

Ministry of Transportation Ontario

# Foundation Investigation Report For Environmental Assessment (Hydrogeology Specialty)

## HIGHWAY 407 EAST EXTENSION – CENTRAL SECTION

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Prepared by:

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Date:

January, 2009

Project Number:

107903 / 50613

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February 2, 2009

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Ms. Betty Bennett  
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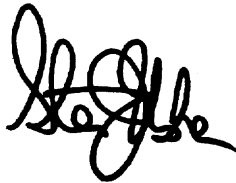
Dear Ms. Bennett:

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

We are pleased to convey this report on the Hydrogeological Investigations along the Central Mainline 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.



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SU:pc  
Attach.

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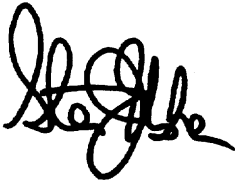
Signature Page

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## 1. Introduction

This report presents a summary of the Hydrogeological Investigations for the Foundation Investigation Report for the Central Mainline of the Technically Preferred Route (TPR) of the Highway 407 East Extension. Gartner Lee Limited acting as AECOM was retained by Totten Sims Hubicki acting as AECOM 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 Central Mainline covers approximately 15 km between Ashburn Road in the west and Enfield Road in the east (Figure 1). 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 Central Mainline has been divided into sub-sections based upon differences in geology / hydrogeology that exist within the larger Central 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: *Central 1 (C1a)* from Ashburn Road to Simcoe Street; and *Central 2* from Simcoe Street to Enfield Road. *Central 2* was further subdivided into *C2a* from Simcoe Street to Wilson Road; and *C2b* from Wilson Road to Enfield Road. 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 Totten Sims Hubicki acting as AECOM (AECOM).

## 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 South Slope is a gently rolling till plain, characterized by numerous drumlins oriented upslope. The majority of the Technically Preferred Route (TPR) Central Mainline is located within this region. The Iroquois Plain physiographic region is found extending from the till plain of the South Slope Region down to Lake Ontario. 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.

### 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 (*Thornccliffe 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 Central Mainline [*Central 1 (C1a)* and *Central 2 (C2a and C2b)*]. 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 and deep cuts), 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 3. 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. They provide a summary at each structure along the Central Mainline, 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 3 to 6.

### 5.3 Borehole Drilling

Hydrogeological field investigations included drilling a total of six (6) boreholes at 3 locations along the Central Mainline. The borehole logs are presented in Appendix A. Each hydrogeology borehole 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 8.

### 5.4 Geological Cross-Sections

Geological Cross-Sections were created for Sections *Central 1 (C1a)* and *Central 2 (C2a and C2b)* 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 9 and 10). Cross-Section locations are shown on Figures 3 to 8. In cases where the geology interpreted from borehole drilling differed from the surficial geology, 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 Central Mainline Profile was provided by TSH acting as AECOM and was added to each cross-section. The profile used was provided to AECOM in April 2008 and may differ from the current profile. The final version of this report will include the final version of the Central Mainline Profile.

### 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 streams 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 Thurber has provided additional subsurface information at or near many of the deep cut locations. The deep cut locations are presented on Figures 4, 6, and 8. A summary of the deep cut locations are presented on Table 7. 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 11 to 17.

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, and 8. A summary of the high fill locations are presented on Table 7.

## 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-one (21) residences 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 Figure 18.

# 6. Miscellaneous

## 6.1 Numbering System

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

CM- xx represents a structure along the Central Mainline.

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 Central Mainline.

## 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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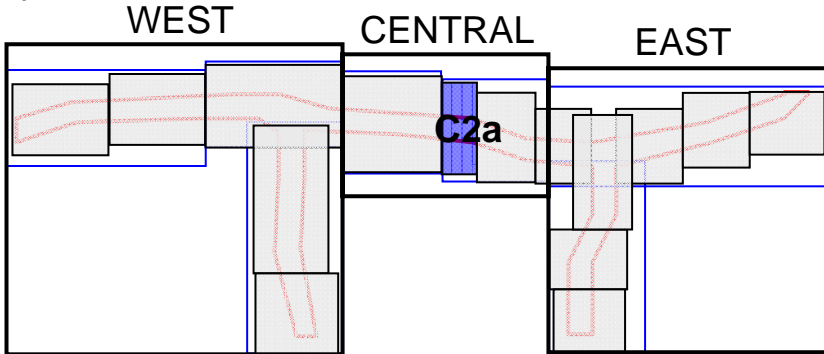
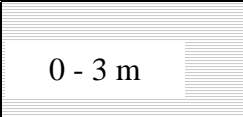
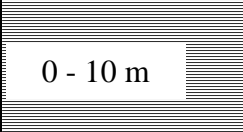
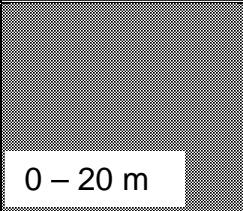
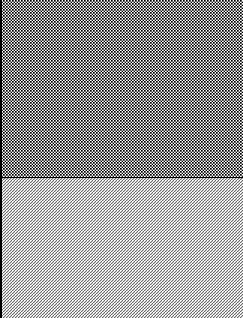
# 407 East Extension – Central Section

## Summary Table 1 (C1a) – Hydrogeological Conditions and Preliminary Recommendations

Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS:		POTENTIAL IMPACTS:
<div><div>WESTCENTRALEAST</div><div></div></div>		Central 1 (C1a) Section		<b>Groundwater Effects on Foundation Design and Construction:</b> <ul style="list-style-type: none"><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>▶ Structures CM-3/ CM-3B and CM-10/ CM-10B<ul style="list-style-type: none"><li>◦ Dewatering is anticipated for excavations within alluvial sediments. A PTTW will be required</li><li>◦ Fill placement in alluvial valleys has the potential to disrupt GW flow/ discharge</li></ul></li><li>▶ Deep Cut DC-C1 (7.5 m deep cut) will likely encounter the GWT at &lt;3.0 mBGS. High potential for side slope seepage at the contact between upper glaciolacustrine materials and lower till</li><li>▶ Deep Cut DC-C2 (7 m deep cut) will likely encounter the GWT at ~2.5 mBGS. Isolated sand lenses are expected in the upper 6 m. Lenses should drain in the short term. Low potential for dewatering</li><li>▶ Deep Cut DC-C3 (6 m cut depth) will likely encounter the GWT at ~5.0 mBGS. Low potential for dewatering. Permeable ORM sediments may be within 3 m of bottom of cut and may have upwards ground water pressures</li></ul> <b>Surface Water Features:</b> <ul style="list-style-type: none"><li>▶ The Whitby-Oshawa Iroquois Wetland Complex is present south of the TPR<ul style="list-style-type: none"><li>◦ Construction activities primarily occur in low permeability till units are not expected to affect these wetlands due to a lack of hydraulic connection and separation distance</li></ul></li><li>▶ Dewatering for bridge abutments in the valleys near Lynde Creek (CM-3) and West Oshawa Creek (CM-10) are anticipated to reduce groundwater discharge into the creeks over the dewatering period<ul style="list-style-type: none"><li>◦ A PTTW will be required. 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>▶ The ORM sand and gravel aquifer is occasionally present within Section C1a as southerly oriented “finger” like intrusions at the contact between the Halton and Newmarket till units<ul style="list-style-type: none"><li>◦ Significant dewatering and/ or impacts to private wells will occur if unit is encountered</li></ul></li><li>▶ The Thorncliffe Aquifer was not encountered in Section C1a</li><li>▶ Glacial Lake Iroquois Shoreline sediments are found along the southern boundary of this section. Construction activities are not expected to impact these features due to the distance separating them</li><li>▶ Deep Cut DC-C1 (7.5 m deep cut) – Excavations estimated to be 6.0 m below the water table (figure 11)<ul style="list-style-type: none"><li>◦ Radius of water table drawdown is estimated to be 50 m</li><li>◦ Low potential to impact wells/ aquifers unless continuous sand lenses are encountered</li></ul></li><li>▶ Deep Cut DC-C2 (7 m deep cut) – Excavations estimated to be 6.0 m below the water table (figure 12)<ul style="list-style-type: none"><li>◦ Radius of water table drawdown is estimated to be 50 m</li><li>◦ Low potential to impact wells/ aquifers unless continuous sand lenses are encountered</li></ul></li><li>▶ Deep Cut DC-C3 (6 m cut depth) – Excavations estimated to be 2.0 m below the water table (figure 13)<ul style="list-style-type: none"><li>◦ Potential ORM sand and gravel deposit present at 8.7 mBGS. If encountered, dewatering is anticipated</li><li>◦ Radius of water table drawdown in till is estimated to be 25 m</li><li>◦ Potential to impact one (1) well north of the ROW – Well ID 2106</li></ul></li><li>▶ Central Mainline (C1a) – 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>◦ SWM ponds placed in alluvial valleys will require clay 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>Opportunities for Avoidance/ Mitigation/ Compensation:</b> <ul style="list-style-type: none"><li>▶ Structure CM-3/ CM-3B and CM-10/ CM-10B – dewatering required for excavations for bridge footings<ul style="list-style-type: none"><li>◦ Use pile footings to minimize dewatering (high permeability sand units at surface)</li><li>◦ Time dewatering period to avoid fish spawning seasons and to coincide with seasonal low GWT</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 groundwater flow and avoid “wicking” of GW into fill</li></ul></li><li>▶ Deep Cut DC-C1 – Area may require passive GW control at the contact between glaciolacustrine sediment and till to softly convey seepage. May require a PTTW to construct GW drains. Performance monitoring required</li><li>▶ Deep Cut DC-C2 – Estimated permanent lowering of water table within 50 m of cut<ul style="list-style-type: none"><li>◦ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction</li></ul></li><li>▶ Deep Cut DC-C2 – Estimated permanent lowering of water table within 25 m of cut. Potential ORM deposits<ul style="list-style-type: none"><li>◦ Limit excavation to a maximum of 7.0 m below grade to avoid ORM deposits and potential GW pressure</li><li>◦ Potential to affect one (1) private well. Up to three (3) more if ORM deposits encountered</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 Brooklin municipal supply (long-term), or drilling a new well (long-term)</li></ul></li><li>▶ Central Mainline (Central 1 – C1a) – Low potential for reduction in groundwater quality from road run-off<ul style="list-style-type: none"><li>◦ Collect storm water in clay lined ponds with passive treatment and vegetative polishing</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>▶ A PTTW will be required for setting bridge foundations at CM-3/ CM-3B and CM10/ CM-10B</li><li>▶ Confirm depth of excavation for bridge abutments in the valleys of Lynde Creek and West Oshawa Creek so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts</li><li>▶ Plan to monitor shallow wells near the deep cuts for water level and quality for 1 month before construction, during construction and for 1 month following construction</li><li>▶ Borehole drilling along the length and transverse of the deep cut locations DC-C1, DC-C2, DC-C3 so the presence of aquifer units and extent of local drawdown can be confirmed. Hydraulic testing will be required</li><li>▶ Further design of passive groundwater control system at DC-C1 and detailed calculations of GW flow rates</li></ul>
<p><b>Map:</b> Central 1 – C1a (see Figure 2 for location)</p> <p><b>Section Boundaries:</b> Ashburn Road to Simcoe Street</p> <p><b>Figure(s):</b> Figure 3 and Figure 4 (Section C1a)</p> <p><b>Cross-section(s):</b> Central 1 (Figure 9)</p> <p><b>Proposed Structures:</b> Central Mainline CM-1,CM-2,CM-3,CM-4, CM-5,CM-6,CM-7,CM-8,CM-9,CM-10,CM 10b,CM-11,CM-12,CM-12b,CM-13,CM-13b,CM-14</p>		0 – 20 m		
<p><b>Deep Cuts:</b> DC-C1 (11+200 to 12+250) – 7.5 m cut depth (drawdown curve – Figure 11) DC-C2 (13+050 to 13+625) – 7 m cut depth (drawdown curve – Figure 12) DC-C3 (14+250 to 14+750) – 6 m cut depth (drawdown curve – Figure 13)</p> <p><b>High Fills:</b> HF-C1 (12+500 to 12+750) – 10 m fill height HF-C2 (15+000 to 15+260) – 15 m fill height HF-C3 (15+550 to 16+000) – 7 m fill height HF-C4 (16+750 to 17+000) – 7 m fill height</p>		0 – 50 m		
<p><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 4 (Section C1a)</p>				
FIELD DATA SOURCES:				
<p><b>Boreholes:</b> P13,P14,P15,P21,P22, CM3-1,CM3-2,CM3b-1,CM3b-2,CM6-1,CM6-2,CM6b-1, CM6b-2,CM9-1,CM9-2,CM9b-1,CM9b-2,CM10-1,CM10-2,CM10b-1,CM10b-2,CM11-1,CM11-2, WM43-1, WM43-2</p> <p><b>Monitoring Wells:</b> G1C-1, G1C-2</p> <p><b>Mini-Piezometers:</b> MP15,MP16</p>				
<p><b>Stream Reconnaissance Sites:</b> SR17a,b, SR18a,b, SR19a,b, SR20a,b, SR21</p>		GROUNDWATER FLOW:		
<p><b>Residential Water Wells:</b> 74 private water wells. 27% dug, 24% drilled, 52% unknown, 1% community (drilled). Between 7 and 10 wells within the TPR boundary (will require decommissioning)</p>		<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, mainly Lynde Creek and West Oshawa Creek. Lateral flow in minor and regional groundwater flow is primarily downwards through the till.</li><li>▶ Low amounts 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. This caused dendritic drainage patterns to form on valley slopes and created numerous seasonal or ephemeral creeks that are perched on the surficial till. Where buried sand horizons are intersected by the creek valleys, significant local groundwater discharge may occur and facilitate perennial stream flow.</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>		
<p><b>PHYSIOGRAPHIC SETTING:</b></p> <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., West Oshawa 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>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>▶ 20 dug wells (~5 to ~12 m deep), 18 drilled wells (~10 to ~55 m deep), 1 community well, no commercial/ industrial wells, 35 other wells (unknown construction details)</li></ul>		

407 East Extension – Central Section

Summary Table 2 (C2a) – Hydrogeological Conditions and Preliminary Recommendations

<div>Key Map</div> <div></div> <div><b>Map:</b> Central 2 – C2a (see Figure 2 for location)</div> <div><b>Section Boundaries:</b> Simcoe Street to Wilson Road</div> <div><b>Figure(s):</b> Figure 5 and Figure 6 (Section C2a)</div> <div><b>Cross-section(s):</b> Central 2 (Figure 10)</div> <div><b>Proposed Structures:</b> Central Mainline CM-15, CM-15B, CM-15C, CM-16, CM-16B, CM-17, CM-17B, CM-18, CM-19, CM-19B</div> <div><b>Deep Cuts:</b> None <b>High Fills:</b> HF-C5 (18+400 to 18+600) – 12 m fill height</div> <div><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 5 (Section C2a)</div> <div><b>FIELD DATA SOURCES:</b></div> <div><b>Boreholes:</b> P22, P23, CM17-1, CM17-1a, CM17-2, CM17-3, CM17-3a, CM17b-1, CM17b-2, CM17b-3</div> <div><b>Monitoring Wells:</b> G2C-1, G2C-2</div> <div><b>Mini-Piezometers:</b> MP17</div> <div><b>Stream Reconnaissance Sites:</b> SR22a,b, SR23a,b</div> <div><b>Residential Water Wells:</b> 37 private water wells. 38% dug, 11% drilled, 51% unknown. Approximately 11 wells within the TPR boundary (will require decommissioning)</div> <div><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., Oshawa Creek) and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys.</div> <div><b>Notes:</b> mBGS – metres below ground surface GWT – groundwater table ORM – Oak Ridges Moraine PTTW – Permit To Take Water</div>	<b>TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS:</b> <b>Central 2 (C2a) Section</b>		<b>POTENTIAL IMPACTS:</b>
		<b>Unit 1: Modern Alluvial Deposits</b> (surficial aquifer) – brown colour on figure 5 ► Silt, Sand and Gravel ► Glacial Outwash deposits derived from modern, post-glacial rivers	<b>Groundwater Effects on Foundation Design and Construction:</b> ► Shallow GWT (<1 mBGS) will be encountered in alluvial sediments near Oshawa Creek. ◦ Excavations in these deposits will require dewatering and a PTTW ► Shallow GWT (<1 mBGS) may be encountered within till units because the unit is poorly drained ► Flowing artesian conditions encountered at monitor G2C-1 at a depth of 12.2 mBGS ► Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term ► Structure CM-17/ CM-17B ◦ Dewatering is anticipated for excavations within alluvial sediments. A PTTW will be required ◦ Anticipate artesian conditions at 12.2 mBGS ◦ Fill placement in alluvial valley has the potential to disrupt GW flow/ discharge
		<b>Unit 2: Glaciolacustrine Deposits</b> (surficial aquifer) – yellow colour on figure 5 ► 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	
		<b>Unit 3: Halton Till</b> (aquitard) – dark green colour on figure 5 ► Clayey silt till, compact to very dense ► Ranges in thickness from 0 to 20 m ► 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 ► ORM sand and gravel deposits are occasionally encountered at the base of the Halton Till	<b>Surface Water Features:</b> ► No PSW are located within this Section ► Dewatering for bridge abutments in the valley Oshawa Creek (CM-17) are anticipated to reduce groundwater discharge into the creeks over the dewatering period ◦ A PTTW will be required ◦ A site specific investigation will be required during detailed design
		<b>Unit 4: Newmarket Till</b> (aquitard) – light green colour on figure 5 ► Silty sand to sandy silt till, with gravel and occasional boulders, very dense ► Ranges in thickness from 10 to 50 m ► Unit is exposed at ground surface in places ► 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>Aquifer/Well Vulnerability:</b> ► The ORM sand and gravel aquifer is occasionally present within Section C2a as southerly oriented “finger” like intrusions at the contact between the Halton and Newmarket till units. ◦ Significant dewatering and/ or impacts to private wells will occur if unit is encountered ► The Thorncliffe Aquifer was not encountered in Section C1a. ► Central Mainline (C2a) – Highway constructed partly on high permeability alluvial and glaciolacustrine aquifer sediments (17+900 to 18+700) ◦ Potential for long-term impact to groundwater quality from de-icing compounds ◦ SWM ponds and ditching placed between 17+900 and 18+700 will require clay lining to prevent infiltration ◦ No reduction in GW recharge due to the small surface area of the highway
	<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 the perennial river valley of Oshawa Creek. Local groundwater flow within the unconfined aquifer sandy deposits is horizontal towards Oshawa Creek. Regional groundwater flow is primarily downwards through the till. Lateral groundwater flow is minor ► Groundwater recharge occurs locally within areas of the surficial sand aquifer. Minor groundwater recharge also occurs on upland till deposits, although run-off exceeds recharge in these areas. Groundwater discharge is predominant where incised river valleys intercept the water table, creating perennial streams		
	<b>Groundwater Use:</b> ► Majority of private wells obtain potable water from surficial alluvial or glaciolacustrine aquifer units ► Some private wells obtain potable water from thin, discontinuous sand lenses/ seams within till units ► 14 dug wells (~5 to ~12 m deep), 4 drilled wells (~10 to ~55 m deep), no commercial/ industrial wells, 19 other wells (unknown construction details)		<b>Opportunities for Avoidance/ Mitigation/ Compensation:</b> ► Structure CM-16/ CM-16B – shallow dewatering may be required for construction of bridge footings ◦ Time dewatering period to avoid fish spawning seasons and to coincide with seasonal low GWT ◦ Discharge water into receptor stream following temperature and clarity controls to maintain baseflow ► Structure CM-17/ CM-17B – dewatering required for construction of bridge footings ◦ Use pile footings to minimize dewatering (high permeability sand units at surface), but be aware of potential artesian conditions at 12.2 mBGS ◦ Time dewatering period to avoid fish spawning seasons and to coincide with seasonal low GWT ◦ Discharge water into receptor stream following temperature and clarity controls to maintain baseflow ◦ Design valley fill with $K_{fill} > 100K_{native}$ to maintain groundwater flow and avoid “wicking” of GW into fill ◦ Potential to affect three (3) private wells over the dewatering period – Well IDs 2033, 2034, and 6452 ◦ Establish groundwater monitoring program to monitor quality and quantity prior to, during and following construction ◦ Compensate for impacts by: trucking in water (short-term) or deepening well (long-term) ► Central Mainline (Central 2 – C2a) – Potential for reduction in groundwater quality from road run-off ◦ Sandy alluvial materials extend across the TPR and are unavoidable ◦ Limit the use of de-icing salts ◦ Collect storm water in clay lined ponds with passive treatment and vegetative polishing ◦ Compensate for impacts by: trucking in water (short-term) or drilling a new well (long-term) ◦ Deeper wells should encounter permeable deposits at depth, but may yield less water than surficial aquifer ◦ No reduction in GW recharge due to the small surface area of the highway



407 East Extension – Central Section

Summary Table 3 (C2b) – Hydrogeological Conditions and Preliminary Recommendations

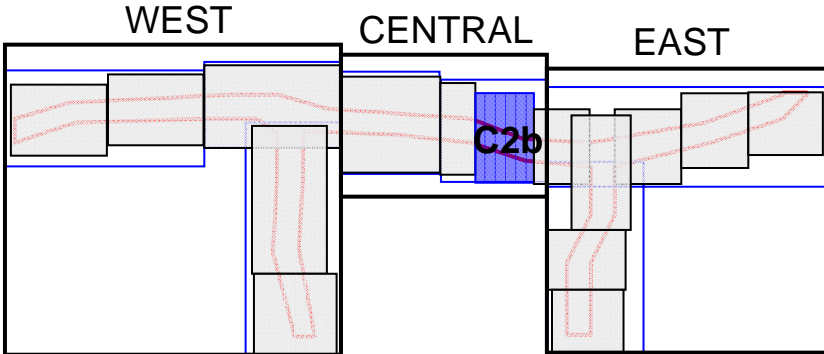
Key Map		TYPICAL STRATIGRAPHIC/ HYDROSTRATIGRAPHIC UNITS: Central 2 (C2b) Section		POTENTIAL IMPACTS:
		<p><i>Few surficial sand deposits are present in this section (yellow and brown on Figure 5)</i></p> <p>Exceptions:</p> <ul style="list-style-type: none"><li>▶ Thin deposits of modern alluvial sediments are present in modern river valleys of Oshawa Creek and Harmony Creek tributaries</li><li>▶ A small deposit of glaciolacustrine sand is found at surface north of Concession 6 west of Enfield Road</li></ul>		<p><b>Groundwater Effects on Foundation Design and Construction:</b></p> <ul style="list-style-type: none"><li>▶ Shallow GWT (&lt;1 mBGS) may be encountered within till units because the unit is poorly drained</li><li>▶ Flowing artesian conditions possible near Harmony Road at a depth of 7.3 mBGS</li><li>▶ Anticipate encountering discontinuous sand lenses below the GWT within till units. Will drain in the short term</li><li>▶ Structures CM-20/ CM-20B/ CM-20C and CM-26/ CM-26B<ul style="list-style-type: none"><li>◦ Shallow dewatering is anticipated for excavations within alluvial sediments. A PTTW may be required</li><li>◦ Fill placement in alluvial valleys has the potential to disrupt GW flow/ discharge</li></ul></li><li>▶ Deep Cut DC-C4 (5 m deep cut) will likely encounter the GWT at ~3.0 mBGS. Potential ORM deposits at 7.3 mBGS which may cause upwards groundwater pressure. Dewatering is anticipated if unit is encountered</li><li>▶ Deep Cut DC-C5 (8 m cut depth) will likely encounter the GWT at ~6.0 mBGS. Potential ORM deposits at &gt;7.3 mBGS which be used as a potable water supply for private wells. Dewatering is anticipated if unit is encountered</li><li>▶ Deep Cut DC-C6 (5 m cut depth) will likely encounter the GWT at ~4.0 mBGS. Sand lenses will drain in the short term. Low potential for dewatering</li><li>▶ Deep Cut DC-C7 (8 m cut depth) will likely encounter the GWT at ~3.0 mBGS. Sand lenses will drain in the short term. Low potential for dewatering</li></ul>
<p><b>Map:</b> Central 2 – C2b (see Figure 2 for location)</p> <p><b>Section Boundaries:</b> Wilson Road to Enfield Road</p> <p><b>Figure(s):</b> Figure 7 and Figure 8 (Section C2b)</p> <p><b>Cross-section(s):</b> Central 2 (Figure 10)</p> <p><b>Proposed Structures:</b> Central Mainline CM-20, CM-20B, CM-20C, CM-21, CM-21B, CM-22, CM-22B, CM-23, CM-24, CM-26, CM-26B, CM-27, CM-27B, CM-28, CM-28B, CM-29, CM-29B</p> <p><b>Deep Cuts:</b> DC-C4 (20+700 to 21+200) – 5 m cut depth (drawdown curve – Figure 11) DC-C5 (21+400 to 22+200) – 8 m cut depth (drawdown curve – Figure 12) DC-C6 (23+200 to 23+800) – 5 m cut depth (drawdown curve – Figure 13) DC-C7 (24+250 to 25+150) – 8 m cut depth (drawdown curve – Figure 14)</p> <p><b>High Fills:</b> HF-C6 (20+100 to 20+350) – 13 m fill height HF-C7 (24+030 to 24+220) – 8 m fill height HF-C8 (25+200 to 25+500) – 7 m fill height</p>		0 – 20 m	<p><b>Unit 1: Halton Till</b> (aquitard) – dark green on figure 7</p> <ul style="list-style-type: none"><li>▶ Clayey silt till, compact to very dense</li><li>▶ Ranges in thickness from 0 to 20 m</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>▶ ORM sand and gravel deposits are occasionally encountered at the base of the Halton Till</li></ul>	<p><b>Surface Water Features:</b></p> <ul style="list-style-type: none"><li>▶ Dewatering for bridge abutments in the valleys near Oshawa Creek tributary (CM-20) and Harmony Creek (CM-26) is anticipated to reduce GW discharge into the creeks over the dewatering period. A PTTW may be required</li><li>▶ The Solina Bog Wetland Complex is located east of Enfield Road and is a PSW<ul style="list-style-type: none"><li>◦ Sediment and erosion control measures will be required for construction near this feature</li><li>◦ There is no hydraulic connection between Farewell Creek and the Solina Bog</li></ul></li></ul>
		2 - 5 m	<p><b>Unit 2: Interstadial Sand Deposits</b> (aquifer) – yellow or brown at the base of dark green (see cross section – figure 10)</p> <ul style="list-style-type: none"><li>▶ Silty sand, compact, waterbearing</li><li>▶ Possibly “finger-like” protrusions of ORM oriented southwards</li><li>▶ Encountered in the northwest portion of Section near Harmony Road</li></ul>	<p><b>Aquifer/Well Vulnerability:</b></p> <ul style="list-style-type: none"><li>▶ The ORM sand and gravel aquifer is occasionally present within Section C2b as southerly oriented “finger” like intrusions at the contact between the Halton and Newmarket till units<ul style="list-style-type: none"><li>◦ Significant dewatering and/ or impacts to private wells will occur if unit is encountered</li></ul></li><li>▶ The Thorncliffe Aquifer may have been encountered in MOE well records in Section C2b near Enfield Road</li><li>▶ Deep Cut DC-C4 (5 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 30 m</li><li>◦ If sand deposit at 7.3 mBGS is encountered, high potential to impact local wells</li></ul></li><li>▶ Deep Cut DC-C5 (8 m cut depth) – Excavations estimated to be 6.0 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>◦ Many private wells within 250 m of cut. Nine (9) wells near the deep cut should be monitored prior to, during and following construction for both quality and quantity</li></ul></li><li>▶ Deep Cut DC-C6 (5 m cut depth) – Excavations estimated to be 4.0 m below the water table (figure 16)<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-C7 (8 m cut depth) – Excavations estimated to be 3.0 m below the water table (figure 17)<ul style="list-style-type: none"><li>◦ Radius of water table drawdown is estimated to be 50 m</li><li>◦ Many private wells within 250 m of cut. Seven (7) wells near the deep cut should be monitored prior to, during and following construction for both quality and quantity</li></ul></li><li>▶ Central Mainline (C2b) – 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>◦ SWM ponds placed in alluvial valleys will require clay lining to prevent infiltration</li><li>◦ No reduction in GW recharge due to the small surface area of the highway</li></ul></li></ul>
<p><b>Foundation Risk Assessment Hydrogeology Table:</b> Table 6 (Section C2b)</p>		0 – >30 m	<p><b>Unit 3: Newmarket Till</b> (aquitard) – light green on figure 7</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 10 to &gt;30 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>Opportunities for Avoidance/ Mitigation/ Compensation:</b></p> <ul style="list-style-type: none"><li>▶ Structures CM-20/ CM-20B/ CM-20C and CM-26/ CM-26B – dewatering required for construction of bridge footings<ul style="list-style-type: none"><li>◦ Use pile footings to minimize dewatering (high permeability sand units at surface)</li><li>◦ Time dewatering period to avoid fish spawning seasons and to coincide with seasonal low GWT</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 groundwater flow and avoid “wicking” of GW into fill</li></ul></li><li>▶ Deep Cut DC-C4 – Limit excavation to a maximum of 7.0 m below grade to avoid ORM deposits<ul style="list-style-type: none"><li>◦ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction</li></ul></li><li>▶ Deep Cut DC-C5 – Limit excavation to a maximum of 7.0 m below grade to avoid ORM deposits<ul style="list-style-type: none"><li>◦ Nine (9) wells require monitoring for quality and quantity prior to, during and following construction</li><li>◦ Compensate for impacts by: trucking in water (short-term), or drilling a new well (long-term)</li></ul></li><li>▶ Deep Cut DC-C6 – Estimated permanent lowering of water table within 25 m of cut<ul style="list-style-type: none"><li>◦ Establish GW monitoring program to monitor quality and quantity prior to, during and following construction</li></ul></li><li>▶ Deep Cut DC-C7 – Estimated permanent lowering of water table within 50 m of cut<ul style="list-style-type: none"><li>◦ Seven (7) wells require monitoring for quality and quantity prior to, during and following construction</li><li>◦ Compensate for impacts by: trucking in water (short-term), or drilling a new well (long-term)</li></ul></li><li>▶ Central Mainline (Central 2 – C2b) – Low potential for reduction in groundwater quality from road run-off<ul style="list-style-type: none"><li>◦ Collect storm water in clay lined ponds with passive treatment and vegetative polishing</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>PRIORITIES FOR DETAILED DESIGN:</b></p> <ul style="list-style-type: none"><li>▶ A PTTW will be required for setting bridge foundations at CM-20/ CM-20B/ CM-20C and CM-26/ CM-26B</li><li>▶ Confirm depth of excavation for bridge abutments in the valley of the Oshawa Creek tributary (CM-20) so dewatering rates can be estimated. Hydraulic testing will be required to establish potential impacts</li><li>▶ Plan to monitor shallow wells near the deep cuts for water level and quality for 1 month before construction, during construction and for 1 month following construction</li><li>▶ Borehole drilling along the length and transverse of the deep cut locations DC-C4, DC-C5, DC-C6, DC-C7 so the presence of aquifer units and extent of local drawdown can be confirmed. Hydraulic testing will be required</li></ul>	
<p><b>Boreholes:</b> P25, P26, P27, CM20b-2, CM20b-3, CM21-1, CM21-2, CM21b-1, CM21b-3, CM23b-2, CM24-1, CM24-2, CM24-3, CM24-4</p> <p><b>Monitoring Wells:</b> G3C-1, G3C-2</p> <p><b>Mini-Piezometers:</b> MP18, MP19s/d, MP20s/d</p> <p><b>Stream Reconnaissance Sites:</b> SR24a,b, SR25a,b, SR26a,b,</p> <p><b>Residential Water Wells:</b> 96 private water wells. 26% dug, 23% drilled, 51% unknown. Approximately 12 wells within the TPR boundary (will require decommissioning)</p>				
<p><b>PHYSIOGRAPHIC SETTING:</b></p> <p>▶ 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 and deposited coarse-textured glaciofluvial sediments along their path. Modern alluvial silts, sands and gravels can be found in these valleys.</p>				
<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 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. That is, shallow lateral groundwater flow is from high ground towards discharge areas in perennial river valleys, mainly Oshawa Creek and tributaries of Harmony Creek. Lateral groundwater flow is minor and regional groundwater flow is primarily downwards through the till</li><li>▶ Low amounts of groundwater recharge occur in upland till plains, although surface runoff often exceeds recharge due to the presence of low permeability till deposits. This caused dendritic drainage patterns to form on valley slopes and created numerous seasonal or ephemeral creeks that are perched on the surficial till. Where buried sand horizons are intersected by the creek valleys, significant local groundwater discharge may occur and facilitate perennial stream flow</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>	
			<p><b>Groundwater Use:</b></p> <ul style="list-style-type: none"><li>▶ Private wells near Harmony Road obtain potable water from sand deposits at the base of the Halton Till that may be ORM deposits</li><li>▶ Other private wells obtain potable water from thin, discontinuous sand lenses/ seams within till units</li><li>▶ 25 dug wells (~5 to ~12 m deep), 22 drilled wells (~8 to ~55 m deep), no commercial/ industrial wells, 49 other wells (unknown construction details)</li></ul>	

TABLE 4 Highway 407 East Extension Central Section (Sub-section C1a) - 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	TSH ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
CENTRAL SECTION - Subsection C1a	CM - 1			Bridge	Underpass	Ashburn Road	WM43-1, WM43-2	Surficial sandy silt till (Newmarket Till) aquitard to 9.6 mBGS. Overlain by 1.5 m of glaciolacustrine clayey silt.	Water table perched on till unit. Depth to water table ranges from 1.2 to 2.3 mBGS.	Low	No Watercourse (Street Crossing)				60
	CM - 1b			Bridge	Underpass	Ashburn Road	WM43-1, WM43-2	Surficial sandy silt till (Newmarket Till) aquitard to 9.6 mBG. Overlain by 1.5 m of glaciolacustrine clayey silt.	Water table perched on till unit. Depth to water table ranges from 1.2 to 2.3 mBGS.	Low	No Watercourse (Street Crossing)				60
	CM - 2	CM-3		Bridge	Underpass	Baldwin Street	P13	Surficial glaciolacustrine clayey silt that grades to sandy silt. Below, sandy silty till (Newmarket Till) aquitard to 12.4 mBGS. Potential confined aquifer at >45.0 mBGS.	Groundwater seepage anticipated at constact between glaciolacustrine materials and Newmarket Till due to deep cut. Watertable perched on till unit. Depth to water table is <3.0 mBGS.	High	No Watercourse (Street Crossing)				60
	CM - 2b	CM-3		Bridge	Underpass	Baldwin Street	P13	Surficial glaciolacustrine clayey silt that grades to sandy silt. Below, sandy silty till (Newmarket Till) aquitard to 12.4 mBGS. Potential confined aquifer at >45.0 mBGS.	Groundwater seepage anticipated at constact between glaciolacustrine materials and Newmarket Till due to deep cut. Watertable perched on till unit. Depth to water table is <3.0 mBGS.	High	No Watercourse (Street Crossing)				60
	CM - 3	CM-5	CM-LC-24	Bridge	Overpass	Lynde Creek	CM3-1, CM3-2, CM3b-1, CM3b-2, MP15	Surficial aquifer to 9.4 mBGS in valley - alluvial sediments (sand and gravel), and glaciolacustrine silty sand. Water table near surface (<1.0 mBGS) and upwards hydraulic gradient within stream (i.e., groundwater discharge). Sand and silt till (Newmarket Till) aquitard below surficial aquifer to a depth of 16.9 mBGS.	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	Wide, moderately deep valley with 15-25° steep valley sides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material (e.g., a 0.15 m thick organic layer, evidence of previous floodplain elevation, exists approx. 1.5 m below current floodplain)	>100	55
	CM - 3b	CM-5	CM-LC-24	Bridge	Overpass	Lynde Creek	CM3-1, CM3-2, CM3b-1, CM3b-2, MP15	Surficial aquifer to 9.4 mBGS in valley - alluvial sediments (sand and gravel), and glaciolacustrine silty sand. Water table near surface (<1.0 mBGS) and upwards hydraulic gradient within stream (i.e., groundwater discharge). Sand and silt till (Newmarket Till) aquitard below surficial aquifer to a depth of 16.9 mBGS.	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	Wide, moderately deep valley with 15-25° steep valley sides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material (e.g., a 0.15 m thick organic layer, evidence of previous floodplain elevation, exists approx. 1.5 m below current floodplain)	>100	55
	CM - 4	CM-6	CM-TBLC-25	Culvert	Overpass	Creek	P14	Surficial silty to clayey till aquitard to a depth of at least 11.4 mBGS.	Depth to water table is <3.0 mBGS. Watercourse perched on till. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Box Culvert	Narrow, shallow, channelized valley with no geomorphic evidence of significant valley side instability	Likely no appreciable alluvial deposits, based on field checks of similar valleys	<10	55
	CM - 5	CM-7		Bridge	Underpass	Anderson Street	None	Surficial silty to clayey till aquitard to a depth of at least 11.4 mBGS (P14).	Water table perched on till unit. Depth to water table is <3.0 mBGS.	Low	No Watercourse (Street Crossing)				60
	CM - 5b	CM-7		Bridge	Underpass	Anderson Street	None	Surficial silty to clayey till aquitard to a depth of at least 11.4 mBGS (P14).	Water table perched on till unit. Depth to water table is <3.0 mBGS.	Low	No Watercourse (Street Crossing)				60
	CM - 6	CM-9		Bridge	Underpass	Thickson Road	G1C-1, G1C-2, CM6-1, CM6-2, CM6b-1, CM6b-2	Surficial silty sand to sandy silt till (Newmarket Till) aquitard to a depth of at least 12.8 mBGS. Isolated lenses of silt and sand in upper 12.8 m. Water table near surface (<1.0 to 2.0 mBGS) and downward hydraulic gradient measured in groundwater monitors indicating a groundwater recharge area.	Water table perched on till unit. Depth to water table ranges from <1.0 to 2.0 mBGS. Low potential for dewatering due to shallow water table in low permeability till soils.	Low	No Watercourse (Street Crossing)				60
	CM - 6b	CM-9		Bridge	Underpass	Thickson Road	G1C-1, G1C-2, CM6-1, CM6-2, CM6b-1, CM6b-2	Surficial silty sand to sandy silt till (Newmarket Till) aquitard to a depth of at least 12.8 mBGS. Isolated lenses of silt and sand in upper 12.8 m. Water table near surface (<1.0 to 2.0 mBGS) and downward hydraulic gradient measured in groundwater monitors indicating a groundwater recharge area.	Water table perched on till unit. Depth to water table ranges from <1.0 to 2.0 mBGS. Low potential for dewatering due to shallow water table in low permeability till soils.	Low	No Watercourse (Street Crossing)				60
	CM - 7	CM-10	CM-TBPC-27	Culvert	Overpass	Pringle Creek	None	Surficial silty sand to sandy silt till (Newmarket Till) aquitard to a depth of at least 12.8 mBGS.	Watercourse is perched on till. Low potential for dewatering due to shallow water table in low permeability till soils. Culvert installation should occur when stream flow is low.	Low	Closed Bottom Box 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	60
	CM - 8			Culvert	Overpass	Creek / Pond	None	Surficial silty sand to sandy silt till (Newmarket Till) aquitard to a depth of at least 12.8 mBGS.	Watercourse is perched on till. Low potential for dewatering due to shallow water table in low permeability till soils. Culvert installation should occur when stream flow is low.	Low	No Watercourse (Small Pond Located to the North of the TPR)	Narrow, shallow swale with no geomorphic evidence of significant valley side instability	Small pond located to the north of the TPR. Likely no appreciable alluvial deposits, based on field checks of similar ponds and swales		60
	CM - 9			Cul-De-Sac	Underpass	Garrard Road	CM9-1, CM9-2, P15	Surficial silty to clayey till (Halton Till) aquitard to a depth of 7.6 mBGS. Sandy silt till (Newmarket Till) to a depth of between 8.7 and 17.6 mBGS. Gravelly sand aquifer unit encountered between 8.7 and 17.6 mBGS in geotechnical boreholes. Newmarket Till encountered below aquifer unit.	Water table is likely perched on till. Estimated depth to groundwater is <5.0 mBGS. Gravelly sand aquifer unit may be Oak Ridges Moraine (ORM) sediments. Low potential for dewatering unless excavating to a depth of >8.7 mBGS.	Medium	No Watercourse. No Street Crossing. Cul-De-Sac				55
	CM - 10	CM-12	CM-OCE-28	Bridge	Overpass	West Oshawa Creek	CM10-2, CM10b-2, MP16	Surficial coarse-textured sandy and alluvial aquifer deposits in West Oshawa Creek to a depth of 7.2 mBGS. Water table near surface (<1.0 mBGS), evidence of upward gradients along creek bed indicating groundwater discharge	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	Wide, deep valley with 30° steep valley sides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps (bridge abutment locations should take into account potential for continued down-valley migration of meander immediately northwest of proposed footprints); thin soil cover and minor irregularities on east valley side suggest localized erosion and instability	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; riparian wetlands likely contain <1 m deep organic material	50-100	35



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	TSH ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
CENTRAL SECTION - Subsection C1a	CM - 10b	CM-12	CM-OCE-28	Bridge	Overpass	West Oshawa Creek	CM10-2, CM10b-2, MP16	Surficial coarse-textured sandy and alluvial aquifer deposits in West Oshawa Creek to a depth of 7.2 mBGS. Water table near surface (<1.0 mBGS), evidence of upward gradients along creek bed indicating groundwater discharge	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	Wide, deep valley with 30° steep valley sides, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps (bridge abutment locations should take into account potential for continued down-valley migration of meander immediately northwest of proposed footprints); thin soil cover and minor irregularities on east valley side suggest localized erosion and instability	Valley bottom sediments >2 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; riparian wetlands likely contain <1 m deep organic material	50-100	35
	CM - 11	CM-14		Bridge	Underpass	Thornton Road	CM11-1, CM11-2, P21	Surficial silty to clayey till (Halton Till) aquitard to a depth of between 13.1 and 16.3 mBGS. Aquitard confines sand aquifer unit (potential ORM Aquifer) supplying residential wells. Isolated sand/silt lenses in upper 9.4 m.	Water table is likely perched on till. Estimated depth to groundwater is <5.0 mBGS. Sand aquifer unit may be Oak Ridges Moraine (ORM) sediments. Low potential for dewatering unless excavating to a depth of >13.1 mBGS.	Low	No Watercourse (Street Crossing)				50
	CM - 12	CM-16		Bridge	Overpass	Winchester Road	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of between 13.1 and 16.3 mBGS. Aquitard confines sand aquifer unit (potential ORM Aquifer) supplying residential wells. Isolated sand/silt lenses in upper 9.4 m. (CM11-1, CM11-2, P21)	Water table is likely perched on till. Estimated depth to groundwater is <5.0 mBGS. Sand aquifer unit may be Oak Ridges Moraine (ORM) sediments. Low potential for dewatering unless excavating to a depth of >13.1 mBGS.	Low	No Watercourse (Street Crossing)	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
	CM - 12b	CM-16		Bridge	Overpass	Winchester Road	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of between 13.1 and 16.3 mBGS. Aquitard confines sand aquifer unit (potential ORM Aquifer) supplying residential wells. Isolated sand/silt lenses in upper 9.4 m. (CM11-1, CM11-2, P21)	Water table is likely perched on till. Estimated depth to groundwater is <5.0 mBGS. Sand aquifer unit may be Oak Ridges Moraine (ORM) sediments. Low potential for dewatering unless excavating to a depth of >13.1 mBGS.	Low	No Watercourse (Street Crossing)	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
	CM - 13	CM-18	CM-TAOCW-32	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till and is intermittent. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Box 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
	CM - 13b	CM-18	CM-TAOCW-32	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial poorly drained silty sand alluvial plain with thin peaty organic materials underlain by silty to clayey till. Underlying till more than 20 m thick. GWT near surface.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till and is intermittent. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Box 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
	CM - 14	CM-19		Bridge	Overpass	Simcoe Street	P22	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Water table perched on till unit. Depth to water table is likely <3.0 mBGS.	Low	No Watercourse (Street Crossing)				55
	CM - 14b	CM-19		Bridge	Overpass	Simcoe Street	P22	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Water table perched on till unit. Depth to water table is likely <3.0 mBGS.	Low	No Watercourse (Street Crossing)				55

TABLE 5  
Highway 407 East Extension  
Central Section (Sub-section C2a) - 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	TSH ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS						
CENTRAL SECTION - Subsection C2a	CM - 15	CM-20	CM-TBOCW-33	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till and is intermittent. Culvert installation should occur when stream bed is dry.	NA	Stream Realigned to the North	Narrow, moderately deep 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
	CM - 15b	CM-20	CM-TBOCW-33	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till and is intermittent. Culvert installation should occur when stream bed is dry.	NA	Stream Realigned to the North	Narrow, moderately deep 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
	CM - 15c	CM-20	CM-TBOCW-33	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial silty to clayey till (Halton Till) aquitard to a depth of 5.5 mBGS, overlying silty sand till (Newmarket Till) aquitard to a depth of 12.6 mBGS. Potential for thin alluvial sediments in valley.	Depth to water table is likely <3.0 mBGS. Watercourse perched on till and is intermittent. Culvert installation should occur when stream bed is dry.	NA	Stream Realigned to the North	Narrow, moderately deep 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
	CM - 16	CM-21	CM-TA1OCW-34	Bridge	Overpass	Oshawa Creek Tributary	None (Ecoplans provided comments on groundwater discharge)	Surficial coarse textured sandy aquifer deposits (unknown thickness - estimated to be <5.0 m). Ecoplans reports no indicators of groundwater discharge within TPR boundary. Surficial sand aquifer underlain by silty sand till (Newmarket Till) aquitard to depth.	Water table estimated to be close to ground surface (<1.0 mBGS) due to poor drainage below. Potential for dewatering if excavating alluvial sediments.	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	50
	CM - 16b	CM-21	CM-TA1OCW-34	Bridge	Overpass	Oshawa Creek Tributary	None (Ecoplans provided comments on groundwater discharge)	Surficial coarse textured sandy aquifer deposits (unknown thickness - estimated to be <5.0 m). Ecoplans reports no indicators of groundwater discharge within TPR boundary. Surficial sand aquifer underlain by silty sand till (Newmarket Till) aquitard to depth.	Water table estimated to be close to ground surface (<1.0 mBGS) due to poor drainage below. Potential for dewatering if excavating alluvial sediments.	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	50
	CM - 17	CM-22	CM-TCEBOC-35	Bridge	Overpass	Ritson Road and Oshawa Creek	G2C-1, G2C-2, CM17-1, CM17-2, CM17-3, CM17b-1, CM17b-3, MP17	Surficial aquifer up to 11.0 mBGS in valley - alluvial sediments (sand and gravel), and glaciolacustrine silty sand. Silty sand and sand units up to 4.0 m thick found between units of silty sand till (Newmarket Till) aquitard to a depth of 20.1 mBGS. Water table near surface (<1.0 mBGS) and upwards hydraulic gradient within stream (i.e., groundwater discharge).	Groundwater level at G2C ranges between - 1.3 and 2.3 bmgs. Deep well (15 mBGS) is flowing artesian. Strong upwards hydraulic gradient between shallow and deep well. Spring seepage and cattails at toe of steep east valley side. Potential to intercept flowing artesian conditions at 12mBGS. Dewatering will be required if excavating alluvial sediments in valley. A PTTW will be required.	High	Span Bridge	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valley side and 35° steep east valley side, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps; h	Modern valley bottom sediments >1.5 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; early post-glacial alluvial sediments comprising terrace on west side valley dominantly sandy gravel	20-50	40
	CM - 17b	CM-22	CM-TCEBOC-35	Bridge	Overpass	Ritson Road and Oshawa Creek	G2C-1, G2C-2, CM17-1, CM17-2, CM17-3, CM17b-1, CM17b-3, MP17	Surficial aquifer up to 11.0 mBGS in valley - alluvial sediments (sand and gravel), and glaciolacustrine silty sand. Silty sand and sand units up to 4.0 m thick found between units of silty sand till (Newmarket Till) aquitard to a depth of 20.1 mBGS. Water table near surface (<1.0 mBGS) and upwards hydraulic gradient within stream (i.e., groundwater discharge).	Groundwater level at G2C ranges between - 1.3 and 2.3 bmgs. Deep well (15 mBGS) is flowing artesian. Strong upwards hydraulic gradient between shallow and deep well. Spring seepage and cattails at toe of steep east valley side. Potential to intercept flowing artesian conditions at 12mBGS. Dewatering will be required if excavating alluvial sediments in valley. A PTTW will be required.	High	Span Bridge	Wide, deep valley (old glacial meltwater spillway and early post-glacial river valley) with gentle west valley side and 35° steep east valley side, except where meandering channel is undercutting and steepening slope, which has lead to localized slumps; h	Modern valley bottom sediments >1.5 m deep and dominantly silty gravelly sand alluvium, locally interbedded with buried organic material; early post-glacial alluvial sediments comprising terrace on west side valley dominantly sandy gravel	20-50	40
	CM - 18	CM-23	CM-TCEBOC-36	Culvert	Overpass	Oshawa Creek Tributary	None	Surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <10.0 mBGS. Watercourse perched on till. Culvert installation should occur when stream bed is dry.	Low	Closed Bottom Box 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	45
	CM -19			Bridge	Overpass	Wilson Road	None	Surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <10.0 mBGS.	Low	No Watercourse (Street Crossing)				65
	CM -19b			Bridge	Overpass	Wilson Road	None	Surficial silty to clayey till (Halton Till) aquitard to overlying silty sand till (Newmarket Till) aquitard.	Depth to water table is likely <10.0 mBGS.	Low	No Watercourse (Street Crossing)				65

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	TSH ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
CENTRAL SECTION - Subsection C2b	CM - 20	CM-26	CM-TEEBOC-38	Bridge	Overpass	East Oshawa Creek	CM20b-2, MP18	Surficial silty sand alluvial aquifer and organic material underlain by silty to clayey till (Halton Till) aquitard. Surficial aquifer likely limited to <5.0 in thickness. Groundwater table near surface in river valley (<1.0 mBGS). Upwards hydraulic gradients measured in East Oshawa Creek river valley indicating groundwater discharge.	Stream Reconnaissance data suggests that creek flows year round. Shallow dewatering will be required if excavating alluvial sediments in valley. A PTTW will be required.	Medium	Span Bridge	Narrow, moderately deep valley; meandering channel is undercutting valley side, which has lead to localized slumps	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	70
	CM - 20b	CM-26	CM-TEEBOC-38	Bridge	Overpass	East Oshawa Creek	CM20b-2, MP18	Surficial silty sand alluvial aquifer and organic material underlain by silty to clayey till (Halton Till) aquitard. Surficial aquifer likely limited to <5.0 in thickness. Groundwater table near surface in river valley (<1.0 mBGS). Upwards hydraulic gradients measured in East Oshawa Creek river valley indicating groundwater discharge.	Stream Reconnaissance data suggests that creek flows year round. Shallow dewatering will be required if excavating alluvial sediments in valley. A PTTW will be required.	Medium	Span Bridge	Narrow, moderately deep valley; meandering channel is undercutting valley side, which has lead to localized slumps	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	70
	CM - 20c	CM-28	CM-TEEBOC-39	Bridge	Overpass	East Oshawa Creek	CM20b-2, MP18	Surficial silty sand alluvial aquifer and organic material underlain by silty to clayey till (Halton Till) aquitard. Surficial aquifer likely limited to <5.0 in thickness. Groundwater table near surface in river valley (<1.0 mBGS). Upwards hydraulic gradients measured in East Oshawa Creek river valley indicating groundwater discharge.	Stream Reconnaissance data suggests that creek flows year round. Shallow dewatering will be required if excavating alluvial sediments in valley. A PTTW will be required.	Medium	Span Bridge	Narrow, moderately deep valley; meandering channel is undercutting valley side, which has lead to localized slumps	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	70
	CM - 21	CM-27		Bridge	Overpass	Harmony Road	CM21-1, CM21b-1, CM21-2	Surficial silty to clayey till (Halton Till) aquitard. Sand unit encountered at between 7.3 and 8.7 mBGS (likely ORM Aquifer deposits). Below sand, silty sand till (Newmarket Till) is present to a depth of 15.4 mBGS.	Water table depth likely <3.0 mBGS. Low potential for dewatering due to shallow water table in low permeability till soils. If ORM deposits are encountered in excavation, dewatering will be required.	Medium	No Watercourse (Street Crossing)				85
	CM - 21b	CM-27		Bridge	Overpass	Harmony Road	CM21-1, CM21b-1, CM21-2	Surficial silty to clayey till (Halton Till) aquitard. Sand unit encountered at between 7.3 and 8.7 mBGS (likely ORM Aquifer deposits). Below sand, silty sand till (Newmarket Till) is present to a depth of 15.4 mBGS.	Water table depth likely <3.0 mBGS. Low potential for dewatering due to shallow water table in low permeability till soils. If ORM deposits are encountered in excavation, dewatering will be required.	Medium	No Watercourse (Street Crossing)				85
	CM - 22			Bridge	Overpass	Grandview Street	None	Surficial silty clay to clayey silt till (Halton Till) aquitard to a depth of 8.3 mBGS. Boulder encountered at 8.3 mBGS according to geotech borehole log. Sandy silt till (Newmarket Till) aquitard is present below to a depth of 10.8 mBGS.	Water table perched on till unit. Depth to water table is expected to be <3.0 mBGS.	Medium	No Watercourse (Street Crossing)				105
	CM - 22b			Bridge	Overpass	Grandview Street	None	Surficial silty clay to clayey silt till (Halton Till) aquitard to a depth of 8.3 mBGS. Boulder encountered at 8.3 mBGS according to geotech borehole log. Sandy silt till (Newmarket Till) aquitard is present below to a depth of 10.8 mBGS.	Water table perched on till unit. Depth to water table is expected to be <3.0 mBGS.	Medium	No Watercourse (Street Crossing)				105
	CM - 23	CM-31		Bridge	Underpass	Winchester Road	CM23b-2	Surficial silty clay to clayey silt till (Halton Till) aquitard to a depth of 8.3 mBGS. Boulder encountered at 8.3 mBGS according to geotech borehole log. Sandy silt till (Newmarket Till) aquitard is present below to a depth of 10.8 mBGS.	Water table perched on till unit. Depth to water table is expected to be <5.0 mBGS.	Medium	No Watercourse (Street Crossing)				105
	CM - 23b	CM-31		Bridge	Underpass	Winchester Road	CM23b-2	Surficial silty clay to clayey silt till (Halton Till) aquitard to a depth of 8.3 mBGS. Boulder encountered at 8.3 mBGS according to geotech borehole log. Sandy silt till (Newmarket Till) aquitard is present below to a depth of 10.8 mBGS.	Water table perched on till unit. Depth to water table is expected to be <3.0 mBGS.	Medium	No Watercourse (Street Crossing)				105
	CM - 24	CM-32	CM-HC-53(54)	Culvert	Overpass	Harmony Creek tributary	G3C-1, G3C-2, CM24-1, CM24-2, CM24-3, CM24-4	Surficial silty clay to clayey silt till (Halton Till) aquitard to a depth of 10.7 mBGS. Sandy silt till (Newmarket Till) aquitard is present below to a depth of 29.0 mBGS. Silty clay and silty sand deposits interbedded within Till units.	Water table perched on till unit. Shallow water table ranges from 1.9 to 2.5 mBGS. Deep water level indicates a downwards gradient (recharge area) Moderate potential for dewatering if excavating alluvial sediments in valley.	Medium	Closed Bottom Box Culvert	Narrow, shallow, channelized valley with no geomorphic evidence of significant valley side instability	Valley bottom sediments likely <1 m deep and dominantly silty gravelly sand alluvium, based on field checks of similar valleys	<10	95
	CM - 26	CM-35	CM-HC-56	Bridge	Overpass	Harmony Creek	None	Surficial silt till and sandy silt glaciolacustrine plain with silty sand alluvial plain. Likely <5.0 m in thickness. Groundwater table near surface in river valley (<1.0 mBGS). Evidence of year round groundwater discharge (stream temperature logs)	Stream reconnaissance data suggests that groundwater discharge occurs in the creek along the distance of the TPR. Water table likely <1.90 mBGS. Moderate potential for dewatering if excavating alluvial sediments in valley.	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	80
	CM - 26b	CM-35	CM-HC-56	Bridge	Overpass	Harmony Creek	None	Surficial silt till and sandy silt glaciolacustrine plain with silty sand alluvial plain. Likely <5.0 m in thickness. Groundwater table near surface in river valley (<1.0 mBGS). Evidence of year round groundwater discharge (stream temperature logs)	Stream reconnaissance data suggests that groundwater discharge occurs in the creek along the distance of the TPR. Water table likely <1.90 mBGS. Moderate potential for dewatering if excavating alluvial sediments in valley.	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	80

TABLE 6 Highway 407 East Extension Central Section (Sub-section C2b) - 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	TSH ID	Drainage Crossing ID					SUBSURFACE CONDITIONS	REMARKS	HYDROGEOLOGY					
CENTRAL SECTION - Subsection C2b	CM - 27	CM-36		Bridge	Underpass	Langmaid Road	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)				90
	CM - 27b	CM-36		Bridge	Underpass	Langmaid Road	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)				90
	CM - 28	CM-37		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	CM-37		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	CM-38		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	CM-38		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
	Nil	CM-37a	CM-FC-57	Bridge	Overpass	Enfield Road over Farewell Creek	MP20	Surficial alluvial sediments underlain by glaciolacustrine sand. Thin veneer of organic materials may be present to the west of Enfield Rd. Water table expected to be at or near surface. Evidence of shallow groundwater discharge, but deeper flow is downwards indicating recharge. Area immediately to the north is a flood plain for Farewell Creek.	Water table is expected to be <1.0 mBGS. Potential for dewatering if excavating alluvial sediments. Culvert construction should occur when stream flow is low.	Medium	Open Bottom Culvert				95
	Nil	CM-	CM-FC-57A	Bridge	Overpass	Enfield Connecting Road over Farewell Creek	MP20	Surficial alluvial sediments underlain by glaciolacustrine sand. Thin veneer of organic materials may be present to the west of Enfield Rd. Water table expected to be at or near surface. Evidence of shallow groundwater discharge, but deeper flow is downwards indicating recharge. Area immediately to the north is a flood plain for Farewell Creek.	Water table is expected to be <1.0 mBGS. Potential for dewatering if excavating alluvial sediments. Culvert construction should occur when stream flow is low.	Medium	Open Bottom Culvert				

**Table 7**  
Highway 407 East Extension  
Central Section  
Deep Cuts Water Table Drawdown Analysis

AECOM ID	Drawdown Curve Figure	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-C1	Figure 18a	Ashburn Road to east of Baldwin Street	11+200 to 12+250	7.5 m	WM43-1, WM42-2, P13	Glaciolacustrine silty clay grading to sandy silt to 1.5 mBGS. Newmarket Till below.	1.2 to 2.3 mBGS	6.0 m	1.0E-07	50 m	No wells are anticipated to be affected by deep cut.	None	The vertical geometry of this cut creates a "boal" strcuture at the base of the cut, where surface water and groundwater will accumulate. Sandy deposits at the contact between the glaciolacustrine materials and the till may require permanent drainage to prevent continual seepage.
DC-C2	Figure 18a	Anderson Street to Thicksen Road	13+050 to 13+625	7 m	G1C-1, G1C-2, CM6-1, CM6b-1, CM6-2, CM6b-2	Newmarket Till and Halton Till Aquitard - sandy silt till to clayey silt till	1.0 to 2.5 mBGS	6.0 m	1.0E-07	50 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-C3	Figure 18a	Garrard Road	14+250 to 14+750	6 m	G1C-1, G1C-2, CM9-1, CM9-2	Halton Till Aquitard - clayey silt till. Potential ORM Gravelly Sand Aquifer at ~9.0 mBGS	~4.0 mBGS	2.0 m	1.0E-07	25 m	One (1) shallow, dug well within 50 m of excavation.	One (1) well requires monitoring prior to, during and following excavations for both water quality and quantity.	Water level obtained from CM9-1. Water level may possibly be higher. Estimation does not account for potential sand lenses/ seems. Encountering these features will significantly increase the radius of influence.
DC-C4	Figure 18c	Harmony Road to Grandview Street	20+700 to 21+200	5 m	G3C-1, G3C-2, CM21-1, CM21-2, CM21b-1, CM21b-3, CM23b-2	Newmarket Till Aquitard - sandy silt till. Potential ORM Silty Sand to Sand Aquifer at ~7.3 m BGS	~1.0 - 3.0 mBGS. Potential to encounter perched water table within areas of ablation moraine on east side of Harmony Rd.	3.0 m	1.0E-07	30 m	No wells are anticipated to be affected by deep cut	None	Site specific data is required to confirm analysis. Most wells in this area are drilled wells, but homeowners report that wells are sensitive to changes in the local water table (i.e., drilling of a new well)
DC-C5	Figure 18c	Grandview Street and Winchester Road E.	21+400 to 22+200	8 m	G3C-1, G3C-2, CM21-1, CM21-2, CM21b-1, CM21b-3, CM23b-2	Newmarket Till Aquitard - sandy silt till. Potential ORM Silty Sand to Sand Aquifer at ~7.3 m BGS	~2.0 - 3.0 mBGS. Potential to encounter perched water table within areas of ablation moraine on east side of Harmony Rd.	6.0 m	1.0E-07	50 m	Potential to encounter aquifer unit at base of cut. Nine (9) wells within 250 m of the cut.	Nine (9) wells require monitoring prior to, during and following excavations for both water quality and quantity.	Site specific data is required to confirm analysis. Most wells in this area are drilled wells, but homeowners report that wells are sensitive to changes in the local water table (i.e., drilling of a new well)
DC-C6	Figure 18c	Leask Road	23+200 to 23+800	5 m	G3C-1, G3C-2, CM24-1, CM24-2, CM24-3, CM24-4, P25, P26	Newmarket Till Aquitard - sandy silt till	1.0 to 7.0 mBGS	4.0 m	1.0E-07	25 m	Two (2) shallow, dug wells within 250 m of maximum cut elevation. Deep Cut may intercept sand lenses used for potable water supply.	Two (2) wells require monitoring prior to, during and following excavations for both water quality and quantity. Raising highway grade would reduce cut depth.	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-C7	Figure 18c	Landmaid Road and Concession 6 Road	24+250 to 25+150	8 m	CM29-1, CM29-2, P26, P27	Newmarket Till Aquitard - sandy silt till	< 7.0 mBGS	3.0 m	1.0E-07	50 m	Seven (7) wells within 250 m of maximum cut elevation. Deep Cut may intercept sand lenses used for potable water supply.	Seven (7) wells require monitoring prior to, during and following excavations for both water quality and quantity. Raising highway grade would reduce cut depth.	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.

Profile Reviewed: Provided by TSH (December, 2008)

**Table 8**  
High Fills Summary  
Hwy 407 - Central Section

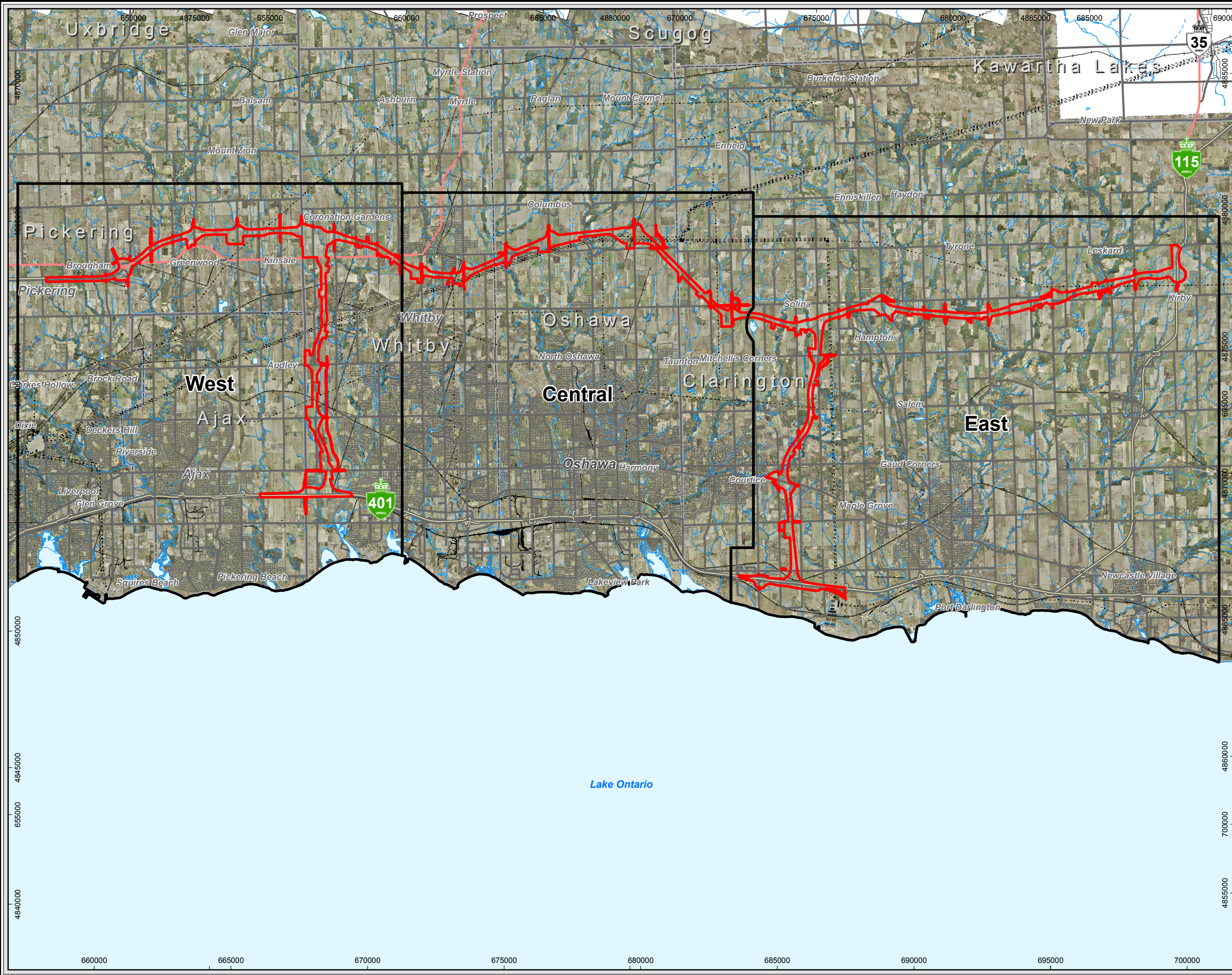
Name (Map)	Location	Chainage	Description of Fill Placement	Maximum Height of Fill	Data Sources	Geology	Hydrogeology	Potential Issues	Proposed Mitigation Measures
HF-C1 (C1a)	East Lynde Creek	12+500 to 12+750	CM-3/3B Bridge Abutments	10.0 m	CM3-1, CM3-2, CM3b-1, CM3b-2	Silty sand till (Newmarket Till) at surface on valley slopes. Alluvial sand and gravel present within the valley.	Water table at <3.0 mBGS on valley slopes. Water table at <1.0 mBGS in river valley. Groundwater flow is downward and towards East Lynde Creek. Groundwater discharge is occurring in West Oshawa Creek.	1) 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 East Lynde Creek and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-C2 (C1a)	East side of West Oshawa Creek	15+000 to 15+260	CM-10/10B Bridge Abutments on east side	15.0 m	CM10-2, CM10b-2, Hand Augering	Surficial silty clay and clayey silt deposits to a depth of ~0.7 mBGS. Alluvial sand and gravel deposits are present below. Silty clay till (Halton Till) and sandy silt till (Newmarket Till) are present below alluvial deposits.	Water table at <1.0 mBGS within river valley. Groundwater is perched on low permeability sediments and minor amount of groundwater seepage may be occurring.	1) Evidence of groundwater discharge in river valley. 2) Potential for "wicking" of groundwater into fill due to shallow water table. 3) Compressible and frost susceptible silt and clay deposits present at or near surface, becoming finer grained with depth.	1) Fill should be designed with a permeable sub-base to maintain groundwater discharge to West Oshawa Creek and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ). 2) Engineering measures to deal with settlement and frost will be required.
HF-C3 (C1a)	Winchester Road East crossing	15+550 to 16+000	Fill for Raised Alignment and Bridge Abutments for Overpass over Winchester Road at CM-12/12B	7.0 m	CM11-1, CM11-2	Surficial silty clay till (Halton Till).	Water table estimated to be <5.0 mBGS due to poor drainage through the silty clay. Groundwater flow direction is downward.	None. Consolidated till soils at surface	None
HF-C4 (C1a)	West Oshawa Creek tributary	16+750 to 17+000	CM-13/13B Culvert Fill	7.0 m	P22	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-C5 (C2a)	Ritson Road and Oshawa Creek	18+400 to 18+660	Bridge Abutments for Overpass over Ritson Road and Oshawa Creek (CM17/17B)	12.0 m	G2C-1, G2C-2, CM17-1, CM17-3, CM17b-1, CM17b-3	Surficial silt and sand (glaciolacustrine) to a depth of ~5.0 mBGS. Underlain by sandy silt till (Newmarket Till). Alluvial sand and gravel deposits present in the Oshawa Creek river valley.	Water table at 2.0 mBGS. Groundwater flow direction is eastward towards the Oshawa Creek. Observations of groundwater seepage within river valley. Groundwater is discharging into Oshawa Creek.	Avoid placement of fill in Oshawa Creek valley. Fill placed here may require perforated subdrains. Current Bridge GA shows no fill in valley. 1) 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 Oshawa Creek and to prevent a perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-C6 (C2b)	East Oshawa Creek	20+100 to 20+350	CM-20/20B Bridge Abutments	13 m	CM21-1, CM21-2, CM21b-1, CM21b-2	Surficial silty sand (glaciolacustrine). Potential for alluvial sand and gravel in East Oshawa Creek river valley. Underlain by silty clay till (Halton Till).	Water table at <1.0 mBGS within river valley. Groundwater is perched on low permeability sediments. Shallow groundwater flow direction is towards East Oshawa Creek. Groundwater is discharging into East Oshawa Creek.	No significant groundwater issues related to fill placement on valley slopes. 1) Potential for "wicking" of groundwater into fill due to shallow water table in river valley.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-C7 (C2b)	Harmony Creek	24+030 to 24+220	CM-26/26B Bridge Abutments	8.0 m	None	Surficial sandy silt (glaciolacustrine), underlain by sandy silt till (Newmarket Till).	Water table estimated to be <1.0 mBGS due to poor drainage through the till. Minor groundwater discharge may be occurring in the stream.	No significant groundwater issues related to fill placement on valley slopes. 1) Potential for "wicking" of groundwater into fill due to shallow water table in river valley.	1) Use of higher permeability fill layer above native materials will prevent perched water table from forming ( $K_{fill} > 100 K_{native}$ ).
HF-C8 (C2b)	Enfield Road	25+200 to 25+500	Fill for Raised Alignment over low-lying area west of Enfield Road	7.0 m	None (CM29-1?)	Surficial sandy silt till (Newmarket Till)	Water table estimated at ~7.0 mBGS. Groundwater flow direction is downwards.	None. Consolidated till soils at surface	None

# 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

**AECOM**

**Figure 1**





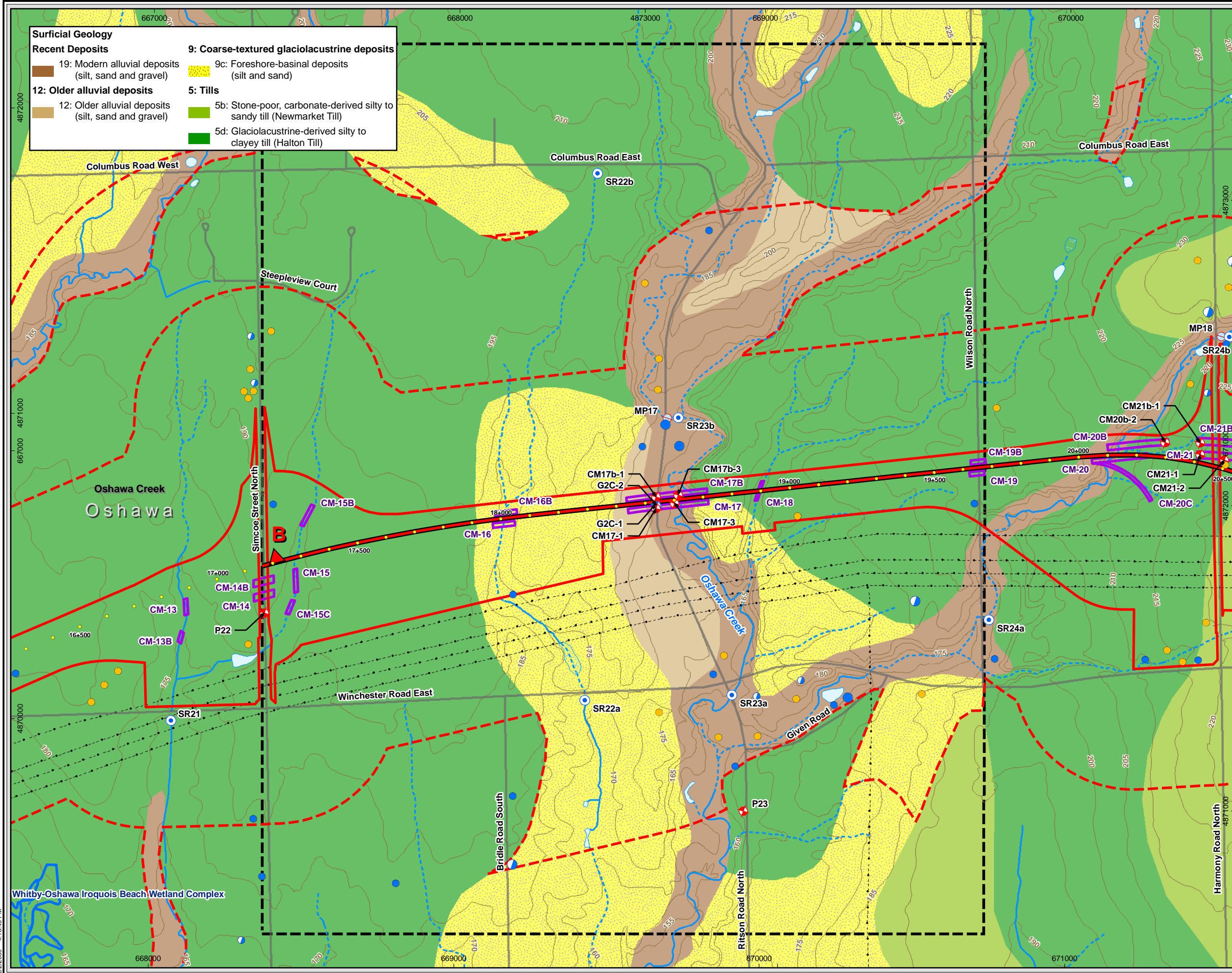












**Surficial Geology**

**Recent Deposits**

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

**Boreholes**

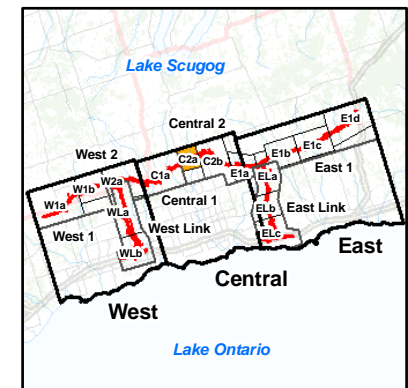
- Geotechnical (Red circle with cross)
- Groundwater Monitor (Blue circle with cross)

**Engineering Station**

- Surface Water Monitor (Blue circle with cross)
- Mini-piezometer (Red circle with cross)

**Other Symbols**

- Contour (5m) (Thin grey line)
- Intermittent Stream (Blue dashed line)
- Permanent Stream (Blue solid line)
- Cross-section (Red triangle)
- Water Well Survey Study Area (Dashed red 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)



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

1:12,500

UTM Zone 17N, NAD 83

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407 Environmental Assessment

**Instrumentation (Hydrogeology, Geotechnical, Water Wells)**

**Central Mainline Section C2a**

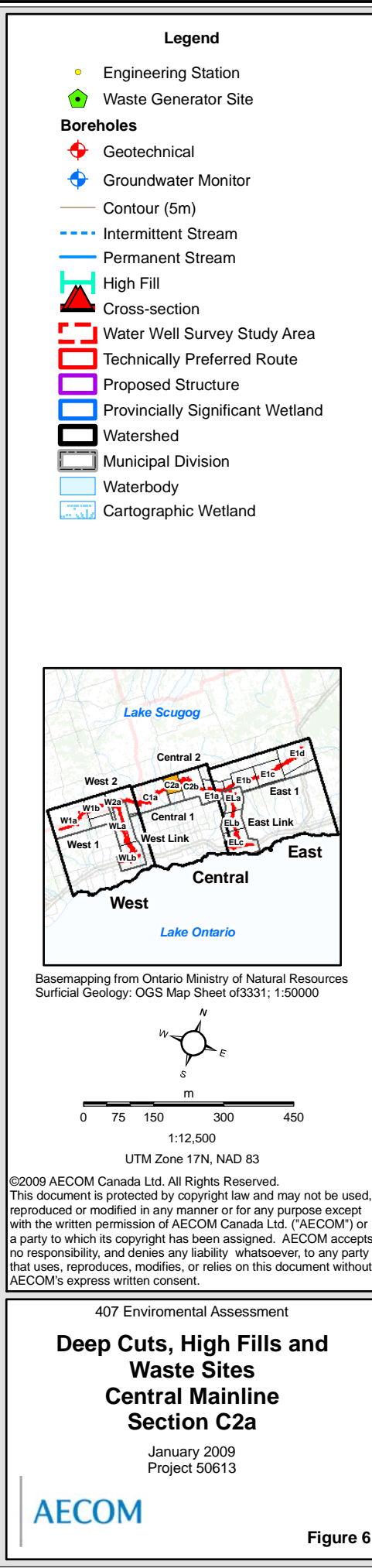
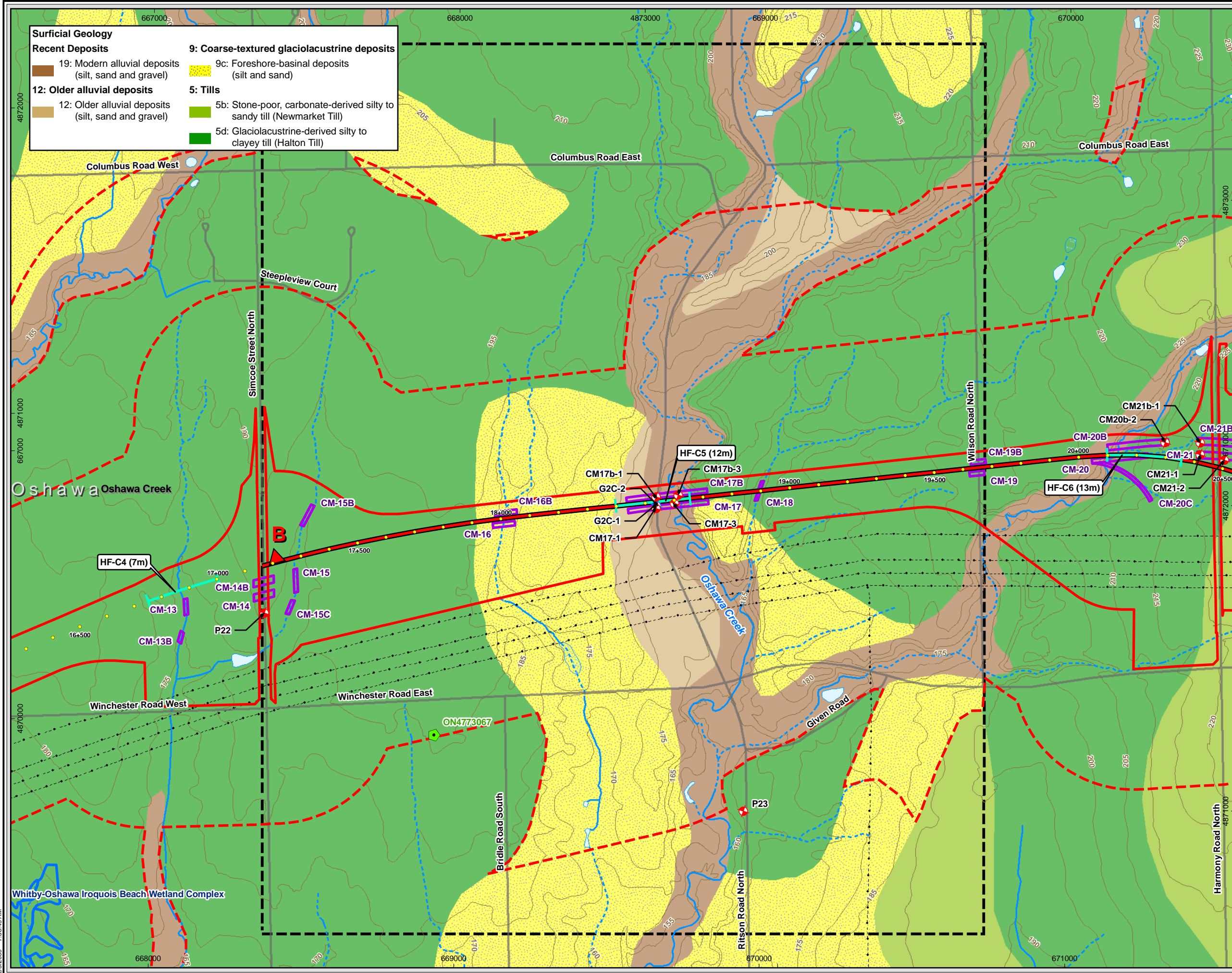
January 2009  
Project 50613

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Figure 5



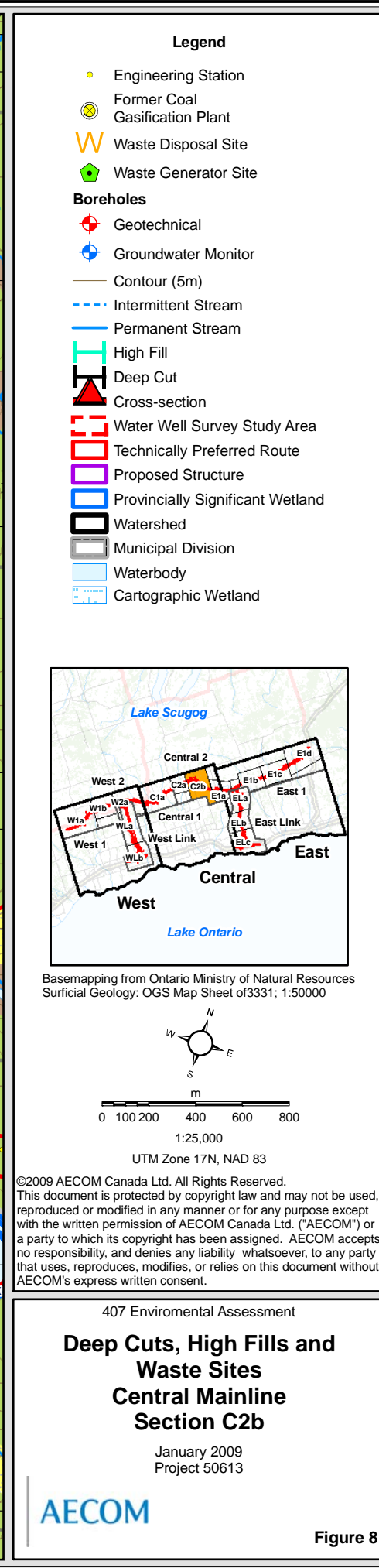
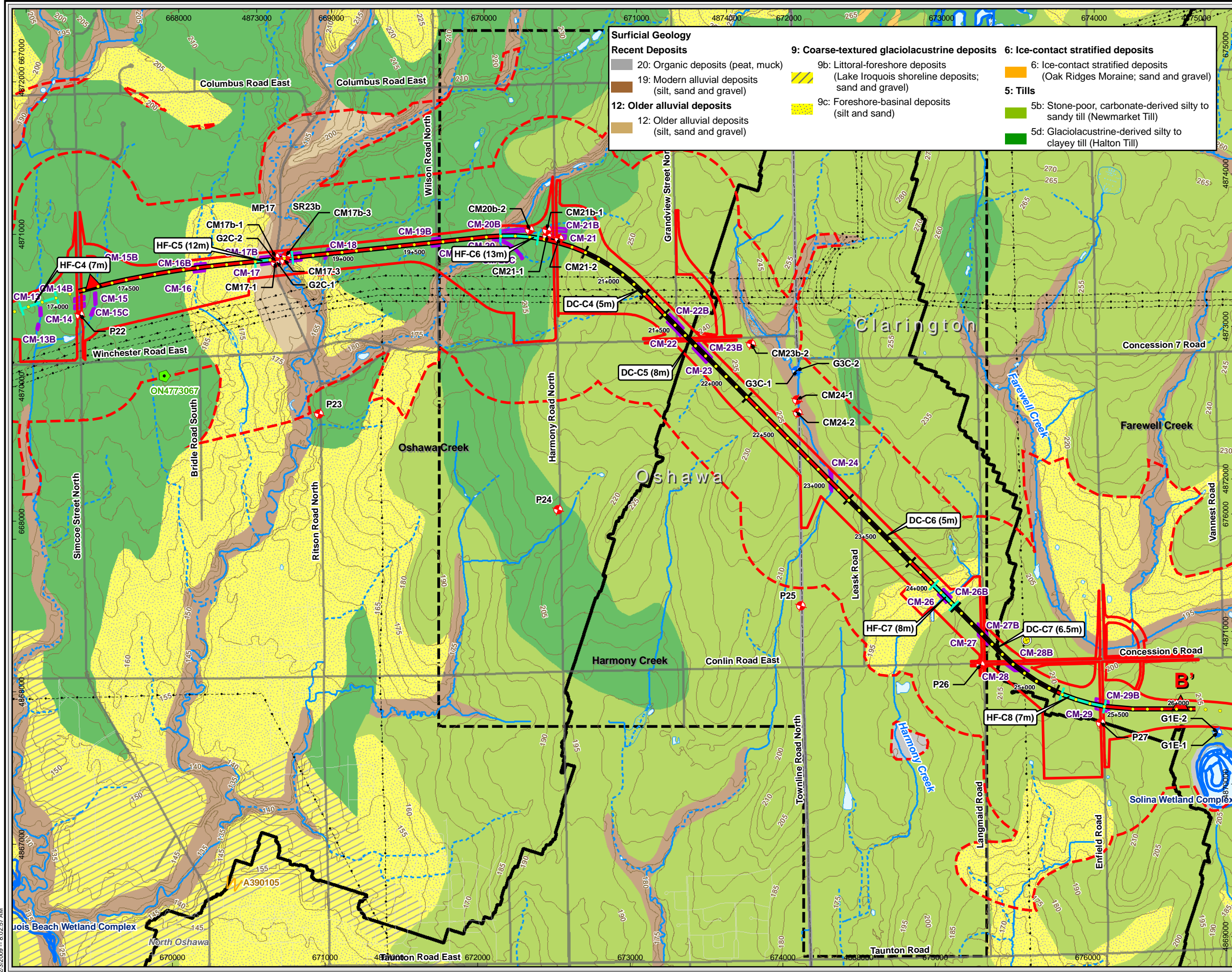
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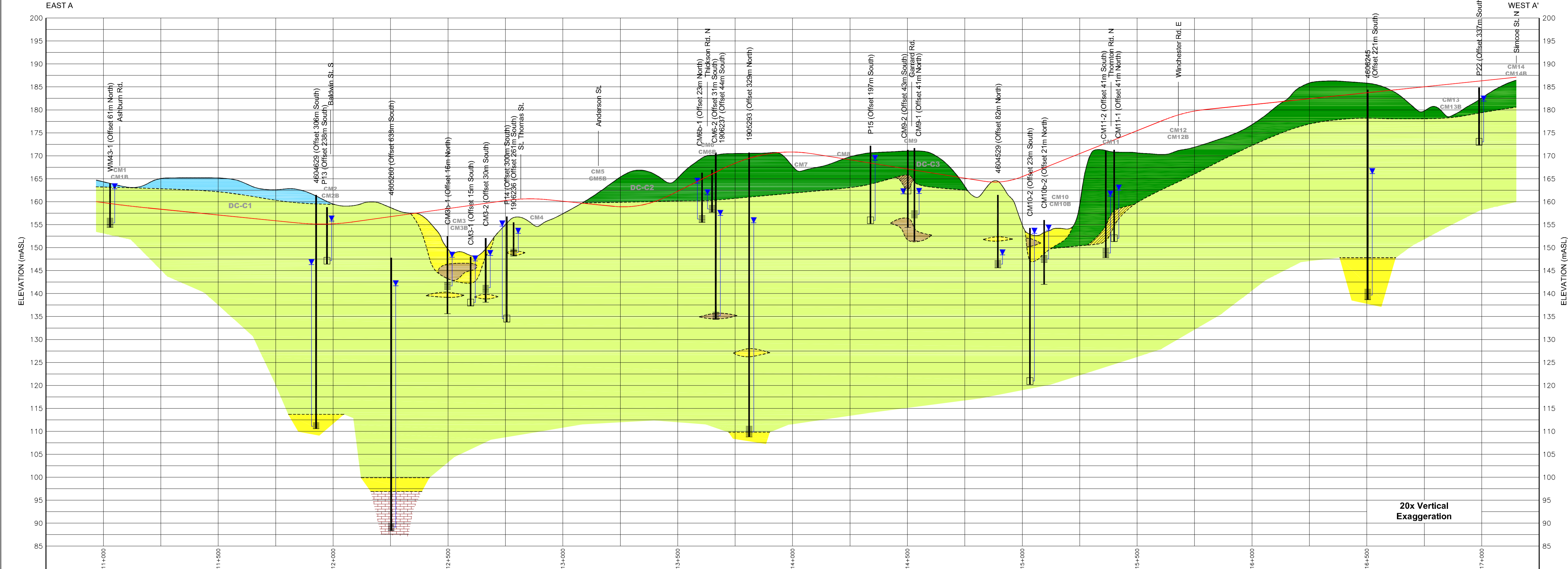








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**Legend**

- Sand and Gravel
- Sand
- Clayey Silt Till (Horton Till)
- Silty Sand to Sandy Silt Till (Newmarket Till)
- Silt and Clay
- Bedrock (Shale)
- Potential Oak Ridges Moraine

**CM14 DC-C3**

- PROPOSED STRUCTURE OR DEEP CUT LOCATION

**4600545**

- BOREHOLE LOCATION AND IDENTIFICATION
- GROUND SURFACE
- PROPOSED ROAD PROFILE
- INFERRED STRATIGRAPHIC CONTACT
- WATER LEVEL
- SCREENED INTERVAL
- OPEN BOREHOLE

**Notes:**

- Stratigraphy inferred from MOE water well records, geotechnical borehole logs completed by Thurber Engineering Limited (2007-2008), geotechnical borehole logs from the MTO Foundation Investigation and Design Report (1994), and from Garner Lee Limited (acting as AECOM) groundwater monitor borehole logs (2008), within 500m of the cross-section line and refined from the Ontario Geological Survey's regional geological model.
- Ground surface derived from 10m digital elevation model.

Horizontal 1 : 10,000  
Vertical 1 : 500

File Name: 50613-X01-R3.dwg  
Reviewed by: SJJ  
Date Issued: February, 2009

Prepared by: JEP  
Project Number: 50613

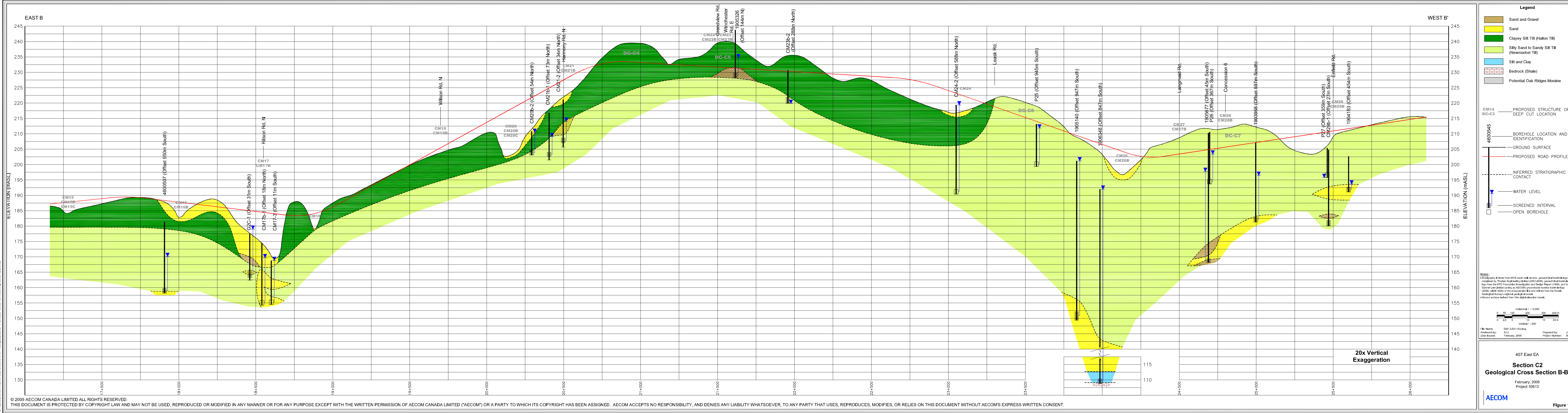
407 East EA  
**Section C1**  
**Geological Cross Section A-A'**  
February, 2009  
Project 50613

**AECOM**

**Figure 9**

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**Legend**

- Sand and Gravel
- Sand
- Clayey Silt Till (Halton Till)
- Silty Sand to Sandy Silt Till (Newmarket Till)
- Silt and Clay
- Bedrock (Shale)
- Potential Oak Ridges Moraine

CM14  
DC-C3

4600545

BOREHOLE LOCATION AND IDENTIFICATION

GROUND SURFACE

PROPOSED ROAD PROFILE

INFERRED STRATIGRAPHIC CONTACT

WATER LEVEL

SCREENED INTERVAL

OPEN BOREHOLE

**Notes:**

- Stratigraphy inferred from MOE water well records, geotechnical borehole logs compiled by Thurber Engineering Limited (2001-2003), geotechnical borehole logs from the MTO Foundation Investigation and Design Report (1994), and from Garver Lee Limited (acting as ASCEM) groundwater monitor borehole logs (2006), within 500m of the cross-section line and refined from the Ontario Geological Survey's regional geological model.
- Ground surface defined from 10m digital elevation model.

Horizontal 1 : 10,000  
Vertical 1 : 500

0 50 100 200 300 400 m  
0 2.5 5 10 15 20 m

File Name: 50613A01-R3.dwg  
Reviewed by: SLJ  
Date Revised: February, 2009

Prepared by: JEP  
Project Number: 50613

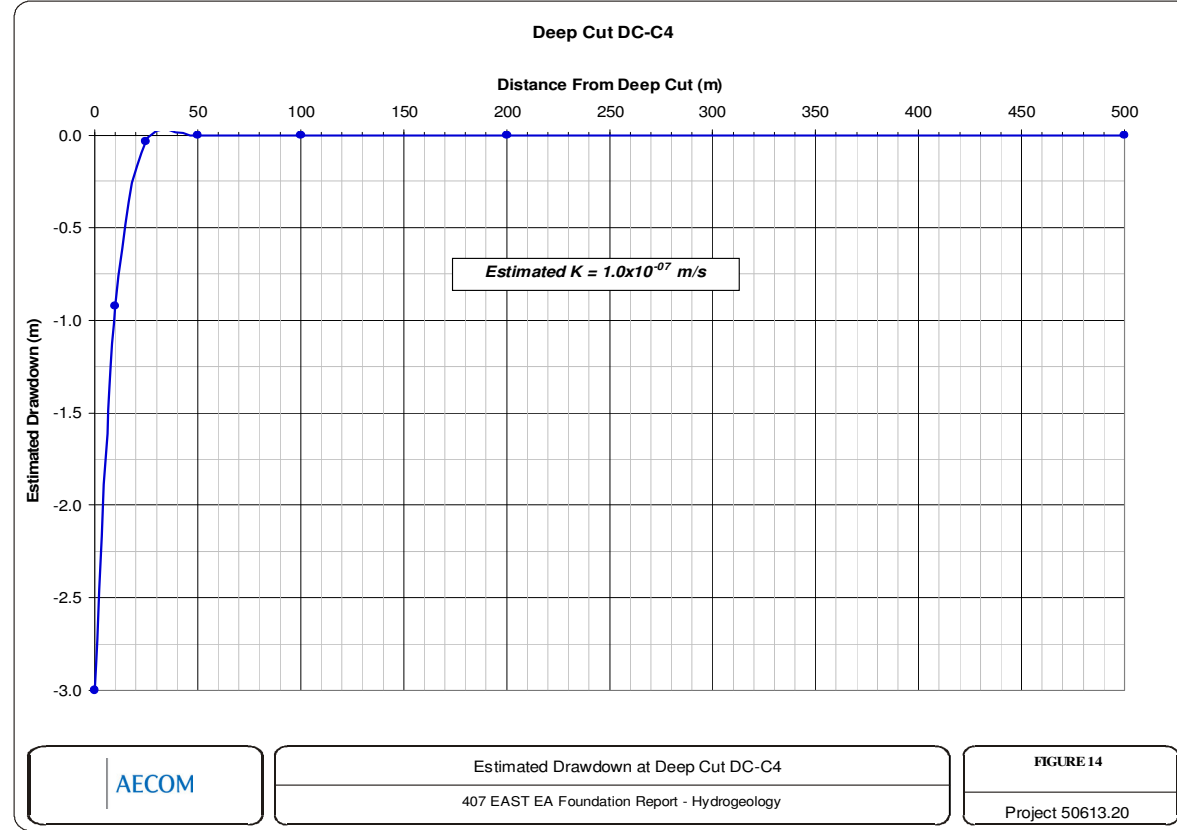
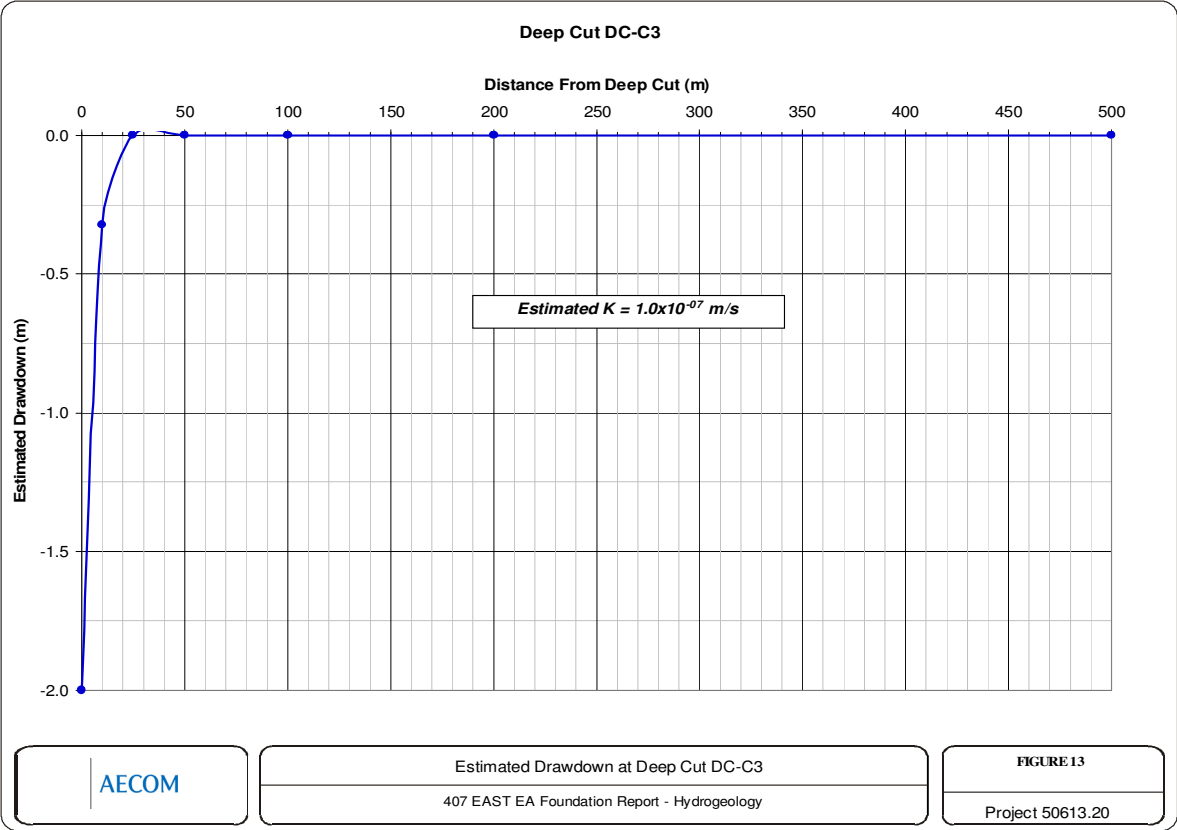
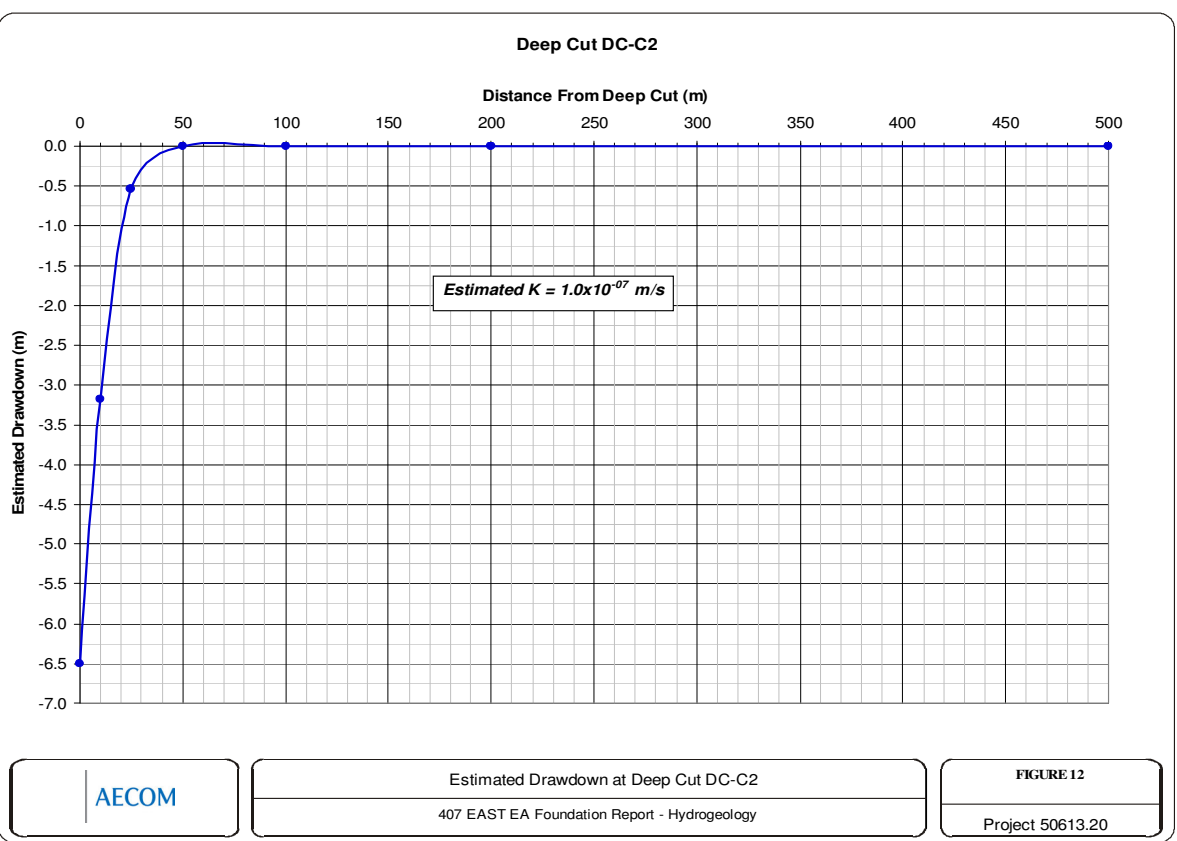
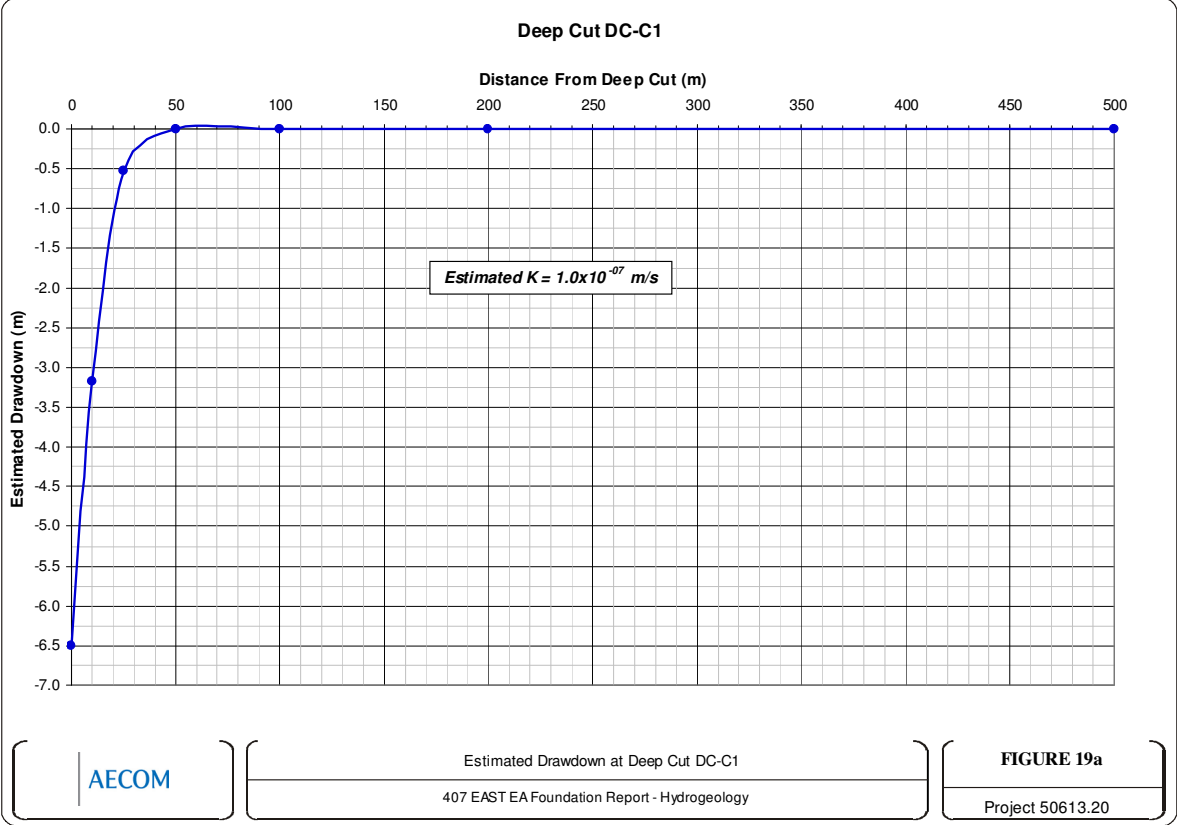
407 East EA

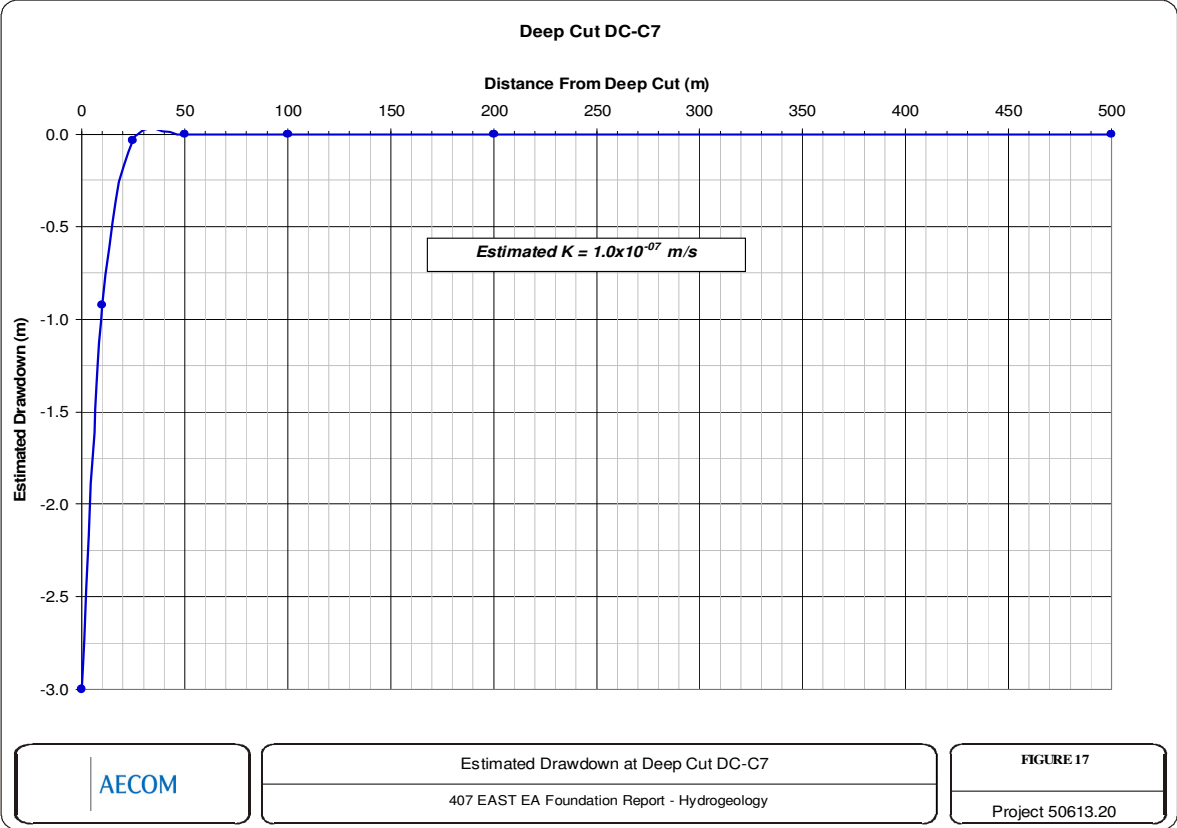
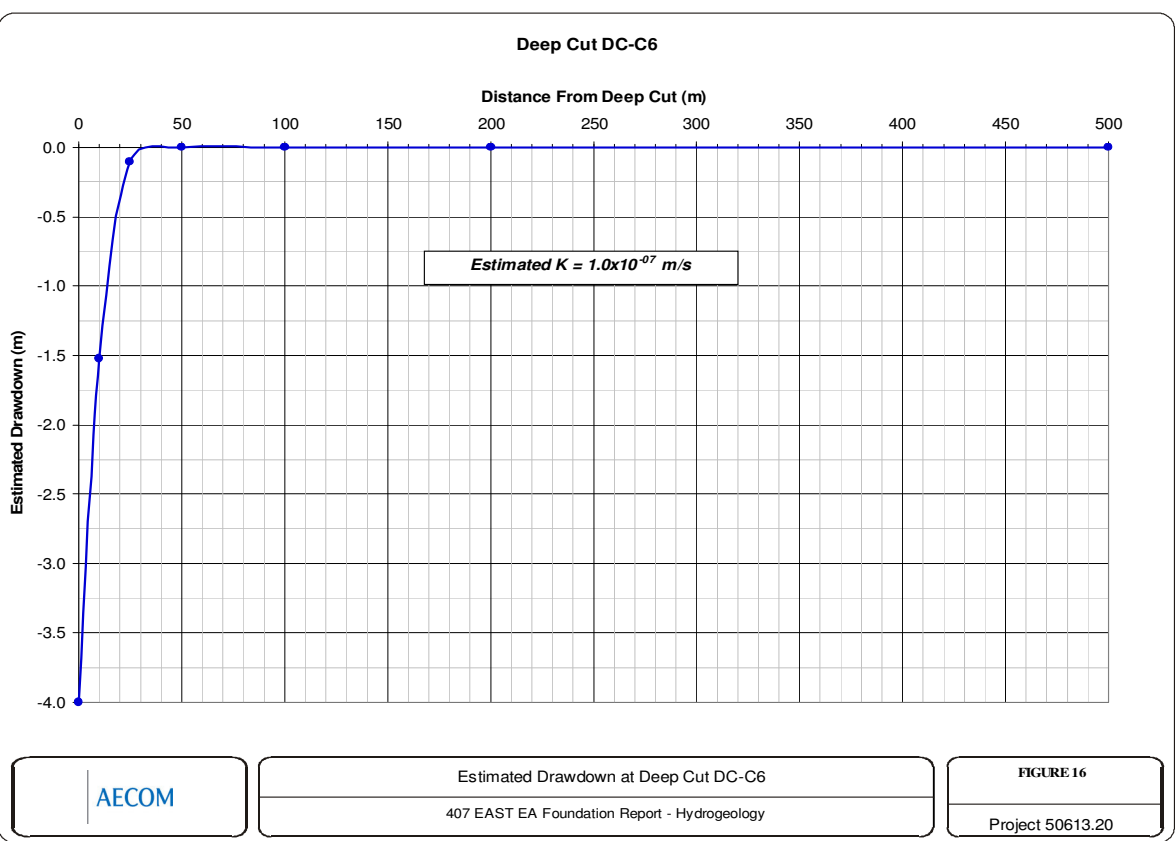
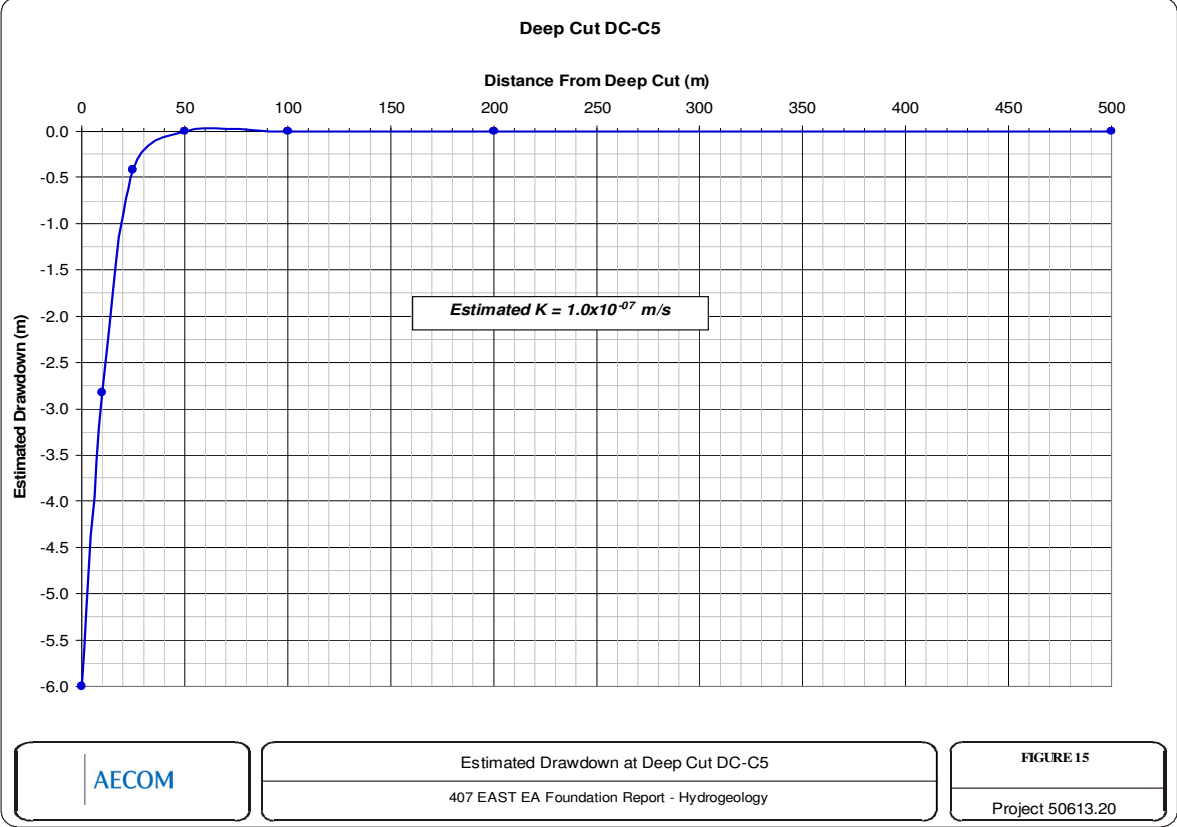
**Section C2**  
**Geological Cross Section B-B'**

February, 2009  
Project 50613

**AECOM**

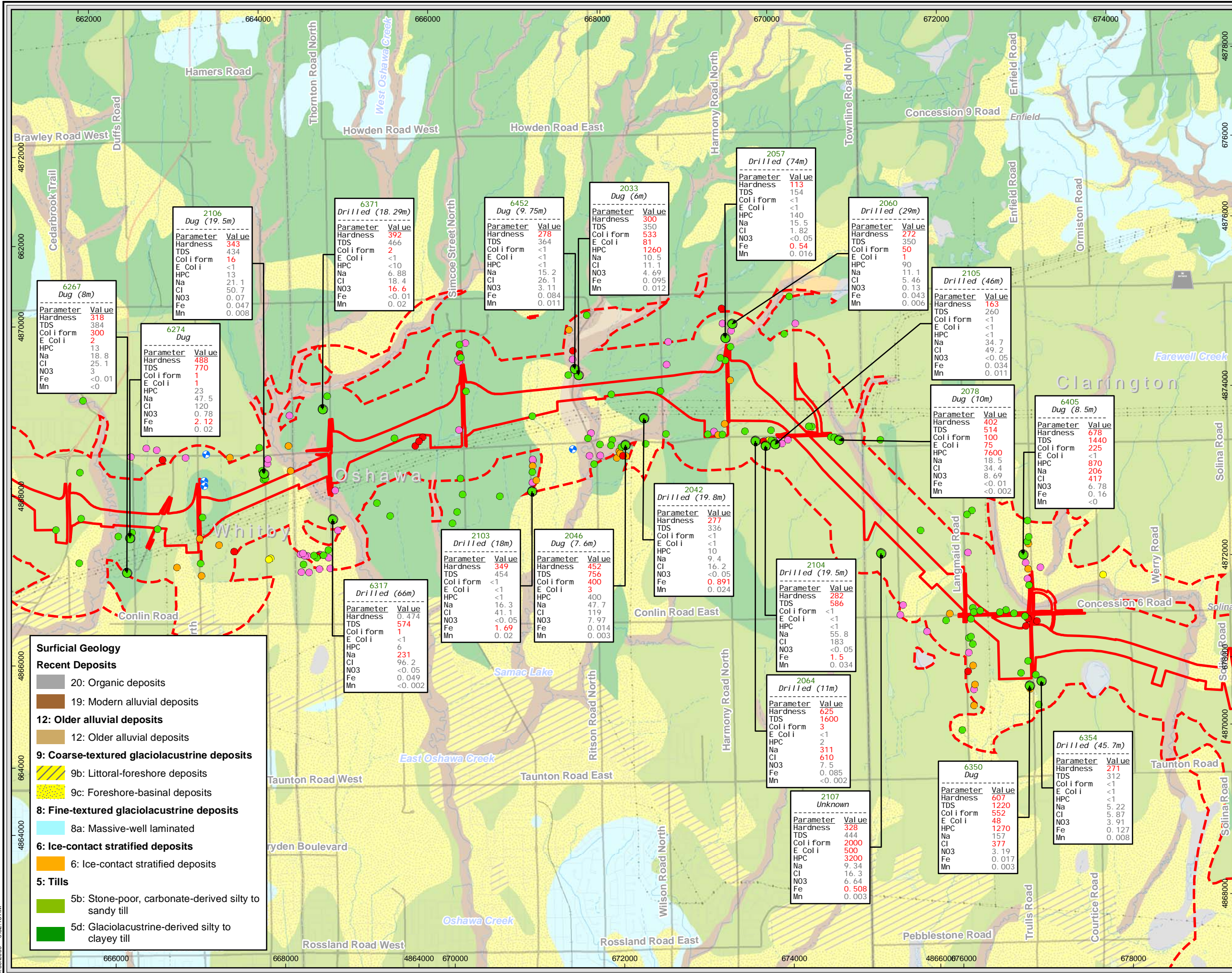
**Figure 10**







Map Document: (N:\Projects\2005\0613\2008\FinalGIS\Spatial\MXDs\Report\MXDs\Hydrogeology\January2009\WaterWellSurvey\50613\WaterWellSurvey.TPR-Central-11x17.mxd)  
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# Appendix A

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## Bore Hole Logs



<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G1C-2 1 of 1
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 10, 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 topsoil, grass, rootlets.															
1.0	1	<b>SILTY SAND TO SANDY SILT TILL</b> (Newmarket Till) Brown silty sand to sandy silt till, trace to some clay, trace to some fine sub-angular gravel, dry to moist, very dense.															
2	2																
3	3																
4	4																
5	5																
6.0	6	Borehole terminated at 6.02 m in silty sand till.															
		Water Level : 0.535 mBGS, measured January 14, 2008															
		Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G1C-1.															

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G2C-1 1 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 14, 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							
		<b>TOPSOIL</b> Dark grey to black topsoil, rootlets			1		SS	9		41							
1.0	1	<b>SAND</b> Brown fine sand interbedded with fine to coarse well rounded gravel, trace medium to coarse sand, trace clay, saturated, compact.  -Silty sand encountered from about 2.3 to 3.1 m.			2		SS	5		74							
					3		SS	42		39							
2.3	2				4		SS	17	13	82							
3.1	3				5		SS	24	14	49							
					6		SS	18	16	66							
4	4				7		SS	15	24	56							
5	5																
6	6				8		SS	17	22	100							
7.6	7				9		SS	22	17	100							
8	8																
		<b>SAND AND GRAVEL</b> Grey sand and gravel, trace to some silt, trace clay, saturated, compact.															
9	9	<b>SILTY SAND TILL</b> (Newmarket Till) Grey silty sand till, trace angular to sub-angular gravel, trace clay, saturated, dense to very dense.															
9.4	9				10		SS	76	16	100							

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G2C-1 2 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 14, 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								
11					11	SS 0.13m	50/	12	31								
12					12	SS	24	13	100								
12.2		-Grey fine sand, some silt, trace clay from about 12.2 to 12.9 m.			13	SS		15	95								
12.9					14	SS 0.13m	50/	23	44								
13.8		<b>CLAYEY SILT TILL</b> Grey clayey silt till, trace angular to subangular gravel, saturated, very dense.			15	SS 0.13m	50/	26	69								
15					16	SS 0.10m	50/	18									
15.2		Borehole terminated at 15.24 m in clayey silt till.  Water level: flowing above top of pipe to 1.04 mAGS, measured June, 2008.															

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G2C-2 1 of 1
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> January 15, 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								
1.0		<b>TOPSOIL</b> Dark grey to black topsoil, rootlets															
2		<b>SAND</b> Brown fine sand interbedded with fine to coarse well rounded gravel, trace medium to coarse sand, trace clay, saturated, compact.															
2.3		-Silty sand encountered from about 2.3 to 3.1 m.															
3.1																	
4																	
5																	
6.1		Borehole terminated at 6.1 m in sand and gravel  Water level: 2.13 mBGS, measured February 8, 2008.  <i>Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G2C-1.</i>															



<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3C-1 1 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 18, 2007 <b>LOGGED BY</b> RBC/JED <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE					WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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0.8		<b>TOPSOIL,</b> Brown topsoil, rootlets, lens of brown fine sand at 0.03m			1	SS	7	24	17																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												</

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3C-1 2 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 18, 2007 <b>LOGGED BY</b> RBC/JED <b>GROUND ELEV</b> m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	WATER LEVEL	SAMPLE					N VALUE				WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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10.7		<b>SILTY SAND TILL</b> (Newmarket Till) brownish grey silty sand till, trace clay, trace fine to coarse sub-angular gravel, moist, very dense			10		SS	50/ 0.13m	15	42																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

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<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3C-2 1 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 18, 2007 <b>LOGGED BY</b> RBC/JED <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								
0.8		<b>TOPSOIL,</b> Brown topsoil, rootlets, lens of brown fine sand at 0.03m																
1		<b>SILT AND SAND TILL</b> (Halton Till) Brown silt and sand till, some clay, trace fine sub-angular gravel, moist, compact.																
2																		
3.1		<b>CLAYEY SILT AND SAND TILL</b> (Halton Till) Brown to grey, clayey silt to silty clay till, with sand, trace fine sub-angular gravel, wet, compact to very dense.																
4																		
5																		
6.1		<b>SANDY SILT AND CLAY TILL</b> (Halton Till) Brownish grey trending to grey, sandy silt and clay silt, fine and coarse sand, trace fine to coarse sub-angular gravel, saturated, dense to very dense.																
7																		
8																		
9.1		Borehole terminated at 9.14 m in silty clay till.																
		Water Level: 4.84 mBGS, measured January 14, 2008.																

<b>BOREHOLE LOG</b>	<b>PROJECT:</b> 50-613	<b>BOREHOLE:</b> G3C-2 2 of 2
407 East Extension Central Mainline <b>FOR:</b> Ontario Ministry of Transportation	<b>DATE:</b> December 18, 2007 <b>LOGGED BY</b> RBC/JED <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								
		Please note borehole was augered without sampling. Lithology inferred from soils sampled at adjacent borehole G3C-1.																

# Appendix B

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## Geotechnical Bore Hole Logs

ONTM4S 0510 GPJ 8/1202

+ 3, X 3: Numbers refer to Sensitivity

CONTINUED ON 0510.GPJ 8/12/08

4. <sup>3</sup>,  $\times^3$ : Numbers refer to Sensitivity



ONTM:T4S 0510.GPJ 2/12/08

Continued Next Page

4, 3, X 3 Numbers refer to Sensitivity

QNTMT4S C510 CBI 8/13/08

+ 3, x 3: Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM3b-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 857 733.5 E 348 614.6		ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2008.03.03 - 2008.03.03		CHECKED BY MEF									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	UNIT WEIGHT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	GR SA SI CL		
152.5	TOPSOIL, trace roots and rootlets: (200mm)												
0.0	Dark Brown Moist												
0.2	Gravelly SAND, trace silt Compact Brown Moist		1	SS	14								
			2	SS	10								
150.3	Silty CLAY, trace gravel Firm Brown		3	SS	7								
2.2	SAND, some silt Loose Brown Moist		4	SS	6								
149.6	becoming Very Dense trace to some gravel		5	SS	60								
2.8	Gravelly SAND, trace silt Dense to Very Dense Brown Wet		6	SS	44								
146.4	silt seams		8	SS	100								
0.1	Silty SAND, some gravel Dense Gray		7	SS	72								
143.0													
9.4													

Continued Next Page

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



RECORD OF BOREHOLE No CM3b-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 857 733.5 E 348 614.6		ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES									
DATUM Geodetic		DATE 2008.03.03 - 2008.03.03		CHECKED BY MEF									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	UNIT WEIGHT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	GR SA SI CL		
	Continued From Previous Page												
	Moist to Wet (TILL)		9	SS	45								
140.3	SAND, trace silt, trace gravel Very Dense Grey Moist		10	SS	71								
12.2	Silty SAND, trace gravel Very Dense Grey Moist (TILL)		11	SS	100								
13.4	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		12	SS	100								
139.1			13	SS	100								
13.0	END OF BOREHOLE AT 16.9m Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2007.04.28 4.6 147.9												
14.5													
138.0													
14.5													
137.0													
136.6													
16.9													

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



RECORD OF BOREHOLE No CM3b-2 1 OF 2 METRIC														
G.W.P. W.O. 07-20016		LOCATION N 4 857 742.9 E 348 642.2			ORIGINATED BY JM									
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES									
DATUM Geodetic		DATE 2008.03.13 - 2008.03.13			CHECKED BY MEF									
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
146.6	TOPSOIL, with roots: (300mm) Brown Moist													
148.5	SAND, some gravel to gravelly, trace silt Loose to Compact Brown Moist		1	SS	4									
			2	SS	13									
			3	SS	15									
			4	SS	26									
144.7	Silty SAND, trace gravel Very Dense Grey Moist (TILL)		5	SS	100/125									
142.7	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		6	SS	100/175									
			7	SS	100/233									
140.4	Silty SAND, trace gravel Very Dense Grey Moist (TILL)													
139.3	END OF BOREHOLE AT 9.5m. BOREHOLE OPEN TO 1.1m AND WATER LEVEL AT 1.0m UPON		8	SS	100/175									

ONTM14S 0510.GPJ 8/12/08

Continued Next Page

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



RECORD OF BOREHOLE No CM3b-2 2 OF 2 METRIC														
G.W.P. W.O. 07-20016		LOCATION N 4 857 742.9 E 348 642.2			ORIGINATED BY JM									
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES									
DATUM Geodetic		DATE 2008.03.13 - 2008.03.13			CHECKED BY MEF									
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
	Continued From Previous Page													
	COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE													

ONTM14S 0510.GPJ 8/12/08

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



RECORD OF BOREHOLE No CM6-1															1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 858 012.8 E 349 677.0, Thickson Road					ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.03.06 - 2008.03.06					CHECKED BY MEF											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T <sub>N</sub> VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	2D 40 60 80 100	30 40 50 60 70 80 90 100	WATER CONTENT (%)	W <sub>p</sub> W <sub>L</sub>	UNIT WEIGHT	GR SA SI CL					
165.7	TOPSOIL, with roots: (30mm)																	
165.4	Dark Brown Moist																	
0.3	Silty CLAY, some sand, trace gravel Stiff to Hard Brown (TILL)(CL)		1	SS	14													
	becoming Grey		2	SS	31													
			3	SS	80													
			4	SS	46													
161.6	inferred cobble at 4.04 to 4.11m																	
4.1	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		5	SS	107													
	inferred cobble at 5.33 to 5.49m																	
			6	SS	100													
					100													
			7	SS	100													
					100													
	inferred cobble at 8.31 to 8.43m																	
156.6	END OF BOREHOLE AT 9.2m. BOREHOLE OPEN TO 8.8m AND WATER LEVEL AT 8.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH		8	SS	100													
9.2					.050													

ONTM7-LS 0510 GPJ 8/12/08

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



RECORD OF BOREHOLE No CM6-1															2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 858 012.8 E 349 677.0, Thickson Road					ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.03.06 - 2008.03.06					CHECKED BY MEF											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T <sub>N</sub> VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	2D 40 60 80 100	30 40 50 60 70 80 90 100	WATER CONTENT (%)	W <sub>p</sub> W <sub>L</sub>	UNIT WEIGHT	GR SA SI CL					
	Continued From Previous Page																	
	BENTONITE HOLEPLUG TO 0.3m and AUGER CUTTINGS TO SURFACE.																	

ONTM7-LS 0510 GPJ 8/12/08

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





RECORD OF BOREHOLE No CM6-2										1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 858 035.5 E 349 726.8, Thickson Road				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008.03.04 - 2008.03.04				CHECKED BY MEF							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT (w <sub>p</sub> )	NATURAL MOISTURE CONTENT (w)	LIQUID LIMIT (w <sub>L</sub> )	UNIT WEIGHT (γ)	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
167.0	TOPSOIL, with roots (50mm) Brown Moist												
	Silty SAND, trace gravel Compact to Dense Brown Moist	1	SS	25									
		2	SS	33								1 72 26 (SI+CL)	
164.4		3	SS	100									
2.5	SAND and SILT, some clay, trace gravel, occasional oxide staining Very Dense Brown to Gray Moist (TILL)	4	SS	100								0 20 70 10	
		5	SS	100									
		6	SS	100									
		7	SS	100								0 42 39 19	
167.7	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN TO 9.1m AND WATER LEVEL AT 1.2m UPON COMPLETION. Piezometer installation consists of	8	SS	100									

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



RECORD OF BOREHOLE No CM6-2										2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 858 035.5 E 349 726.8, Thickson Road				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2008.03.04 - 2008.03.04				CHECKED BY MEF							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT (w <sub>p</sub> )	NATURAL MOISTURE CONTENT (w)	LIQUID LIMIT (w <sub>L</sub> )	UNIT WEIGHT (γ)	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
	Continues From Previous Page												
	100mm diameter schedule 40 PVC pipe with a 1.52m skirted screen WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.03.07 4.8 162.2 2008.03.12 5.5 161.5												

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



RECORD OF BOREHOLE No CM6b-1															1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 868 060.4 E 349 661.6, Thickson Road					ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.03.04 - 2008.03.04					CHECKED BY MEF											
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 (%)				
166.3	TOPSOIL, with roots (50mm) Brown Moist Clayey SILT, trace sand, trace gravel Stiff Brown		1	SS	14													
164.8	Silty CLAY, some sand, trace gravel Very Stiff to Hard Brown (TILL)(CL)		2	SS	19													
			3	SS	50													
			4	SS	60													
			5	SS	35													
166.2	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		6	SS	100/125													
			7	SS	100/0.75													
			8	SS	100/1.50													
	inferred cobble at 8.97 to 9.12m																	

Continued Next Page

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



RECORD OF BOREHOLE No CM6b-1															2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 868 060.4 E 349 661.6, Thickson Road					ORIGINATED BY SLL											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.03.04 - 2008.03.04					CHECKED BY MEF											
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 (%)				
	Continued From Previous Page																	
155.5	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/150													
10.8	END OF BOREHOLE AT 10.8m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH (m) ELEV. (m) 2008.03.07 8.6 157.7 2008.03.12 2.3 164.0																	

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

+3, X3: Numbers refer to Sensitivity

+ <sup>3</sup> , × <sup>3</sup>	Numbers refer to Sensitivity	20 15-0-5 10	(%) STRAIN AT FAILURE
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RECORD OF BOREHOLE No CM9-1															2 OF 2		METRIC		
G.W.P. W.O. 07-20016			LOCATION N 4 858 640.5 E 350 373.3			ORIGINATED BY SLL													
HWY 407			BOREHOLE TYPE Solid Stem Augers			COMPILED BY SM													
DATUM Geodetic			DATE 2007.12.05 - 2007.12.05			CHECKED BY MEF													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	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, trace to some clay, trace gravel, occasional cobbles Dense to Very Dense Gmy Moist (Till.)		8	SS	55		161												
							160												
			9	SS	42		159												
	becoming Compact						158												
			10	SS	25		157												
							156												
			11	SS	14		155												
	becoming Very Dense						154												
154.6	BOREHOLE CONTINUED ON CM9-1A.		2	SS	100		153												
17.1	END OF BOREHOLE AT 17.1m. BOREHOLE OPEN TO 15.4m. Piezometer installation consists of 15 mm diameter Schedule 40 PVC pipe with a 1.52 m Skirted Screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV (m) 2007.12.10 11.2 160.5 2007.12.21 10.2 161.5 2008.01.16 9.9 161.8																		

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



RECORD OF BOREHOLE No CM9-1a															1 OF 3		METRIC		
G.W.P. W.O. 07-20016			LOCATION N 4 858 640.5 E 350 373.3			ORIGINATED BY SLL													
HWY 407			BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES													
DATUM Geodetic			DATE 2007.12.10 - 2007.12.10			CHECKED BY MEF													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W.P.	W.L.	W.P.	W.L.	Y	GR	SA	SI	CL
171.7																			
0.0																			
							171												
							170												
							169												
							168												
							167												
							166												
							165												
							164												
							163												
							162												

Continued Next Page

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



ONTMT4S 05:10 GPJ 8/12/08ONTARIO 05\CGPJ 211202



RECORD OF BOREHOLE No CM9-2															1 OF 2		METRIC						
G.W.P. W.O. 07-20016		LOCATION N 4 858 557.6 E 350 406.6				ORIGINATED BY SLL																	
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM																	
DATUM Geodetic		DATE 2007.12.06 - 2007.12.10				CHECKED BY MEF																	
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 <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL			
171.3	ASPHALT (150mm)																						
0.0																							
0.2	SAND, some gravel, trace silt		1	AS																			
170.7	Brown Moist (FILL)																						
0.6	Clayey SILT, some sand to with sand, trace gravel		1	SS	33																		
	Hard Brown (TILL)(CL)		2	SS	37																		
			3	SS	48																		
			4	SS	51																		
			5	SS	32																		
165.8	SAND and SILT, trace to some clay, trace gravel																						
5.5	Very Dense Grey Moist (TILL)		6	SS	80																		
			7	SS	101																		
162.6	Gravelly SAND, some silt																						
8.7	Very Dense Grey Moist BOREHOLE CONTINUED ON CM9-2A.		8	SS	100																		
161.7	END OF BOREHOLE AT 9.6m BOREHOLE OPEN TO 9.5m AND																						
9.0																							

Continued Next Page



RECORD OF BOREHOLE No CM9-2															2 OF 2		METRIC						
G.W.P. W.O. 07-20016		LOCATION N 4 858 557.6 E 350 406.6				ORIGINATED BY SLL																	
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM																	
DATUM Geodetic		DATE 2007.12.06 - 2007.12.10				CHECKED BY MEF																	
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 <sub>p</sub>	W	W <sub>L</sub>	γ	GR	SA	SI	CL			
	Continued From Previous Page																						
	DRY ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m AND ASPHALT TO SURFACE																						

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ONTM4S 0510.GPJ 2/12/03DONTM74S 0510.GPJ 5/12/08

ONTM4S C5:C.GPJ 9:2023

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

+ 3, X 3. Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM10b-2 1 OF 2 METRIC																
G.W.P. W.O. 07-20016		LOCATION N 4 888 991.9 E 350 815.3			ORIGINATED BY JM											
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES											
DATUM Goodelle		DATE 2008.03.05 - 2008.03.07			CHECKED BY MEF											
SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL MOISTURE CONTENT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAIT 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	W.P. W. W.L.	WATER CONTENT (%)	Y	GR SA SI CL		
158.0	TOPSOIL, with roots: (150mm)						156									
0.2	Brown Moist SAND, some silt, trace gravel, trace clay, trace to some rootlets Loose Brown Moist		1	SS	10		155									
153.8			2	SS	10		154									
2.1	SAND and SILT, trace clay Loose to Very Loose Brown to Grey Wet		3	SS	8		153						0 46 46 7			
151.9			4	SS	2		152									
4.1	Silty SAND, trace gravel Compact Grey Wet		5	SS	11		151						1 69 29 (SI+CL)			
149.9			6	SS	27		150									
6.1	Sandy SILT, some clay Compact Grey Moist						149									
148.8			7	SS	52		148									
7.2	Silty CLAY, trace sand, trace gravel Hard Grey (TILL)(CL)						147									
147.3			8	SS	100											
8.7	Silty SAND, trace gravel Very Dense Grey Moist															

Continued Next Page

+<sup>3</sup>, X<sup>3</sup>, Numbers refer to Sensitivity 75 15-5 10 (%) STRAIN AT FAILURE

ONTMT-4S 0510.GPJ 8/12/08



RECORD OF BOREHOLE No CM10b-2 2 OF 2 METRIC																
G.W.P. W.O. 07-20016		LOCATION N 4 888 991.9 E 350 815.3			ORIGINATED BY JM											
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES											
DATUM Goodelle		DATE 2008.03.05 - 2008.03.07			CHECKED BY MEF											
SOIL PROFILE		SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL MOISTURE CONTENT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAIT 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	W.P. W. W.L.	WATER CONTENT (%)	Y	GR SA SI CL		
	Continued From Previous Page						140									
	Silty SAND, trace gravel Very Dense Grey Moist		9	SS	100		145							4 72 23 (SI+CL)		
143.8							144									
12.2	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100		143									
141.9			11	SS	100		142									
14.0	END OF BOREHOLE AT 14.1m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.04.28 2.35 153.7 2009.07.28 2.17 153.8															

+<sup>3</sup>, X<sup>3</sup>, Numbers refer to Sensitivity 75 15-5 10 (%) STRAIN AT FAILURE

ONTMT-4S 0510.GPJ 8/12/08



RECORD OF BOREHOLE No CM11-1										1 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 869 206.2 E 351 033.7				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM							
DATUM Geodetic		DATE 2007.12.06 - 2007.12.06				CHECKED BY MEF							
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
171.3	ASPHALT (60 mm)												
170.7	SAND, some gravel, some silt Brown Moist (FILL)		1	AS								15 71 14 (SH+CL)	
169.1	Silty CLAY, some sand, trace gravel Very Stiff Brown (TILL)		1	SS	16								
			2	SS	17								
168.1	SILT, trace clay, trace sand Dense to Very Dense Brown Moist		3	SS	30							0 3 91 7	
			4	SS	52								
167.1	Silty CLAY, trace thin sand seams Hard Brown to Grey Moist (Cl)		5	SS	54							0 7 28 65	
165.5	Silty CLAY, some sand, trace gravel Hard Grey Moist (TILL)		6	SS	94								
164.2	SAND and SILT, some clay, trace gravel, occasional inferred cobbles Very Dense Grey Moist (TILL)		7	SS	72							4 44 35 17	
			8	SS	100/								
					125								

Continued Next Page

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



RECORD OF BOREHOLE No CM11-1										2 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 869 206.2 E 351 033.7				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM							
DATUM Geodetic		DATE 2007.12.06 - 2007.12.06				CHECKED BY MEF							
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												
161.0	Silty CLAY, trace sand seams Hard Grey Moist (Cl)		9	SS	59								
			10	SS	75							0 0 34 66	
158.2	SAND, trace to some silt Very Dense to Compact Grey Wet		11	SS	57								
			12	SS	25							0 61 9 (SH+CL)	
154.9	SILT, some sand, trace clay Very Dense Grey Moist to Wet		13	SS	100/								
			14	SS	100/								
					150								
151.4			15	SS	100/								

Continued Next Page

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



RECORD OF BOREHOLE No CM11-1															3 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 669 206.2 E 351 033.7			ORIGINATED BY SLL													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY SM													
DATUM Geodetic		DATE 2007.12.05 - 2007.12.06			CHECKED BY MEF													
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	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	W.P.	W	W.L.			
20.0	Continued From Previous Page END OF BOREHOLE AT 20.0m. BOREHOLE OPEN TO 9.4m AND WATER LEVEL AT 8.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m AND ASPHALT TO SURFACE																	

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

ONTM14S 0510.GPJ 8/2008



RECORD OF BOREHOLE No CM11-2															1 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 669 120.2 E 351 059.4			ORIGINATED BY SLL													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY SM													
DATUM Geodetic		DATE 2007.12.07 - 2007.12.07			CHECKED BY MEF													
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	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	W.P.	W	W.L.			
171.1	ASPHALT (50 mm)																	
0.1	SAND, some gravel (FILL)		1	AS														
0.6	ASPHALT (50 mm)																	
	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	34													
	Silty CLAY, some sand, trace gravel Hard Brown Moist (FILL)		2	SS	37													
169.9																		
2.2	SILT, trace sand, trace clay Very Dense Brown Wet		3	SS	55													
			4	SS	86													
166.9																		
4.3	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (FILL)		5	SS	100/175													
			6	SS	100/175													
164.2																		
6.9	Silty CLAY, with sand, trace gravel Hard Grey Moist (FILL/CL)		7	SS	100													
			8	SS	75													

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

ONTM14S 0510.GPJ 8/2008





RECORD OF BOREHOLE No CM11-2															2 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 889 120.2 E 351 059.4				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM												
DATUM Geodetic		DATE 2007.12.07 - 2007.12.07				CHECKED BY MEF												
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	"N" VALUES					SHEAR STRENGTH kPa	WATER CONTENT (%)	GR	SA	SI	CL	
Continued From Previous Page																		
159.5	Silty CLAY, with sand, trace gravel Hard Grey (TILL)(CL)		9	SS	62							0 24 43 32						
151.7	Silty CLAY, trace sand Hard Grey Moist (Cl-CH)		10	SS	54													
			11	SS	64							0 1 23 76						
			12	SS	52													
154.8	SAND, some silt Very Dense to Dense Grey Wet		13	SS	70													
			14	SS	49							0 81 19 (Si+Cl)						
151.5	SILT, some clay, trace sand																	

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15-10-5  
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CM11-2															3 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 889 120.2 E 351 059.4				ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY SM												
DATUM Geodetic		DATE 2007.12.07 - 2007.12.07				CHECKED BY MEF												
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	"N" VALUES					SHEAR STRENGTH kPa	WATER CONTENT (%)	GR	SA	SI	CL	
Continued From Previous Page																		
	SILT, some clay, trace sand Very Dense Grey Wet		15	SS	100													
			16	SS	100													
			17	SS	100							0 0 01 19						
147.8 23.3	END OF BOREHOLE AT 23.4m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted Screen WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2008 01 16 9.9 161.3																	

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15-10-5  
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CM17-1										1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 870 854.8 E 353 677.7				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007.12.11 - 2007.12.11				CHECKED BY MEF							
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	GR SA SI CL
173.4	ASPHALT (135 mm)		1	AS									
172.5	SAND, some gravel, trace silt Dark Brown Moist (FILL)		1	SS	47								17 66 17 (SH+CL)
171.2	SAND, some gravel, some silt Dense Brown Moist		2	SS	30								
170.4	Sandy SILT, trace gravel, trace clay Dense Brown Moist (TILL)		3	SS	38								
169.4	SAND, some silt, trace gravel Compact to Very Dense Brown Wet		4	SS	21								0 80 20 (SH+CL)
168.4			5	SS	54								
167.4			6	SS	55								
166.4			7	SS	100 225								
165.4			8	SS	100 250								
164.4	becoming Grey												

Continued Next Page

Numbers refer to  
Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CM17-1										2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 870 854.8 E 353 677.7				ORIGINATED BY SLL							
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES							
DATUM Geodetic		DATE 2007.12.11 - 2007.12.11				CHECKED BY MEF							
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	GR SA SI CL
162.5	SAND, some silt, trace gravel Very Dense Grey Wet		9a	SS	100								0 75 25 (SH+CL)
161.9	Sandy SILT, trace gravel, trace clay Very Dense Grey Moist (TILL) BOREHOLE CONTINUED ON CM17-1A		9b	SS	275								
161.1	END OF BOREHOLE AT 11.1m. Piezometer installation consists of 15 mm diameter Schedule 40 PVC pipe with a 1.52 in slotted Screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV(m) 2007.12.12 3.0 170.5 2008.01.16 2.1 171.4												

Numbers refer to  
Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CM17-1a															1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION			ORIGINATED BY SLL													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES													
DATUM Geodetic		DATE 2007.12.13 - 2007.12.13			CHECKED BY MEF													
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	20 40 60 80 100	W.P. W. W.L.	Y	GR SA SI CL					
173.4 0.0																		
173																		
172																		
171																		
170																		
169																		
168																		
167																		
166																		
165																		
164																		

Continued Next Page

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

RECORD OF BOREHOLE No CM17-1a															2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION			ORIGINATED BY SLL													
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES													
DATUM Geodetic		DATE 2007.12.13 - 2007.12.13			CHECKED BY MEF													
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	20 40 60 80 100	W.P. W. W.L.	Y	GR SA SI CL					
	Continued From Previous Page																	
	BOREHOLE CONTINUED FROM CM-17A. No Sampling until 12.19m																	
161.2 12.2	Sandy SILT, trace gravel, trace clay Very Dense Grey Moist (TILL)		1	SS	102/236													
			2	SS	100/225													
158.0 15.4	END OF BOREHOLE AT 15.4m. BOREHOLE OPEN TO 0.8m AND WATER LEVEL AT 5.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m AND ASPHALT TO SURFACE.		3	SS	100/													

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



RECORD OF BOREHOLE No CM17-2															1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION					ORIGINATED BY WB											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.05.26 - 2008.05.26					CHECKED BY MEF											
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	TR VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100					W P	W	W L	Y	GR SA SI CL	
								SHEAR STRENGTH kPa										
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL x LAB VANE										
0.0	TOPSOIL, peat, sandy, roots		1	AS														
0.3	Silty SAND, trace clay, trace gravel Compact to Dense Brown-grey Moist		1	SS	13													
			2	SS	31													
2.2	Silty SAND, trace clay, trace gravel Compact to Very Dense Grey Moist		3	SS	26													
			4	SS	18													
			5	SS	100/ 275													
			6	SS	100													
5.5	SAND and SILT, trace clay, trace gravel Very Dense Grey Moist (TILL)		7	SS	68/ 100													
			8	SS	100/ 225													
9.5	END OF BOREHOLE AT 9.53m. WATER LEVEL AT 0.3m UPON COMPLETION																	

Continued Next Page

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



RECORD OF BOREHOLE No CM17-2															2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION					ORIGINATED BY WB											
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES											
DATUM Geodetic		DATE 2008.05.26 - 2008.05.26					CHECKED BY MEF											
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	TR VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100					W P	W	W L	Y	GR SA SI CL	
								SHEAR STRENGTH kPa										
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL x LAB VANE										
	Continued From Previous Page																	
	BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																	

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

CONTAMTAS C510 GP.1 8/12/03

INSTITUTIONAL 05:00 GP: 8/27/08



+ 3, X 3: Numbers refer to Sensitivity

+ 3, X 3: Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM17b-1 1 OF 3 METRIC														
G.W.P. W.O. 07-20016		LOCATION N 4 870 893.4 E 353 665.0			ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES									
DATUM Geodetic		DATE 2007.12.12 - 2007.12.12			CHECKED BY MEF									
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
174.4	ASPHALT (100 mm)													
173.9	SAND, some gravel, trace silt Brown Moist (FILL)		1	AS										
173.8	ASPHALT (75 mm)													
172.9	SAND, some gravel, trace silt Brown Moist (FILL)		1	SS	41									
172.9	Silty CLAY, some sand, trace gravel Very Stiff Brown (TILL)		2	SS	20									
172.6	Sandy SILT, trace clay, trace gravel Dense Brown Moist (TILL)		3	SS	30									
171.8	SAND, some silt, trace gravel Compact Brown Moist to Wet		4	SS	27							4 77 15 (SI+CL)		
166.0	Sandy SILT, some clay Very Dense Grey Moist (TILL)		7a	SS	100/							0 33 53 15		
166.0	SAND, some silt to silty, trace clay Very Dense to Dense Grey Wet		7b	SS	225									
166.0			8	SS	100/									
165.0														

Continued Next Page

Numbers refer to  
Sensitivity

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CM17b-1 2 OF 3 METRIC														
G.W.P. W.O. 07-20016		LOCATION N 4 870 893.4 E 353 665.0			ORIGINATED BY SLL									
HWY 407		BOREHOLE TYPE Solid Stem Augers			COMPILED BY ES									
DATUM Geodetic		DATE 2007.12.12 - 2007.12.12			CHECKED BY MEF									
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
	Continued From Previous Page													
164.0	SAND, some silt to silty, trace clay Dense to Very Dense Grey Wet		9	SS	47							0 66 32 2		
163.0														
162.0			10	SS	100/									
161.0														
160.7	Sandy SILT, trace clay Dense to Very Dense Grey Wet		11	SS	42							0 29 65 6		
160.0														
159.0			12	SS	30									
158.0														
157.0			13	SS	100/									
156.4	Silty CLAY, trace sand Hard Grey (CL)		14	SS	100/							0 2 55 43		
155.0														

Continued Next Page

Numbers refer to  
Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CM17b-1										3 OF 3		METRIC	
G.W.P.	W.O. 07-2006		LOCATION		N 4 870 893.4 E 353 665.9			ORIGINATED BY		SLL			
HWY	407		BOREHOLE TYPE		Solid Stem Augers			COMPILED BY		ES			
DATUM	Geodetic		DATE		2007.12.12 - 2007.12.12			CHECKED BY		MEF			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● CLICK TRIAXIAL x LAB VANE	PLASTIC LIMIT FLUIDITY INDEX SHRINKAGE INDEX	NATURAL MOISTURE CONTENT (%)  WATER CONTENT (%)	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES								
154.2		Continued From Previous Page		15'	SS	100							
20.1	END OF BOREHOLE AT 20.1m BOREHOLE OPEN TO 6.3m AND WATER LEVEL AT 4.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m AND ASPHALT TO SURFACE.					175	154						

RECORD OF BOREHOLE No CM17b-2										1 OF 1	METRIC				
G.W.P.	W.O. 07-20016			LOCATION							ORIGINATED BY WB				
HWY	407			BOREHOLE TYPE Solid Stem Augers							COMPILED BY ES				
DATUM	Geodetic			DATE			2008.05.26 - 2008.05.26				CHECKED BY MEF				
SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT (%)	UNIT WEIGHT γ <sub>t</sub> kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W <sub>p</sub>	LIQUID LIMIT W <sub>L</sub>	SHRINKAGE RATIO W <sub>s</sub>				
0.0	TOPSOIL, silty Brown Moist	[Pattern]													
0.6	Silty SAND, trace gravel, trace clay Dense Brown Moist (TILL)	[Pattern]	1	SS	41										
1.8	Silty SAND, trace gravel, trace clay Dense Gray Moist	[Pattern]	2	SS	13										
2.7	SILT, sandy, trace gravel Very Dense Gray Damp (TILL)	[Pattern]	3	SS	31										
			4	SS	80/ 100										
4.3	Cisley SILT, some sand, trace gravel Hard Grey (TILL)	[Pattern]	5	SS	100/ 150										
5.2	Cloyey SILT, trace sand Hard Grey	[Pattern]													
			6	SS	100/ 150										
6.3	END OF BOREHOLE AT 6.30m. WATER LEVEL AT 0.60m 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)				.200										

ONTARIO C5-CGPJ 0/1208





RECORD OF BOREHOLE No CM17b-3										1 OF 2		METRIC								
G.W.P. W.O. 07-20016		LOCATION N 4 870 921.4 E 353 736.5				ORIGINATED BY SLL														
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES														
DATUM Geodetic		DATE 2007.03.12 - 2007.03.12				CHECKED BY MEF														
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		FLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	W <sub>p</sub>	W <sub>L</sub>	W <sub>u</sub>	Y	GR	SA	SI	CL
170.7	TOPSOIL, with roots (275mm)																			
170.4	Brown Moist																			
166.3	SAND, trace gravel Compact Brown Moist		1	SS	17															
164.9	Silty SAND, trace clay, trace gravel Compact to Very Dense Brown to Grey Moist (TILL)		2	SS	12															
			3	SS	31															
			4	SS	60															
			5	SS	60															
164.9	SAND and SILT, trace clay, trace gravel Very Dense Grey Moist to Wet		6	SS	100/200															
			7	SS	100/250															
162.2	SILT and SAND, some clay, trace gravel Hard Grey (TILL)		8	SS	100/150															

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



RECORD OF BOREHOLE No CM17b-3										2 OF 2		METRIC								
G.W.P. W.O. 07-20016		LOCATION N 4 870 921.4 E 353 736.5				ORIGINATED BY SLL														
HWY 407		BOREHOLE TYPE Solid Stem Augers				COMPILED BY ES														
DATUM Geodetic		DATE 2007.03.12 - 2007.03.12				CHECKED BY MEF														
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		FLASTIC LIMIT		NATURAL MOISTURE CONTENT		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	W <sub>p</sub>	W <sub>L</sub>	W <sub>u</sub>	Y	GR	SA	SI	CL
160.3	Continued From Previous Page																			
10.4	Gravelly SAND, with weathered shale fragments Very Dense Grey Wet		9	SS	105															
158.6																				
11.1	END OF BOREHOLE AT 11.1m. BOREHOLE OPEN TO 9.8m AND WATER LEVEL AT 1.6m 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 (% STRAIN AT FAILURE

+ 3, X 3: Numbers refer to Sensitivity

+ 3, X 3: Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM21-1															1 OF 2		METRIC		
G.W.P. W.O. 07-20016		LOCATION N 4 871 578.4 E 355 414.6					ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2008.03.05 - 2008.03.06					CHECKED BY MEF												
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	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80	100	20	40	60				
217.8	TOPSOIL, trace roots: (150mm)																		
0.2	Brown Moist Silty CLAY Stiff Brown		1	SS	14														
216.4	Silty CLAY, sandy, trace gravel Stiff to Very Stiff Brown (TILL) (CL)		2	SS	12														
			3	SS	28														
			4	SS	13														
			5	SS	20														
211.7	Silty CLAY, trace sand Stiff Gray (CL)		6	SS	8														
			7	SS	13														
209.1	Silty SAND Compact Gray Wet		8	SS	16														

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

ONTM14S 0510.GPJ 8/12/08



RECORD OF BOREHOLE No CM21-1															2 OF 2		METRIC		
G.W.P. W.O. 07-20016		LOCATION N 4 871 578.4 E 355 414.6					ORIGINATED BY SLL												
HWY 407		BOREHOLE TYPE Solid Stem Augers					COMPILED BY ES												
DATUM Geodetic		DATE 2008.03.05 - 2008.03.06					CHECKED BY MEF												
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	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80	100	20	40	60				
207.5	SAND and SILT, trace clay, trace gravel Very Dense Gray Moist (TILL)		9	SS	100/153														
	occasional cobbles at 12.3 to 12.5m		10	SS	100/100														
204.0	END OF BOREHOLE AT 14.1m. BOREHOLE OPEN AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		11	SS	100/075														

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

ONTM14S 0510.GPJ 8/12/08





RECORD OF BOREHOLE No CM21-2										1 OF 2		METRIC		
G.W.P. W.O. 07-20016		LOCATION N 4 071 584.2 E 355 499.9		ORIGINATED BY SLL										
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES										
DATUM Geodetic		DATE 2008 03 07 - 2008 03 07		CHECKED BY MEF										
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		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 P	W	V L	Y	GR SA SI CL
221.1	TOPSOIL, with roots and rootlets: (500mm) Brown Moist						221							
220.5	Sandy SILT, some clay, trace gravel Loose Brown Wet		1	SS	8		220							
219.6	SAND and SILT, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		2	SS	18		219							
218.6			3	SS	24		218							
217.6			4	SS	49		217							
216.6	becoming Grey		5	SS	81		216							4 41 38 17
215.4	Silty CLAY, sandy, trace gravel Hard Grey (TILL)(CL)		6	SS	33		215							1 22 38 38
213.8	Silty SAND, trace gravel Loose Grey Wet		7	SS	7		213							
212.2	SAND, some gravel, trace silt Loose Grey Wet		8	SS	4		212							14 79 6 (SI+CL)

Continued Next Page

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



RECORD OF BOREHOLE No CM21-2										2 OF 2		METRIC		
G.W.P. W.O. 07-20016		LOCATION N 4 071 584.2 E 355 499.9		ORIGINATED BY SLL										
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES										
DATUM Geodetic		DATE 2008 03 07 - 2008 03 07		CHECKED BY MEF										
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		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 P	W	V L	Y	GR SA SI CL
	Continued From Previous Page													
211	SAND, some gravel, trace silt Loose Grey Wet		9	SS	38		211							
209.6	SILT and SAND, some clay, trace gravel Very Dense Grey Moist (TILL)		10	SS	100/150		209							3 40 45 12
208.6			11	SS	100/150		208							
207.6			12	SS	100/125		207							
205.7	END OF BOREHOLE AT 15.4m. BOREHOLE OPEN TO 14.0m AND WATER LEVEL AT 2.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.37m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV (m) 2008.03.12 7.0 214.1						205							

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

Continued Next Page

+3, X3: Numbers refer to Sensitivity

[illegible]

+ 3, X 3: Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM21b-3															1 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION			ORIGINATED BY													
HWY 407		BOREHOLE TYPE			COMPILED BY													
DATUM Geodetic		DATE 2008.05.27 - 2008.05.27			CHECKED BY													
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	20 40 60 80 100	W.P.	W.L.	GR SA SI CL						
0.0	TOPSOIL		1	AS														
0.3	Silty CLAY, some sand, trace gravel Very Stiff to Hard Brown to Grey (TILL)		1	SS	19													
			2	SS	24													
			3	SS	25													
			4	SS	53													
	50 mm layer is sand		5	SS	51													
			6	SS	26													
7.0	Silty CLAY, trace sand, trace gravel Very Stiff Grey		7	SS	28													
9.5	SAND and SILT, trace gravel, trace clay Very Dense Grey Moist (TILL)		8	SS	43													

ONTM14S 0510.GPJ 8/12/08

Continued Next Page

Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CM21b-3															2 OF 2		METRIC	
G.W.P. W.O. 07-20016		LOCATION			ORIGINATED BY													
HWY 407		BOREHOLE TYPE			COMPILED BY													
DATUM Geodetic		DATE 2008.05.27 - 2008.05.27			CHECKED BY													
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	20 40 60 80 100	W.P.	W.L.	GR SA SI CL						
	Continued From Previous Page																	
	SAND and SILT, trace gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	50/ 125													
11.6	Sandy GRAVEL, trace silt, trace clay Very Dense Grey Wet (TILL)		10	SS	83													
13.3	SAND, some gravel, trace silt Compact Brown to Grey Moist		11	SS	25													
14.0	Sandy SILT, some clay, trace gravel Very Dense Grey (TILL)		12	SS	100/ 050													
			13	SS	102/ 100													
			14	SS	107/ 075													
18.4	END OF BOREHOLE AT 18.36 m Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen																	
	WATER LEVEL READINGS: DATE DEPTH (m)																	

ONTM14S 0510.GPJ 8/12/08

Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

ONTM4S 0510 GPJ 8/12/05

Continued Next Page

+ 3, X 3 Numbers refer to Sensitivity

CONTINUED ON 0517 CSPJ 81720A

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



ONTM4S C510GPJ 8/12K8

Continued Next Page

+3, X3: Numbers refer to Sensitivity

CONTINUED ON 0510 G01 8/12/08

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+ 3, x 3: Numbers refer to Sensitivity

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RECORD OF BOREHOLE No CM24-2										2 OF 4		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 870 915.6 E 357 422.8		ORIGINATED BY JM		COMPILED BY ES		CHECKED BY MEF					
HWY 407		BOREHOLE TYPE Solid Stem Augers											
DATUM Geodetic		DATE 2008 03 17 - 2008 03 18											
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL MOISTURE LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60	WATER CONTENT (%)	GR SA SI CL		
Continued From Previous Page													
	Silty CLAY, some sand, trace gravel Very Stiff Grey (TILL) (CL)		9	SS	28		209				2 18 35 44		
							208						
			10	SS	23		207						
206.2													
13.3	Sandy SILT, trace clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	100		200						
					125		205						
204.1													
15.4	Silty CLAY, trace sand, trace gravel Very Stiff Grey (TILL)		12	SS	20		204				0 8 44 47		
203.1													
10.3	Sandy SILT, trace clay, trace gravel Compact to Very Dense Grey Moist (TILL)		13	SS	16		203						
							202						
			14	SS	70		201				5 57 31 7		
							200						

Continued Next Page

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

ONTM74S 0510.GPJ 2/12/08



RECORD OF BOREHOLE No CM24-2										3 OF 4		METRIC	
G.W.P. W.O. 07-20016		LOCATION N 4 870 915.6 E 357 422.8		ORIGINATED BY JM		COMPILED BY ES		CHECKED BY MEF					
HWY 407		BOREHOLE TYPE Solid Stem Augers											
DATUM Geodetic		DATE 2008 03 17 - 2008 03 18											
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL MOISTURE LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	TN VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60	WATER CONTENT (%)	GR SA SI CL		
Continued From Previous Page													
	Sandy SILT, trace clay, trace gravel Very Dense to Dense Grey Moist (TILL)		15	SS	100		199						
					250		198				1 13 74 12		
			16	SS	31		197						
190.6													
22.9	Silty SAND, trace gravel Very Dense Grey Moist (TILL)		17	SS	100		196						
					125		195						
			18	SS	51		194						
194.0													
25.5	Silty SAND, trace gravel Very Dense Grey Moist		19	SS	100		193						
					075		192						
192.5													
26.9	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		20	SS	100		191						
					075								
190.4													
29.0	BOREHOLE ENDED AT 29.0m. BOREHOLE OPEN TO 16.5m AND WATER LEVEL AT 1.1m UPON COMPLETION BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m AND AUGER		21	SS	100								
					075								

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

ONTM74S 0510.GPJ 2/12/08



RECORD OF BOREHOLE No CM24-2																		
4 OF 4																		
METRIC																		
G.W.P. W.O. 07-20016		LOCATION N 4 870 915.6 E 357 422.8		ORIGINATED BY JM														
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES														
DATUM Geodetic		DATE 2008.03.17 - 2008.03.18		CHECKED BY MFF														
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	20	40	60	80	100	
Continued From Previous Page																		
CUTTINGS TO SURFACE																		

+ 3, x 3, Numbers refer to Sensitivity 70 15 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CM24-3																		
1 OF 3																		
METRIC																		
G.W.P. W.O. 07-20016		LOCATION		ORIGINATED BY ES														
HWY 407		BOREHOLE TYPE Solid Stem Augers		COMPILED BY ES														
DATUM Geodetic		DATE 2008.05.29 - 2008.05.29		CHECKED BY MFF														
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20	40	60	80	100	20	40	60	80	100	
TOPSOIL: (100mm)																		
0.0	Clayey SILT, trace gravel, mixed with topsoil		1	AS														
0.1	Compact Brown		1	SS	10													
1.5	Clayey SILT, some sand, trace gravel		2	SS	18													
2.2	Very Silty Brown (TILL)		3	SS	24													
3.0	Sandy SILT, some clay to clayey, trace gravel		4	SS	41													
	Compact Brown Damp (TILL)		5	SS	76													
	Auger grinding at 5.3 to 5.6m		6	SS	88													
6.2	SAND and SILT, some clay, trace gravel		7	SS	74													
	Very Dense Grey Dry (TILL)		8	SS	36													
	Auger grinding at 6.2 to 6.5m																	

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+ 3, x 3, Numbers refer to Sensitivity 70 15 10 (%) STRAIN AT FAILURE



ONTM74S 0510.GPJ 2/12/08

Continued Next Page

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

ONTM74S 0510.GPJ 8/12/08

+ 3, X 5. Numbers refer to Sensitivity



RECORD OF BOREHOLE No CM24-4															1 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION										ORIGINATED BY WB						
HWY 407		BOREHOLE TYPE Solid Stem Augers										COMPILED BY ES						
DATUM Geodetic		DATE 2008.05.20 - 2008.05.20										CHECKED BY MEF						
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	IN VALUES					20	40	60	80	100	GR	SA
0.0	TOPSOIL, trace clay, trace gravel Brown Moist		1	AS														
0.5	Clayey SILT, sandy, trace gravel Firm Brown to Grey (TILL)		1	SS	22													
			2	SS	29													
			3	SS	30													
			4	SS	37													
			5	SS	26													
			6	SS	70													
			7	SS	100/ 250													
			8	SS	50													

Continued Next Page

4 3 X 3

Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CM24-4															2 OF 3		METRIC	
G.W.P. W.O. 07-20016		LOCATION										ORIGINATED BY WB						
HWY 407		BOREHOLE TYPE Solid Stem Augers										COMPILED BY ES						
DATUM Geodetic		DATE 2008.05.20 - 2008.05.20										CHECKED BY MEF						
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	IN VALUES					20	40	60	80	100	GR	SA
	Continued From Previous Page																	
	Clayey SILT, sandy, trace gravel Firm Brown to Grey (TILL)		9	SS	35													
			10	SS	35													
13.1	Silty CLAY, some sand, trace gravel Hard Grey		11	SS	49													
			12	SS	47													
16.2	Clayey SILT, some sand, trace gravel Hard Grey (TILL)		13	SS	75													
			14	SS	54													
19.2	Sandy SILT, some clay, trace gravel Very Dense Grey Moist (TILL)																	

Continued Next Page

4 3 X 3

Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No P13 1 OF 1 METRIC																	
W.P. 282-86-01		LOCATION N 4 867422.8 E 348100.7			ORIGINATED BY DK												
DIST 6 HWY 407		BOREHOLE TYPE H.S. Auger, Cone Test			COMPILED BY DT												
DATUM Geodetic		DATE 93 12 13			CHECKED BY BI												
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 <sub>p</sub>	W <sub>n</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>n</sub>	W <sub>L</sub>	7	GR SA SI CL
158.8	Ground Surface																
0.0	Granular Fill		1	SS	8												
0.5	Clayey Silt, Trace Sand, with Organic Inclusions (Fill)		2	SS	20												
1.4	Heterogeneous Mixture of Clayey Silt, Gravel, Brown, Very Silty		3	SS	37												
156.7	Brown, Dense Grey, Very Dense		4	SS	123												
2.1	Heterogeneous Mixture of Silt, Sand and Gravel, Occasional Cobbles and Boulders (Glacial Till)		5	SS	120												
152.7			6	SS	103												
6.1	Heterogeneous Mixture of Clayey Silt, Trace Gravel Occasional Sand layers, Cobbles and Boulders, Grey, Hard (Glacial Till)		7	SS	117												
			8	SS	120												
			9	SS	120												
146.4			10	SS	100												
12.4	End of Borehole																
* Unstabilized water level measured upon completion of drilling on 93 12 13																	

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

RECORD OF BOREHOLE No P14 1 OF 1 METRIC																	
W.P. 282-86-01		LOCATION N 4 867482.6 E 348937.8			ORIGINATED BY DK												
DIST 6 HWY 407		BOREHOLE TYPE H.S. Auger, Cone Test, BW Coating			COMPILED BY DT												
DATUM Geodetic		DATE 93 12 06 - 93 12 10			CHECKED BY BI												
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 <sub>p</sub>	W <sub>n</sub>	W <sub>L</sub>	W <sub>p</sub>	W <sub>n</sub>	W <sub>L</sub>	7	GR SA SI CL
158.8	Ground Surface																
0.0	Granular Fill		1	SS	6												
0.8	Clayey Silt, Trace Gravel Brown, Firm (Fill)		2	SS	30												
1.3	Heterogeneous Mixture of Clayey Silt Trace Sand and Gravel Occasional Cobbles and Boulders		3	SS	33												
	Silt and Sand Grey, Dense		4	SS	39												
	Occasional Cobbles and Boulders		5	SS	30												
	Occasional Sand layers and Silt zones Grey		6	SS	72												
	Brown, Hard (Glacial Till)		7	SS	104												
			8	SS	65												
145.4			9	SS	100												
11.4			10	SS	58												
	Silty Sand with Gravel Occasional Cobbles and Boulders Grey, Very Dense		11	WS	-												
			12	SS	100												
			13	SS	113												
			14	WS	-												
136.2			15	SS	160												
20.6	Heterogeneous Mixture of Clayey Silt Trace Sand & Gravel Grey, Hard (Glacial Till)		16	SS	150												
133.8			17	SS	150												
23.0	End of Borehole																
* Unstabilized water level measured 1.5 hours after completion of drilling on 93 12 10																	

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



RECORD OF BOREHOLE No P15 1 OF 1 METRIC												
W.P. 282-86-01		LOCATION N 4 868335.2 E 350382.7				ORIGINATED BY DK						
DIST 6		HWY 407		BOREHOLE TYPE H.S. Auger, Cone Test				COMPILED BY DT				
DATUM Geodetic		DATE 93 12 06 - 93 12 07		CHECKED BY BL								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID MOISTURE CONTENT			UNIT WEIGHT $\gamma$ $\text{KN/m}^3$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W <sub>n</sub> W <sub>L</sub>	WATER CONTENT (%)		
172.2	Ground Surface											
171.4	Granular Fill		1	SS	31							
0.8	Heterogeneous Mixture of Clayey Silt, Trace Sand & Gravel Occasional Sand layers, Cobbles and Boulders, Hard		2	SS	38							7 37 42 14
			3	SS	37							
			4	SS	48							
			5	SS	40							
			6	SS	89							
163.8			7	SS	70							
8.4	Heterogeneous Mixture of Silt, Sand and Gravel Occasional Cobbles and Boulders Grey, Very Dense		8	SS	71							28 41 25 6
			9	SS	58							
			10	SS	50							
			11	SS	100							
			12	SS	110							
			13	SS	100							46 42 9 3
155.2			14	SS	100							
17.0	End of Borehole											
	• Unstabilized water level measured 5 hours after completion of drilling on 93 12 07											

RECORD OF BOREHOLE No P21 1 OF 1 METRIC															
W.P. 326-88-01		LOCATION Coords.: N 4 868 931.8 E 351 038.5					ORIGINATED BY LO								
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem / Hollow Stem					COMPILED BY LO								
DATUM Geodetic		DATE 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					
172.0	Ground Surface														
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	31										
	Sandy Silt		2	SS	31										
			3	SS	41										
			4	SS	57										
			5	SS	104										
162.5			6	SS	128										
9.4	End of Borehole														

4, 3, x<sup>5</sup> Numbers refer to  
Sensitivity 20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P23 1 OF 1 METRIC															
W.P. 326-88-01		LOCATION Coords.: N 4 869 724.6 E 354 258.5					ORIGINATED BY LO								
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem					COMPILED BY LO								
DATUM Geodetic		DATE 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					
166.3	Ground Surface														
0.0			1	SS	16										
	Silty Clay to Clayey Silt Some Sand, Trace Gravel V. Stiff to Hard (Glacial Till)		2	SS	52										
			3	SS	27										
160.8			4	SS	76										
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		5	SS	46										
			6	SS	53										
156.7															
9.8	End of Borehole														

4, 3, x<sup>5</sup> Numbers refer to  
Sensitivity 20  
15-5 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P22 1 of 1 METRIC																
W.P. 326-B6-01		LOCATION Coords.: N 4 869 896.0 E 352 482.8				ORIGINATED BY LO										
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem / Hollow Stem				COMPILED BY LO										
DATUM Geodetic		DATE 1994 05 26				CHECKED BY KA										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30	10 20 30			10 20 30
184.9	Ground Surface															
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	74											
			2	SS	100											
179.4			3	SS	39											
5.5	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel Dense to V. Dense (Glacial Till)		4	SS	41											
			5	SS	108											
			6	SS	100											
172.3			7	SS	101											
12.6	End of Borehole															

+3, x 5 Numbers refer to  
Sensitivity

20  
15-25 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P24 1 of 1 METRIC																
W.P. 326-B8-01		LOCATION Coords.: N 4 859 574.1 E 356 028.6				ORIGINATED BY LO										
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LO										
DATUM Geodetic		DATE 1994 05 27				CHECKED BY KA										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30	10 20 30			10 20 30
203.2	Ground Surface															
0.0	Clayey Silt Some Sand, Trace Gravel Hard (Glacial Till)		1	SS	44											
			2	SS	78											
			3	SS	120											
			4	SS	85											
			5	SS	104											
193.6			6	SS	105											
9.8	End of Borehole															

+3, x 5 Numbers refer to  
Sensitivity

20  
15-25 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P25 1 of 1 METRIC															
W.P. 326-B8-01		LOCATION Coords: N 4 869 427.6, 357 821.1				ORIGINATED BY LO									
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LO									
DATUM Geodetic		DATE 1994 05 25				CHECKED BY KA									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	VALUES	20	40	60	80	100			W <sub>p</sub>
213.2	Ground Surface														
0.0															
	Sandy Silt to Silty Trace Clay, Trace Gravel V. Dense (Glacial Till)		1	SS	58										
			2	SS	150	/8cm									
	Clayey Silt		3	SS	150	/8cm									
			4	SS	150	/18cm									
			5	SS	111										
199.3			6	SS	150	/10cm									
13.8	End of Borehole														

4, 5, 6 Numbers refer to  
Sensitivity 20  
15-25 (X) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No P26 1 of 1 METRIC															
W.P. 326-B8-01		LOCATION Coords: N 4 869 399.7, E 358 124.9				ORIGINATED BY LO									
DIST 6 HWY 407		BOREHOLE TYPE Solid Stem				COMPILED BY LO									
DATUM Geodetic		DATE 1994 05 25				CHECKED BY KA									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	VALUES	20	40	60	80	100			W <sub>p</sub>
210.8	Ground Surface														
0.0															
	Silty Sand to Sandy Silt Trace of Clay, Trace of Gravel V. Dense (Glacial Till)		1	SS	135										
			2	SS	150										
			3	SS	138										
			4	SS	150	/15cm									
200.8															
9.8			5	SS	150	/16cm									
	Clayey Silt Some Sand, Some Gravel Hard (Glacial Till)		6	SS	150	/18cm									
			7	SS	138										
			8	SS	150	/15cm									
			9	SS	150	/15cm									
193.6															
16.9	End of Borehole														

4, 5, 6 Numbers refer to  
Sensitivity 20  
15-25 (X) STRAIN AT FAILURE  
10



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