3, x 3, Numbers refer to Sensitivity  
20 15 10 5 0 (%) STRAIN AT FAILURE



ONTM74S 1140.GPJ 2/12/08

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

QNTMT4S 1120.GPJ 8/12/98

+  $\frac{3}{4}$   $\times$   $\frac{3}{4}$  Numbers refer to Sensitivity

+<sup>3</sup>, ×<sup>3</sup>; Numbers refer to Sensitivity



+ 3, X 3. Numbers refer to Sensitivity



RECORD OF BOREHOLE No EL27-3										2 OF 3		METRIC		
G.W.P. W.O. 07-20017		LOCATION				ORIGINATED BY WB								
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES								
DATUM Geodetic		DATE 2008.06.09 - 2008.06.09				CHECKED BY AEG								
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		GR SA SI CL		
	Continued From Previous Page							20 40 60 80 100	Wp	W	WL	KN/m <sup>3</sup>	GR SA SI CL	
	Silty CLAY, trace sand Hard Grey		9	SS	20									
10.4	SAND and SILT, some clay, trace gravel Compact to Very Dense Grey Moist		10	SS	48							2 50 37 11		
			11	SS	51									
			12	SS	46									
			13	SS	100/175									
			14	SS	100/225							3 56 31 10		
			15	SS	100/									

Continued Next Page

+ 3 . X 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140.GPJ 8/12/08



RECORD OF BOREHOLE No EL27-3										3 OF 3		METRIC		
G.W.P. W.O. 07-20017		LOCATION				ORIGINATED BY WB								
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES								
DATUM Geodetic		DATE 2008.06.09 - 2008.06.09				CHECKED BY AEG								
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT		REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		GR SA SI CL		
	Continued From Previous Page							20 40 60 80 100	Wp	W	WL	KN/m <sup>3</sup>	GR SA SI CL	
19.9	END OF BOREHOLE AT 19.94m. BOREHOLE WATER LEVEL AT 1.52m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS TO SURFACE.				125									

+ 3 . X 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

ONTM14S 1140.GPJ 8/12/08

RECORD OF BOREHOLE No P28 1 OF 1 METRIC																
W.P. 326-88-01		LOCATION Coords.: N 4 869 551.5, E 361 241.7				ORIGINATED BY TC										
DIST. 6 HWY 407		BOREHOLE TYPE Hollow Stem				COMPILED BY LG										
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	VALUES	20	40	60						80
211.1	Ground Surface															
0.0																
	Silty Sand to Sandy Silty Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	107											
			2	SS	96											
			3	SS	150											
			4	SS	120											
198.7			5	SS	130											
12.4	End of Borehole															
	Unable to Measure Ground Water Due to the Hole Collapsing															

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

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 TC										
DIST. 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LG										
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	VALUES	20	40	60						80
188.5	Ground Surface															
0.0																
	Silty Sand Trace of Clay, Trace of Gravel V. Dense		1	SS	185											
183.6			2	SS	184											
4.9			3	SS	184											
	Clayey Silt Silty Sand, Trace Gravel Hard (Glacial Till)		4	SS	140											
179.2			5	SS	126											
9.3	End of Borehole															

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



[illegible]

+3, x3: Numbers refer to Sensitivity

[illegible]

+5, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No P32 1 OF 1 METRIC															
W.P. 326-85-01		LOCATION Coords.: N 4 871 347.3 E 365 431.0					ORIGINATED BY TC								
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO								
DATUM Geodetic		DATE 1984 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					
172.9	Ground Surface														
0.0															
	Silty Clay Trace of Sand, Trace of Gravel		1	SS	19										
			2	SS	43										
			3	SS	13										
	Stiff to Hard Firm		4	SS	6										
			5	SS	5										
165.3			6	SS	8										
9.6	End of Borehole														

+3, x5: Numbers refer to 20  
15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P33 1 OF 1 METRIC															
W.P. 326-88-01		LOCATION Coords.: N 4 871 673.1 E 367 022.7					ORIGINATED BY TC & YB								
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO								
DATUM Geodetic		DATE 1984 05 27					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					
178.2	Ground Surface														
0.0															
	Silty Sand Trace of Clay, With Some Gravel (Glacial Till)		1	SS	9										
175.8			2	SS	47										
2.4			3	SS	37										
	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		4	SS	23										
			5	SS	36										
168.6			6	SS	21										
9.6	End of Borehole														

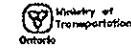
+3, x5: Numbers refer to 20  
15-0-5 (%) STRAIN AT FAILURE



Foundation Design

RECORD OF BOREHOLE No P34 1 OF 1 METRIC														
W.P. 325-B8-01		LOCATION		Coords.: N 4 871 786.0, E 367 844.0		ORIGINATED BY TC								
DIST 6 HWY 407		BOREHOLE TYPE Hollow Stem		COMPILED BY LO										
DATUM Geodetic		DATE 1994 05 30		CHECKED BY KA										
SOIL PROFILE			SAMPLES		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	GROUND WATER CONDITIONS	UNCONFINED
188.4	Ground Surface													
0.0	Clayey Silt Some Sand, Trace of Gravel V. Stiff to Hard (Glacial Till)		1	SS	19									
184.4			2	SS	41									
4.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		3	SS	55									
181.4			4	SS	90									
7.0	Silty Clay to Clayey Silt Some Sand, Trace of Gravel V. Stiff to Hard (Glacial Till)		5	SS	38									
175.8			6	SS	29									
			7	SS	42									
			8	SS	164	25cm								
12.6	End of Borehole													

4, 5, Numbers refer to Sensitivity  
20 15-25 (%) STRAIN AT FAILURE  
10



Foundation Design

RECORD OF BOREHOLE No P35 1 OF 1 METRIC														
W.P. 325-B8-01		LOCATION		Coords.: N 4 872 244.1, E 369 422.3		ORIGINATED BY TB								
DIST 5 HWY 407		BOREHOLE TYPE Solid Stem		COMPILED BY LO										
DATUM Geodetic		DATE 1994 05 25		CHECKED BY KA										
SOIL PROFILE			SAMPLES		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	GROUND WATER CONDITIONS	UNCONFINED
184.4	Ground Surface													
0.0			1	SS	66									
			2	SS	77									
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		3	SS	81									
			4	SS	83									
			5	SS	152									
174.8			6	SS	125									
9.8	End of Borehole													

3, 5, Numbers refer to Sensitivity  
20 15-25 (%) STRAIN AT FAILURE  
10

[illegible]

+3, x5: Numbers refer to Sensitivity

[illegible]

+3, x5; Numbers refer to  $\frac{20}{15-0.5}$  (X) STRAIN AT FAILURE



RECORD OF BOREHOLE No P38 1 of 1 METRIC														
W.P. 326-88-01		LOCATION Coords.: N 4 874 706.1, E 373 460.3			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			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	γ	GR SA SI CL			
202.3	Ground Surface													
0.0	Silty Sand Trace of Clay, Trace of Gravel Occasional Pockets of Gravel Compact to V. Dense (Glacial Till)		1	SS	30									
			2	SS	28									
			3	SS	35									
			4	SS	46									
			5	SS	33									
192.8			6	SS	92									
9.5	End of Borehole													

+3, x3: Numbers refer to Sensitivity 20 15-25 (%) STRAIN AT FAILURE 10

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			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	γ	GR SA SI CL			
244.4	Ground Surface													
0.0	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Occasional Layers of Gravely Sand Compact to V. Dense (Glacial Till)		1	SS	18									
			2	SS	37									
			3	SS	120									
			4	SS	99									
			5	SS	120									
232.0			6	SS	120									
12.3	End of Borehole													
	Ground Water Not Established													

+3, x3: Numbers refer to Sensitivity 20 15-25 (%) STRAIN AT FAILURE 10

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 TH							
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 $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	VALUES	20	40	60	80			100
255.9	Ground Surface													
0.0	Clayey Silt Some Sand, Traces of Gravel (Clock Tail)		1	SS	11									
			2	SS	8									
252.0			3	SS	49									
4.0	Silt to Silty Sand V. Dense		4	SS	94									
			5	SS	25									
246.3			6	SS	57									
9.6	End of Borehole													

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

RECORD OF BOREHOLE No P41 1 OF 1 METRIC														
W.P. 326-88-01		LOCATION Coords: N 4 876 682.4, E 374 562.7					ORIGINATED BY TH							
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 $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	VALUES	20	40	60	80			100
319.0	Ground Surface													
0.0	Silty Clay to Clayey Silt Some Sand, Traces of Gravel V. Silt 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									
			6	SS	144									
309.4														
9.6	End of Borehole													
	• Ground Water Not Established													

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

RECORD OF BOREHOLE No 1															1 OF 1		METRIC	
W.P. 663 - 89 - 00		LOCATION Co-ords: N 4 860 046.5 : E 364 817.7		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		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	Wp	W	Wp	W	Wp	W	GR SA SI CL		
104.5	Ground Surface																	
0.0	Sand and Gravel (Fill) occ. Silt layers		1	SS	34		104											
102.9	Organic Silt d. brown - grey		2	SS	13		102											
1.6			3	SS	38		100											
			4	SS	100		98											
			5	SS	100		96											
			6	SS	106		94											
			7	SS	68		92											
			8	SS	17		90											
			9	SS	37													
			10	SS	75													
			11	SS	100													
89.1			12	SS	125													
15.4	End of Borehole																	

+3, x 5, Numbers refer to 20 15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2															1 OF 1		METRIC	
W.P. 663 - 89 - 00		LOCATION Co-ords: N 4 860 257.7 : E 364 725.3		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		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	Wp	W	Wp	W	Wp	W	GR SA SI CL		
105.0	Ground Surface																	
0.0	Clayey Silt, trace of Sand, silt		1	SS	8		104											
103.6			2	SS	16		102											
102.9	Silty Sand, compact		3	SS	105		100											
2.1			4	SS	100		98											
			5	SS	100		96											
			6	SS	120		94											
			7	SS	120		92											
96.9							90											
8.1	End of Borehole																	

+3, x 5, Numbers refer to 20 15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4															1 OF 1		METRIC	
W.P. 663 - 89 - 00		LOCATION Co-ords: N 4 882 364.1 ; E 364 504.3		ORIGINATED BY T K														
DIST 8 HWY 401/407		BOREHOLE TYPE HOLLOW STEM AUGER		COMPILED BY D O														
DATUM GEODETIC		DATE 93 12 13		CHECKED BY T K														
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT		REMARKS								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	7	GR SA SI CL					
126.8	Ground Surface																	
0.0	Pavement																	
125.4	Sand and Gravel (Till), dense		1	SS	30													
1.4			2	SS	121													
			3	SS	103													
			4	SS	103													
			5	SS	68													
121.2			6	SS	31													
5.6			7	SS	31													
			8	SS	43													
115.8			9	SS	87													
118.2			10	SS	108													
11.0	End of Borehole																	

4, 5 Numbers refer to 20 15-0-5 (X) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5															1 OF 1		METRIC	
W.P. 663 - 89 - 00		LOCATION Co-ords: N 4 882 915.5 ; E 363 863.7		ORIGINATED BY DO & TK														
DIST 8 HWY 401/407		BOREHOLE TYPE HOLLOW STEM AUGER		COMPILED BY D O														
DATUM GEODETIC		DATE 93 12 08		CHECKED BY T K														
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT		REMARKS								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	W <sub>p</sub> W <sub>L</sub>	7	GR SA SI CL					
134.0	Ground Surface																	
0.0																		
			1	SS	45													
			2	SS	100													
			3	SS	120													
			4	SS	120													
129.8			5	SS	110													
4.1			6	SS	120													
			7	SS	140													
125.5			8	SS	140													
6.5	End of Borehole at probable Boulders or Bedrock																	

4, 5 Numbers refer to 20 15-0-5 (X) STRAIN AT FAILURE



+  $\delta$ ,  $\times \delta$ : Numbers refer to Sensitivity

RECORD OF BOREHOLE No 7						1 OF 1 METRIC				
W.P.		LOCATION		Co-ords:		ORIGINATED BY D.O. & T.K.				
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 I.K.				
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa $\diamond$ UNCONFINED + FIELD VANE $\bullet$ QUICK TRIAXIAL = LAB VANE 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w L	UNIT WEIGHT UNITS kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	ELEVATION SCALE		WATER CONTENT (%) 10 20 30		
140.4	Ground Surface									
0.0	Pavement base material									
139.3	Organic Silt dark brown		1	SS	17					
1.1	Sandy SILL brown		2	SS	29					
138.3	compact brown grey		3	SS	20					
2.1	Cloey Silt, trace of Gravel firm to stiff		4	SS	26					
			5	SS	4					
			6	SS	3					
			7	SS	3					
			8	SS	5					
			9	SS	6					
128.5										
11.9	Sandy SILL,		10	SS	23					
127.2	trace of Gravel, compact									
13.2	Heterogeneous Mixture of SILT, Sand and Gravel (Glacial Till) very dense		11	SS	105					
124.7			12	SS	120					
15.7	End of Borehole				30cm					

[illegible]

2.5 5. Numbers refer to  $\frac{20}{1000}$  (%) STRAIN AT FAILURE

[illegible]

+ 3, X 5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 10 1 of 1 METRIC														
W.P. 663 - 89 - 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 NATURAL MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			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	85									
2.9			4	SS	118									
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) very dense		5	SS	121									
			6	SS	106									
			7	SS	128									
			8	SS	109									
143.0	End of Borehole													
9.6	Perched Water at 1.6 m													

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

RECORD OF BOREHOLE No 11 1 of 1 METRIC														
W.P. 663 - 89 - 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 NATURAL MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			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														
176.1	Sand and Gravel, some Silt very dense		5	SS	91									
174.7			6	SS	15cm									
174.1			7	SS	141									
172.1	Heterogeneous Mixture of Silt, Sand and Gravel, ecc. Clayey Silt layers, (Glacial Till) very dense		8	SS	106									
170.8			9	SS	153									
170.0	End of Borehole													

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

RECORD OF BOREHOLE No 12												1 OF 1		METRIC	
W.P. 663 - 89 - 00		LOCATION Co-ords: N 4 868 492.6 : E 351 267.6				ORIGINATED BY M.V.									
DIST 6 HWY 401/407		BOREHOLE TYPE SOILD STEEL 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 NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100	W <sub>p</sub>	W <sub>L</sub>	W <sub>U</sub>	WATER CONTENT (%)	10 20 30		
214.3	Ground Surface														
0.0	Top Soil		1	SS	21										
			2	SS	39										
			3	SS	54										
			4	SS	81										
			5	SS	117										
			6	SS	121										
			7	SS	144										
			8	SS	114										
			9	SS	126										
			10	SS	113										
			11	SS	139										
			12	SS	126										
198.9	End of Borehole														
15.4	Borehole dry on completion														