

# The Windsor-Essex Parkway Project

## Geotechnical Investigation and Design Report

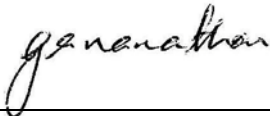


### Pedestrian Tunnel TB-6

(9+926.276 Geraedts Drive, LaSalle)



Geocres No. 40J3-24

Revision History					
Revision	Date	Status	Prepared By	Checked By	Reviewed By
0	12/18/2012	Issued for Construction	GN	BL	DD

	Name, Title	Signature	Date
<b>Prepared By</b>	Ganan Nadarajah, M.A.Sc., P.Eng. Geotechnical Engineer		12/18/2012
<b>Reviewed By</b>	Dan Dimitriu, Ph.D., P.Eng. Associate Geotechnical Engineer (Project Lead Designer)		12/18/2012
<b>Approved By</b>	Brian Lapos, M.Sc., P.Eng., Geotechnical Engineer (Project Manager, AMEC)		12/18/2012

This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of HMM being obtained. HMM accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify HMM for all loss or damage resulting there from. HMM accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

## List of Contents and Appendices Page

1	Introduction .....	1
1.1	Preface.....	1
1.2	Report Introduction.....	2
2	Background Information .....	3
2.1	Geological Setting .....	3
2.2	Site Seismic Background .....	4
2.3	Site Conditions .....	4
2.4	Frost Depth.....	4
3	Geotechnical Investigation .....	5
3.1	Scope and Procedures of Geotechnical Investigations.....	5
3.2	Additional Investigation at the Tunnel Site.....	5
3.2.1	Fieldwork at Tunnel Site.....	5
3.2.2	Laboratory and Analytical Testing .....	6
3.2.3	Data Interpretation – General Discussion .....	6
4	Subsurface Conditions.....	9
4.1	Topsoil, and Surficial Fills .....	9
4.2	Silty Clay to Clayey Silt Stratum.....	9
4.3	Lower Granular Deposit.....	12
4.4	Bedrock .....	12
4.5	Groundwater Conditions .....	12
4.6	Subsurface Gases .....	13
5	Development of Geotechnical Design.....	14
5.1	Geotechnical Design Criteria and Considerations .....	14
5.2	Design Soil Properties.....	14
5.3	Excavation and Temporary Cut Slopes .....	15
5.4	Concrete Box Tunnel .....	16
5.4.1	General.....	16
5.4.2	ULS Bearing Resistance .....	16
5.4.3	ULS Sliding Resistance .....	16
5.4.4	SLS Resistance and Performance .....	17
5.5	RSS Wing Walls .....	17
5.5.1	General.....	17
5.5.2	Global Stability .....	18
5.5.3	RSS External Stability .....	19

5.6	Backfilling.....	20
5.7	Flood Events.....	22
5.8	Permanent Cut Slope Stability.....	22
6	Other Geotechnical Recommendations .....	23
6.1	Construction Dewatering .....	23
6.2	General Construction Requirements .....	23
6.3	Corrosion Potential .....	24
6.4	Construction Quality Control .....	25
6.5	Instrumentation and Monitoring .....	25
7	Limitations of Report .....	26
8	Closure .....	28
9	References .....	29

## List of Tables

Table 3-1:	Test Holes at and around Pedestrian Tunnel TB-6 Site .....	5
Table 4-1:	Summary of Index Properties (Based on TB6-1 and Nearby Boreholes) .....	10
Table 4-2:	Summary of Compressibility Properties .....	11
Table 4-3:	Summary of Interpreted Elastic Moduli Properties .....	11
Table 4-4:	Summary of Measured Water Levels .....	12
Table 4-5:	Summary of Natural Groundwater Chemistry .....	13
Table 4-6:	Pumping Tests Data.....	13
Table 5-1:	Summary of Interpreted Design Clay Strength and Consolidation History .....	15
Table 5-2:	Summary of Other Interpreted Design Parameters .....	15
Table 5-3:	Assumed Proprietary Product Properties .....	18
Table 5-4:	Assumed Backfill Material Properties .....	18
Table 5-5:	Results of Global Stability Analyses .....	19
Table 5-6:	Tentative Wingwall Dimensions .....	20
Table 5-7:	Soil Parameters for Earth Pressure Calculations .....	21
Table 5-8:	Results of Global Stability Analyses .....	22
Table 6-1:	Results of Analytical Testing on Soils.....	24

## Drawings

285380-03-060-WIP1-6601	Hwy. 401 Pedestrian Tunnel TB-6 General Arrangement
285380-03-061-WIP1-6606	Hwy. 401 Pedestrian Tunnel TB-6 RSS Walls Layout
285380-04-090-WIP1-6601	Location Plan and Interpreted Stratigraphic Profile STA 11+500L to STA 12+300L
285380-04-090-WIP1-6602	Hwy. 401 Pedestrian Tunnel TB-6 Borehole Locations and Soil Strata
285380-04-091-WIP1-6603	Hwy. 401 Pedestrian Tunnel TB-6 Soil Stratigraphy

## List of Figures

- Figure 3.1: Field Vane Correction Factor vs. Plasticity Index Derived from Embankment Failures (Figure 5.1, Ladd & DeGroot, 2004, ref. R-29)
- Figure 3.2: Field Vane Undrained Strength Ratio at OCR = 1 vs. Plasticity Index for Homogeneous Clays (Figure 5.2, Ladd & DeGroot, 2004, ref. R-29)
- Figure 3.3: Soil Properties Profiles, Sta. 11+500L to 12+300L
- Figure 4-1: Compressibility Parameters at WEP
- Figure 4-2: Cc versus C $\alpha$  Relationship at WEP
- Figure 4-3: Effective Friction Angle ( $\phi'$ ) for Silty Clay to Clayey Silt Stratum at WEP
- Figure 4-4: Relationship between  $\sin \phi'$  and Plasticity Index for Normally Consolidated Soils (Kenney, 1959)
- Figure 4.5: Inferred Clay Stratum Permeability from CPT Pore Pressure Dissipation and Oedometer Tests
- Figure 5.1: Pedestrian Tunnel TB-6 Under Geraedts Drive – Excavation and Backfill Details

## List of Appendices

- Appendix A: Borehole, CPT and DMT logs from Additional Geotechnical Investigation
- Appendix B: Borehole Logs from Previous Investigations
- Appendix C: Analytical Laboratory results
- Appendix D: Slope Stability Analyses



# 1 Introduction

## 1.1 Preface

The Windsor Essex Parkway (the Parkway, or the WEP) was conceived to strengthen transportation and trade links between Canada and the United States, reduce road congestion, and foster economic growth. The Parkway will connect Highway 401 to a new Canadian inspection plaza and a new international crossing over the Detroit River to Interstate 75 in Michigan, USA. It will be a six-lane highway, 11 kilometers long with 15 bridges, 11 tunnels and a four-lane service road that will provide full access to schools, neighbourhoods, natural areas, and shopping. Other components of the project include community and environmental features, such as: 300+ acres of green space, 20 kilometers of recreational trails, extensive landscaping throughout the corridor, as well as noise and environmental mitigation measures. The environmental mitigation measures were based upon Permit AY-D-001-09 which was approved in February 2010.

The Parkway's strategic international importance, urban location, and unique ecological context necessitate strong design and planning principles to guide infrastructure development. The Parkway is to be a state-of-the-art facility within a contextually sensitive landscape setting that has ecological integrity, builds physical and cultural connections, and establishes a sustainable network of amenities that can be enjoyed by present and future generations.

The plans for the Parkway strive to build and strengthen linkages within and between both human and ecological communities. Over time, restored green space will evolve into a tall grass prairie and oak savannah landscape that will, through ecological succession, allow the roadway to become a 'Parkway in a Prairie'. All of the green space areas of the Parkway, (whether associated with the Roadway, the Stormwater Management Areas, the Ecological Landscape areas, or the Screening), are ecologically based areas that in their totality will represent an extensive habitat network consisting of existing, new and rehabilitated terrestrial and aquatic communities.

Natural and cultural history are proposed to be celebrated in the artful design of three Gateways, and eleven Land Bridges that support the existing municipal road system and the inter-connected multi-use pathway system. The Gateways are conceived as bold and commanding landscapes that draw on sculpted landform, strong patterning, and public art to create strong visual elements for the driving experience within themes of 'Arrival, Settlement, and Flow'.

The Land Bridges draw on natural and cultural influences to create distinct and memorable places that serve as markers, urban respite areas, and focal points to the overall green space system. Other opportunities for artistic expression include the streetscapes and urban amenity areas, trail bridges; tunnel abutments, and noise walls. These structural elements offer opportunities for simple expression of the surrounding natural environment, area history and the 'prairie' landscape in particular, through color, form, materials, and the integration of public art.

The lasting legacy of the Windsor Essex Parkway project will not only be its significant contribution as an international trade and transportation route, but rather include the establishment of a contiguous and sustainable green space system that contributes to the quality of life in the community and supports the re-establishment of an ecologically rich Carolinian landscape.

On December 17, 2010 Infrastructure Ontario and Ministry of Transportation of Ontario (MTO) announced that the Windsor Essex Mobility Group (WEMG) reached financial close and signed a fixed-price contract with the Province to design, build, finance, and maintain the Windsor-Essex Parkway. To build the initial works, WEMG has formed a Design-Build Joint Venture – Parkway Infrastructure Constructors (PIC). This team includes Dragados Canada, Inc., Acciona Infrastructure Canada Inc., and Fluor Canada Ltd. This combination brings a wide range of local and international experience to the project.

## 1.2 Report Introduction

The 11.2 km long proposed WEP will run generally east-west and connect the existing Highway 401 in Tecumseh to the proposed new international crossing bridge across Detroit River (near Zug Island). It will run sequentially along segments of Highway 3 and Huron Church Road and then adjacent to the E.C. Row Expressway to its intersection with Ojibway Parkway. It will be constructed mostly within a cut section until the intersection of Huron Church Road and E.C. Row Expressway, beyond which it will be mostly on embankments. The proposed WEP includes 15 bridges (Bridges B-1 to B-15), 11 tunnels (T-1 to T-11), 9 trail bridges, approximately 5.5 km length of retaining walls, 2 submerged culverts, 5 box culverts, and other structures.

This report presents the geotechnical design of Pedestrian Tunnel TB-6, located at approximate Sta. 9+926 below Geraedts Drive, near Sta. 11+660L Highway 401 in LaSalle sector of the proposed Windsor-Essex Parkway (WEP) project. The proposed one-span concrete box structure of the pedestrian tunnel will pass underneath the Geraedts Drive and will be used to carry pedestrian traffic along Geraedts Trail as shown on Drawing 285380-03-060-WIP1-6601.

The report includes the results of the additional geotechnical investigation carried out to support the design and other relevant background information and addresses review comments from MTO on the 90% design report. This report is issued for construction (IFC). The geotechnical design has been developed through interactive collaboration of the geotechnical, structural, other design disciplines as well as the Parkway Infrastructure Constructors (PIC).

The report is organized in two parts. Part 1 is the factual information and is presented in Sections 1 to 4. Part 2 presents the geotechnical design and recommendations in Sections 5 and 6. Other information is presented in Sections 7 to 9.

The design complies with the requirements of the execution version of the Project Agreement (PA), Schedule 15-2 Part 2 Article 5.

## 2 Background Information

### 2.1 Geological Setting

The WEP project site is located within the Essex Clay Plain (a part of the St. Clair Clay Plain physiographic region) (ref. R-15, R-17, R-18 and R-25). The Essex Clay Plain was deposited during the retreat of the late Pleistocene Era ice sheets, when a series of glacial lakes inundated the area. The ice sheets generally deposited materials with a glacial till like gradation in the Windsor area. Depending on the locations of the glacial ice sheets and depths of water in the ice-contact glacial lakes, the materials may have been directly deposited at the contact between the ice sheet and bedrock or, as the lake levels rose and the ice sheets retreated and floated, the soil and rock debris within and at the base of ice may have been deposited through the lake water (i.e., lacustrine environment). It is considered that unlike typical till deposits (that have undergone consolidation and densification under the weight of the ice sheet), the majority of the “glacial till” soils in the Windsor and Detroit area were deposited through water and have a soft to firm consistency below a surficial crust layer that has become stiff to hard due to weathering and desiccation. Geologically, the deposit in the project area is considered to be slightly over-consolidated, having experienced no major overburden stresses in excess of the existing stresses.

The overburden in the St. Clair Clay Plain has variously been described as clayey silt till, silty clay till and glaciolacustrine clay. P.P. Hudec (ref. R-25) summarized the overburden geology in Windsor as consisting of the following successive strata: desiccated lacustrine clay, normally consolidated lacustrine clay, silty Tavistock till, glaciolacustrine clay and coarse Catfish Creek till. A distinct change in overburden deposits occurs in the east-west direction along a boundary located generally along the Huron-Church Road. Whereas, the eastern part of Windsor is underlain by firm to stiff glaciolacustrine silts and clays with upper deposits of stiff sandy to silty weathered clay and hard to stiff lacustrine clay-silt crust, the western part of Windsor is characterized by a thin surficial granular deposit underlain by thin crust layer underlain by soft to firm glaciolacustrine silts and clays.

At the WEP project area, the glacial till like deposit is typically 20 to 35 m thick and consists primarily of silty clay and clayey silt gradation with a random distribution of coarser particles. Random and apparently discontinuous seams / lenses of silt, sand and or gravel are present at various depths within the mass of the silty clay deposit. A firm to hard surficial crust layer has formed due to weathering and desiccation. Up to 2 m thick surficial layers of lacustrine silty clay or silt and sand are also encountered in the western sector of the project. A 1 m to 6 m thick very dense or hard basal glacial till or dense silty sand may be found directly overlying the bedrock surface. The bedrock at the project area comprises the Devonian Dundee Formation of the Hamilton Group and the underlying Devonian Lucas Formation of the Detroit River Group.

The Windsor area, referred to as the Essex Domain (with respect to bedrock geology), is located in the Grenville Front Tectonic Zone (GFTZ) (ref. R-25). The bedrock geology within the Essex Domain was formed as part of the midcontinent rift south-eastern extension. The midcontinent rift south-eastern extension is composed of Paleozoic cover rocks which form the bedrock foundation of the Essex Domain. The bedrock was deposited in the Paleozoic Era during the Middle Devonian period. Within the Essex Domain the following strata were deposited the Hamilton Group, Dundee Formation, and Detroit River Group Onondaga Formation all consisting of Limestone, Dolostone, and Shale.

## 2.2 Site Seismic Background

Windsor-Tecumseh area is described in CHBDC (ref. R-9) by a seismic hazard associated to a Velocity Zone  $Z_v = 0$  and Acceleration seismic zone  $Z_a = 0$ . Zonal Velocity ratio,  $V$ , and Zonal Acceleration ratio,  $A$ , are both 0.

In accordance with the Canadian Highway Bridge Design Code (CHBDC) and based on a series of cross-hole tests completed during the background investigation program (ref. R-20), the soil profile at the site of the project in general meets the description for Soil Profile Type III (soft clay and silts greater than 12 m in depth). The above noted cross-hole tests were carried out during the background investigation program at locations distributed along the project alignment between Howard Road (east end) and Matchette Road (west end). The measured velocities of the shear waves were consistently over 200 m/s, with the bulk of results ranging between 200 and 300 m/s.

## 2.3 Site Conditions

Pedestrian Tunnel TB-6 site is situated in the middle of the LaSalle segment of the Parkway, just north of the realigned Cahill Drain (Culvert CV-4) and Tunnel T-8. The structures at this site will be constructed under Phase I of WEP. As shown on the Drawing 285380-03-060-WIP1-6601, the tunnel is 25 m in length and the side slopes vary from 3H:1V to 2.4H:1V at the entrance/exit of the tunnel. The wing walls of the tunnel will be of constructed using reinforced soil structures (RSS).

The topography of the lands immediately adjacent to Pedestrian Tunnel TB-6 is essentially flat with ground surface elevations about elevation 183 to 184 m. Adjacent land use is typically urban residential, parkland and light commercial.

## 2.4 Frost Depth

In accordance with MTO-SDO-90-01 Pavement Design and Rehabilitation Manual (ref. R-32) and OPSD 3090.101, the frost depth below the ground surface in Windsor area is estimated to 1.0 m. This estimate is considered applicable for natural soils and/or conventional pavement materials where the ground surface is usually cleaned from the snow cover.

In the case of rip/rap, or otherwise coarse rockfill cover, the insulation effects of such materials are considered to be one half of the insulation offered by soil deposits /cover, and the depth of frost penetration will have to be increased proportionally.

### 3 Geotechnical Investigation

#### 3.1 Scope and Procedures of Geotechnical Investigations

Geotechnical investigations involving boreholes, cone penetration tests (CPT), and Nilcon vane tests had been carried out between 2006 and 2009 by Golder Associates (ref. R-15 to R-22) as part of background information for development of the WEP proposal designs. Additional geotechnical investigation was carried out to supplement the previously obtained (pre-bid) subsurface soil data, as required to support the detailed design development of the WEP embankment and structures. One borehole (TB6-1) was advanced within the footprint area of the proposed tunnel. However, additional boreholes, CPT and Flat Blade Dilatometer (DMT) were carried out for the nearby Culvert CV-4, tunnel structure (Tunnel T-8) and other structures in close proximity (such as Tunnels T-9) and highway design components (slopes, retaining structures). One of the main objectives of Borehole TB6-1 was to examine the site specific subsurface conditions and confirm the background information from the nearby tests and investigations. Table 3.1 lists the test holes located at or in close proximity to the tunnel site during both the previous and the current geotechnical investigations.

**Table 3-1: Test Holes at and around Pedestrian Tunnel TB-6 Site**

Reference	Boreholes	Nilcon Vane Tests	CPT's	DMT's
This Investigation (2011)	TB6-1	NIL T8-1	CPT T8-1	DMT T8-1
	T8-1			
	HG-MW-3			
	CV4-1			
Previous Studies (2007-09)	BH-7		CPT-7	
	BH-118		CPT-315	
	BH-118A			

The locations of boreholes, Nilcon tests, CPTs and DMTs executed during the pre-bid and additional investigations, and the inferred soil profile in the general area of the tunnel are shown on Drawing 285380-03-090-WIP1-6602. Borehole and DMT logs from the additional investigation are included in Appendix A. Relevant borehole logs from the previous investigation are included in Appendix B.

Drawings 285380-03-090-WIP1-6602 and 285380-03-090-WIP1-6603 show the location of the test holes and an interpreted soil stratigraphic profile at Pedestrian Tunnel TB-6 site.

#### 3.2 Additional Investigation at the Tunnel Site

This section presents the exploration procedure and the results of the investigation. The interpreted soil and groundwater data from all the boreholes within the vicinity have been considered in the design of Pedestrian Tunnel TB-6.

##### 3.2.1 Fieldwork at Tunnel Site

Borehole TB6-1 was drilled on July 9, 2011 for this study. The borehole was advanced using a track-mounted CME 650 auger rig owned and operated by Marathon Drilling Co. Ltd. under contract to



AMICO and under full-time technical direction by AMEC engineers and technicians. The borehole was advanced to a maximum depth of 10.1 m below grade using 200 mm diameter hollow stem augers.

Soil sampling was advanced using a 50 mm diameter split spoon sampler. Soil sampling was performed at 0.75 m to 1.5 m depth intervals to the depths explored. All samples were classified and placed in airtight containers and transported to AMEC's Tecumseh (Windsor) laboratories for further examination and testing. Standard Penetration Tests (SPT, ASTM D1586) were carried out in conjunction with split spoon sampling. Field vane tests (using conventional vanes) were conducted between split spoon sampling at selected depths. The borehole was decommissioned using a bentonite-cement grout following completion of sampling and testing.

### 3.2.2 Laboratory and Analytical Testing

All recovered soil samples were examined in the field and the AMEC geotechnical laboratory. Natural moisture content measurements were performed on most of the recovered samples from Borehole TB6-1. The results are presented on the borehole log (Appendix A).

Analytical testing consisting of pH, redox potential, resistivity, sulphide and sulphate contents were carried out on one sample collected from Borehole TB6-1. The results from these chemical tests are presented in Appendix C.

### 3.2.3 Data Interpretation – General Discussion

**Field Vane Test Data Correction:** The chart shown in Figure 3.1,<sup>1</sup> initially developed by Bjerrum (1972) and updated subsequently by Ladd et al (1977) based on circular arc failure analyses of embankment failures, suggests correction by multiplying the field vane data by 1.05 to 1.10 for soils with plasticity index of about 15 (ref. R-5 and R-30). However, based on re-evaluation of the Bjerrum chart by Aas et al. (1986), the Canadian Foundations Manual suggests that the vane test data for clays with PI<20 should not be corrected (ref. R-1 and R-42, and Figure 3-2). The field vane test data (from conventional and Nilcon vane tests) at this site were not corrected for PI.

**Strength Profiles from Cone Penetration Tests:** The undrained shear strength of the silty clay deposit was estimated using the CPT tip resistance,  $Q_t$ , as follows:

$$S_{u\ CPT} = \frac{Q_t - \sigma_{vo}}{N_{kt}}$$

Where:

$S_{u\ CPT}$  is the undrained shear strength estimated from the CPT test;

$Q_t$  is the corrected total cone tip resistance;

$\sigma_{vo}$  is the total vertical stress at the corresponding depth of measurement of the  $Q_t$  value;  
and

$N_{kt}$  is an empirical factor that varies, depending on soil type and test arrangement, typically between 8 and 20.

<sup>1</sup> All figures are included at the end of the report text.

The CPT based  $S_u$  profiles were developed to achieve a general agreement with the nearby Nilcon vane test profiles by modifying the  $N_{kt}$  factor values used to calibrate the CPT strength profiles varied for different segments of the WEP and the soil strata. Thus, a  $N_{kt}$  factor of 14 was used to estimate the undrained shear strength of the clay crust and transition layers. The  $N_{kt}$  factors used for the underlying grey silty clay to clayey silt stratum and the lower clayey silt stratum were 16 and 12, respectively. Figure 3.3 presents the undrained shear strength profiles for WEP segment between Sta. 11+500L and Sta. 12+300L.

**Pre-Consolidation Pressures from Cone Penetration Tests:** The approach used for estimating the pre-consolidation pressures from the estimated  $S_u$  profiles follows the Stress History and Normalized Soil Engineering Properties (SHANSEP) method developed at MIT (Ladd and Foott, 1974, ref. R-30)). The following relationship was used to compute the pre-consolidation pressures:

$$OCR = \frac{\sigma'_p}{\sigma'_{vo}} = \left[ \frac{S_u / \sigma'_{vo}}{S} \right]^{1/m}$$

Where:

- $S_u$  is the undrained shear strength,
- $\sigma'_{vo}$  is the vertical effective stress,
- $\sigma'_p$  is the pre-consolidation pressure (also referred as maximum past pressure),
- $S$  is the normalized strength ratio,  $S_u / \sigma'_{vo}$ , of normally consolidated soil,
- $OCR$  is the overconsolidation ratio, and
- $m$  is an empirically determined exponent, typically varying between 0.7 and 1.0.

Based on plasticity index of the clayey silt to silty clay deposit, values of  $S = 0.18$  and  $m = 0.95$  were chosen to estimate the maximum past pressures from the inferred undrained shear strength profile. The maximum past pressure,  $\sigma'_p$  can then be estimated as:

$$\sigma'_p = \sigma'_{vo} \times \left[ \frac{S_{u,CPT}}{\sigma'_{vo}} \frac{1}{0.18} \right]^{1.05}$$

#### Flat Blade Dilatometer (DMT) Test Data:

DMT tests along WEP were conducted following ASTM D6635-01 (2007). The soil properties from the results of these tests were developed in general accordance with the guidelines layout in ISSMGE, 2001 (ref. R-26), except that the undrained shear strength values for the clay deposits were estimated using the relationship  $S_u = S \sigma'_{vo} (0.5 K_d)^{1.25}$ , where  $S = 0.18$  and  $K_d$  is the horizontal stress index represented by:



$$K_d = (p_0 - u_0) / \sigma'_{vo}$$

Where:

$p_0$  is the corrected instrument lateral pressure reading at zero membrane deformation ('null method')

$u_0$  is the pore water pressure in the soil prior to the blade insertion

The undrained shear strength ( $S_u$ ) profiles inferred from the DMTs were similar with data from the nearby Nilcon tests.

The undrained shear strength ( $S_u$ ), pre-consolidation pressure ( $\sigma'_p$ ), natural water content ( $w_N$ ) and compression index ( $C_c$ ) profiles based on field and laboratory testing from boreholes, CPTs and DMT carried out between Sta. 11+500L and Sta. 12+300L are presented on Figure 3.3. Also included on the figure are  $0.18 \times \sigma'_{vo}$  curve (representing OCR=1) and simplified soil stratigraphic deposits to facilitate correlation of soil properties to the individual soil units. The constant 0.18 for  $S_u/\sigma'_{vo}$  for OCR=1 curve is based on average plasticity of the silty clay to clayey silt stratum and Chandler 1988 relationship (Figure 3-2) (refs. R-11 and R-30).

## 4 Subsurface Conditions

The subsurface conditions described below are based on data gathered in the historic investigations and the current investigation.

The general soil stratigraphy at the site consists of the following successive strata: topsoil and upper granular deposit below the existing ground surface at about elevation 183<sup>2</sup>, an extensive clayey silt to silty clay deposit below about elevation 181 to 183, and a possible discontinuous lower granular deposit below about elevation 153.7 (BH-118), overlying limestone and dolostone bedrock below about elevation 150 m. The thickness of the clayey silt to sandy/silty clay deposit based on the available nearby boreholes is about 30 to 32 m. The bedrock was encountered at depths approximately 32 to 33 m below the ground surface.

### 4.1 Topsoil, and Surficial Fills

A layer of topsoil was encountered at the ground surface in Boreholes TB6-1, HG-MW-3, BH T8-1, BH-118, BH-118A, and BH-7. The thickness of the topsoil was about 0.1 to 0.4 m at these locations. Topsoil was encountered in Borehole TB6-1. The topsoil encountered in Borehole TB6-1 was about 0.1 m thick.

Fill layers were also encountered in Boreholes BH-118 and BH-118A below topsoil. The fills were variable and consisted of silty clay to sand to silty sand and gravel. The fill thickness was about 1.5m at the borehole locations.

### 4.2 Silty Clay to Clayey Silt Stratum

An extensive cohesive silty clay to clayey silt stratum, was encountered directly underlying the topsoil and/or fill deposit. The encountered depth below existing ground surface varied from 0.1 to 2.1 m corresponding to elevation 181.2 to 182.9 m. Based on the gradation, in-situ moisture content and strength characteristics, the stratum may be subdivided into four layers as follows: brown desiccated stiff to hard clay crust, transition zone, upper grey silty clay to clayey silt deposit (referred to hereafter as silty clay), and then a generally coarser lower grey clayey silt deposit (referred to as clayey silt). The natural water content, Atterberg limits, and total unit weights of the clay sub-strata are summarized in Table 4-1 and illustrated in Figure 3.3.

<sup>2</sup> Elevations are in metres and are referred to geodetic datum.

**Table 4-1: Summary of Index Properties (Based on TB6-1 and Nearby Boreholes)**

Property <sup>1</sup>	Clay Crust	Transition	Upper Silty Clay	Lower Clayey Silt
Elevation Range (m)	183 <sup>2</sup> to 178	178 to 175	175 to 163	163 to 151 <sup>2</sup>
Natural Water Content, $w_N$ , %	10 to 23	10 to 18	11 to 38	7 to 35
Liquid Limit, $w_L$ , %	25 to 27	23 to 25	15 to 43	15 to 31
Plastic Limit, $w_P$ , %	13 to 15	13 to 14	12 to 22	11 to 18
Plasticity Index, PI	11 to 14	9 to 12	2 to 19	4 to 15
Liquidity Index, LI	-0.34 to -0.07	0.10 to 0.23	-0.35 to 1.05	-0.31 to 0.93
Unit Weight, $\gamma$ , kN/m <sup>3</sup>	22 <sup>3</sup>	22 <sup>3</sup>	21.4	21

Notes:

1. Index Properties are based on laboratory results from Boreholes: TB6-1, T8-1, HG-MW-3, CV4-1, BH-7, BH-118, BH-115, BH-116, BH-314, BH 14-RW, BH 15-RW, T9-1, TB7-1, TB7-2, TB7-3, CV3-1, CPT 43-RW.
2. Ground surface elevation reported in reviewed studies varies
3. Estimated from boreholes along the project alignment beyond the area of the pedestrian tunnel

As illustrated on Figure 3.3, the undrained shear strength of the silty clay stratum varied with depth generally as follows:

- Crust layer: > 100 kPa
- Transition layer: 80±20 kPa to 70±10 kPa
- Upper silty clay: 70±10 kPa to 60±10 kPa
- Lower clayey silt: ±100 kPa

The stress-strain properties and the effective shear strength properties of the silty clay deposit were based on test results from the pre-bid geotechnical investigations (ref. R-15, R-16, R-17 and R-18). These interpreted trends are supported by published correlations in the literature (Kulhawy and Mayne, 1990, ref. R-30, Leroueil et al., 2001, ref. R-34 and Terzaghi et al., ref. R-41) and were confirmed by the additional investigation and testing.

The compressibility indexes are correlated to natural water content ( $w_N$ , expressed as percent) as illustrated in Figures 4.1 and 4.2 and summarized as follows:

$$C_c = 0.0086w_N - 0.0086$$

$$C_r = 0.11C_c$$

The interpreted representative values used for the silty clay/ clayey silt substrata for the Pedestrian Tunnel TB-6 site are summarized as follows:

**Table 4-2: Summary of Compressibility Properties**

Property	Clay Crust	Transition	Grey Silty Clay ("Upper Clay")	Grey Silty Clay ("Lower Clay")	Clayey Silt ("Upper Silt")	Clayey Silt ("Lower Silt")
Average Natural Water Content, $w_N$ , %	13	15	20	16	16	20
Virgin Compression Index, $C_c$	0.10	0.12	0.16	0.13	0.13	0.16
Recompression Index, $C_r$	0.011	0.013	0.018	0.014	0.014	0.018

The effective shear strength properties applicable to the silty clay to clayey silt stratum were determined from triaxial and direct shear tests performed during the pre-bid and additional geotechnical investigations (Figure 4-3), and also supported by published PI versus  $\phi'$  relationships (ref. R-33 and R-41, Figure 4.3 and Figure 4.4), and are summarized as follows:

Apparent cohesion, $c'$	0 kPa
Angle of internal friction, $\Phi$	30°
Friction angle at critical state, $\Phi_c$	25-26° (*)

(\*) Based on Triaxial tests (ref. R-15)

The modulus of elasticity has been correlated with the average undrained shear strength of the material, published information (ref R-41), and local experience (ref R-18).

$$\text{Undrained Elastic Modulus } E_u = 300 S_u$$

$$\text{Drained Elastic Modulus } E' = 0.9E_u$$

For the portion of the silty clay stratum the empirical relationship were used based on average shear strength profiles for the material, as follows:

**Table 4-3: Summary of Interpreted Elastic Moduli Properties**

Soils Stratigraphy	Elastic Modulus (Undrained), MPa	Poisson's Ratio (Undrained) *	Elastic Modulus (Drained), MPa	Poisson's Ratio (Drained)*
Clay Crust	23	0.49	20	0.35
Transition	20		18	
Upper Silty Clay	17		15	
Lower Silty Clay	16		14	
Upper Clayey Silt	21		18	
Lower Clayey Silt	24		22	

\*-Assumed values

The hydraulic conductivity of the silty clay to clayey silt stratum was interpreted from pore pressure dissipation tests carried out in the CPT probes as well as the laboratory oedometer tests. The hydraulic

conductivity values obtained from previous (2007-09) and additional (2011) investigations are plotted on Figure 4.5.

### 4.3 Lower Granular Deposit

Beneath the silty clay to clayey silt, a deposit of layered sequences of sand, clayey silt, and silty sand and gravel were encountered in the nearest deep borehole, BH-118. This deposit is referred to as lower granular deposit, and is essentially a non-cohesive material comprising silty sand and gravel and varying amount of clay fraction. This layer was encountered around elevation 153.7 in Borehole BH-118. The thickness of the lower granular deposit was approximately 3.4 m at the borehole location. The lower granular deposit had 'N' values ranging from 19 to 100 indicating a medium dense to very dense state of compactness.

### 4.4 Bedrock

Boreholes TB6-1, CV4-1 and HGMW-3 were terminated within the overburden deposits. Boreholes T8-1, BH-118, and BH-7 refused on material considered to be bedrock beneath the lower granular deposit or below the silty clay to clayey silt stratum at about elevation 150.3 to 150.0. The bedrock was light grey, fairly porous, and fine grained limestone bedrock. The Rock Quality Designation (RQD) of the recovered rock cores ranged from 0 to 100 percent, indicating a poor to excellent quality.

### 4.5 Groundwater Conditions

Shallow and deep vibrating wire and standpipe piezometers were installed in selected boreholes to measure the water levels within overburden and bedrock, respectively (Table 4-4). The piezometric levels measured in the clayey silt overburden and the limestone bedrock varied from 180.1 to 181.2 and around 177.4 and 177.6, respectively. The highest piezometric levels within the overburden and the bedrock were recorded at about elevations 181.2 and 177.6, respectively (Table 4-4). These observations suggest a slight downward gradient between the overburden and the bedrock. Nevertheless, given the general prevalence in the Windsor area, occurrence of local artesian condition in bedrock cannot be entirely ruled out.

**Table 4-4: Summary of Measured Water Levels**

Borehole	Ground Surface El, m	Piezometer Type	Screen El, m	Strata Type at Screen Depth	Measured Water level	
					Date	El, m
T8-1	182.8	VWP	172.1	Clayey Silt	Aug. 29, 2011	181.2
			162.2	Clayey Silt	Aug. 29, 2011	179.9
HG-MW-3	182.91	S-Piez	179.9 – 181.7	Clayey Silt & Sand	Oct. 13, 2011	180.63
BH-7	183.17	S-Piez	165 – 169	Clayey Silt	Nov. 14, 2006	180.1
			145.3 – 149.2	Limestone	Nov. 14, 2006	177.6
BH-118	182.66	S-Piez	146.6 – 149.0	Limestone	Jan. 28, 2009	177.40
BH-118A	182.66	S-Piez	172.6 – 174.0	Clayey Silt	Jan. 28, 2009	180.9

Legend: S-Piez Standpipe Piezometer  
VWP Vibrating Wire Piezometer

Perched groundwater is known to accumulate seasonally within the upper deposits of fill, topsoil and granular layers, and within the fissures in the silty clay crust. In periods of wet weather, the perched groundwater levels can rise to near the ground surface.

#### 4.6 Subsurface Gases

The groundwater in the project area, especially within the lower granular deposit and bedrock, is known to contain dissolved hydrogen sulphide ( $H_2S$ ) and methane ( $CH_4$ ) gases that are liberated from the water on exposure to atmospheric pressure.

The  $H_2S$  gas can frequently be detected by odour at concentrations on the order of 0.5 mg/L (ppm) and can be corrosive at concentrations of about 2 to 3 mg/L in the groundwater.

A summary of sampling and testing of the groundwater by Golder (ref. R-16) and the recent investigation, in the boreholes near Pedestrian Tunnel TB-6 is presented in Table 4-5.

**Table 4-5: Summary of Natural Groundwater Chemistry**

Borehole	Surface El, m	Sample El, m	Strata Type at Screen / Sensor Depth	$H_2S$	$CH_4$
				mg/L	µg/L
BH-118	182.66	151.7	Bedrock	2.55	65

Although the  $H_2S$  and  $CH_4$  gases were not detected during the 2011 geotechnical investigation at TB-6 site, their presence cannot be entirely ruled out. Pumping tests were conducted at three locations across the proposed parkway to determine concentration levels of hydrogen sulphide gas in the groundwater of the area. A summary of the results of these tests is provided in Table 4-6.

**Table 4-6: Pumping Tests Data**

Test #	Approximate Location	$H_2S$ Gas Concentration (mg/L)
TOW-1	East of Tunnel T-10A	<0.2
TOW-2	North of Tunnel T-7	20.0
TOW-3	South of Tunnel T-4	7.0

Dissolved methane was also sampled by Golder (ref. R-17) with most samples below detection (<5 µg/L) with the largest values generally measured where artesian conditions occur (up to 485 µg/L). These data are consistent with general water chemistry sampling taken at the end of the pumping tests.

The understanding of the engineering behaviour (related to the impact on design and construction) of the gassy soils is rather limited. In the case of low permeability cohesive soils it is known that these soils may experience rapid drop in undrained shear strength during unloading. Due to the relatively high compressibility of the pore water fluid in gassy soils, the immediate pore water pressure response ( $\Delta U$ ) to total stress changes can be very low. This phenomena leads to reduction in effective stress and hence shear strength (ref. R-24 and R-40). It is, therefore, recommended that the design and construction methodologies should be developed in consideration of the potential presence of these gases (ref. R-14).

## 5 Development of Geotechnical Design

It is understood that the proposed box tunnel structure will be a cast-in-place, one-span, rigid frame box with 4 m inside width and 3.6 m inside height. The invert elevation (i.e., top of the base slab) varies from 179.2 to 179.3 m at the west and east ends of the tunnel, respectively. The general arrangement is shown on Drawing 285380-03-060-WIP1-6601 and RSS walls layout detail on Drawing 285380-03-061-WIP1-6606.

RSS wing walls will be constructed at both ends of the box tunnel structure as shown on Drawing 285380-03-060-WIP1-6601 and 285380-03-061-WIP1-6606. The walls will retain the backfill behind the structure at the end of permanent 2.4H:1V cut slope from the edge of Geraedts Drive pavement near elevation 184 to 1 m below the bottom of the pedestrian tunnel at approximate elevation 178.

### 5.1 Geotechnical Design Criteria and Considerations

The geotechnical design has been completed in compliance with the requirements of the execution version of the Project Agreement Schedule 15-2 Part 2, Article 5 (PA) for the Windsor-Essex Parkway Project. The foundations' design was carried out following the Limit States Design (LS method) based on Load and Resistance Factors (CHBDC, ref. R-9 and CFEM, ref. R-8).

Working Stress Design (WS Method) was employed for global stability of the earthworks, soil mass containing earth retaining structures and the external stability (bearing, sliding and overturning) of the RSS structures. The stability of the soil mass containing the wing-walls is checked for all potential surfaces of sliding and has a minimum factor of safety of not less than 1.3.

### 5.2 Design Soil Properties

The design undrained shear strength ( $S_u$ ) and preconsolidation pressure ( $\sigma'_p$ ) profiles for the silty clay to clayey silt deposit were interpreted from the CPT, DMT and Nilcon vane tests profiles and the laboratory test results from the old and new investigations carried out between Sta. 11+500L and Sta. 12+300L (Figure 3.3).

The  $S_u$  and  $\sigma'_p$  profiles inferred from the CPT and DMT advanced around Pedestrian Tunnel TB-6 are shown in Figure 3.3. Selected typical design values obtained from these profiles and the trends in the east part of the WEP project are summarized in Table 5-1.



**Table 5-1: Summary of Interpreted Design Clay Strength and Consolidation History**

Clay Substratum	Elevation Range, m	Undrained Shear Strength ( $S_u$ ), kPa (*)	Effective Strength Parameters	Preconsolidation Pressure ( $\sigma_p'$ ), kPa (*)	OCR Range
Clay Crust	183 to 178	75 (**)	Cohesion, $c' = 0$ Friction Angle, $\phi = 30^\circ$	600	>7
Transition	178 to 175	75 to 60		600 to 400	7 to 2
Upper Silty Clay	175 to 166	60 to 50		400 to 280	7 to 2
Lower Silty Clay	166 to 163	50 to 57		280 to 310	2 to 1.2
Upper Clayey Silt	163 to 161	57 to 80		310 to 450	2 to 1.2
Lower Clayey Silt	161 to 151	80		450	2 to 1.2

(\*) Varies with depth as illustrated in Figure 3.3

(\*\*) Lower limit from CPT tests to be used in global stability only

The design values of the coefficient of horizontal permeability ( $k_h$ ), the hydraulic conductivity anisotropy ratio ( $A = k_h/k_v$ ) and in-situ void ratios required for the analysis of stress and deformation response of the soils are provided in Table 5-2. The design permeability values are slightly (2 to 5 times) higher than the values interpreted from the field test results (Figure 4.5) and are considered to be within range of precision of the measurements.

**Table 5-2: Summary of Other Interpreted Design Parameters**

Clay Substratum	Horizontal Permeability, cm/sec	Anisotropy ratio, $k_h/k_v$	Initial Void Ratio, $e_0$
Clay Crust	$6.8 \times 10^{-7}$	1	0.44
Transition	$3.9 \times 10^{-7}$		0.42
Upper Silty Clay	$1.1 \times 10^{-7}$		0.60
Lower Silty Clay	$1.1 \times 10^{-7}$		0.62
Upper Clayey Silt	$1.1 \times 10^{-7}$		0.41
Lower Clayey Silt	$1.1 \times 10^{-7}$		0.59

For design purposes the initial groundwater level in the overburden was considered to be at elevation 180.0.

### 5.3 Excavation and Temporary Cut Slopes

The discussion of the temporary slopes in this report relates only to the anticipated subsurface conditions to assist the designer of temporary works and as they affect the design of the tunnel foundation. The shapes and slopes of the temporary excavations shown in this report do not constitute the recommended design of the temporary slopes. The Contractors are fully responsible for the design, construction methods and performance (stability, deformability and deterioration) of the temporary slopes. The Contractors also must ensure that the temporary slopes meet the Project Agreement criteria and the needs to accommodate the construction of the structure as per design.

The excavations are expected to encounter surficial fills, topsoil and water bearing upper granular soils and will be extended into the native stiff clayey silt to silty clay. The anticipated invert of the excavation for box tunnel structure is near elevation 178.2, i.e., about 4.1 to 4.3 m maximum excavation depth (Figure 5.1).

Basal hydrostatic uplift stability was calculated based on the highest measured water level, 181.2 m measured in the silty sand deposit encountered in BH-T8-1 (Table 4-2) and the anticipated deepest excavation depth (elevation 178.2 m). With highest granular deposit encountered at 153.7 m (BH 118), the minimum thickness of the silt-clay layer above the silty sand deposit would be 24.5 m. The calculated factor of safety against hydrostatic uplift was greater than 1.9 based on the weight only of the clay cap.

## 5.4 Concrete Box Tunnel

### 5.4.1 General

All topsoil, disturbed soils and other deleterious materials must be completely removed from the footprint area of the structure foundation. The exposed subgrade should be inspected and upon approval, a subgrade protection layer comprising at least 75 mm of lean concrete over the areas of cast-in-place foundation should be placed the same day as excavated.

The excavations and foundation grades should be inspected in accordance with OPSS 902. Any low areas should be brought to grade with lean concrete fill, or approved soil backfill, as directed by the engineer. Depending on the site conditions, the use of geofabric may be required where soil backfilling is approved for subgrade corrections.

### 5.4.2 ULS Bearing Resistance

A net factored geotechnical resistance of 160 kPa at Ultimate Limit States (ULS) was determined for the native undisturbed silty clay subgrade soils supporting the box tunnel structure near elevation 179.2 and higher.

Due to the culvert embedment after construction, the ULS resistance will increase with the completion of the compacted backfill along the tunnel walls at an approximate rate of 20 kPa for every 1 meter of embedment below the finished grade.

### 5.4.3 ULS Sliding Resistance

**ULS at Sliding:** The factored geotechnical resistance can be determined with the following expression (ref. R-9):

$$H_{ti} = 0.8 A' c' + 0.8 V \tan \delta > H_f$$

Where:

$A'$  = effective contact area of the base ( $m^2$ ).

$c'$  = cohesion = 0 (long-term loading condition)

$c'$  = undrained shear strength = 65 kPa (short-term loading conditions for concrete cast over native silty clay subgrade)

$\delta = 30^\circ$  for foundations cast directly on the native soil, or over lean concrete mat placed on native soils, or granular bedding. (long-term loading condition)

$\delta = 0^\circ$  (short term loading condition)

$V$  = unfactored vertical force (kN)

$H_f$  = factored horizontal load (kN)

Allowance for buoyancy should be made, where applicable.

#### 5.4.4 SLS Resistance and Performance

A net SLS resistance (soil stress increase) of 175 kPa was determined on the basis of an assumed maximum of 25 mm post-construction settlement. Hence, the foundation design is dictated by the more critical short-term ULS condition.

Since the construction of the tunnel involves ground unloading (associated with removal of the existing soil) followed by reloading (new construction), the net soil stress increase is expected to be minimal (current and proposed finished grades are similar with a depth of excavation of approximately 4.3 m) and time-dependent settlement should be less than 25 mm. Assuming the load distribution along the tunnel is relatively uniform, differential settlement between the centre and the ends of the culvert is expected to be less than 15 mm.

All the ground movement and deformations discussed above are estimates based on soil deformation/compressibility properties interpreted from laboratory tests and empirical correlations. Therefore, the reported values are approximate and should be considered only as an indication of the magnitude of the soil response. These estimates should be verified and refined with respect to the actual performance monitoring in the field.

The settlements discussed above do not include deformations caused by seasonal temperature and moisture variations, or deformation related to compression of the backfill materials, which for well compacted fill should be small. In this regard, stringent compaction control should be exercised to minimize the magnitude of backfill compression (see Section 5.6).

### 5.5 RSS Wing Walls

#### 5.5.1 General

The general configurations developed for the typical wing wall at Pedestrian Tunnel TB-6 are shown in Drawings 285360-03-060-WIP1-6601 and 285380-03-061-WIP1-6606. The wing walls comprise RSS founded on a granular pad. These configurations and preliminary dimensions were developed at the maximum section along the wing wall to verify the geotechnical design requirements with respect to (a) the global stability of the soil mass containing the structure and (b) the foundation soil bearing resistances. The design assessments were based on (a) assumed strength and deformation properties of the proprietary components (RSS), which will have to be confirmed by proprietary suppliers, and (b) the assumed external loads and backfill properties. The final design of the abutment may require adjustments based on the proprietary components and structural design.

The properties of the proprietary products used in the geotechnical analyses are described in Table 5-3.

**Table 5-3: Assumed Proprietary Product Properties**

Backfill Material	Unit weight, kN/m <sup>3</sup>	Limit Equilibrium Analyses (Drained)	
		Friction Angle, °	Apparent Cohesion, kPa
RSS with Approved Granular Fill	21	35	50 (*)

(\*) For global stability models only

The properties assumed for the backfill materials are also given in Table 5-4.

**Table 5-4: Assumed Backfill Material Properties**

Backfill Material	Unit weight, kN/m <sup>3</sup>	Limit Equilibrium Analyses	
		Undrained Shear Strength, kPa	Drained Angle of Internal Friction(*), °
Compacted Clay Fill	21	50	30
Approved Granular Fill	21	N/A	32

(\*)  $c' = 0$  kPa

The RSS foundation is to be installed on prepared subgrade (intact native stratum with no disturbance due to construction activities, groundwater inflow, etc., and appropriately protected immediately after excavation to final grade).

Working Stress Design (WS Method) was employed for global stability of the earthworks and soil mass containing earth retaining structures. The stability of the soil mass containing the tunnel abutments was checked for all potential surfaces of sliding and has a minimum factor of safety of 1.3 according to the PA.

Working Stress method was also employed for the external design of the RSS walls.

The following general recommendations are considered applicable:

- All topsoil and other deleterious materials are to be completely removed from the footprint area of the structure so that it is founded directly on the competent native soils.
- Any low areas should be brought to grade using lean concrete fill.
- The base of each wall segment shall be stepped in a manner than ensure a minimum soil cover over native subgrade of 1 m along the length of each wall segment.

### 5.5.2 Global Stability

Based on the arrangement of the retaining walls shown on Drawings 285380-03-060-WIP1-6601 and 285380-03-061-WIP1-6606, the RSS wall heights at both ends of the tunnel are similar. It is anticipated that the RSS wall height will be up to 5.2 m with backfill behind the wall.

Slope stability analyses (Limit Equilibrium) were carried out using SLOPE/W Version 2007 and the Morgenstern-Price method of analysis.

Figures D-1 and D-2 illustrate the stability models for maximum height section of the RSS wing wall (ie. nearest to the tunnel structure). The global stability analyses were carried out for short-term end of construction (EOC) and long-term steady state (LT) loading conditions using the design soil properties discussed in Section 5.2. Surcharge of 12 kPa for short term and long-term model was applied at the top of the ground surface to represent loading from Geraedts Drive. A tension crack was assumed for the undrained condition only.

The calculated factors of safety (FS) exceed 1.8 against global instability of the wing walls, as shown in Appendix D (Figures D-1 to D-2) and are summarized in Table 5-5.

**Table 5-5: Results of Global Stability Analyses**

Model and Loading Condition	Soil Properties	Figure No.	Factor of Safety*
Tunnel Wing Wall – End of Construction	Undrained	D.1	2.94 (2.55)
Tunnel Wing Wall – Long-term Steady State	Drained	D.2	2.02 (1.75)

(\*) Values in parentheses refer to factor of safety for non-circular failure surface.

The design ground water level for the analysis was taken as 181.2.

### 5.5.3 RSS External Stability

The external stability factors of safety against base sliding, overturning about the toe and bearing capacity failures were checked by means of the WS method in accordance with the CFEM guidelines in conjunction with the undrained and drained soils shear strength properties described in Sections 5.2 and 5.5.

#### *Bearing Capacity:*

The following net ultimate bearing capacity values ( $q_{uls}$ ) were determined for the native subgrade soils (at or near elevation 178) at the wing walls for short-term (undrained) and long-term (drained) loading conditions:

- Short-term (undrained): 320 kPa (based on average shear strength of 62 kPa).
- Long-term (drained): 520 kPa based on friction angle of 30° and the minimum wall width of 4 m.

The long-term (drained) bearing resistance of the RSS wing walls was based on a friction angle of 30° and an embedment of at least 1.0 m below finished grade.

#### *Base Sliding:*

The ultimate geotechnical horizontal resistance ( $H_{ri}$ ) can be determined in accordance to the following expression:

$$H_{ri} = A'c' + V \tan \delta > 1.5 H_f$$

Where:

$A'$  (m<sup>2</sup>) = effective contact area of the base;  
 $c'$  (kPa) and  $\delta$  (°) = defined at Section 5.4.3  
 $V$  (kN) = vertical force (kN); and  
 $H_f$  (kN) = design horizontal load.

Based on geotechnical analyses discussed in Section 5.5, tentative wing wall configurations and dimensions summarized in Table 5-6 were determined. The wing wall configurations and dimensions indicated in these analyses are preliminary (e.g., the indicated width of the RSS is the minimum width) and are to be finalized by proprietary suppliers. The design of the abutments is to be developed in consultation with the proprietary component suppliers.

**Table 5-6: Tentative Wingwall Dimensions**

Wingwall Location	RSS Structure (Width × Height) & Length <sup>(1)</sup> , m
Inner Wall Section (closest to tunnel)	4.5 × 5.2 × 4.0
Mid Wall Section	3.5 × 3.9 × 4.0
Outer Wall Section	2.5 × 2.2 × 4.0

<sup>(1)</sup> Measured along the wing wall (perpendicular to the tunnel alignment)

The RSS supplier may require wider structures to meet the internal design requirement.

## 5.6 Backfilling

Behind the concrete box tunnel wall and RSS wing walls, bedding and backfill materials should meet the requirements of OPSS 422, OPSS 902 and the Canadian Highway Bridge Design Code CAN/CSA-S6-06 (CHBDC). Appropriate frost tapers will need to be provided if the associated backfill materials are not compatible with the native soils.

The backfill should be compacted in maximum 200 mm thick loose lifts in accordance with SP 105S 10. Longitudinal drains should be installed to provide positive drainage of the backfill. Other aspects of the abutment backfill requirements with respect to subdrains and frost taper should be in accordance with OPSD 3101.150 and 3190.100.

Heavy compaction equipment should not be used immediately adjacent to the walls of the structure as per the CHBDC and OPSS 501. Effects of backfill compaction activities should be simulated as live load over and above the static lateral earth pressure for structural design in accordance with Section 6.9.3 in the CHBDC.



Earth pressures on wing walls may be calculated on the basis of the parameters given in Table 5-7. Compactable Group III soils may be used as general backfill within approved areas.

In the case of sloping backfill surface, the coefficients in this table should be modified based on the following equations:

$$K_a = \left( \frac{\cos \phi}{1 + \sqrt{\frac{\sin \phi \cdot \sin(\phi - \beta)}{\cos \beta}}} \right)^2 \quad (\text{Eq. 5.7})$$

$$K_0 = (1 - \sin \phi)(1 + \sin \beta) \quad (\text{Eq. 5.8})$$

$$K_p = \left( \frac{\cos \phi}{1 - \sqrt{\frac{\sin \phi \cdot \sin(\phi + \beta)}{\cos \beta}}} \right)^2 \quad (\text{Eq. 5.9})$$

Where:  $\phi$  = Friction angle of backfill material,

$\beta$  = Slope of the backfill surface.

**Table 5-7: Soil Parameters for Earth Pressure Calculations**

Soil Parameter	Group I Soils	Group II Soils	Group III Soils
Fill Unit Weight, kN/m <sup>3</sup>	22	21	20.5
Friction angle, (°)	33-35	29-32	22-30
Coefficients of Static Lateral Earth Pressure:			
'Active' or Unrestrained, $K_a^{(*)}$	0.27 to 0.30	0.31 to 0.35	0.33 to 0.45
'At Rest' or Restrained, $K_0^{(*)}$	0.43 to 0.46	0.47 to 0.52	0.50 to 0.62
'Passive', $K_p^{(*)}$	3.3 to 3.7	2.9 to 3.2	2.2 to 3.0

(\*)Values are given for level backfill and ground surface behind the wall. The coefficients of lateral earth pressure should be adjusted if there is sloping ground at the back of the wall.

Note: Compacted to > 95% Standard Proctor maximum dry density.

Legend:

- Group I Soils: Coarse grained soils (e.g., Granular A and B Type 2).
- Group II Soils: Finer grained than Group I noncohesive soils (e.g., Granular B Type1, pit run, etc).
- Group III Soils: Finer grained soils (e.g., approved site generated silty clay)



## 5.7 Flood Events

Given that the deepest TB-6 excavation level is approximately 178.2 and the estimated elevations of 177.4 and 177.7 for the 100-year and regional flooding events at Pump Station 5 (based on Highway Flood Hazard Analysis<sup>3</sup>) in the vicinity of TB-6, respectively, flooding of the pedestrian tunnel at TB-6 is not anticipated.

## 5.8 Permanent Cut Slope Stability

The undrained and drained analysis for the proposed 2.4:1 V cut slope is provided in Figures D-3 and D-4. The analysis model results are summarized as follows:

**Table 5-8: Results of Global Stability Analyses**

Model and Loading Condition	Soil Properties	Figure No.	Factor of Safety
Trench – During Construction	Undrained	D-3	3.08 (2.79)
Trench – Long-term Drained Slope	Drained	D-4	1.62 (1.43)

(\*) Values in parentheses refer to factor of safety for non-circular failure surface.

<sup>3</sup> HMM document no. 285380-70-126-0010, Rev.0.

## 6 Other Geotechnical Recommendations

### 6.1 Construction Dewatering

The design of the dewatering system should comply with the OPSS 517 and 518 provisions.

Due to the relatively low permeability of the silty clay deposit, groundwater seepage is anticipated to be minor, which should be controllable by conventional temporary dewatering methods.

Runoff and seepage into the excavations from perched groundwater from the fill, existing and abandoned utility trenches, and upper granular layers should also be anticipated. In adverse conditions, the runoff and seepage from perched groundwater can be significant. Provision should be made to deal with the seepage by pumping from properly filtered sumps located within the excavation.

It is anticipated that piping of fine granular materials from embedded seams and at the granular/clay interface will occur. In this area, blanketing of the excavation slopes with a geotextile and free draining granular material may be required to prevent the loss of ground.

Accordingly, provision should be made to prevent runoff and piping erosion of the slope surface by cut-off drains and/or blanketing of the excavation slopes with a geotextile and free draining granular material. The seepage flow should be directed to collection sumps by temporary drainage ditches properly sized, filtered and lined to accommodate the flow rates.

All surface water should be directed away from all open excavations.

### 6.2 General Construction Requirements

The anticipated construction conditions in this report are discussed only to the extent of their potential influence on the design decisions. References to construction methods are not intended to be the suggestions or directions on the construction methodologies. Contractors should be aware that the data presented in this report and their interpretations may not be sufficient to assess all factors that may affect the construction.

The Contractor is fully responsible for the design, construction methods and performance (stability, deformability and deterioration) of the temporary slopes. The Contractor also must ensure that the temporary slopes meet the Project Agreement criteria and the needs to accommodate the construction of the structure as per design.

The following recommendations and comments are considered applicable:

- All excavation works should be carried out in accordance with the guidelines outlined in Occupational Health and Safety Act (OHSA) and Ontario Provincial Standard Specification (OPSS) 902. The native undisturbed soils may be classified as Type 3 soils. The excavations below the original ground levels may intersect water bearing backfill within trenches of active and/or abandoned utilities. In these cases, Type 4 soil conditions may occur and should be addressed accordingly.

- The silty clay soils at the project site are highly susceptible to disturbance and rapid deterioration when exposed to elements, groundwater inflow, weathering and/ or subjected to direct construction traffic.
- Temporary slopes, permanent slopes, and subgrade areas must be appropriately protected at all times against surface erosion due to runoff, desiccation, freeze-thaw effects, etc.
- To protect the integrity of subgrade for foundations and pavements, the final excavation lift above the design elevation should not be less than 500 mm and should be carried out only when the contractor is ready to prepare and cover the subgrade with the materials specified in the design. The subgrade should be covered the same day the final excavation is exposed and approved. No construction traffic should be permitted over subgrade without approved protective covers.
- The excavation of the final soil layer above the design subgrade is to be carried out using buckets equipped with smooth lips. Once exposed, the subgrade must be immediately inspected. Upon approval, the subgrade should be immediately protected; depending on the type of construction, geofabrics, granular mats, a skim coat of lean concrete protection (mud mat), etc. should be used.
- Regular inspection of the condition of the temporary slopes should be carried out by qualified personnel for signs of distress or instability and appropriate mitigation measures should be implemented.

### 6.3 Corrosion Potential

A series of pH, Redox Potential, Resistivity, Sulphide, and Sulphate tests were carried out on a sample from Borehole TB6-1 and samples from nearby boreholes. Table 6-1 provides the results of these analyses that could be used to assess the potential for corrosion on concrete:

**Table 6-1: Results of Analytical Testing on Soils**

Location of Soil Samples	Depth of Soil Sample, m	pH	Redox Potential, mV	Resistivity, ohm.cm	Sulphide, mg/kg	Sulphate, mg/kg
Borehole TB6-1 (SA#10, L1030731-1)	9.4	7.86	125	3700	<0.2	100
Borehole CV4-1 (SA#7, L1059690-1)	5.6	7.87	209	2890	<0.2	244
Borehole T8-1 (SA#6, L1035570-1)	3.8	7.84	100	4670	<0.2	112

The reported results of laboratory testing indicate that based on CSA A23.1, concrete in contact with the tested soil material would have a negligible degree of exposure to sulphate attack.

Based on the measured electrical resistivity, pH, redox potential, sulphide contents etc., the soil would be considered to have a potential for corrosion to buried metallic elements

A corrosion specialist should review the test results and provide recommendations to address corrosion concerns.

## 6.4 Construction Quality Control

To ensure that construction is carried out in a manner consistent with the intent of the recommendations set forth in this report, a construction quality control program, including geotechnical inspection, testing and instrument monitoring, should be developed and implemented throughout the construction phase. In addition, related laboratory testing should be carried out in conjunction with the fieldwork to monitor compliance with the various materials and project specifications.

## 6.5 Instrumentation and Monitoring

As mentioned earlier in Section 5.3, a program of site instrumentation and monitoring of the temporary works during construction should be implemented by the Contractor in addition to the limited instrumentation already installed during the geotechnical investigation (Table 4.4).

Details and recommendations for additional instrumentation, monitoring program, as well as guidelines for alert levels, interpretation and contingencies are provided in a separate report, 285380-04-118-0001.

The Contractor is responsible for planning, installation and maintenance of instrumentation as well as the completion of monitoring of the response of the excavations (ground movement) during construction. Detailed plans and procedures should be submitted to HMQ for approval at least 3 month prior to commencement of the monitoring of the works.

Monitoring is required to check the safety of the work, assess the effects of construction on surrounding ground and existing facilities, evaluate design assumptions, and refine estimates of future performance.

## 7 Limitations of Report

The work performed in this report was carried out in accordance with the Standard Terms and Conditions made part of our contract. The conclusions and recommendations presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.

This report presents the subsurface soil and groundwater conditions inferred from geotechnical investigation and geotechnical design of the structure mentioned in the report. The report was prepared with the condition that the structural and other designs of the WEP will be in accordance with applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practices. Further, the recommendations and opinions expressed in this report are only applicable to the proposed project as described within AMEC's report.

There should also be an ongoing liaison with AMEC during both the design and construction phases of the project to ensure that the recommendations in this report have been interpreted and implemented correctly. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of this project, AMEC should be contacted immediately.

The conclusions and recommendations given in this report are based on data presented in the pre-bid geotechnical investigation reports and information determined at the test hole locations during the additional investigation carried out for the geotechnical design work. The data obtained from the pre-bid investigations (carried out by others) was assumed to be valid and applicable.

The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated.

The soil boundaries indicated have been inferred from non-continuous sampling, observations of drilling resistance, Nilcon vane, CPT and DMT probing. The boundaries typically represent a transition from one soil type to another and are not intended to define exact planes of geological change. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. Thus, unsuitable foundation soils may be encountered at the foundation grade requiring extra sub-excavations, subgrade improvement, and/or changes to the design. It is important that the AMEC geotechnical design engineer be involved during construction throughout the WEP project site to confirm that the subsurface conditions do not deviate materially from those encountered in test holes, and that any material deviations, if encountered, do not adversely affect the geotechnical design.

The stability analyses assumed a certain sequence of the construction; if different construction approaches are considered the geotechnical design will have to be reviewed. The calculated factors of safety assume strict adherence to good construction practices with respect to the protection of the exposed slopes.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that AMEC be engaged during the final design and construction stages to verify that the design and construction are consistent with AMEC's recommendations.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the structural and other designers and constructor. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of the surficial topsoil and the clay crust layer, the presence of artesian conditions and exsolved natural gases, and the strength of the silty clay stratum may vary markedly and unpredictably. The constructor should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. The work presented in this report has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were surveyed and provided by AMICO. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

## 8 Closure

The geotechnical report for Pedestrian Tunnel TB-6 was prepared by Mr. Ganan Nadarajah, P.Eng. and reviewed by Dr. Dan Dimitriu, P.Eng. Mr. Matt Oldewening, P.Eng., managed the geotechnical investigation. Mr. Brian Lapos, P.Eng., is the project manager, who also provided the senior review of the report.

The cooperation received from Ms. Biljana Rajlic, P.Eng. and Mr. Philip Murray, P.Eng. of Hatch Mott McDonald and Mr. Daniel Muñoz, P.Eng. of PIC during the design study is gratefully acknowledged.

Yours truly,

**AMEC Environment & Infrastructure**  
**a Division of AMEC Americas Limited**



Ganan Nadarajah, M.A.Sc., P.Eng.  
Geotechnical Engineer



Dan Dimitriu, Ph.D., P.Eng.  
Associate Geotechnical Engineer  
(Project Lead Designer)



Brian Lapos, M.Sc., P.Eng.  
Geotechnical Engineer  
(Project Manager)



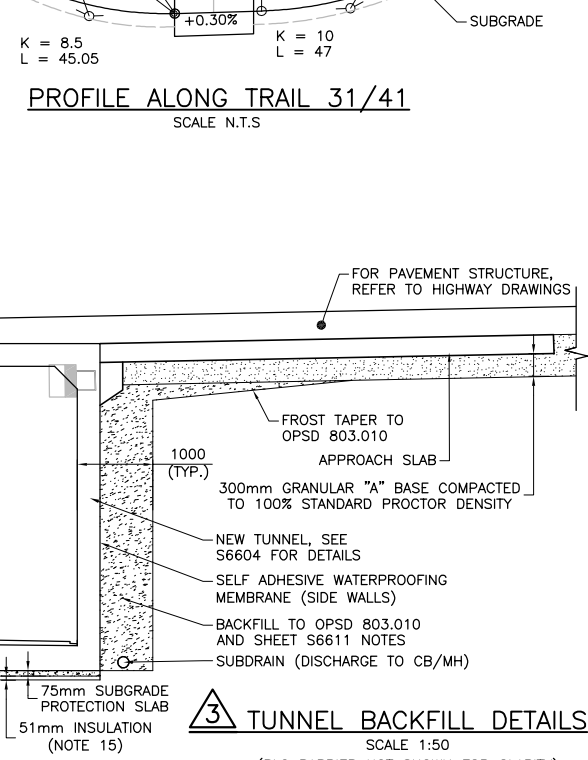
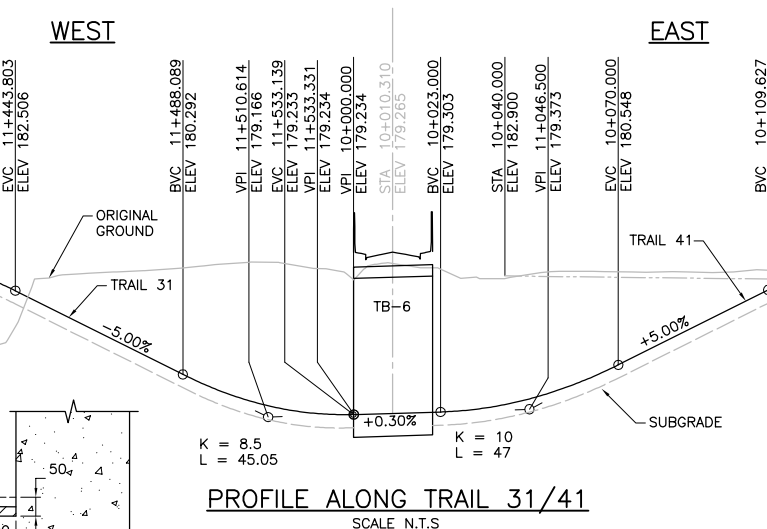
## 9 References

- R-1. Aas, G., Lacasse, S., Lunne, T. and Hoeg, K., 1986, Use of in situ tests for foundation design on clays. Proc. ASCE Spec. Conf. In Situ '86, ASCE GSP 6, 1-30.
- R-2. American Water Works Association, 2005, ANSI/AWWA C105/A21.5-05 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- R-3. Barton, N. R., Lien, R. and Lunde, J., 1974. Engineering Classification of Rock Masses for the Design of Tunnel Support, Rock Mech. 6(4), 189-239.
- R-4. Bhushan, Kul, Amante, Carlos V. and Saaty, Ramzi, 2000, Soil improvement by precompression at a tank farm site in Central Java, Indonesia, Feb. 14.
- R-5. Bieniawski, Z.T., 1976. Rock mass classification in rock engineering. In exploration for rock engineering, Proc.. of the Symp. on Exploration for Rock Engineering (ed. Z.T. Bieniawski) A.A. Balkema, Rotterdam, 1, 97-106. Cape Town.
- R-6. Bjerrum, L. 1972, Embankments on soft ground: SOA Report. Proc. Specialty Conference on Performance of Earth and Earth-Supported Structures, ASCE, Purdue, 2, 1-54.
- R-7. Campanella, R.G. and Howie, J.A., 2005, Guidelines for the Use, Interpretation and application of seismic piezocone test data, A Manual on Interpretation of Seismic Piezocone Test Data for Geotechnical Design, June.
- R-8. Canadian Geotechnical Society, 2006, Canadian Foundation Engineering Manual (CFEM), 4th Edition.
- R-9. Canadian Standard Association, 2006, Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-06 S6.1.06.
- R-10. Canadian Standard Association, 2009, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete CAN/CSA-A23.
- R-11. Chandler, R.J., 1988, The in-situ measurement of the undrained shear strength of clays using the field vane: SOA paper. Vane Shear Strength Testing in Soils Field and Laboratory Studies, ASTM STP 1014, 13-44.
- R-12. Demers, D. and Leroueil, S., 2002, Evaluation of preconsolidation pressure and the overconsolidation ratio from piezocone tests of clay deposits in Quebec. Canadian Geotechnical Journal, 39(1), 174-192.
- R-13. Department of the Navy, 1986, Foundations and Earth Structures – Design Manual 7.2, NAVFAC DM-7.2, Naval Facilities Engineering Command.
- R-14. Dittrich, J.P., Rowe, R.K. Becker, D.E. and Lo, K.Y., 2010, Influence of ex-solved gases on slope performance at the Sarnia approach cut to the St. Clair Tunnel, Canadian Geotechnical Journal, 47, 971-984.
- R-15. Golder Associates Ltd., 2007, Preliminary foundation investigation and design report, Detroit River International Crossing Bridge Approach Corridor, Geocres No. 40J6-18, October.

- R-16. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Geotechnical Data Report, Geocres No. 40J6-27, June.
- R-17. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Subsurface Conditions – Baseline Report, Geocres No. 40J6-28, June.
- R-18. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Subsurface Conditions – Interpretation Report, Geocres No. 40J6-28, Revision December.
- R-19. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Geotechnical Data Report, Addendum No. 1 – Soil Chemistry Data, Geocres No. 40J6-27, February.
- R-20. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Geotechnical Data Report, Addendum No. 2 – In Situ Cross Hole and Vertical Seismic Profile Testing, Geocres No. 40J6-27, March.
- R-21. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Geotechnical Data Report, Addendum No. 3 – Supplementary Cone Penetration Testing, Geocres No. 40J6-27, February.
- R-22. Golder Associates Ltd., 2009, Windsor-Essex Parkway, Geotechnical Data Report, Addendum No. 4 – Supplementary Geotechnical Investigation, March.
- R-23. Grozic, J.L., Nadim, F, and Kvalstad, T.J., 2005, On the undrained shear strength of gassy clays, Computers and Geotechnics, Elsevier, 483-490.
- R-24. Grozic, J.L., Robertson, P.K., and Morgenstern, N.R., 1999, The behaviour of loose gassy sand, Canadian Geotechnical Journal, 36, 482-492.
- R-25. Hudec, P.P., 1998, Geology and Geotechnical Properties of Glacial Soils in Windsor.
- R-26. ISSMGE Committee TC16, 2001, The Flat Dilatometer tests (DMT) in soil investigations Report, by the International Conference on In situ Measurements of Soil Properties, Bali, Indonesia.
- R-27. International Society for Rock Mechanics (ISRM), 1978. Suggested methods for the quantitative description of discontinuities in rock masses. Int. J Rock Mech. Min. Sci. & Geomech. Abstr. 15, 319-368.
- R-28. Kenney, T.C., 1959, Discussion of Geotechnical Properties of Glacial Lake Clays, by T.H. Wu, Journal of the Soil Mechanics and Foundations Division, A SCE, Vol. 85, No. SM 3, PP. 67 – 79.
- R-29. Kulhawy, F.H. and Mayne, P.W., 1990, Manual on Estimating Soil Properties for Foundation Design, Report EPRI-EL6800, Palo Alto, CA, Electric Power Research Institute.
- R-30. Ladd, C.C., and Foott, R. 1974, New design procedure for stability of soft clays, Journal of the Geotechnical Engineering Division, 100(GT7), 763-786.
- R-31. Ladd, C.C., Foott, R., Ishihara, K., Schlosser, F., and Poulos, H.G. 1977, Stress-deformation and strength characteristics: SOA report. Proc., 9th Int. Conf. on Soil Mechanics and Foundation Eng., Tokyo, 2, 421-494.
- R-32. Ladd, Charles C. and DeGroot, Don J., 2004, Recommended practice for soft ground site characterization: Arthur Casagrande Lecture, 12th Pan-American Conference on Soil Mechanics and Geotechnical Engineering, MIT Cambridge, MA USA, June 22-25, 2003, Revised May 9.

- R-33. Leroueil, S., Magnan, J-P., and Tavenas, F., 1990, Embankments on Soft clays, Ellis Horwood.
- R-34. Leroueil, S., Demers, D., and Saihi, F., 2001, Considerations on stability of embankments on clay, Soils and Foundations, Japanese Geotechnical Society, Vol. 41, No. 5, 117-127, Oct.
- R-35. Lo, K.Y. and Hinchberger, S.D., 2006, Stability analysis accounting for macroscopic and microscopic structures in clays, Keynote Lecture, Proceeding 4th International Conference on Soft Soil Engineering, Vancouver, Canada, pp 3-34, Oct. 4-6.
- R-36. Lunne, T., Robertson, P.K., and Powel, J., 1997, Cone Penetration Testing in Geotechnical Practice.
- R-37. Ministry of Transportation Ontario, 1990, Pavement Design and Rehabilitation Manual, SDO-90-01.
- R-38. National Highway Institute, Federal Highway Administration, November 2009, Design of Mechanically Stabilized Earth Walls and Reinforced Walls and Reinforced Soil Slopes – Volume I, FHWA-NHI-10-024.
- R-39. Quigley, Robert M., 1980, Geology, mineralogy, and geochemistry of Canadian soft soils: a geotechnical perspective, National Research Council of Canada, Canadian Geotechnical Journal, Vol. 17, pp. 261-285.
- R-40. Sobkowicz, J.C. and Morgenstern, N.R., 1984, The undrained equilibrium behaviour of gassy sediments, Canadian Geotechnical Journal, Vol. 21, pp. 439-448.
- R-41. Terzaghi, K., Peck, R.B., and Mesri, G., 1990, Soil Mechanics in Engineering Practice, John Wiley and Sons, NY.
- R-42. Windsor-Essex Mobility Group, 2010, Design Submission, Section 5.1.3 – Geotechnical Design.
- R-43. Wyllie, D.C., 1999, Foundations on Rock, 2nd edn, Taylor and Francis, London, UK, 401 pp.

## Drawings



GENERAL NOTES:		Phase 1
		IFC
1.	CLASS OF CONCRETE 30MPa, EXCEPT AS NOTED.	
2.	CLEAR COVER TO REINFORCING STEEL BOTTOM OF TOP SLAB 50±10; BOTTOM OF BOTTOM SLAB 100±25; REMAINDER 70 ± 20 UNLESS OTHERWISE NOTED.	
3.	REINFORCING STEEL TO BE GRADE 40W, UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH PREFIX 'C' DENOTE COATED BAR.	
4.	LEGEND ALT DENOTES ALTERNATE IF DENOTES INSIDE FACE TOC TOP OF CONCRETE.	OF DENOTES OUTSIDE FACE EF DENOTES EACH FACE EOP EDGE OF PAVEMENT
5.	MAXIMUM FILL HEIGHT OVER TUNNEL 0.6 m.	
6.	SOIL BEARING RESISTANCES: TUNNEL: ULS=160KPa, SLS=175KPa (ESTIMATED MAX SETTLEMENT 25mm). RSS WALLS: NET ULTIMATE BEARING CAPACITY=320KPa (SHORT TERM) AND 520Kpa (LONG TERM).	
7.	WATERPROOF TUNNEL TOP SURFACE TO OPSP 3370.100 AND OPSS 914. EXTEND PROTECTION BOARD 1000mm ONTO APPROACH SLABS. FOR REMAINDER, APPLY SELF ADHESIVE WATERPROOFING MEMBRANE (MEL-ROL OR APPROVED EQUIVALENT) TO SIDE WALLS.	
8.	REFER TO LANDSCAPE CONSTRUCTION DRAWINGS AND HIGHWAY NEW CONSTRUCTION DRAWINGS FOR FENCING DETAILS AND LAYOUT, INCLUDING RIGHT OF WAY FENCE, SECURITY FENCE, NOISE WALLS, LANDSCAPE AND TRAIL BARRIERS.	
9.	FOR ALL HIGHWAY WORKS REFER TO HIGHWAY NEW CONSTRUCTION DRAWINGS PHASE 1.	
10.	FOR ALL ELECTRICAL AND ATMS WORKS REFER TO ELECTRICAL AND ATMS NEW CONSTRUCTION DRAWINGS.	
11.	FOR ALL UTILITY WORKS REFER TO UTILITY NEW CONSTRUCTION DRAWINGS.	
12.	FOR INFORMATION ON EXISTING PAVEMENT AND INFRASTRUCTURE REFER TO HIGHWAYS REMOVAL DRAWINGS AND GENERAL NOTES PROVIDED WITHIN HIGHWAYS REMOVAL DRAWING PACKAGE.	
13.	FOR TUNNEL AESTHETIC TREATMENTS REFER TO AESTHETIC TREATMENTS PACKAGE.	
14.	ALL GRATES TO BE BICYCLE SAFE IN DESIGN AND ORIENTATION.	
15.	RIGID FOAM INSULATION TO BE STYROFOAM HIGH LOAD 60 OR APPROVED EQUIVALENT.	
16.	EARTH SLOPE TO TRANSITION TO 2:1 AT RSS WALLS OVER A DISTANCE OF 10m. REFER TO LANDSCAPE CONSTRUCTION DRAWINGS FOR SLOPES BEYOND TRANSITION ZONE.	
17.	REFER TO TRAILS DRAWINGS FOR TUNNEL PORTAL CRASH PROTECTION BARRIER DETAILS.	

## CONSTRUCTION NOTES:

1. CONTRACTOR IS FULLY RESPONSIBLE FOR THE DESIGN, CONSTRUCTION METHODS AND PERFORMANCE OF THE TEMPORARY SLOPES AND WORKS. EXCAVATED CLAY SURFACES ARE SUSCEPTIBLE TO DETERIORATION AND EXPERIENCE DEFORMATIONS AND INSTABILITY. THEY ARE TO BE APPROPRIATELY PROTECTED, REGULARLY INSPECTED, AND TREATED AS REQUIRED.
2. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF TUNNEL KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
3. SUPPORTS FOR REINFORCING STEEL SHALL BE AS PER OPSD 3329.100 ON FORMED SURFACES. ON NON-FORMED SURFACES, CONCRETE BLOCKS (MIN. 20 MPa) SHALL BE USED.
4. ROOF SLAB SHALL NOT BE CAST UNTIL CONCRETE STRENGTH IN WALLS HAS REACHED 25 MPa. 20MPa CONCRETE SUBGRADE PROTECTION SLAB TO BE PLACED AFTER APPROVAL OF SUBGRADE BY GEOTECHNICAL ENGINEER.
5. ALL TOPSOIL, DISTURBED SOILS, AND OTHER DELETERIOUS MATERIALS MUST BE COMPLETELY REMOVED FROM THE FOOTPRINT AREA OF THE STRUCTURE FOUNDATION. CORRECT DEFICIENT SUBGRADE AS DIRECTED BY GEOTECHNICAL ENGINEER WITH APPROVED GRANULAR MATERIAL AND COMPACT TO MIN. 95% PROCTOR DENSITY PRIOR TO PLACEMENT OF CONCRETE BASE SLAB.
6. SUBGRADE MUST BE PROTECTED AGAINST FREEZING AT ALL TIMES UNTIL COMPLETION OF BACKFILLING.
7. CONTROL JOINT POSITIONS ARE SUGGESTED LOCATIONS TO CONTROL UNWANTED CRACKING CAUSED BY STRUCTURE CONTRACTION.

## RSS WALL GENERAL NOTES:

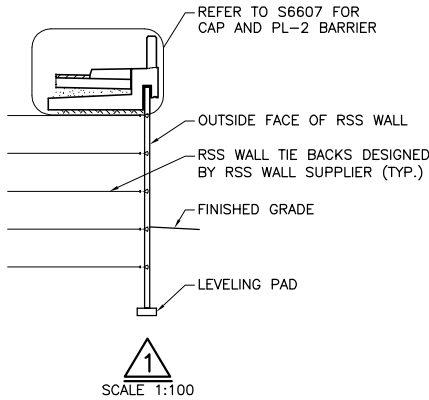
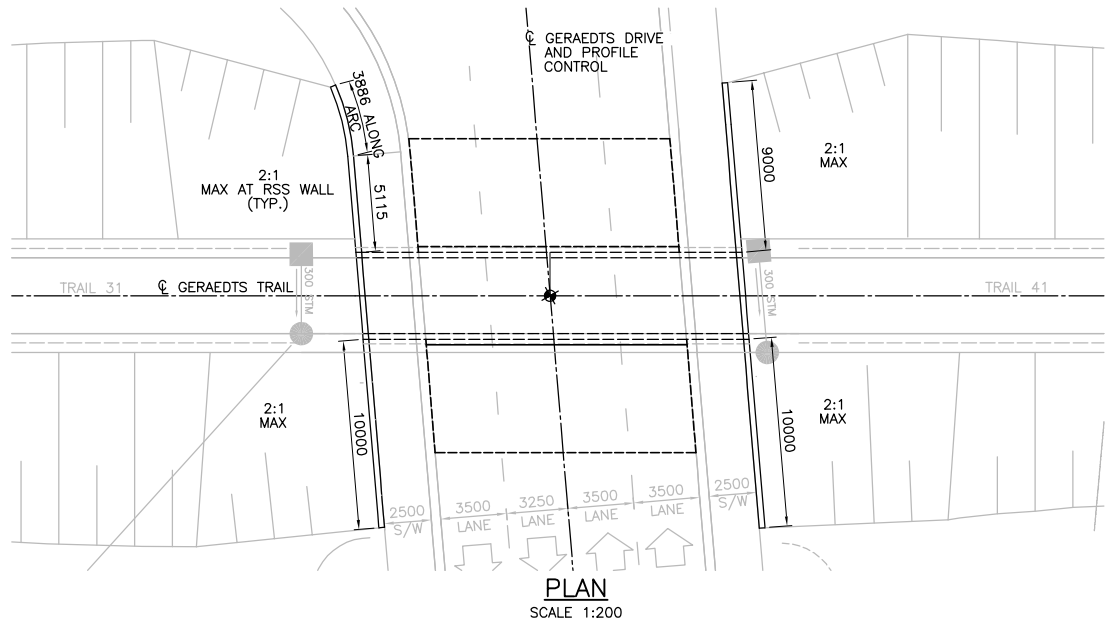
1. APPROVED RSS WALL SUPPLIER TO REFER TO UTILITIES NEW CONSTRUCTION DRAWINGS AND CONFIRM LOCATION OF ALL UTILITIES. RSS WALL DESIGN SHALL ACCOUNT FOR ALL INTERFERENCE WITH UTILITIES.
2. RSS WALL SHALL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE "MTO RSS DESIGN GUIDELINES" AND SPECIAL PROVISIONS SP599S22 AND SP599S23. SELECT RSS TYPE FROM MTO DSM LISTS.
3. THE FACTOR-OF-SAFETY AGAINST EXTERNAL MODES OF FAILURE FOR RSS WALLS SHALL BE AS PER CANADIAN FOUNDATION ENGINEERING MANUAL (CFEM).
4. REFER TO DOCUMENT 285380-72-126-0012 'TECHNICAL MEMO OF AESTHETIC TREATMENT OF PEDESTRIAN TUNNEL WALLS AT TB-6', LATEST ISSUE, FOR AESTHETIC TREATMENT DETAILS.
5. RETAINED SOIL SYSTEM SHALL HAVE THE FOLLOWING ATTRIBUTES:

GEOMETRY:	VERTICAL
APPLICATION:	WALL/SLOPE
PERFORMANCE:	HIGH

## APPLICABLE STANDARD DRAWINGS:

OPSD 803.010	BACKFILL AND COVER FOR CONCRETE CULVERTS
OPSD 3370.100	DECK WATERPROOFING, HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD DETAILS
OPSD 3941.200	FIGURES IN CONCRETE, SITE NUMBER AND DATE, LAYOUT JOINTS, CONCRETE EXPANSION AND
OPSD 3950.100	CONSTRUCTION, ON STRUCTURE

REVISIONS									
	17-DEC-12	0	CRD	ISSUED FOR CONSTRUCTION					
	DATE	REV.	BY	DESCRIPTION					
	DESIGN	CRD	CHK	JF	CODE	CAN/CSA	S6-06	LOAD	CL 625-ONT
DRAWN	RN	CHK	BR	SITE	6-621		DATE	1-MAR-12	



# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

**Parkway  
Infrastructure  
Engineers**



Windsor-Essex  
Parkway Project  
RFP No. 09-54-1007



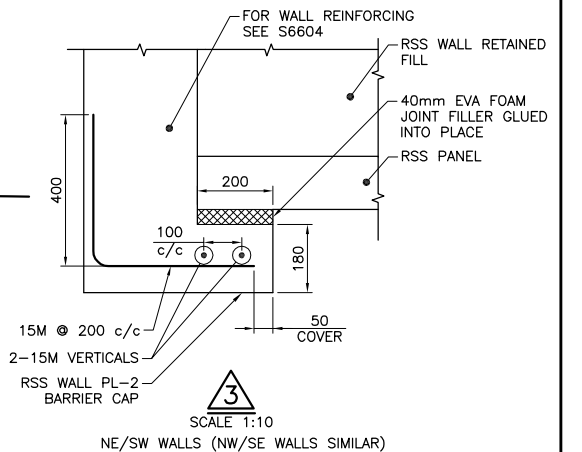
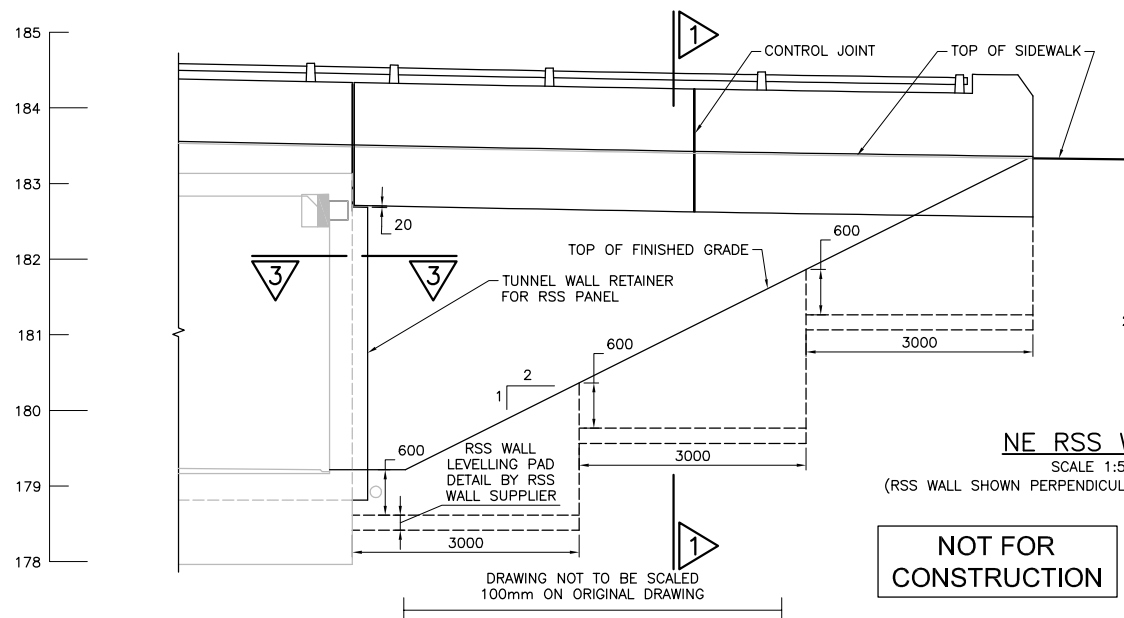
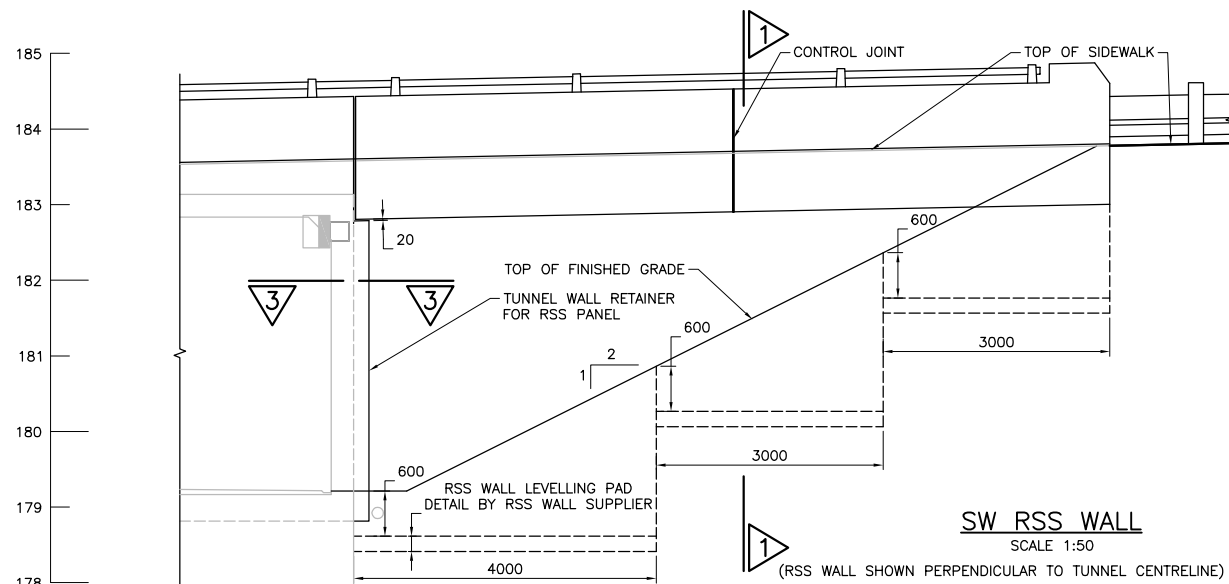
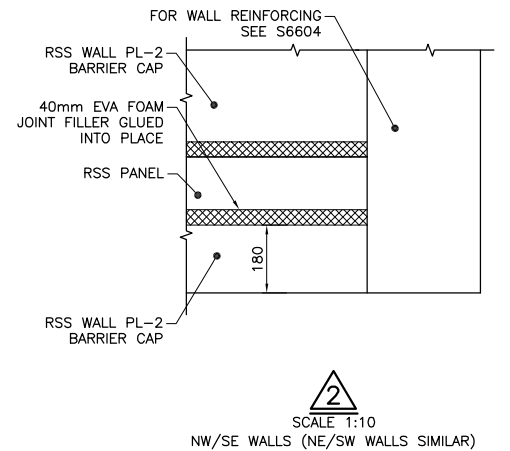
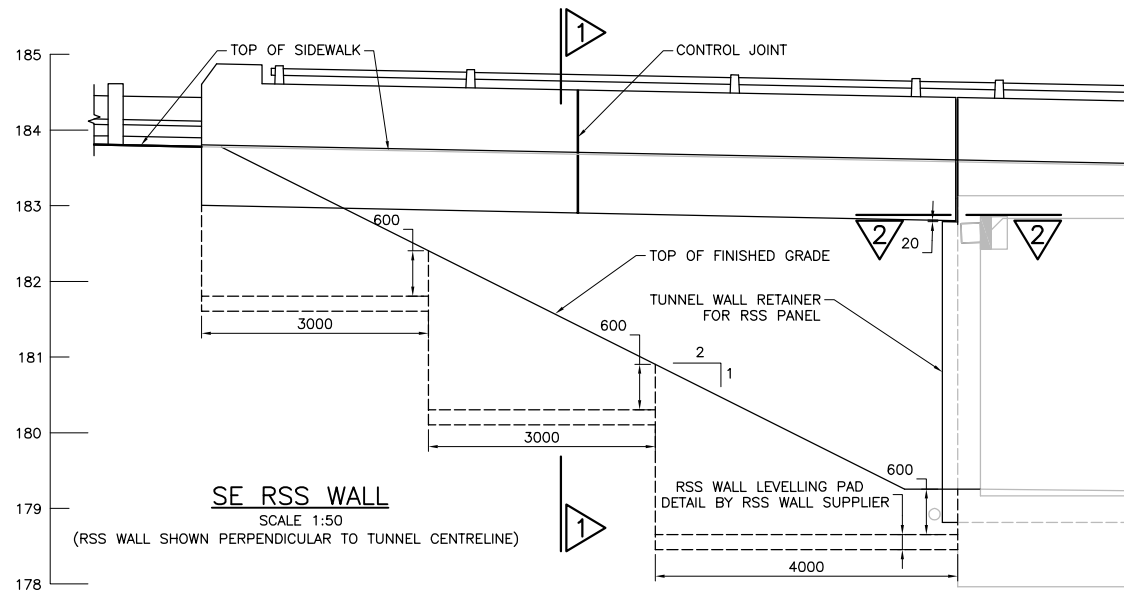
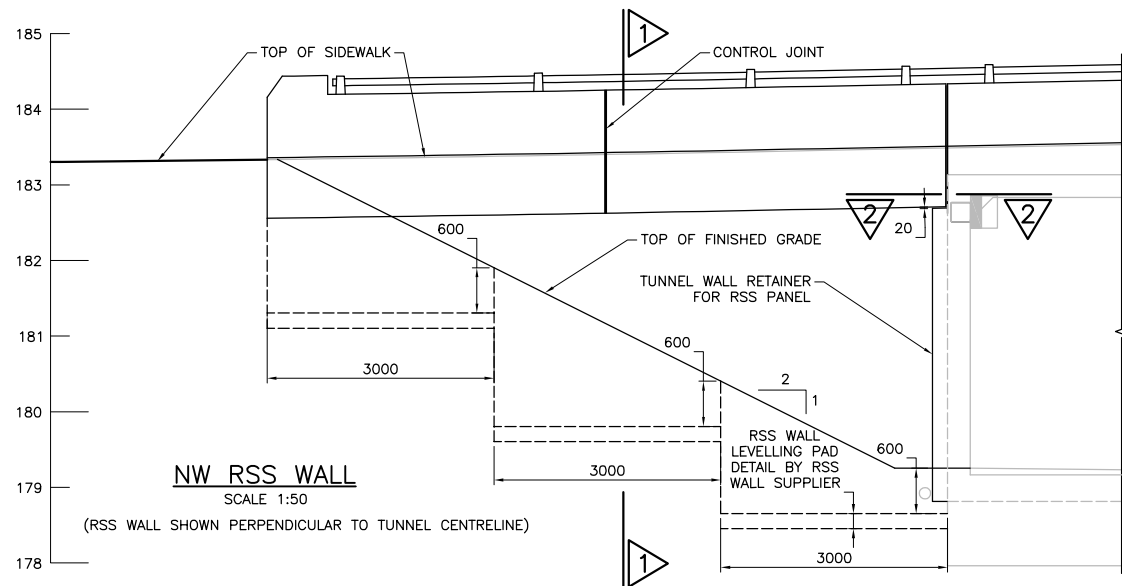
NEW CONSTRUCTION  
HWY 401  
PEDESTRIAN TUNNEL TB-6  
RSS WALLS LAYOUT

SHEET  
S6605

Phase 1  
IFC

## NOTES:

- FOR GENERAL NOTES REFER TO S6601.
- PROVIDE 600mm MIN COVER ABOVE TOP OF RSS WALL FOOTINGS TO FINISHED GRADE.
- PROVIDE ONE CONTROL JOINT IN EACH PL-2 RSS WALL CAP CAP AS PER S6607.

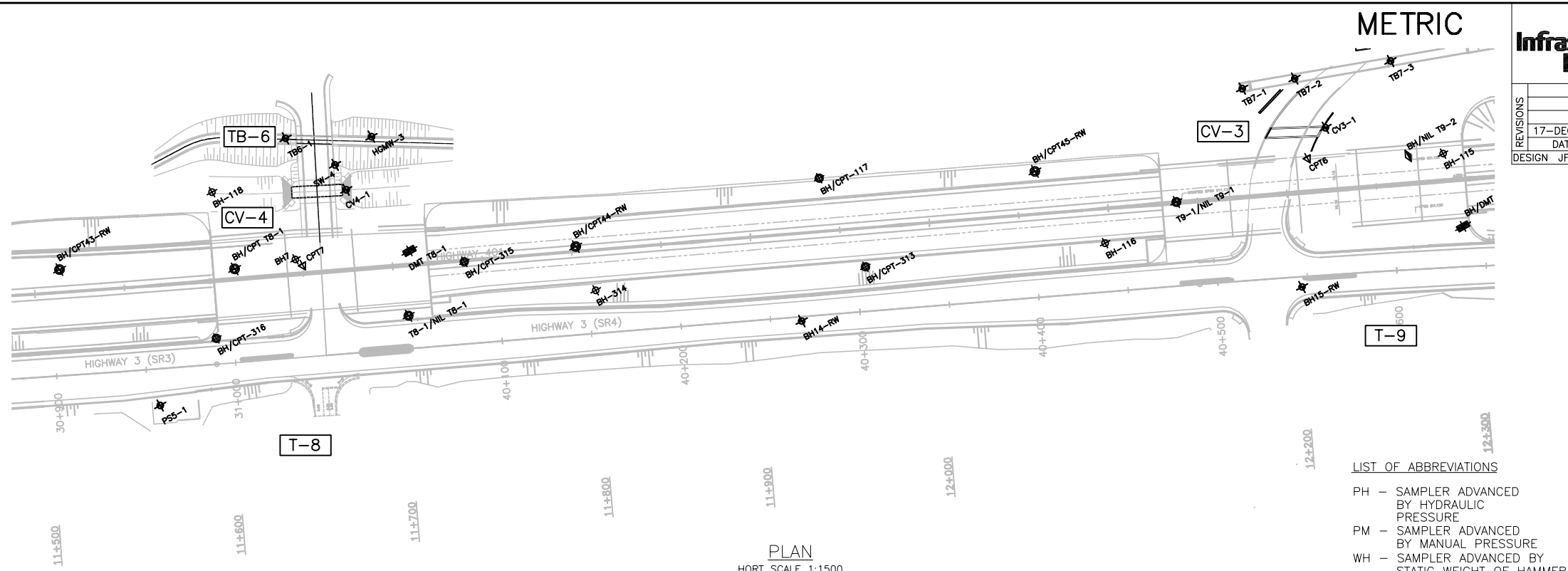


NOT FOR  
CONSTRUCTION

REVISIONS	DATE	REV.	BY	DESCRIPTION
17-DEC-12	0	CRD	ISSUED FOR CONSTRUCTION	
DESIGN	CRD	CHK	JF	CODE CAN/CSA S6-06 LOAD CL 625-ONT
DRAWN	RN	CHK	BR	SITE 6-621 DATE 1-MAR-12

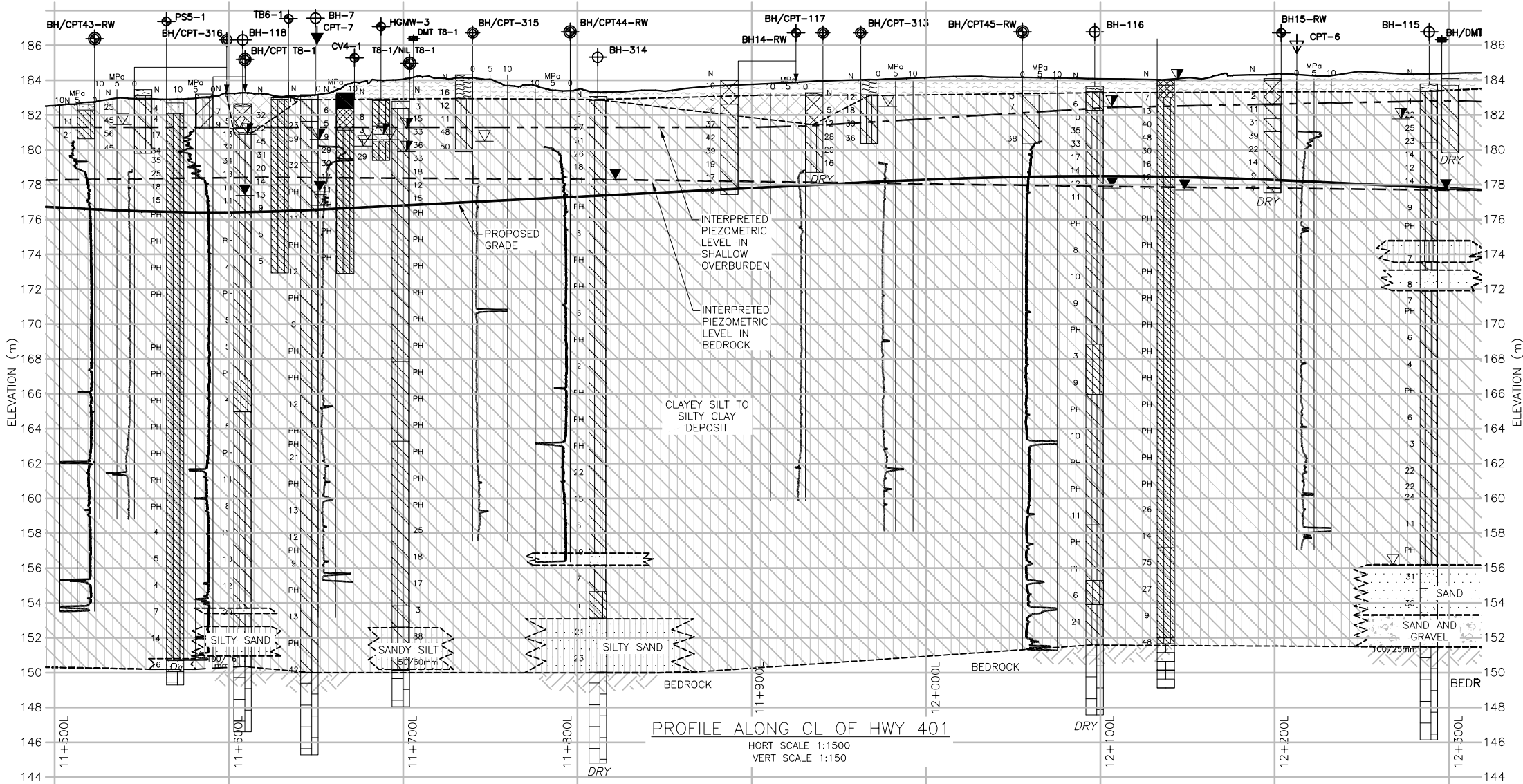


DATE PLOTTED: 12/17/2012 4:31:31 PM  
FILE LOCATION: C:\networking\hmmg\_285380\stephen.lobue@ames.com\dms14185\285380-04-090-WP1-6601.dwg




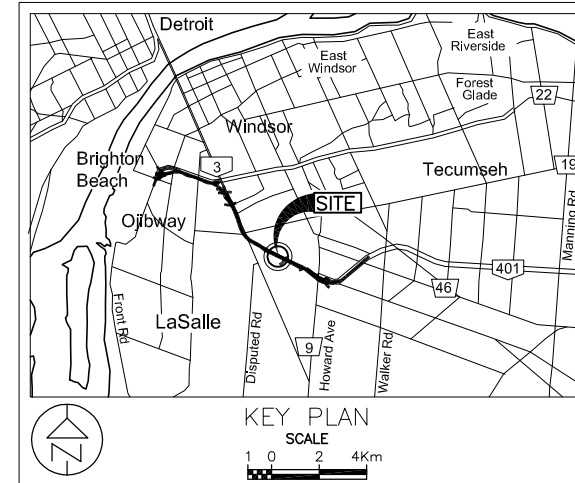
#### LIST OF ABBREVIATIONS

PH - SAMPLER ADVANCED BY HYDRAULIC PRESSURE  
PM - SAMPLER ADVANCED BY MANUAL PRESSURE  
WH - SAMPLER ADVANCED BY STATIC WEIGHT OF HAMMER  
WR - SAMPLER ADVANCED BY WEIGHT OF SAMPLER RODS



Parkway Infrastructure Engineers		amec		Hatch Mott MacDonald	
REVISIONS	DATE	REV.	BY	DESCRIPTION	
17-DEC-12	0	GN		ISSUED FOR CONSTRUCTION	
DESIGN	JF	APR	NSV	DATE	15-MAR-12

Windsor-Essex Parkway Project RFP No. 09-54-1007	
LOCATION PLAN & INTERPRETED STRATIGRAPHIC PROFILE	SHEET G6601
STA 11+500L TO STA 12+300L	



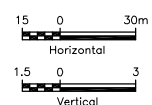
#### LEGEND

BOREHOLE - CURRENT INVESTIGATION	N SPT N-VALUE
BOREHOLE & NILCON VANE - CURRENT INVESTIGATION	WATER LEVEL DURING DRILLING
NILCON VANE - CURRENT INVESTIGATION	DRY BOREHOLE DRY DURING DRILLING
CPT - CURRENT INVESTIGATION	WATER LEVEL (SHALLOW PIEZO)
DMT - CURRENT INVESTIGATION	WATER LEVEL (DEEP PIEZO)
SW/SP HOLE (HYDROGEOLOGY)	PH - SAMPLE OBTAINED UNDER HYDRAULIC PRESSURE
BOREHOLE - PREVIOUS INVESTIGATIONS	MPa 10 5 0
BOREHOLE, CPT & NILCON VANE - PREVIOUS INVESTIGATIONS	CPT, qc
CPT - PREVIOUS INVESTIGATIONS	
TOPSOIL/ORGANICS	SILT
FILL	SANDY SILT
SAND	CLAYEY SILT
SILTY CLAY	SAND AND GRAVEL
SILTY SAND	SILTY SAND AND GRAVEL
COBBLES/BOULDERS	LIMESTONE /BEDROCK
	DOLOSTONE

#### NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL DESIGN REPORT.
- THE INTERPRETED STRATIGRAPHY REPRESENTS SIMPLIFIED SUBSURFACE CONDITIONS. SEE BORING LOGS FOR DETAILED STRATIGRAPHY. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN DEFINED AT BOREHOLE LOCATIONS ONLY. CONDITIONS BETWEEN BOREHOLE LOCATIONS COULD DIFFER FROM ILLUSTRATED CONDITIONS.
- ELEVATIONS ARE REFERENCED TO GEODETIC DATUM. LOCATIONS ALONG THE PROPOSED WEP ARE REFERRING TO STATIONS IN LASALLE (L) SECTOR.

#### SCALES



## METRIC

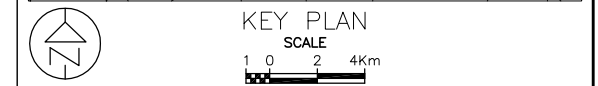
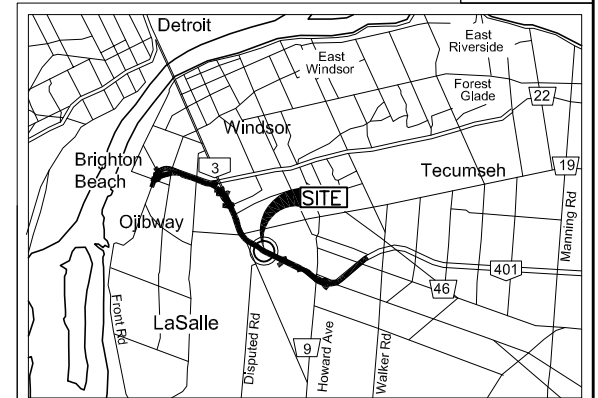
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWNWindsor-Essex  
Parkway Project  
RFP No. 09-54-1007NEW CONSTRUCTION  
HWY 401  
PEDESTRIAN TUNNEL TB-6  
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

G6602

Phase 1

IFC



KEY PLAN

SCALE  
1 0 2 4Km

## LEGEND

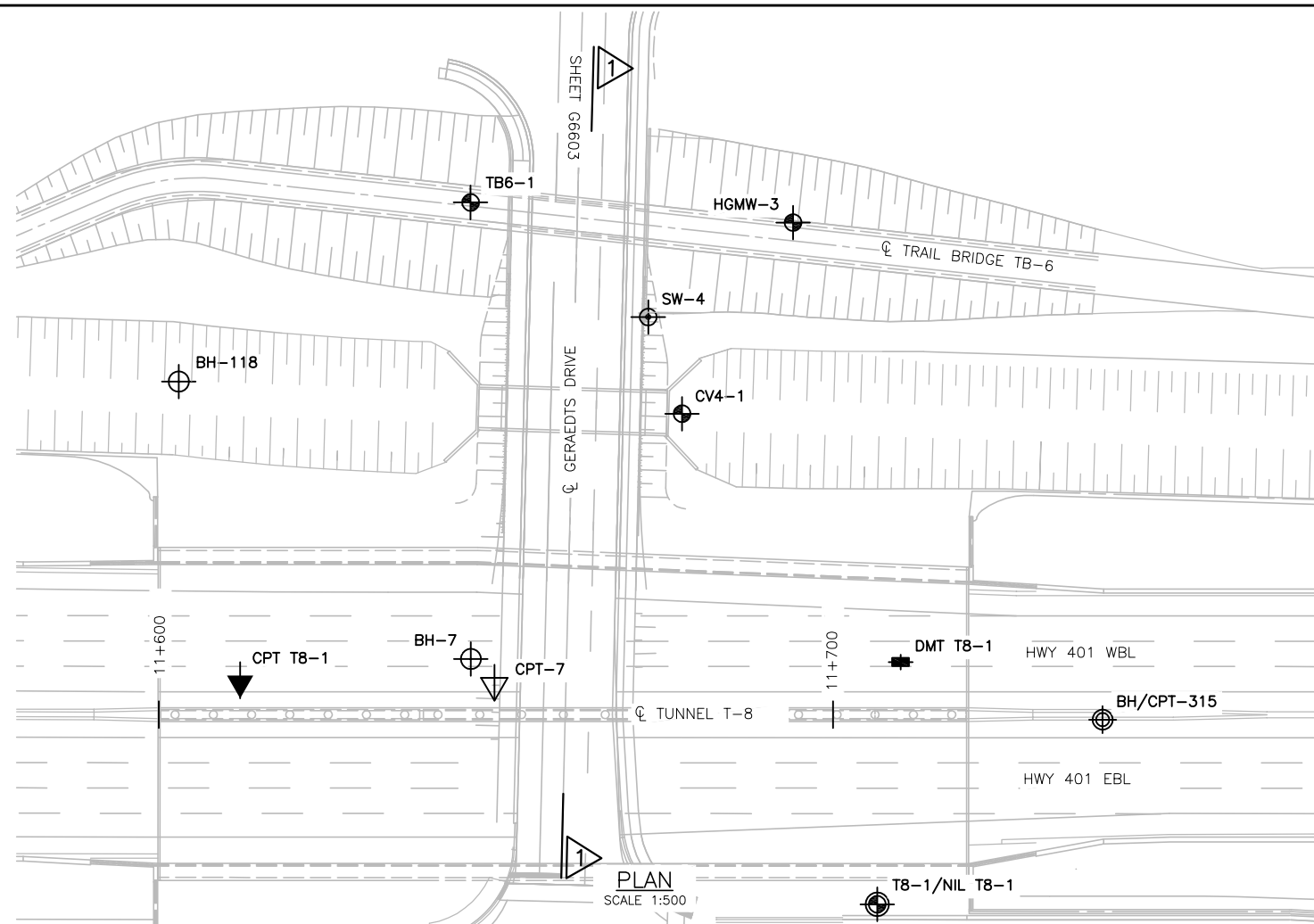
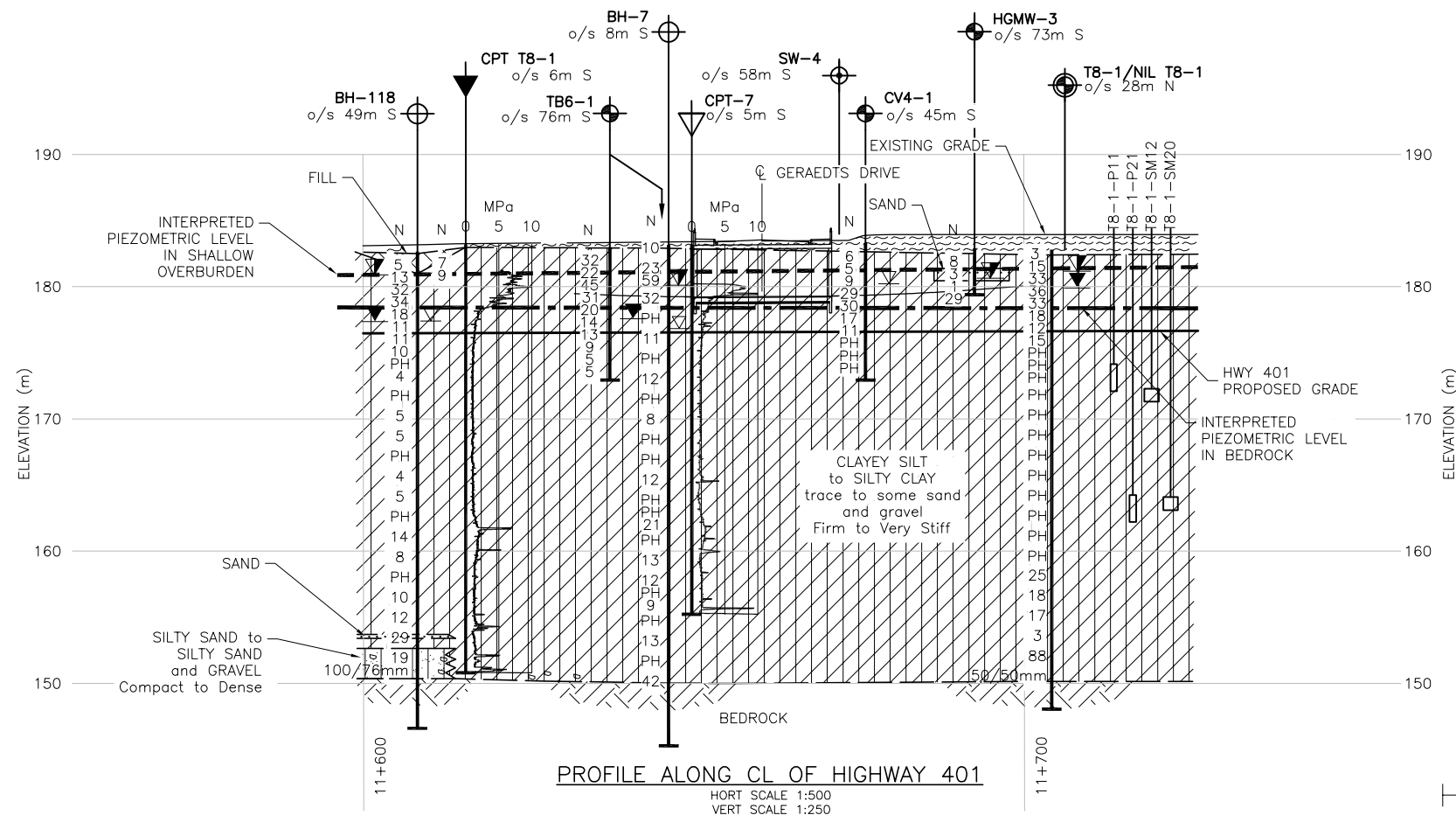
- BOREHOLE CURRENT INVESTIGATION
- BOREHOLE AND NILCON VANE CURRENT INVESTIGATION
- SW/SP HOLE (HYDROGEOLOGY) CURRENT INVESTIGATION
- NILCON VANE CURRENT INVESTIGATION
- CPT - CURRENT INVESTIGATION
- DMT - CURRENT INVESTIGATION
- BOREHOLE PREVIOUS INVESTIGATION
- BOREHOLE, CPT AND NILCON VANE PREVIOUS INVESTIGATIONS
- CPT -PREVIOUS INVESTIGATION
- N SPT N-VALUE
- BLOWS/0.3m UNLESS OTHERWISE STATED (STD. PEN. TEST, 475 J/BLOW)
- MHSG - MAGNETIC HEAVE/SETTLEMENT GAUGE (SM)
- P - VIBRATING WIRE PIEZOMETER (VWP)
- DRY BOREHOLE DRY DURING DRILLING
- WATER LEVEL DURING DRILLING
- WATER LEVEL (SHALLOW PIEZO)
- WATER LEVEL (DEEP PIEZO)

## NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL DESIGN REPORT.
- THE INTERPRETED STRATIGRAPHY REPRESENTS SIMPLIFIED SUBSURFACE CONDITIONS. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN DEFINED AT BOREHOLE LOCATIONS ONLY. CONDITIONS BETWEEN BOREHOLE LOCATIONS COULD DIFFER FROM ILLUSTRATED CONDITIONS.
- ELEVATIONS ARE REFERENCED TO GEODETIC DATUM.

REVISIONS	DATE	REV.	BY	DESCRIPTION
17-DEC-12	0	GN		ISSUED FOR CONSTRUCTION
DESIGN	JF	CHK	NSV	CODE CAN/CSA S6-06 LOAD CL-625-ONT
DRAWN	KT/SL	CHK	DD	SITE 6-621 DATE 15-MAR-12

DOC: 285380-04-090-WP1-6602

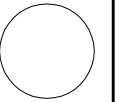
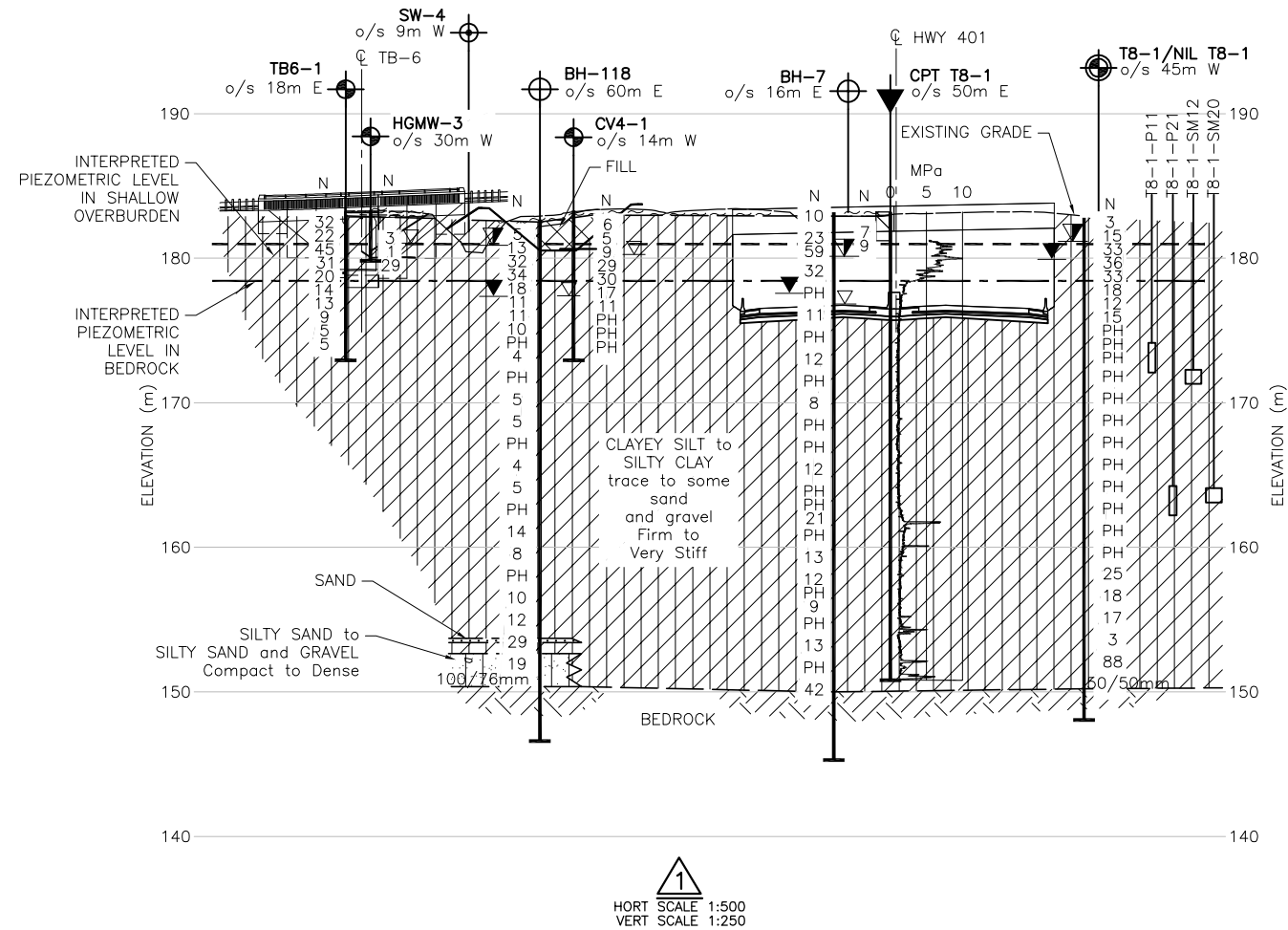
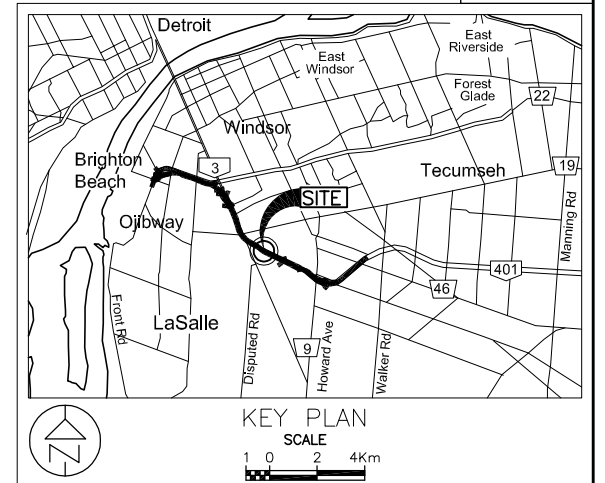
PLAN  
SCALE 1:500

PROFILE ALONG CL OF HIGHWAY 401

HORIZONTAL SCALE 1:500  
VERTICAL SCALE 1:250DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

No.	ELEVATION	CO—ORDINATES (UTM, NAD 83 ZONE 17)	
		NORTHING	EASTING
AMEC BOREHOLES			
CPT T8—1	183.2	4678860.0	333292.9
CV4—1	183.3	4678867.9	333368.7
DMT T8—1	183.0	4678820.9	333382.7
HGMW—3	182.9	4678886.8	333395.5
NIL T8—1	182.9	4678784.8	333381.3
TB6—1	183.0	4678909.5	333353.3
T8—1	182.8	4678789.7	333364.5
PREVIOUS BOREHOLES			
BH—7	183.2	4678848.0	333325.0
BH—118	182.7	4678903.5	333302.9
BH/CPT—315	184.3	4678800.6	333406.3
CPT—7	183.2	4678844.0	333327.0

## METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWNWindsor-Essex  
Parkway Project  
RFP No. 09-54-1007NEW CONSTRUCTION  
HWY 401  
PEDESTRIAN TUNNEL TB-6  
SOIL STRATIGRAPHYSHEET  
G6603Phase 1  
IFC

## LIST OF ABBREVIATIONS

PH - SAMPLER ADVANCED BY HYDRAULIC PRESSURE  
PM - SAMPLER ADVANCED BY MANUAL PRESSURE  
WH - SAMPLER ADVANCED BY STATIC WEIGHT OF HAMMER  
WR - SAMPLER ADVANCED BY WEIGHT OF SAMPLER RODS

## MATERIAL LEGEND

	TOPSOIL/ ORGANICS		SILT
	FILL		SANDY SILT
	SAND		CLAYEY SILT
	SILTY CLAY		SAND AND GRAVEL
	SILTY SAND		SILTY SAND AND GRAVEL
	COBBLES AND BOULDERS		LIMESTONE /BEDROCK

## LEGEND

	BOREHOLE CURRENT INVESTIGATION
	BOREHOLE AND NILCON VANE CURRENT INVESTIGATION
	SW/SP HOLE (HYDROGEOLOGY) CURRENT INVESTIGATION
	NILCON VANE CURRENT INVESTIGATION
	CPT - CURRENT INVESTIGATION
	DMT - CURRENT INVESTIGATION
	BOREHOLE PREVIOUS INVESTIGATION
	BOREHOLE, CPT AND NILCON VANE PREVIOUS INVESTIGATIONS
	CPT -PREVIOUS INVESTIGATION
	N SPT N-VALUE
	BLOWS/0.3m UNLESS OTHERWISE STATED (STD. PEN. TEST, 475 J/BLOW)
	P - VIBRATING WIRE PIEZOMETER (VWP)
	DRY BOREHOLE DRY DURING DRILLING
	WATER LEVEL DURING DRILLING
	WATER LEVEL (SHALLOW PIEZO)
	WATER LEVEL (DEEP PIEZO)
	MHSG - MAGNETIC HEAVE/SETTLEMENT GAUGE (SM)
	CPT, qc

## NOTES

- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL DESIGN REPORT.
- THE INTERPRETED STRATIGRAPHY REPRESENTS SIMPLIFIED SUBSURFACE CONDITIONS. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN DEFINED AT BOREHOLE LOCATIONS ONLY. CONDITIONS BETWEEN BOREHOLE LOCATIONS COULD DIFFER FROM ILLUSTRATED CONDITIONS.
- ELEVATIONS ARE REFERENCED TO GEODETIC DATUM.

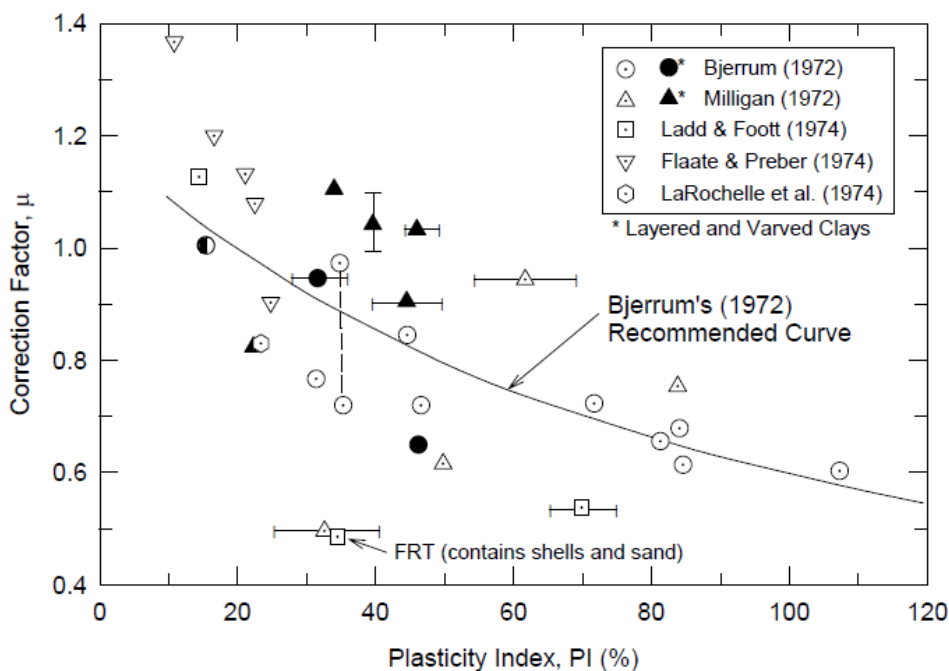
DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

REVISIONS	DATE	REV.	BY	DESCRIPTION
1	17-DEC-12	0	GN	ISSUED FOR CONSTRUCTION
DESIGN	JF	CHK	NSV	CODE CAN/CSA S6-06 LOAD CL-625-ONT
DRAWN	KT/SL	CHK	DD	SITE 6-621 DATE 15-MAR-12

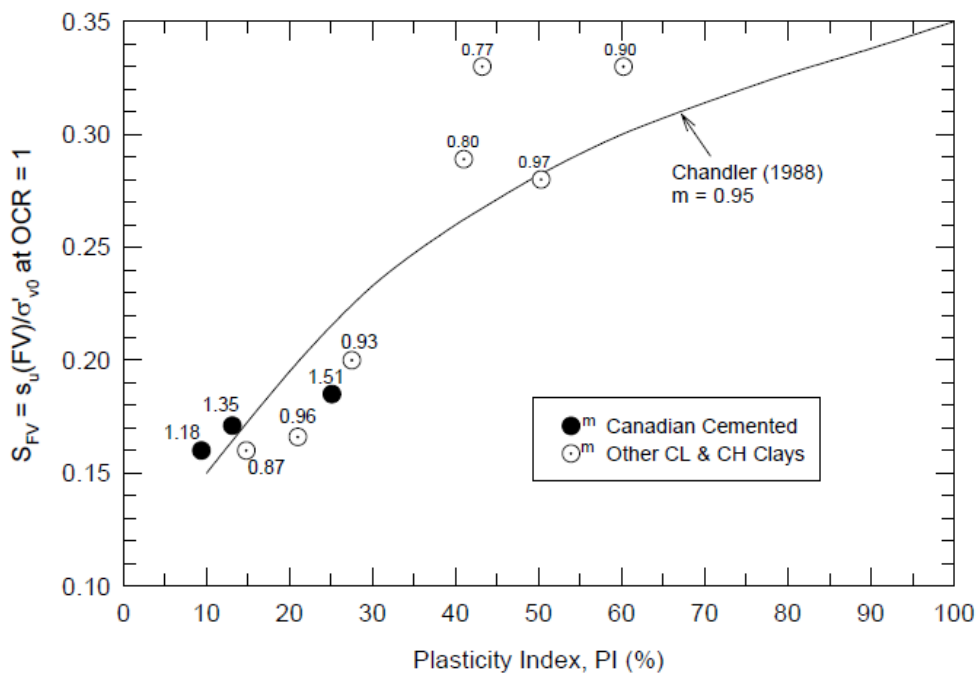
DOC: 285380-04-091-WIP1-6603

## Figures

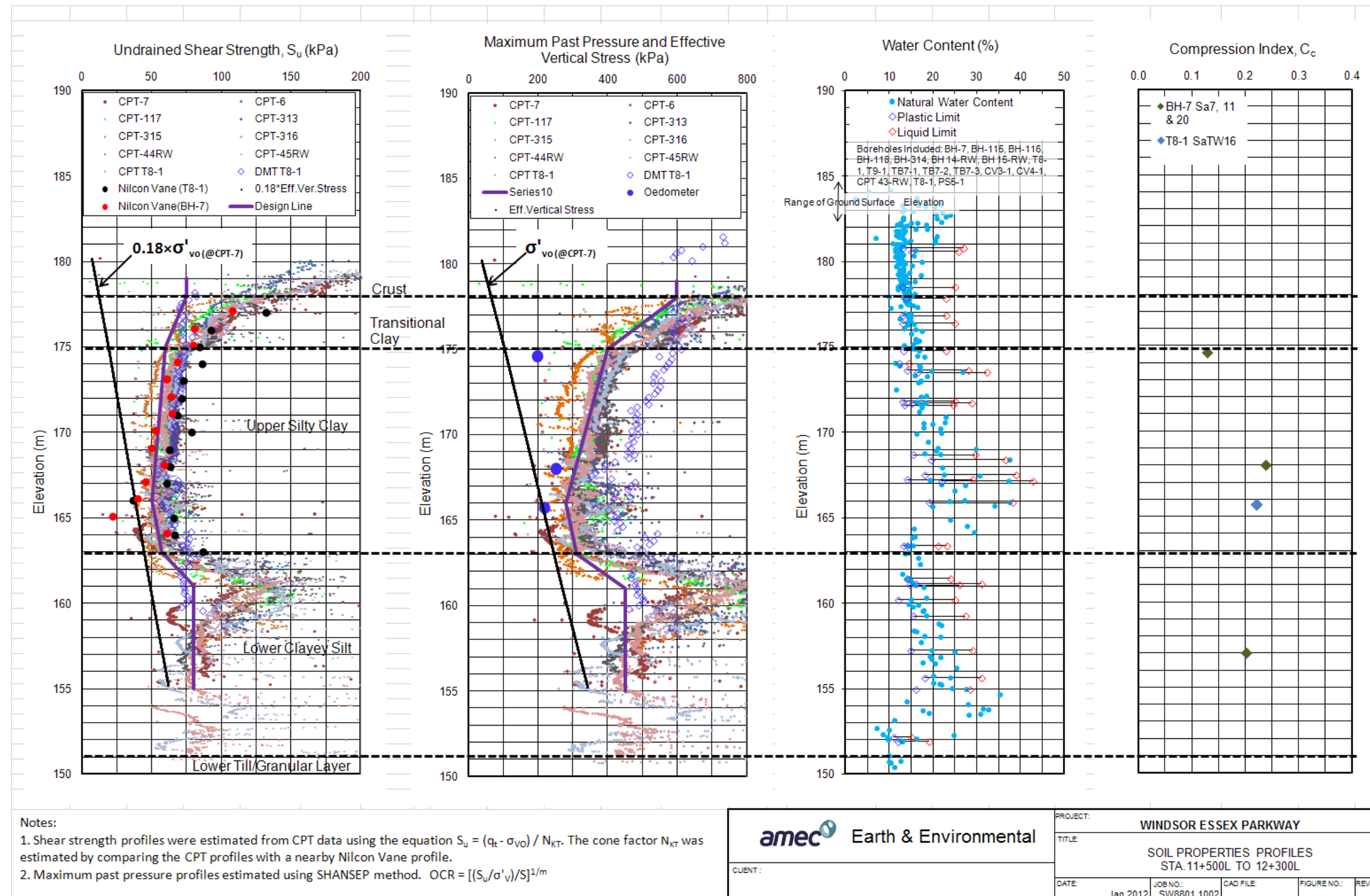
**Figure 3-1: Field Vane Correction Factor vs. Plasticity Index Derived from Embankment Failures**  
(Figure 5.1, Ladd & DeGroot, 2004, ref. R-29)



**Figure 3-2: Field Vane Undrained Strength Ratio at OCR = 1 vs. Plasticity Index for Homogeneous Clays**  
(Figure 5.2, Ladd & DeGroot, 2004, ref. R-29)

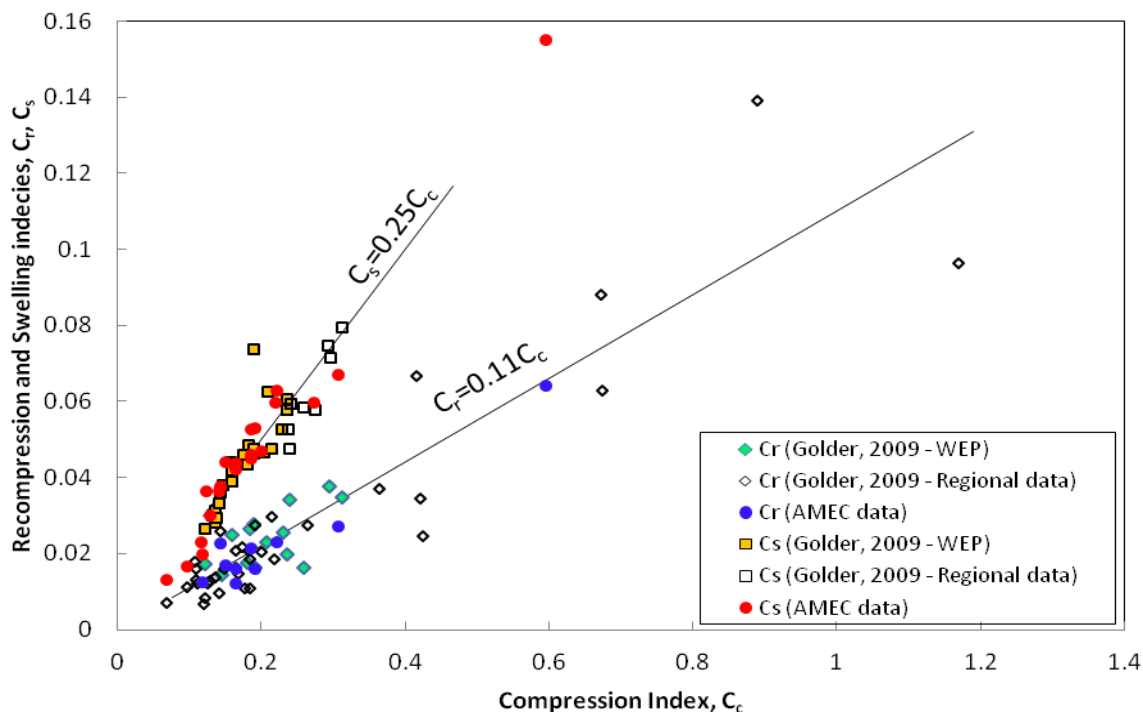
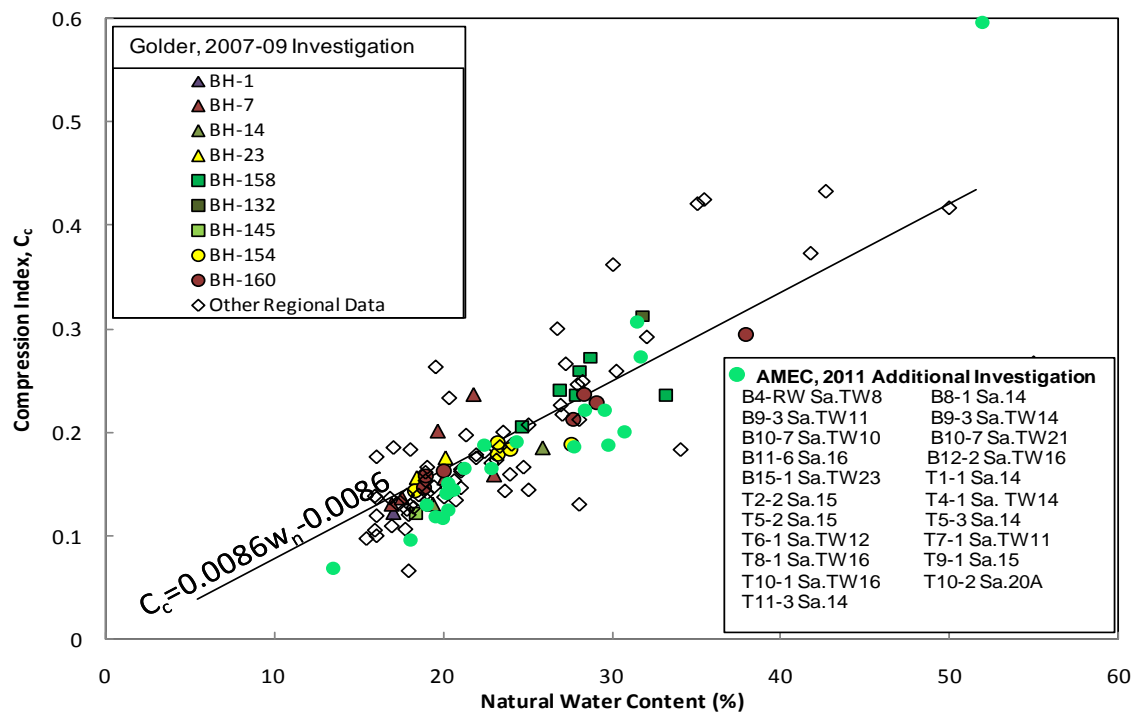


**Figure 3-3: Soil Properties Profiles, Sta. 11+500L to 12+300L**

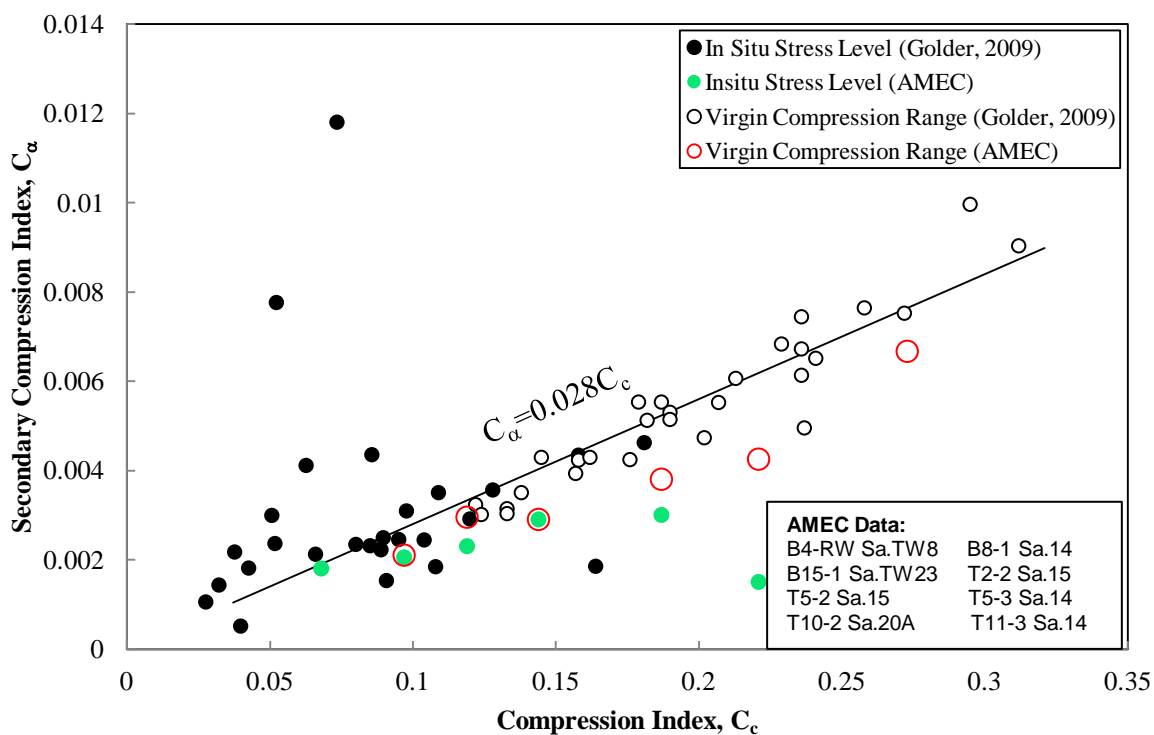




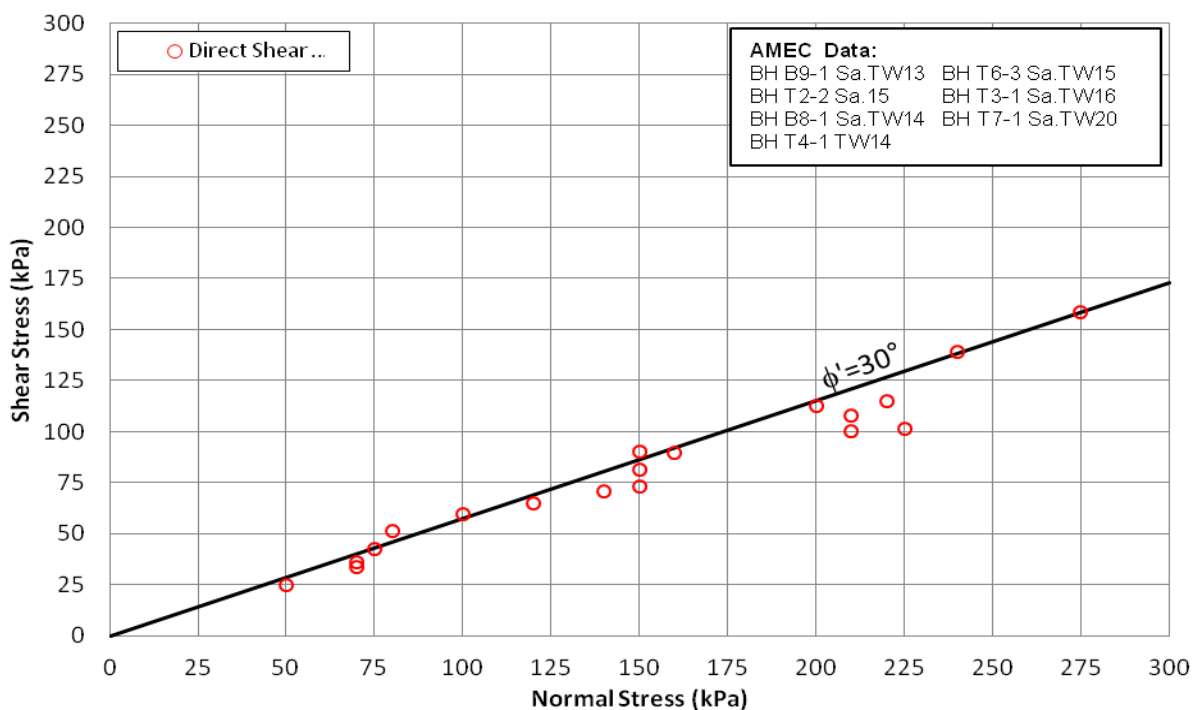
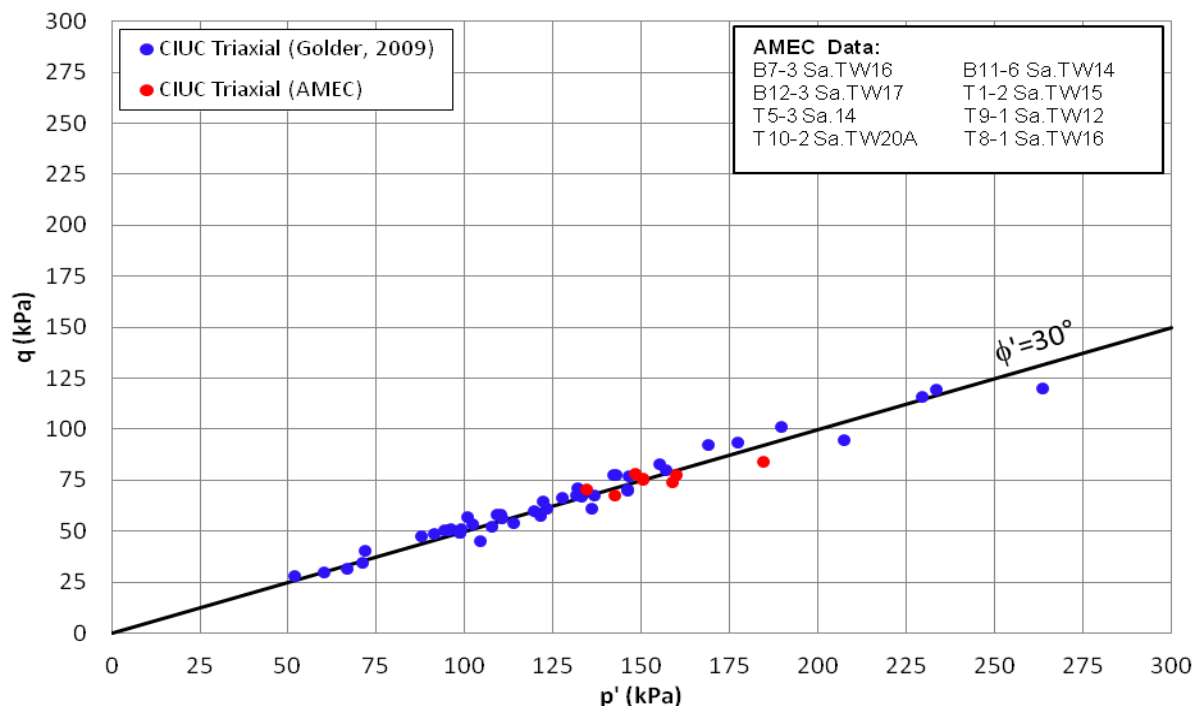
**Figure 4-1: Compressibility Parameters at WEP**



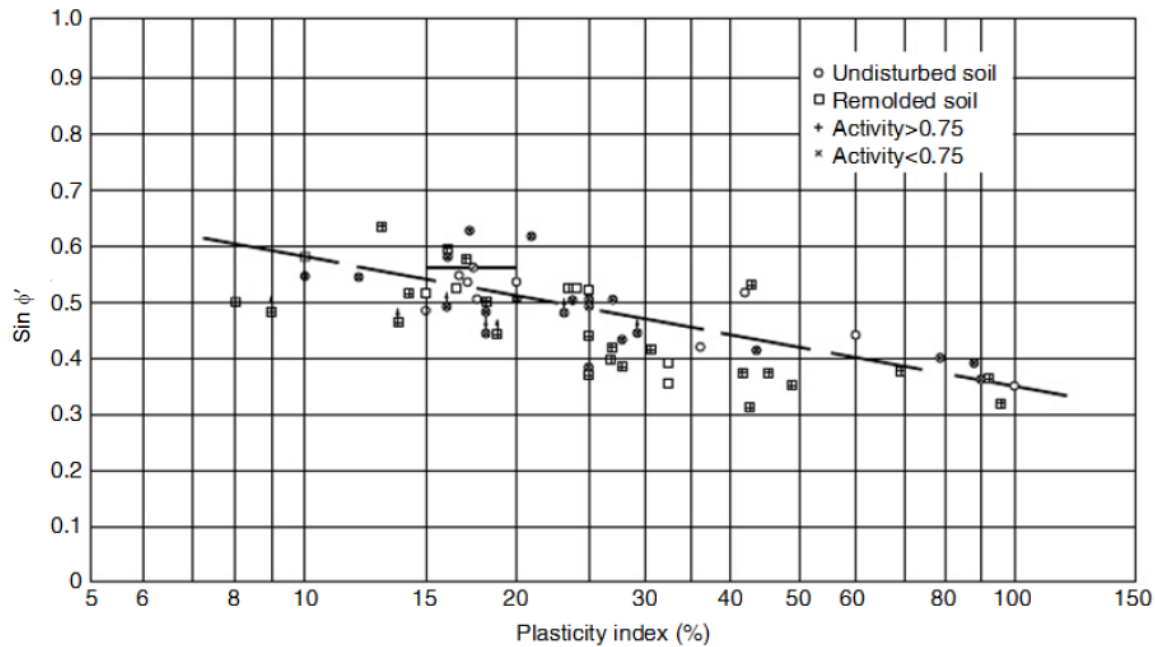
**Figure 4-2:  $C_c$  versus  $C_\alpha$  Relationship at WEP**



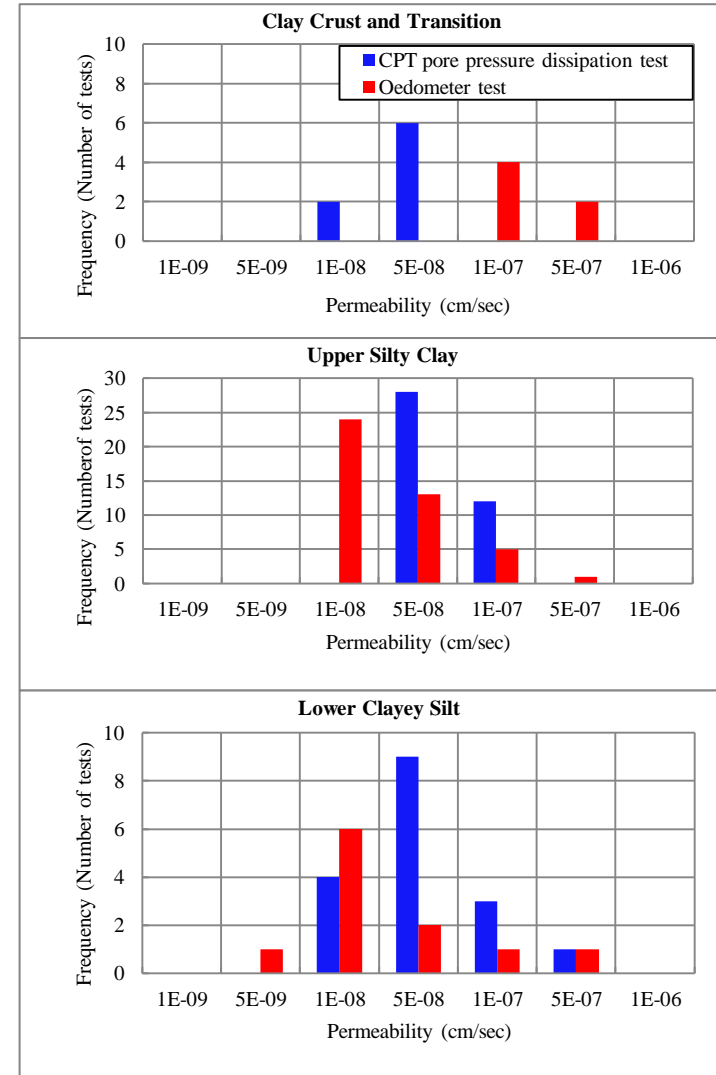
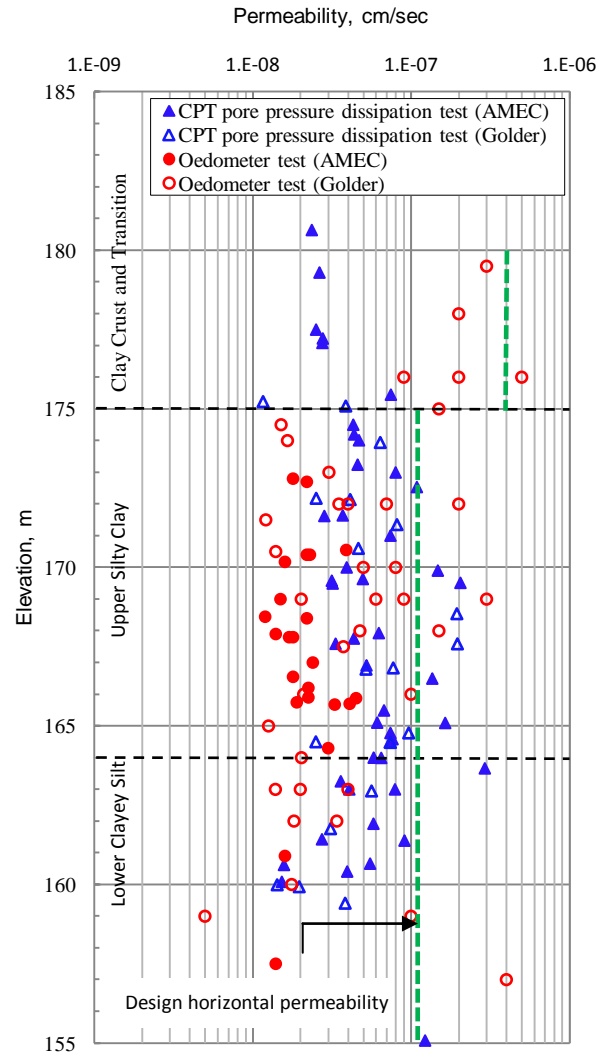
**Figure 4-3: Effective Friction Angle ( $\phi'$ ) for Silty Clay to Clayey Silt Stratum at WEP**



**Figure 4-4: Relationship between  $\sin \phi'$  and Plasticity Index for Normally Consolidated Soils (Kenney, 1959)**



**Figure 4-5: Inferred Clay Stratum Permeability from CPT Pore Pressure Dissipation and Oedometer Tests**

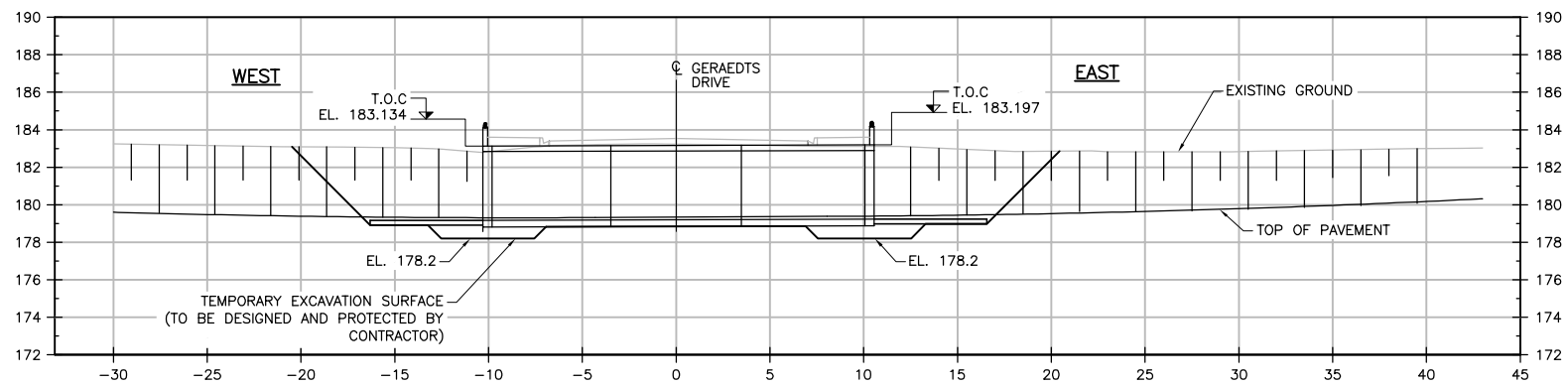


DOC: TB-6 PLAN W TB SECTIONS\_FIG 5.1

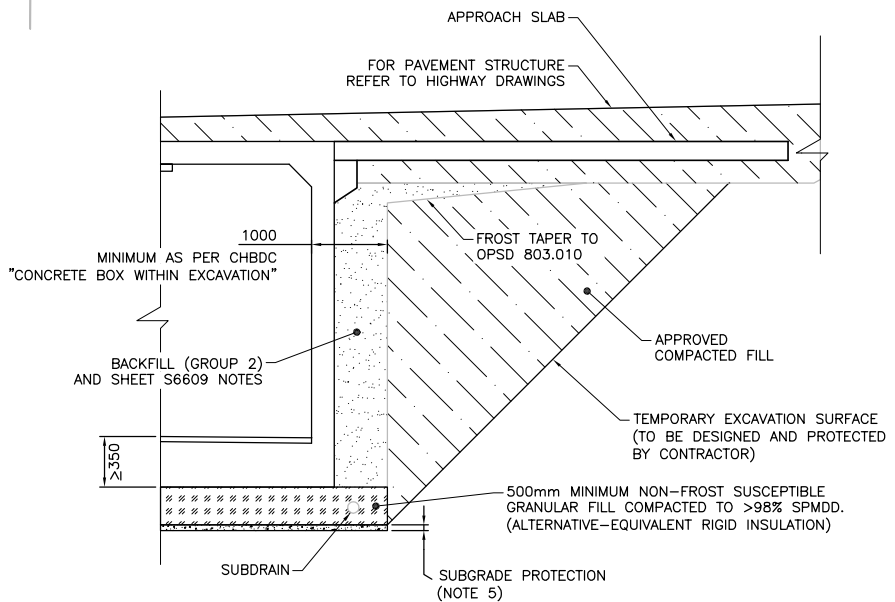


PLAN  
SCALE 1:150

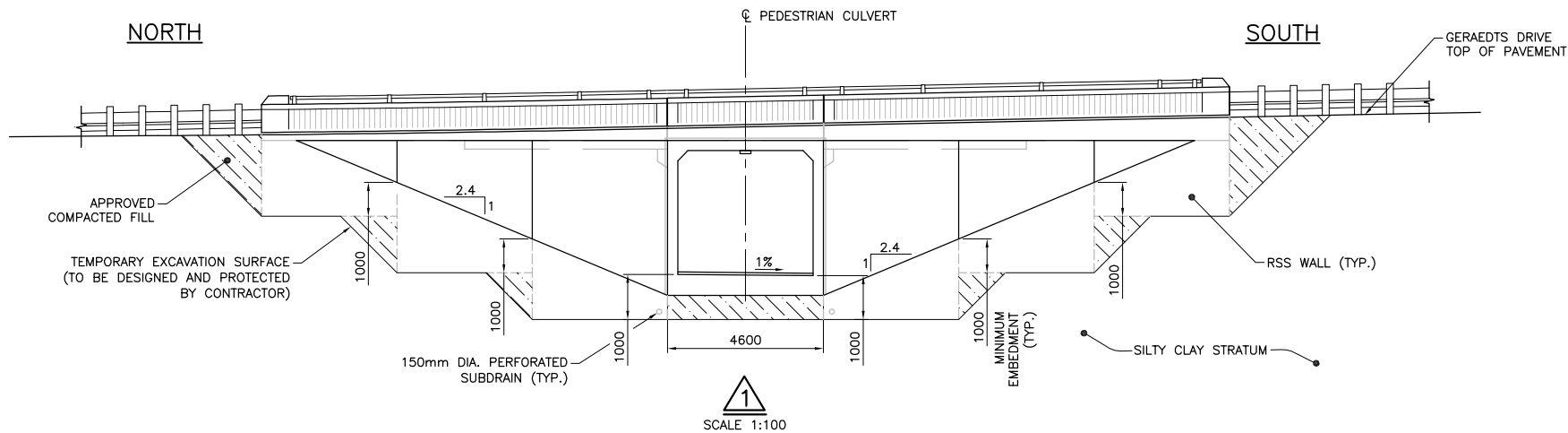
- NOTES:**
1. THIS FIGURE ILLUSTRATES THE GEOTECHNICAL DESIGN ARRANGEMENT OF PEDESTRIAN TUNNEL TB-6.
  2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GEOTECHNICAL DESIGN REPORT AND CONSTRUCTION NOTES.
  3. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN. ELEVATIONS ARE REFERRED TO GEODETIC DATUM.
  4. CONTRACTOR IS FULLY RESPONSIBLE FOR THE DESIGN, CONSTRUCTION METHODS AND PERFORMANCE OF THE TEMPORARY SLOPES AND WORKS. EXCAVATED CLAY SURFACES ARE SUSCEPTIBLE TO DETERIORATION AND MAY EXPERIENCE DEFORMATIONS AND INSTABILITY. THE SLOPES MUST APPROPRIATELY PROTECTED, REGULARLY INSPECTED AND TREATED AS REQUIRED.
  5. THE EXPOSED SUBGRADES SHOULD BE INSPECTED AND UPON APPROVAL, A SUBGRADE PROTECTION LAYER OF AT LEAST 75mm OF LEAN CONCRETE SHOULD BE PLACED SAME DAY AS EXCAVATED TO SUPPORT CONCRETE STRUCTURES. ALTERNATIVELY, 100mm OF WELL-GRADED GRANULAR FILL COMPACTED TO >95% SPMD MAY BE USED.



PROFILE ALONG CL PEDESTRIAN TUNNEL TB-6  
SCALE 1:200



TUNNEL BACKFILL DETAIL  
SCALE 1:50  
(PL2 BARRIER NOT SHOWN FOR CLARITY)



SCALE 1:100

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING



## **Appendix A      Borehole, CPT and DMT logs from Additional Geotechnical Investigation**

## EXPLANATION OF BOREHOLE LOG

This form describes some of the information provided on the borehole logs, which is based primarily on examination of the recovered samples, and the results of the field and laboratory tests. Additional description of the soil/rock encountered is given in the accompanying geotechnical report.

### GENERAL INFORMATION

Project details, borehole number, location coordinates and type of drilling equipment used are given at the top of the borehole log.

### SOIL LITHOLOGY

#### ***Elevation and Depth***

This column gives the elevation and depth of inferred geologic layers. The elevation is referred to the datum shown in the Description column.

#### ***Lithology Plot***

This column presents a graphic depiction of the soil and rock stratigraphy encountered within the borehole.

#### ***Description***

This column gives a description of the soil strata, based on visual and tactile examination of the samples augmented with field and laboratory test results. Each stratum is described according to the *MTC Soil Classification Manual*.

The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined as follows (Ref. *MTC Soil Classification Manual*):

<b>Compactness of Cohesionless Soils</b>	<b>SPT N-Value*</b>
Very loose	0 to 5
Loose	5 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

<b>Consistency of Cohesive Soils</b>	<b>Undrained Shear Strength kPa</b>
Very soft	0 to 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	Over 200

\* For penetration of less than 0.3 m, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimeter penetration).

### Soil Sampling

Sample types are abbreviated as follows:

SS Split Spoon	TW Thin Wall Open (Pushed)	RC Rock Core	GS Grab Sample
AS Auger Sample	TP Thin Wall Piston (Pushed)	WS Washed Sample	AR Air Return Sample

Additional information provided in this section includes sample numbering, sample recovery and numerical testing results.

### Field and Laboratory Testing

Results of field testing (e.g., SPT, pocket penetrometer, and vane testing) and laboratory testing (e.g., natural moisture content, and limits) executed on the recovered samples are plotted in this section.

### Instrumentation Installation

Instrumentation installations (monitoring wells, piezometers, inclinometers, etc.) are plotted in this section. Water levels, if measured during fieldwork, are also plotted. These water levels may or may not be representative of the static groundwater level depending on the nature of soil stratum where the piezometer tips are located, the time elapsed from installation to reading and other applicable factors.

### Comments

This column is used to describe non-standard situations or notes of interest.

## BEDROCK DESCRIPTION

### STRENGTH CLASSIFICATION

Term (Grade)	Field Identification	Approximate Range of Uniaxial Compressive Strength (MPa)
Extremely Weak (R0)	Indented by thumbnail.	0.25 – 1.0
Very Weak (R1)	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	1.0 – 5.0
Weak (R2)	Can be peeled with a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	5.0 – 25
Medium Strong (R3)	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of geological hammer.	25 – 50
Strong (R4)	Specimen requires more than one blow of geological hammer to fracture it.	50 – 100
Very Strong (R5)	Specimen requires many blows of geological hammer to fracture it.	100 – 250
Extremely Strong (R6)	Specimen can only be chipped with geological hammer.	>250

### JOINT SPACING CLASSIFICATION

Term	Average Joint Spacing (m)
Extremely close	< 0.02
Very close	0.02 – 0.06
Close	0.06 – 0.20
Moderately close	0.20 – 0.6
Wide	0.6 – 2.0
Very wide	2.0 – 6.0
Extremely wide	> 6.0

### ROCK QUALITY CLASSIFICATION

Rock Quality Designation, RQD (%)	Description of Rock Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

Reference: Deere et al, 1967

### WEATHERING CLASSIFICATION

Term (Grade)	Description
Fresh (W1)	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered (W2)	Discoloration indicates weathering of rock material on discontinuity surfaces. Less than 5 % of rock mass altered.
Moderately Weathered (W3)	Less than half of the rock material is decomposed and/or disintegrated into a soil. Fresh or discoloured rock is present either as a continuous framework or as core stones.
Highly Weathered (W4)	More than half of the rock material is decomposed and/or disintegrated into a soil. Fresh or discoloured rock is present either as a discontinuous framework or as core stones.
Completely Weathered (W5)	All rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil (W6)	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume but the soil has not been significantly transported.

Reference: Brown, 1981, "Suggested Methods for Rock Characterization Testing and Monitoring". International Society for Rock Mechanics.

### TERMINOLOGY

*Rock Quality Designation (RQD)* is defined as the percentage of intact core pieces longer than 100 mm (4 inches) to the total length of core. The core should be at least NW size (54.7 mm or 2.15 inches in diameter) and typically 5 ft (nominally 1.5 m) in length.

*Solid Core Recovery (SCR)* is defined as the percentage of intact cylindrical core pieces to the total length of core.

*Total Core Recovery (TCR)* is defined as the percentage of intact core pieces to the total length of core.

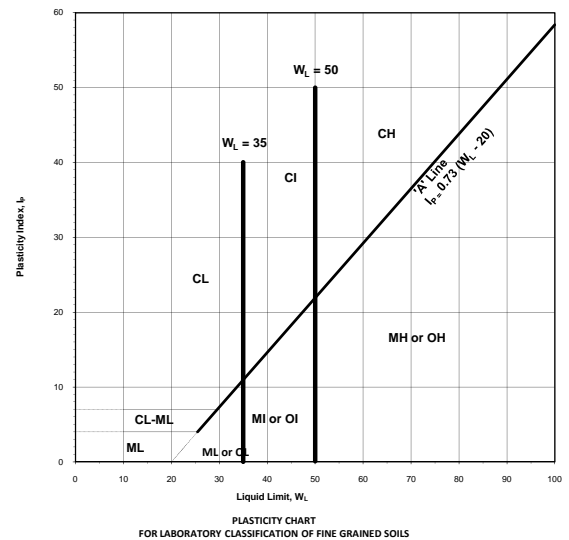
# MTC SOIL CLASSIFICATION

## Based on MTC Soil Classification Manual



MAJOR DIVISION					GROUP SYMBOL	TYPICAL DESCRIPTION	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA			
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICULAR SIZE		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX % OF SAND & GRAVEL ; MAX SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS. LOCAL OR GEOLOGICAL NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION, & SYMBOL IN PARENTHESIS.	$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN 1 AND 3			
			PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH STONE INTERMEDIATE SIZES MISSING		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES					
		GRAVEL WITH FINES (APPLICABLE AMOUNT OF FINES)	NON PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND- SILT MIXTURES					
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES					
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNT OF ALL INTERMEDIATE PARTICLE SIZES		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITION & DRAINAGE CHARACTERISTICS		NOT MEETING ALL GRADATION REQUIREMENTS FOR GW		
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZE MISSING		SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES					
		SANDS WITH FINES (APPLICABLE AMOUNT OF FINES)	NON PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES					
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES					
	FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	IDENTIFICATION PROCEDURE ON FRACTION SMALLER THAN 425µm						USE GRAIN SIZE CURVE IN IDENTIFYING THE FACTORS AS GIVEN UNDER FIELD IDENTIFICATION  DETERMINE PERCENTAGE OF GRAVEL & SAND FROM GRAIN SIZE CURVE, DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 µm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:  LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GM, GC, SM, SC 5% TO 12% BORDER LINE CASES REQUIRE USE OF DUAL SYMBOL.	$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN 1 AND 3	ATTEBERG LIMITS BELOW A-LINE OR Ip LESS THAN 4  ATTEBERG LIMITS ABOVE A- LINE WITH Ip GREATER THAN 7  ATTEBERG LIMITS BELOW A- LINE OR Ip LESS THAN 4  ATTEBERG LIMITS ABOVE A- LINE WITH Ip GREATER THAN 7	ABOVE A-LINE WITH Ip BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS  ABOVE A-LINE WITH Ip BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS  ABOVE A-LINE WITH Ip BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
		LIQUID LIMIT LESS THAN 35	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)						
NONE			QUICK	NONE	ML	INORGANIC SILTS & SANDY SILTS OR SLIGHTLY PLASTICITY, ROCK FLOUR					
MEDIUM TO HIGH			NONE TO VERY SLOW	MEDIUM	CL	SILTY CLAYS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS					
SLIGHT TO MEDIUM			SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS					
NONE TO SLIGHT			SLOW TO QUICK	SLIGHT	MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS					
HIGH			NONE	MEDIUM TO HIGH	CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY					
LIQUID LIMIT BETWEEN 35 AND 50		SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY					
		SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMEACACOUS FINE SANDY SILTS, ELASTIC SILTS					
		HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS					
		MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY					
		HIGH ORGANIC SOILS				Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS				

FRACTION	U.S STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS		
GRAVEL	COARSE	PASSING	RETAINED	PERCENT	DESCRIPTOR
		75 mm	26.5 mm	40-50 30-40 20-30 10-20 1-10	AND Y/EY WITH SOME TRACE
	FINE	26.5 mm	4.75 mm		
SAND	COARSE	4.75 mm	2.00 mm		
	MEDIUM	2.00 mm	425 µm		
	FINE	425 µm	75 µm		
	FINES (SILT OR CLAY BASED ON PLASTICITY)		75 µm		
OVERSIZED MATERIAL					
ROUNDED OR SUBROUNDED: COBBLES 75 mm TO 200 mm BOULDERS > 200 mm				NOT ROUNDED: ROCK FRAGMENTS > 75 mm ROCKS > 0.76 CUBIC METRE IN VOLUME	



**BOUNDARY CLASSIFICATION:** BOUNDARY CLASSIFICATION: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS FOR EXAMPLE GW-GC WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER



AMEC Earth & Environmental,  
a Division of AMEC American

[www.amec.com](http://www.amec.com)

**MTC SOIL CLASSIFICATION MANUAL  
ENGINEERING PROPERTIES OF SOIL**




TYPICAL NAMES OF SOIL GROUPS	GROUP SYMBOLS	PERMEABILITY WHEN COMPACTED	STRENGTH WHEN COMPACTED	COMPRESSIBILITY WHEN COMPACTED	WORKABILITY AS A CONSTRUCTION MATERIAL	SCOUR RESISTANCE	SUSCEPTIBILITY TO SURFICIAL EROSION	SUSCEPTIBILITY TO FROST ACTION	DRAINAGE CHARACTERISTICS
WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GW	PERVIOUS	EXCELLENT	NEGLECTIBLE	EXCELLENT	MEDIUM	NEGLECTIBLE	NEGLECTIBLE	EXCELLENT
POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GP	VERY PERVIOUS	GOOD	NEGLECTIBLE	GOOD	MEDIUM	NEGLECTIBLE	NEGLECTIBLE	EXCELLENT
SILTY GRAVELS, POORLY GRADED GRAVEL- SAND-SILT MIXTURES	GM	SEMI-PERVIOUS TO IMPERVIOUS	GOOD	NEGLECTIBLE	GOOD	LOW TO MEDIUM	SLIGHT	SLIGHT	FAIR TO SEMI IMPERVIOUS
CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES	GC	IMPERVIOUS	GOOD TO FAIR	VERY LOW	GOOD	MEDIUM	SLIGHT	NEGLECTIBLE TO SLIGHT	PRACTICALLY IMPERVIOUS
WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	SW	PERVIOUS	EXCELLENT	NEGLECTIBLE	EXCELLENT	LOW TO MEDIUM	SLIGHT	NEGLECTIBLE	EXCELLENT
POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	SP	PERVIOUS	GOOD	VERY LOW	FAIR TO GOOD	LOW TO MEDIUM	MODERATE	NEGLECTIBLE TO SLIGHT	EXCELLENT
SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES	SM	SEMI-PERVIOUS TO IMPERVIOUS	GOOD	LOW	FAIR	LOW	MODERATE	SLIGHT TO MODERATE	FAIR TO SEMI IMPERVIOUS IMPERVIOUS
CLAYEY SANDS, POORLY GRADED SAND WITH SOME CLAY MIXTURES	SC	IMPERVIOUS	GOOD TO FAIR	LOW	GOOD	VERY LOW TO LOW	MODERATE TO SLIGHT	NEGLECTIBLE	PRACTICALLY IMPERVIOUS
INORGANIC SILTS AND SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR	ML	SEMI-PERVIOUS TO IMPERVIOUS	FAIR	MEDIUM	FAIR	VERY LOW	SEVERE	SEVERE	FAIR TO POOR
INORGANIC CLAYEY SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS	CL	IMPERVIOUS	FAIR	MEDIUM	GOOD TO FAIR	LOW TO MEDIUM	SLIGHT TO MODERATE	MODERATE TO SEVERE	PRACTICALLY IMPERVIOUS
ORGANIC SILTS OF LOW PLASTICITY	OL	SEMI-PERVIOUS TO IMPERVIOUS	POOR	MEDIUM	FAIR TO POOR	VERY LOW TO LOW	SEVERE	SEVERE	POOR
INORGANIC COMPRESSIBLE SILTS OF MEDIUM PLASTICITY	MI	SEMI-PERVIOUS TO IMPERVIOUS	FAIR	MEDIUM TO HIGH	FAIR TO POOR	LOW	MODERATE	MODERATE TO SEVERE	FAIR TO POOR
INORGANIC SILTY CLAYS OF MEDIUM PLASTICITY	CI	IMPERVIOUS	FAIR TO POOR	HIGH	FAIR	LOW TO MEDIUM	SLIGHT	MODERATE TO SEVERE	SEMI IMPERVIOUS TO PRACTICALLY
ORGANIC SILTY CLAY OF MEDIUM PLASTICITY	OI	SEMI-PERVIOUS TO IMPERVIOUS	POOR	HIGH	POOR	VERY LOW TO LOW	SEVERE	MODERATE TO SEVERE	POOR TO PRACTICALLY IMPERVIOUS
INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	MH	SEMI-PERVIOUS TO IMPERVIOUS	FAIR TO POOR	HIGH	POOR	VERY LOW	MEDIUM	SEVERE	POOR
INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	CH	IMPERVIOUS	POOR	HIGH	FAIR TO POOR	LOW TO MEDIUM	SLIGHT TO NEGLECTIBLE	NEGLECTIBLE	PRACTICALLY IMPERVIOUS
ORGANIC CLAYS OF HIGH PLASTICITY	OH	IMPERVIOUS	POOR	HIGH	POOR	LOW	MODERATE	NEGLECTIBLE TO SLIGHT	PRACTICALLY IMPERVIOUS
PEAT AND OTHER HIGHLY ORGANIC SOILS	Pt	-	-	-	-	LOW	SEVERE	-	FAIR TO GOOD

# RECORD OF BOREHOLE No TB6-1

1 OF 1

**METRIC**

W.P. RFP No. 09-54-1007 LOCATION N4678909.5, E333353.3 ORIGINATED BY TA  
 DIST                      HWY WEP BOREHOLE TYPE CME 75 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
 DATUM Geodetic DATE Jul 9, 11 - Jul 9, 11 CHECKED BY MSO

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE							
								● POCKET PEN.	×	LAB VANE							
183.0	Ground Surface																
182.0	<b>TOPSOIL</b>																
	Mottled Brown-Grey <b>CLAYEY SILT</b> Some sand, trace gravel Sandy, dry		1	SS	32												
	Brown -Trace fissures Very Stiff		2	SS	22												
	-Trace inferred cobbles, trace fissures Hard		3	SS	45												
	Grey Very stiff		4	SS	31												
	Stiff	5	SS	20													
					</												

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT SW8801.1004.101.GPJ ONTARIO MOT.GDT 22/09/11



# RECORD OF BOREHOLE No T8-1

1 OF 3

**METRIC**

W.P. RFP No. 09-54-1007 LOCATION N4678789.7, E333364.5 ORIGINATED BY NB  
 DIST                      HWY WEP BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
 DATUM Geodetic DATE Jul 19, 11 - Jul 20, 11 CHECKED BY MSO

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE										○		
								● POCKET PEN.      × LAB VANE										○		
182.8	Ground Surface						20	40	60	80	100	10	20	30						
0.0	400mm TOPSOIL		1	SS	3															
182.4																				
0.4	CLAYEY SILT Some sand, trace gravel Stiff to hard Brown-grey Trace rootlets in upper 2 m		2	SS	15															
			3	SS	33															
			4	SS	36															
			5	SS	33															
			6	SS	18															
	Grey		7	SS	12															
			8	SS	15															
			9	TW	PH						×									
				VT																
			10	TW	PH															
		</																		

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT SW8801.1004.101.GPJ ONTARIO MOT.GDT 22/11/11

# RECORD OF BOREHOLE No T8-1

2 OF 3

**METRIC**

W.P. RFP No. 09-54-1007 LOCATION N4678789.7, E333364.5 ORIGINATED BY NB  
 DIST                      HWY WEP BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
 DATUM Geodetic DATE Jul 19, 11 - Jul 20, 11 CHECKED BY MSO

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● POCKET PEN.	+ FIELD VANE × LAB VANE							
14.9	<b>SILTY CLAY</b> Some silt nodules Firm to stiff Grey, some pink nodules <i>(continued)</i>		15	TW	PH								20.4	1 19 35 45		

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT. SW8801.1004.101.GPJ ONTARIO MOT.GDT 22/11/11

# RECORD OF BOREHOLE No T8-1

3 OF 3

**METRIC**

W.P. RFP No. 09-54-1007 LOCATION N4678789.7, E333364.5 ORIGINATED BY NB  
 DIST                      HWY WEP BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
 DATUM Geodetic DATE Jul 19, 11 - Jul 20, 11 CHECKED BY MSO

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 $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE	×	LAB VANE								
152.6							20	40	60	80	100									
30.2	SANDY SILT, with clayey silt layers Some gravel Very dense Grey		25	SS	88															
	-Some limestone fragments		26	SS	50/ 50mm															
150.2																				
32.6	White-Grey LIMESTONE Fine grained, laminated, pitted Rubble between 33.0m and 33.2m		27	RC																
			28	RC																
148.6																				
34.2	Grey LIMESTONE																			
148.1	Fine grained, pitted, stylolitic contact with upper unit, porous																			
34.7	END OF BOREHOLE																			
	No groundwater observed during drilling from July 19 to July 20, 2011 due to wash boring Piezometric Levels in VWP T8-1-P11 (EL. 172.1m) shallow: Aug 29, 2011: EL. 181.2m  Piezometric Levels in VWP T8-1-P21 (EL. 162.2m) mid-depth: Aug 29, 2011: EL. 179.9m																			

+ <sup>3</sup>, × <sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT SW8801.1004.101.GPJ ONTARIO MOT.GDT 22/11/11

# RECORD OF BOREHOLE No CV4-1

1 OF 1

**METRIC**

W.P. RFP No. 09-54-1007 LOCATION N4678867.9, E333368.7 ORIGINATED BY DG  
 DIST                      HWY WEP BOREHOLE TYPE CME 850 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
 DATUM Geodetic DATE Aug 27, 11 - Aug 27, 11 CHECKED BY MSO

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 (%)		
								○ UNCONFINED	● POCKET PEN.	+ FIELD VANE						× LAB VANE		
183.3	Fill Surface						20	40	60	80	100	10	20	30	GR	SA	SI	CL
0.0	75mm ASPHALT Over FILL, sand and gravel																	
182.4	FILL		1	SS	6													
0.9	Silty Clay/Clayey Silt Some topsoil, trace fine gravel, trace sand, brown		2	SS	5													
181.2	CLAYEY SILT		3	SS	9													
2.1	Some sand, trace fine-coarse gravel Stiff to hard Mottled brown-grey		4	SS	29													
			5	SS	30													
	Grey		6	SS	17													
			7	SS	11													
			8	TW	PH													
			VT															
			9	TW	PH													
			10	TW	PH													
			VT															
172.9	END OF BOREHOLE																	
10.4	(no refusal)																	
	Groundwater observed at 3.0 m (El. 180.3 m) during drilling on Aug. 27, 2011																	

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

ONTARIO MOT SW8801.1004.101.GPJ ONTARIO MOT.GDT 22/11/11

# RECORD OF BOREHOLE No HG-MW-3

1 OF 1

METRIC

W.P. RFP No. 09-54-1007 LOCATION N4678886.8, E333395.5 ORIGINATED BY TA  
DIST                      HWY WEP BOREHOLE TYPE CME 75 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
DATUM Geodetic DATE Jul 9, 11 - Jul 9, 11 CHECKED BY MSO

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED	○ FIELD VANE	○ POCKET PEN.	○ LAB VANE								
182.9	Ground Surface																		
180.9	<b>TOPSOIL</b> Brown <b>CLAYEY SILT</b> Some sand, trace gravel, trace topsoil		1	SS	8											-Observation Well installed in sampled borehole			
181.4																			
181.5	Brown Poorly-Graded <b>SAND</b> Trace gravel, trace silt		2	SS	3														
180.5																			
180.5																			
180.5	Brown <b>CLAYEY SILT</b> Some sand, trace gravel Trace fissures		3A, B	SS	1														
179.4																			
179.4			4	SS	29														
179.4	<b>END OF BOREHOLE</b> (no refusal)																		
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			
179.4																			

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No CPT T8-1

1 OF 1

METRIC

W.P. RFP No. 09-54-1007 LOCATION N4678860.0, E333292.9 ORIGINATED BY TA  
DIST                      HWY WEP BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS  
DATUM Geodetic DATE Aug 4, 11 - Aug 4, 11 CHECKED BY MSO

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED ● POCKET PEN.	+ FIELD VANE × LAB VANE	20	40	60						80	100	10
183.2	Fill Surface																			
180.0	<b>FILL</b> Crushed Limestone, Grey						183													
0.2	<b>FILL</b> Clayey silt, some gravel, brown																			
182.4	<b>SANDY SILT</b> Some clay, trace gravel Mottled brown-grey to brown		1	SS	7		182													
0.8																				
181.2			2	SS	9															
2.0	<b>END OF SAMPLED BOREHOLE</b> Continue with CPT from 2 m to refusal at 32.4 m (El. 181.2 m to El. 150.8 m)  No groundwater observed on Aug. 4, 2011						181													
							180													
							179													
							178													
							177													
							176													
							175													
							174													
							173													
							172													
							171													
							170													
							169													

+ <sup>3</sup>, × <sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# RECORD OF CONE PENETRATION TEST CPT T8-1

**METRIC**

PROJECT Windsor-Essex Parkway

TEST DATE 8/4/2011 - 8/4/2011

SHEET 1 OF 3

LOCATION N4678860.0; E333292.9

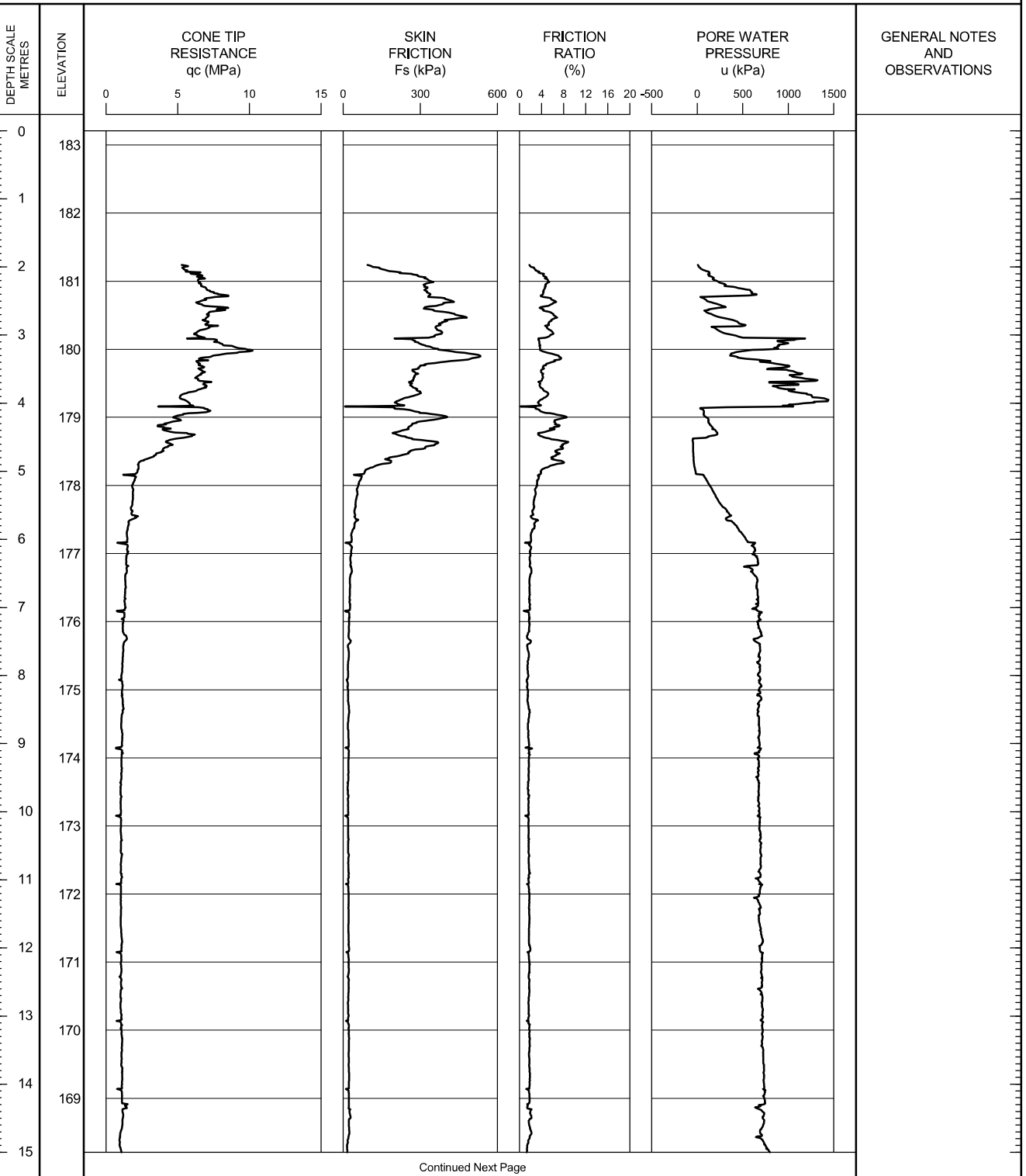
DATUM Geodetic

GROUND SURFACE ELEVATION: 183.2

PREDRILL DEPTH: 1.82

CORRECTION FACTOR A: 0.8

CORRECTION FACTOR B: 0



OPERATOR: TA

CHECKED: DD



# RECORD OF CONE PENETRATION TEST CPT T8-1

**METRIC**

PROJECT Windsor-Essex Parkway

TEST DATE 8/4/2011 - 8/4/2011

SHEET 2 OF 3

LOCATION N4678860.0; E333292.9

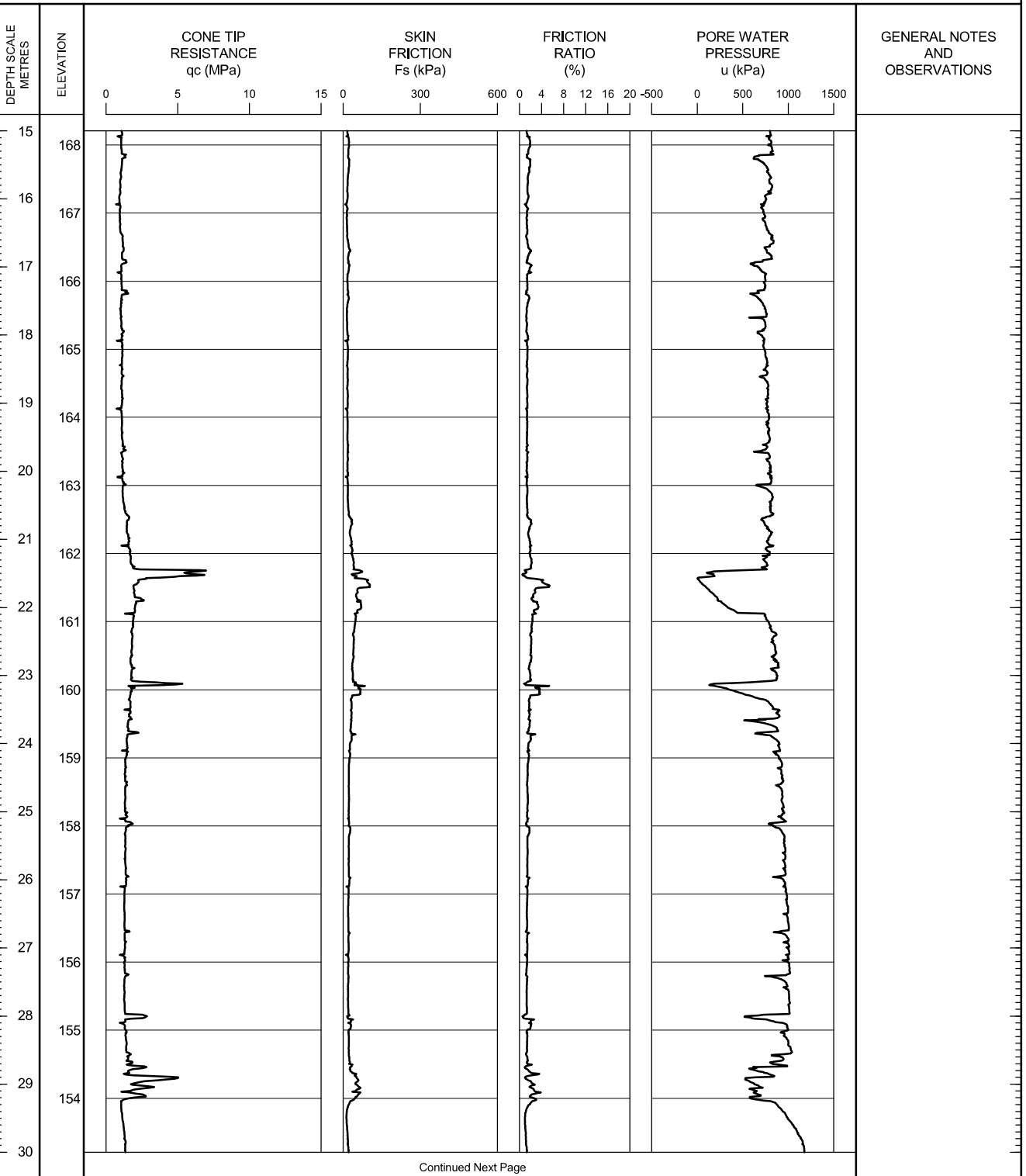
DATUM Geodetic

GROUND SURFACE ELEVATION: 183.2

PREDRILL DEPTH: 1.82

CORRECTION FACTOR A: 0.8

CORRECTION FACTOR B: 0



OPERATOR: TA

CHECKED: DD

# RECORD OF CONE PENETRATION TEST CPT T8-1

METRIC

PROJECT Windsor-Essex Parkway

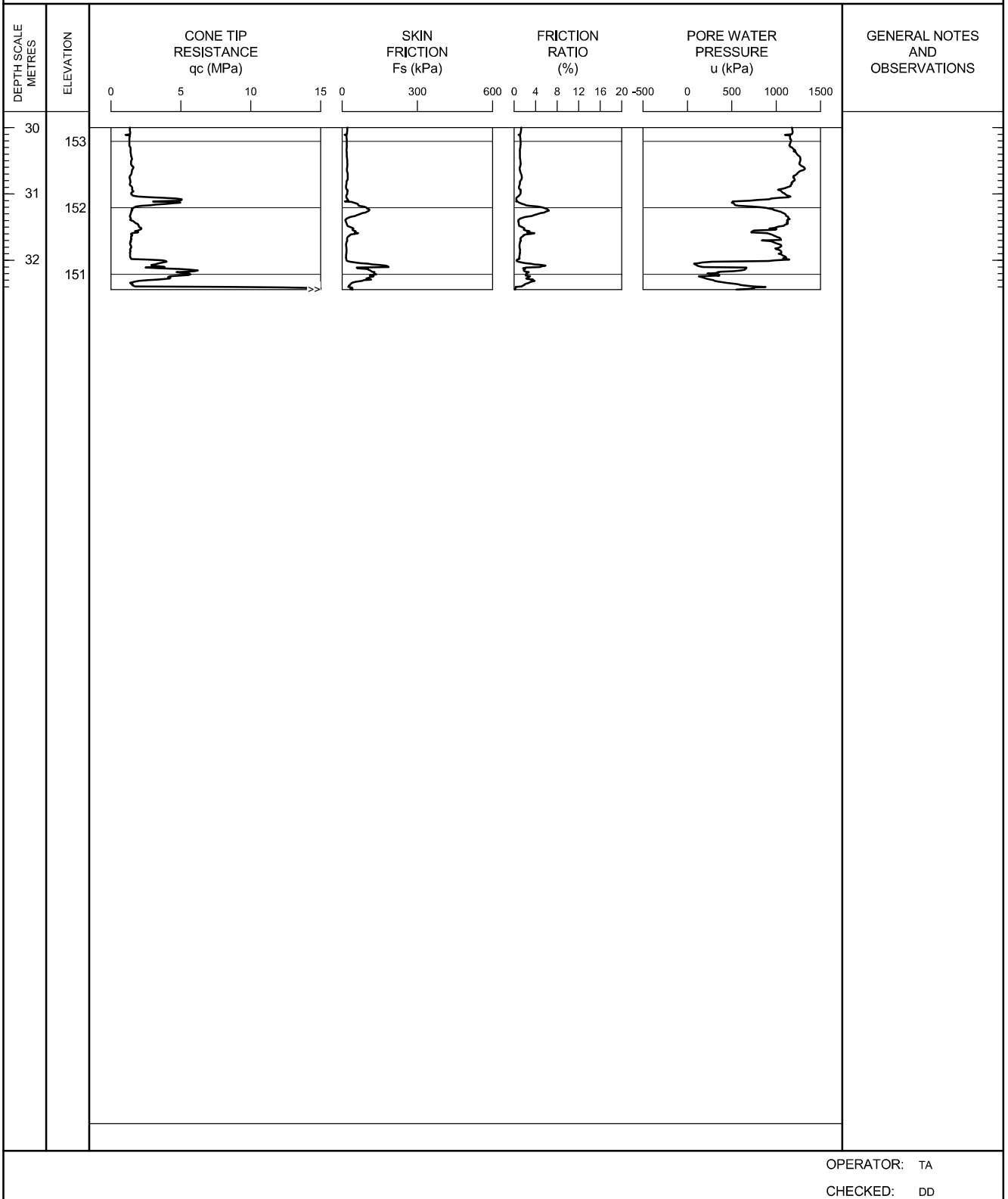
TEST DATE 8/4/2011 - 8/4/2011

SHEET 3 OF 3

LOCATION N4678860.0; E333292.9

DATUM Geodetic

GROUND SURFACE ELEVATION: 183.2    PREDRILL DEPTH: 1.82    CORRECTION FACTOR A: 0.8    CORRECTION FACTOR B: 0



OPERATOR: TA

CHECKED: DD

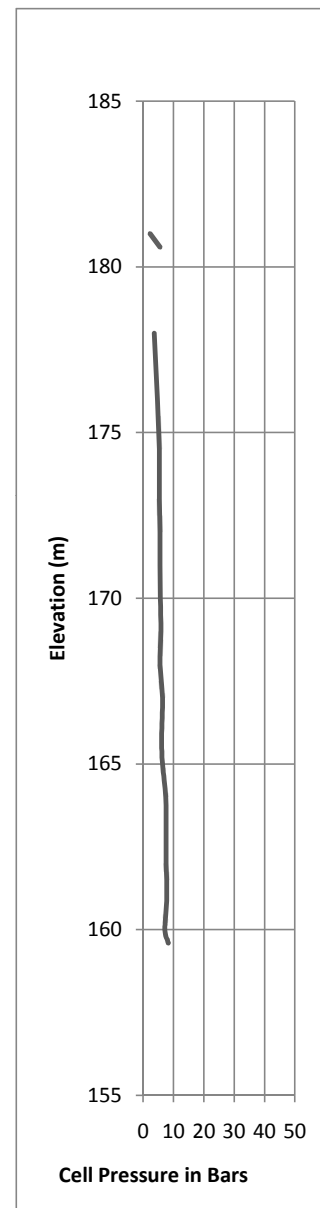
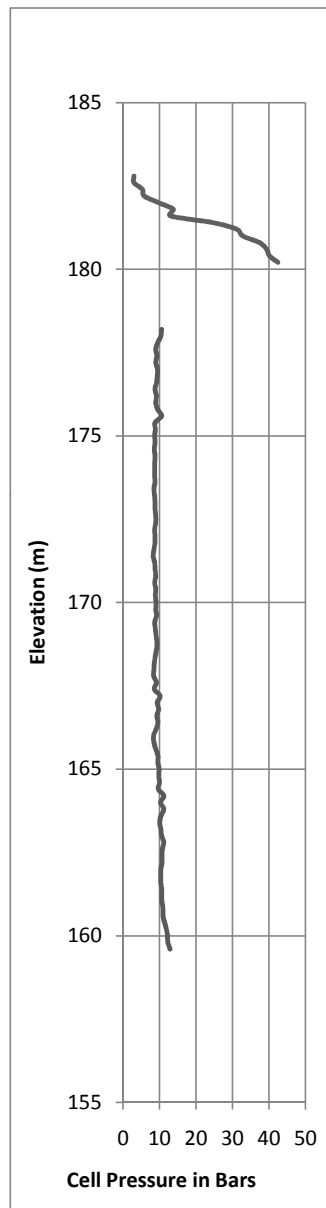
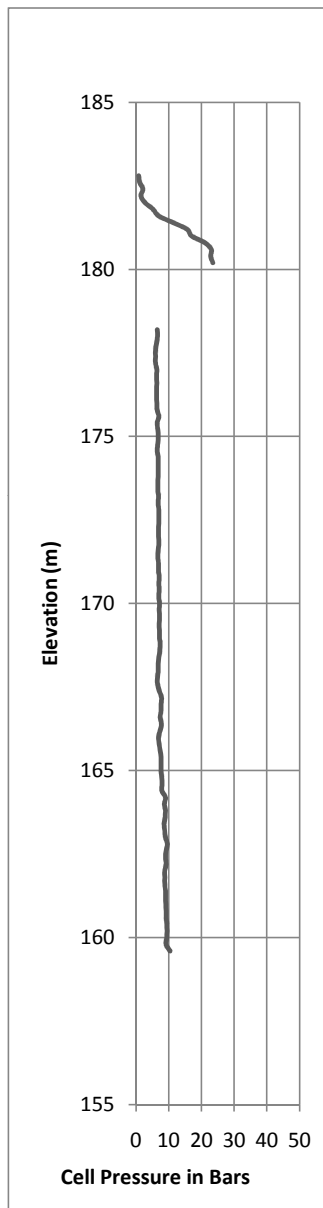


**RECORD OF DILATOMETER TEST DMT T8-1**

Project : Windsor-Essex Parkway  
Location: 4678821N; 333383E  
Ground Surface Elevation : 183.0

Test Date: 7/18/2011  
Predrill Depth : 0.2 m  
Delta A: 0.14 Bar

Sheet 1 of 1  
Datum Geodetic  
Delta B: 0.18 Bar



Note: The first test run terminated at a shallow depth due to hard pushing conditions.  
The hole was then predrilled to a depth of 4.8 m and the second test run was conducted.

Operator: LC

Checked: DD

## Appendix B      Borehole Logs from Previous Investigations

# RECORD OF BOREHOLE No 7

1 OF 4

METRIC

PROJECT 04-1111-060

W.P.

LOCATION

N 4678848.0 :E 333325.0

ORIGINATED BY C.C.

DIST WEST HWY 401 / 3

BOREHOLE TYPE POWER AUGER, HOLLOW STEM

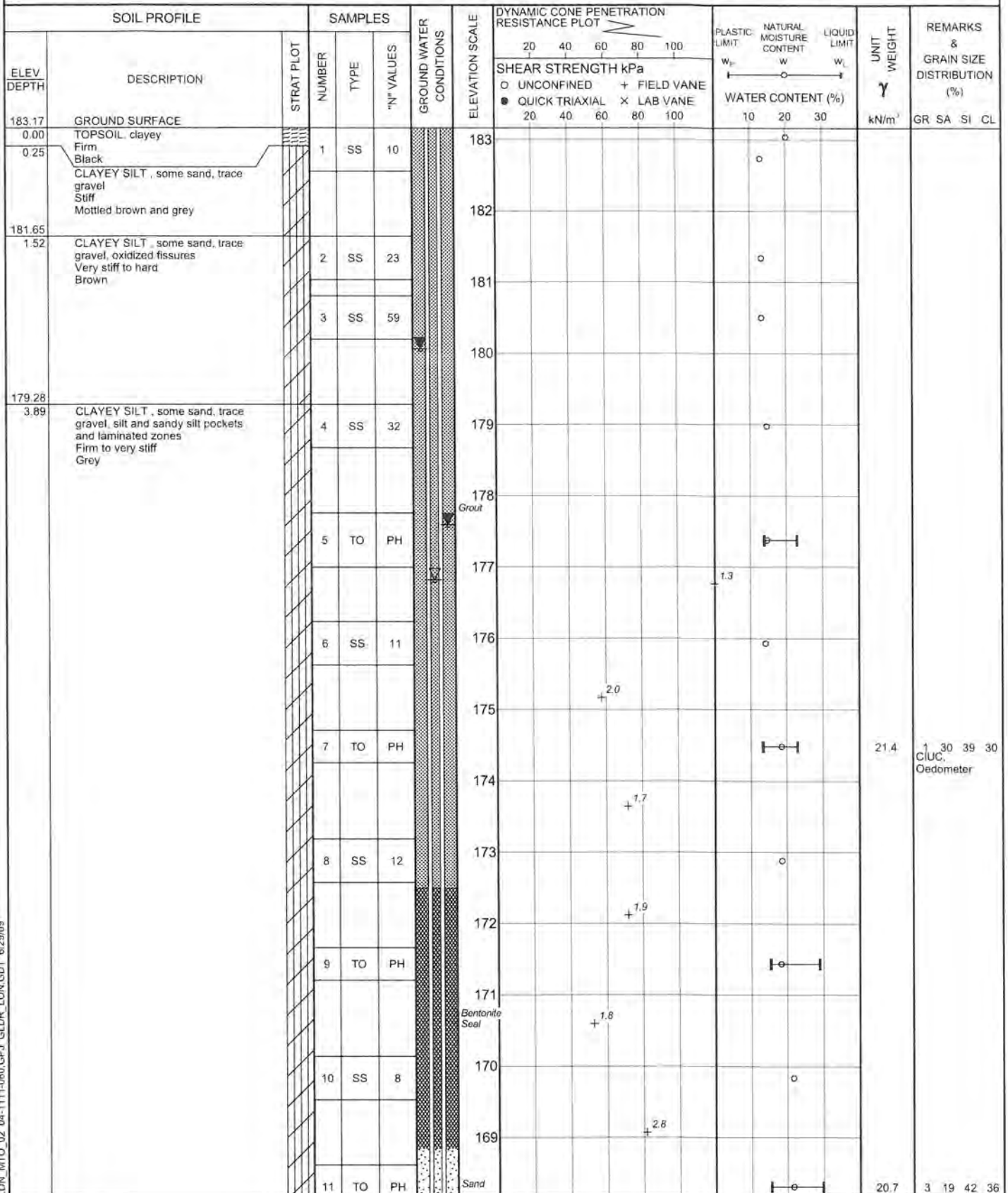
COMPILED BY T.M.

DATUM Geodetic

DATE

November 10, 2006 - November 16, 2006

CHECKED BY *SB*



Continued Next Page

+ 3 x 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

PROJECT <u>04-1111-060</u>		<b>RECORD OF BOREHOLE No 7</b>		2 OF 4	<b>METRIC</b>
W.P. _____	LOCATION <u>N 4678848.0 :E 333325.0</u>	ORIGINATED BY <u>C.C.</u>			
DIST <u>WEST</u> HWY <u>401/3</u>	BOREHOLE TYPE <u>POWER AUGER/HOLLOW STEM</u>	COMPILED BY <u>T.M.</u>			
DATUM <u>Geodetic</u>	DATE <u>November 10, 2006 - November 16, 2006</u>	CHECKED BY <u>SJS</u>			

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
	CLAYEY SILT , some sand, trace gravel, silt and sandy silt pockets and laminated zones Firm to very stiff Grey						168						CIUC, Oedometer		
								167							
			12	TO	PH			166							
			13	SS	12			165							
			14	TO	PH			164							
			15	TO	PH			163							
			16	SS	21			162							
			17	SS	PH			161							
			18	SS	13			160							
			19	SS	12			159							
			20	TO	PH			158							
			21	SS	9			157							
			22	SS	PH			156							
								155							
								154							

LDN\_MTO\_02 04-1111-060.GPJ GLDR LON.GDT 6/29/03

Continued Next Page

+<sup>3</sup> ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



# RECORD OF BOREHOLE No 7

3 OF 4

METRIC

PROJECT 04-1111-060

W.P.

LOCATION

N 4678848.0 ; E 333325.0

ORIGINATED BY C.C.

DIST WEST HWY 401 / 3

BOREHOLE TYPE POWER AUGER, HOLLOW STEM

COMPILED BY T.M.

DATUM Geodetic

DATE

November 10, 2006 - November 16, 2006

CHECKED BY **SB**

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
						20 40 60 80 100	20 40 60 80 100	10 20 30							
150.02	CLAYEY SILT, some sand, trace gravel, silt and sandy silt pockets and laminated zones Firm to very stiff Grey		23	SS	13		153								
							152								
			24	SS	PH										
							151								
			25	SS	42										
33.15	LIMESTONE, fresh, medium strong, laminated, very fine grained, moderately porous, light grey  (FOR DETAILED DESCRIPTIONS REFER TO RECORD OF DRILLHOLE)		26	NQ RC			150								
			27	NQ RC			149								
							148								
			28	NQ RC			147								
							146								
145.28	END OF BOREHOLE		29	NQ RC										UC	
37.89	Water level in borehole at about elevation 176.82m on October 16, 2006  Lower piezometer 32mm PVC screen and riser pipe. Second (Upper) piezometer 13mm porous tip and CPVC riser pipe.  Water level in Upper Piezometer at about elevation 180.06m on November 14, 2006.  Water level in Lower Piezometer at about elevation 177.59m on November 14, 2006.														

PROJECT: 04-1111-060

## RECORD OF DRILLHOLE: 7

SHEET 4 OF 4

LOCATION: N 4678848.0 ; E 333325.0



DRILLING DATE: November 10, 2006 - November 16, 2006

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG:

DRILLING CONTRACTOR:

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		PENETRATION RATE (m/min)	COLOUR FLUSH % RETURN	ELEVATION											ROCK STRENGTH INDEX		WEATH- ERING INDEX		NOTES WATER LEVELS INSTRUMENTATION			
				DEPTH (m)	RUN No.				RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3	DISCONTINUITY DATA				TYPE AND SURFACE DESCRIPTION	R1	R2	R3	WT	X2		X3	X4	
									TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	G	R	S										U
		ROCK SURFACE		150.04				150																		
	MUD ROTARY NW CASING	LIMESTONE, fresh, medium strong, laminated, very fine grained, faintly to moderately porous, light grey		33.13	1																					
		149.64																								
34		LIMESTONE, fresh, medium strong, laminated to thinly laminated, very fine grained, faintly to moderately porous, light grey		33.53	2			149																		
	DIAMOND DRILLING NO ROCK CORE	LIMESTONE, fresh, medium strong, laminated to thinly laminated, very fine grained, faintly to moderately porous, light grey		148.02				148																		
		35.15		3																						
36		Moderately to highly porous from 35.4m to 35.8m and from 36.5m to 36.9m depths.								147																
37					4			146																		
		END OF BOREHOLE		145.28																						
				37.89																						
38																										
39																										
40																										
41																										
42																										
43																										
44																										
45																										
46																										
47																										
48																										

DEPTH SCALE

1 : 75



LOGGED: C.C.

CHECKED: SB

# RECORD OF BOREHOLE No 118

1 OF 4

METRIC

PROJECT 07-1130-207-0

W.P.

LOCATION

N 4678903 5 :E 333302.9

ORIGINATED BY MA

DIST WEST HWY 401/3

BOREHOLE TYPE POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC

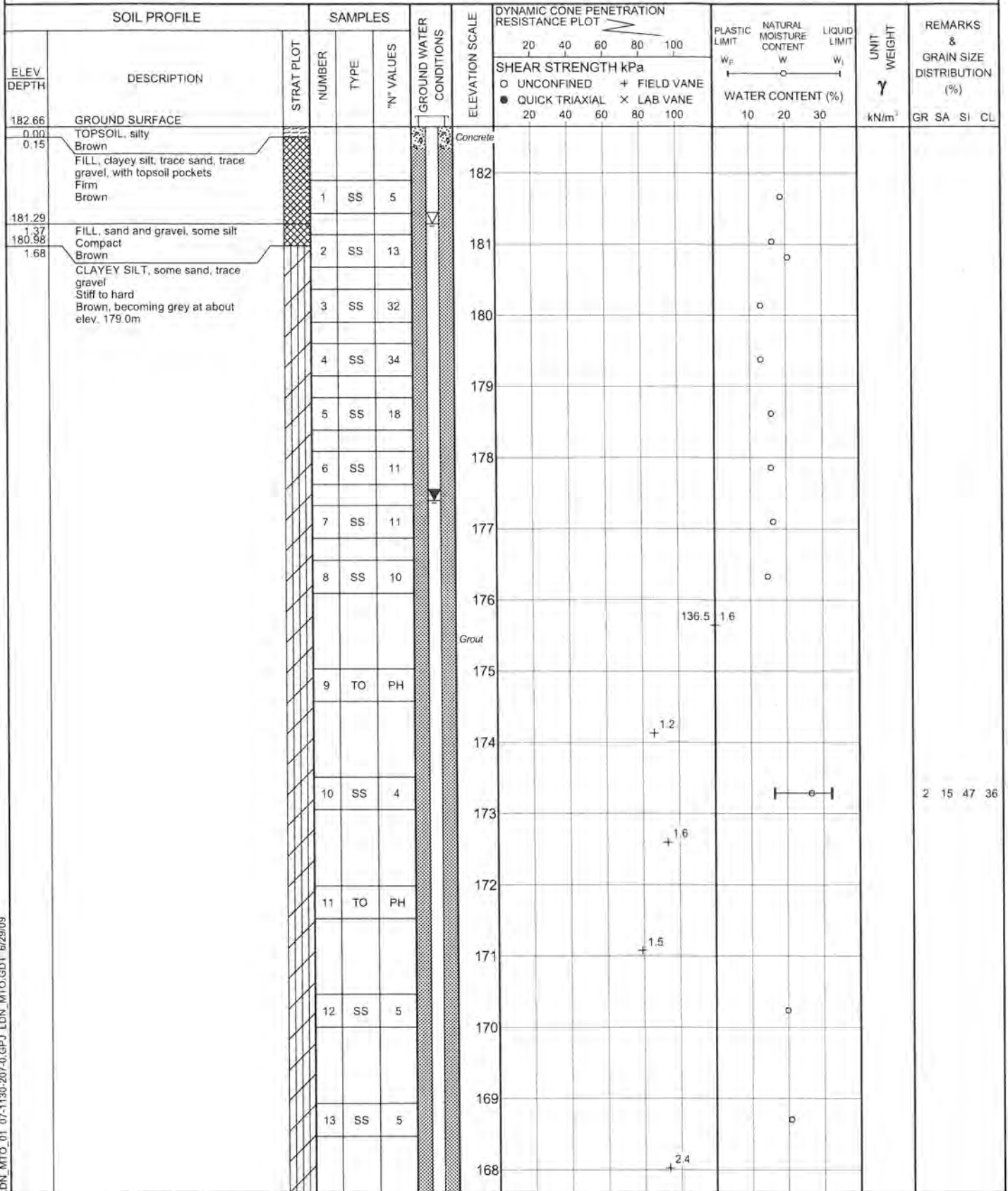
COMPILED BY BRS

DATUM GEODETIC

DATE

February 28, 2008 - March 4, 2008

CHECKED BY SSB

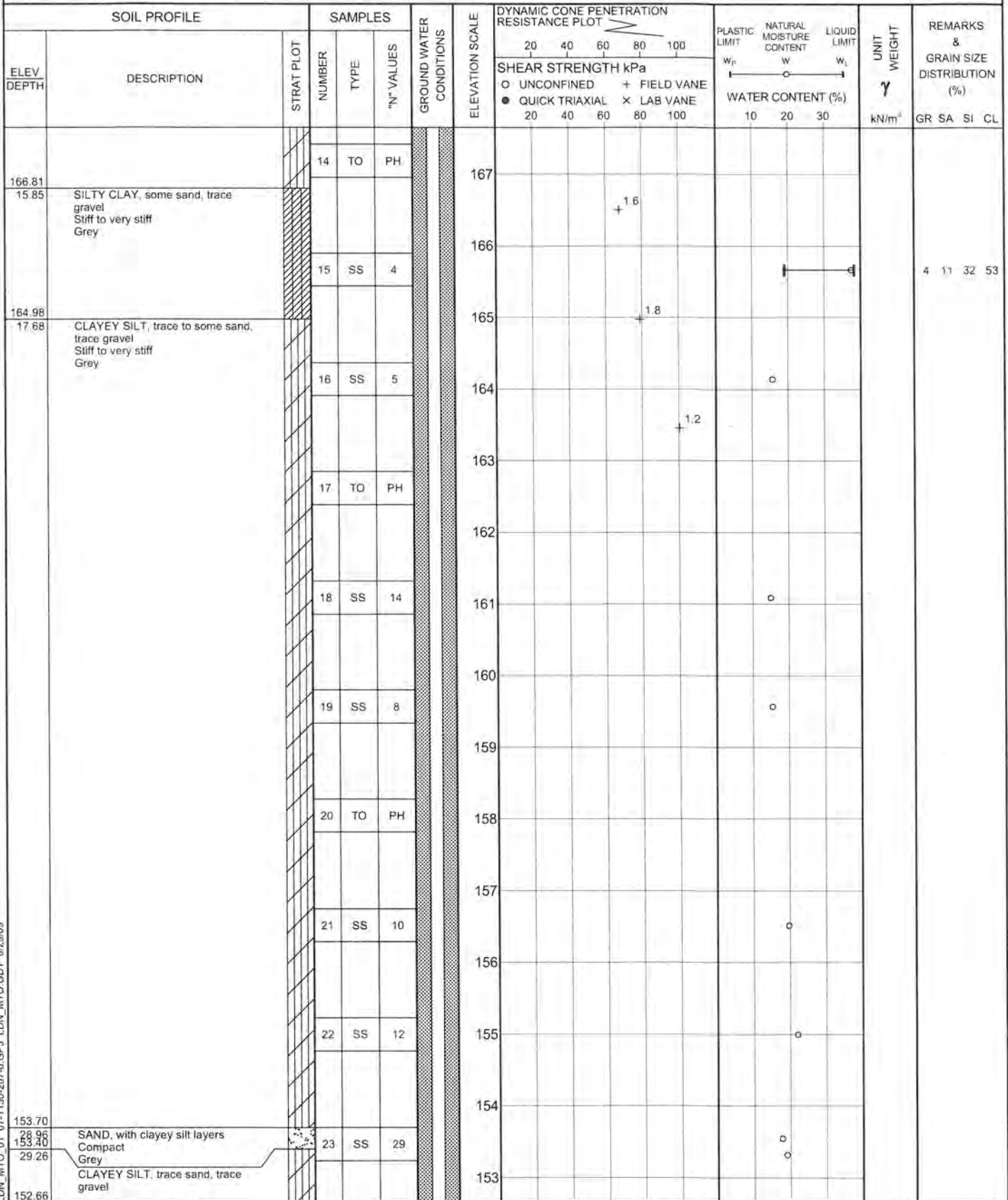


LDN\_MTO\_01 07-1130-207-0.GPJ LDN\_MTO.GDT 6/29/09

Continued Next Page

+ 3, x 3, Numbers refer to Sensitivity  
○ 3% STRAIN AT FAILURE

PROJECT <u>07-1130-207-0</u>		<b>RECORD OF BOREHOLE No 118</b>		2 OF 4	<b>METRIC</b>
W.P. _____		LOCATION <u>N 4678903.5 :E 333302.9</u>		ORIGINATED BY <u>MA</u>	
DIST <u>WEST</u> HWY <u>401/3</u>		BOREHOLE TYPE <u>POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC</u>		COMPILED BY <u>BRS</u>	
DATUM <u>GEODETIC</u>		DATE <u>February 28, 2008 - March 4, 2008</u>		CHECKED BY <u>SJB</u>	



Continued Next Page

+ 3, x 3, Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

LDN MTO\_01 07-1130-207-0.GPJ LDN\_MTO\_GDT 6/29/09

# RECORD OF BOREHOLE No 118

3 OF 4

METRIC

PROJECT 07-1130-207-0

W.P.

LOCATION

N 4678903.5 :E 333302.9

ORIGINATED BY MA

DIST WEST HWY 401/3

BOREHOLE TYPE POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC

COMPILED BY BRS

DATUM GEODETIC

DATE

February 28, 2008 - March 4, 2008

CHECKED BY SJS

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  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE
30.02	Very stiff Grey SILTY SAND, trace clay, trace gravel Compact Grey		24	SS	19										4 48 39 9		
150.96							152										
31.70	SILTY SAND AND GRAVEL, trace clay Dense Grey		25	SS	100/ 76mm		151										
150.32																	
32.34	LIMESTONE, fresh, medium strong, thinly laminated, fine grained, moderately porous Whitish grey  (FOR DETAILED DESCRIPTIONS REFER TO RECORD OF DRILLHOLE)		26	NQ RC			150	100	60	25						UC	
			27	NQ RC			149	99	98	82							
			28	NQ RC			148										
146.61							147										
36.05	END OF BOREHOLE																
	Water levels in borehole at about elev. 181.29m, 153.70m and 150.96m during drilling between February 28 and March 4, 2008.																
	Water level measured in deep piezometer at elev. 176.77m on March 4, 2008.																
	Water level measured in deep piezometer at elev. 177.30m on March 20, 2008.																
	Water level measured in deep piezometer at elev. 177.78m on July 24, 2008.																
	Water level measured in deep piezometer at elev. 177.32m on September 19, 2008.																
	Water level measured in deep piezometer at elev. 177.28m on November 14, 2008.																
	Water level measured in deep piezometer at elev. 177.40m on January 28, 2009.																

+ 3 X 3

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE



PROJECT: 07-1130-207-0

## RECORD OF DRILLHOLE: 118

SHEET 4 OF 4

LOCATION: N 4678903.5 ;E 333302.9


DRILLING DATE: February 28, 2008 - March 4, 2008

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: —

DRILL RIG: MUD ROTARY WITH HQ TRICONE, NQRC

DRILLING CONTRACTOR: AARDVARK DRILLING INC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR FLUSH % RETURN	ELEVATION	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth Ro - Rough Br - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols										DIAMETRAL CORE LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION			
									RECOVERY		FRACT INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec									
									TOTAL CORE %	SOLID CORE %		TYPE AND SURFACE DESCRIPTION											
									80 60 40 20	80 60 40 20		DIP w.r.t. CORE AXIS	0 30 60 90	10 <sup>-5</sup> 10 <sup>-4</sup> 10 <sup>-3</sup> 10 <sup>-2</sup>									
		ROCK SURFACE		150.32																			
	MUD ROTARY NO ROCK CORE	LIMESTONE, fresh, medium strong, thinly laminated, fine grained, faintly porous, whitish grey		32.34	1			150															
33				LIMESTONE, fresh, medium strong, thinly laminated, fine grained, faintly porous, grey	149.56																		
					33.10																		
					149.22																		
					33.44	2			149														
34				LIMESTONE, fresh, medium strong, thinly laminated, fine to very fine grained, pitted, whitish grey																			
					147.97																		
				LIMESTONE, fresh, medium strong, thinly laminated, very fine grained, moderately porous, light grey	34.69																		
					147.61	3			148														
35		LIMESTONE, fresh, medium strong, thinly laminated, fine grained, pitted to vuggy, light brown to grey	35.05																				
36		END OF DRILLHOLE		146.60																			
				36.06																			
37																							
38																							
39																							
40																							
41																							
42																							
43																							
44																							
45																							
46																							
47																							

LDN ROCK 03 07-1130-207-0-ROCK GPJ GLDR LDN GDT 6/29/09 DATA INPUT WDF

DEPTH SCALE

1:75



LOGGED: SG

CHECKED: SSB

PROJECT		RECORD OF BOREHOLE		No 118A		1 OF 1		METRIC	
W.P.		LOCATION		N 4678903.5 E 333302.9		ORIGINATED BY		MA	
DIST		HWY		BOREHOLE TYPE		POWER AUGER, SOLID STEM		COMPILED BY	
BRS		BRS		BRS		BRS		BRS	
DATUM		GEOIDETIC		DATE		March 4, 2008		CHECKED BY	
SB		SB		SB		SB		SB	
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa	
ELEV DEPTH		DESCRIPTION		STRAT PLOT		NUMBER		TYPE	
182.66		SOIL CONDITIONS INFERRED FROM BOREHOLE No. 118		GROUND SURFACE		TOPSOIL, silty		Brown	
0.00		FILL, clayey silt, trace sand, trace gravel, with topsoil pockets		Firm		Brown		Brown	
0.15		FILL, sand and gravel, some silt		Compact		Brown		Brown	
1.37		CLAYEY SILT, some sand, trace gravel		Stiff to hard		Brown, becoming grey at about elev. 179.0m		Brown	
180.95		1.68		1.37		180.95		1.68	
181.29		180.95		1.68		1.37		180.95	
182		181		180		179		178	
181		180		179		178		177	
180		179		178		177		176	
179		178		177		176		175	
178		177		176		175		174	
177		176		175		174		173	
176		175		174		173		172	
175		174		173		172		171	
174		173		172		171		170	
173		172		171		170		169	
172		171		170		169		168	
171		170		169		168		167	
170		169		168		167		166	
169		168		167		166		165	
168		167		166		165		164	
167		166		165		164		163	
166		165		164		163		162	
165		164		163		162		161	
164		163		162		161		160	
163		162		161		160		159	
162		161		160		159		158	
161		160		159		158		157	
160		159		158		157		156	
159		158		157		156		155	
158		157		156		155		154	
157		156		155		154		153	
156		155		154		153		152	
155		154		153		152		151	
154		153		152		151		150	
153		152		151		150		149	
152		151		150		149		148	
151		150		149		148		147	
150		149		148		147		146	
149		148		147		146		145	
148		147		146		145		144	
147		146		145		144		143	
146		145		144		143		142	
145		144		143		142		141	
144		143		142		141		140	
143		142		141		140		139	
142		141		140		139		138	
141		140		139		138		137	
140		139		138		137		136	
139		138		137		136		135	
138		137		136		135		134	
137		136							

+3, X3. Numbers refer to Sensitivity      O 3% STRAIN AT FAILURE



PROJECT 09-1132-0080		RECORD OF BOREHOLE No CPT-315		1 OF 1		METRIC						
W.P. _____		LOCATION N 4678800.6 ; E 333406.3		ORIGINATED BY TA								
DIST WEST HWY 401 / 3		BOREHOLE TYPE POWER AUGER, SOLID STEM		COMPILED BY DMB								
DATUM GEODETIC		DATE January 21, 2010		CHECKED BY _____								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT  W <sub>p</sub> W      W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
184.31 0.00	GROUND SURFACE TOPSOIL, clayey Very stiff Black		1	SS	16		184					
182.94 1.37	CLAYEY SILT, some sand, trace gravel, with occasional fissures and silt partings Stiff to hard Brown		2	SS	12		183					
			3	SS	11		182					
			4	SS	48		181					
			5	SS	50		180					
179.89 4.42	END OF BOREHOLE  Groundwater encountered at about elev. 180.5m during drilling on January 21, 2010.											

PROJECT: 07-1130-207-0

## RECORD OF CONE PENETRATION TEST CPT-7

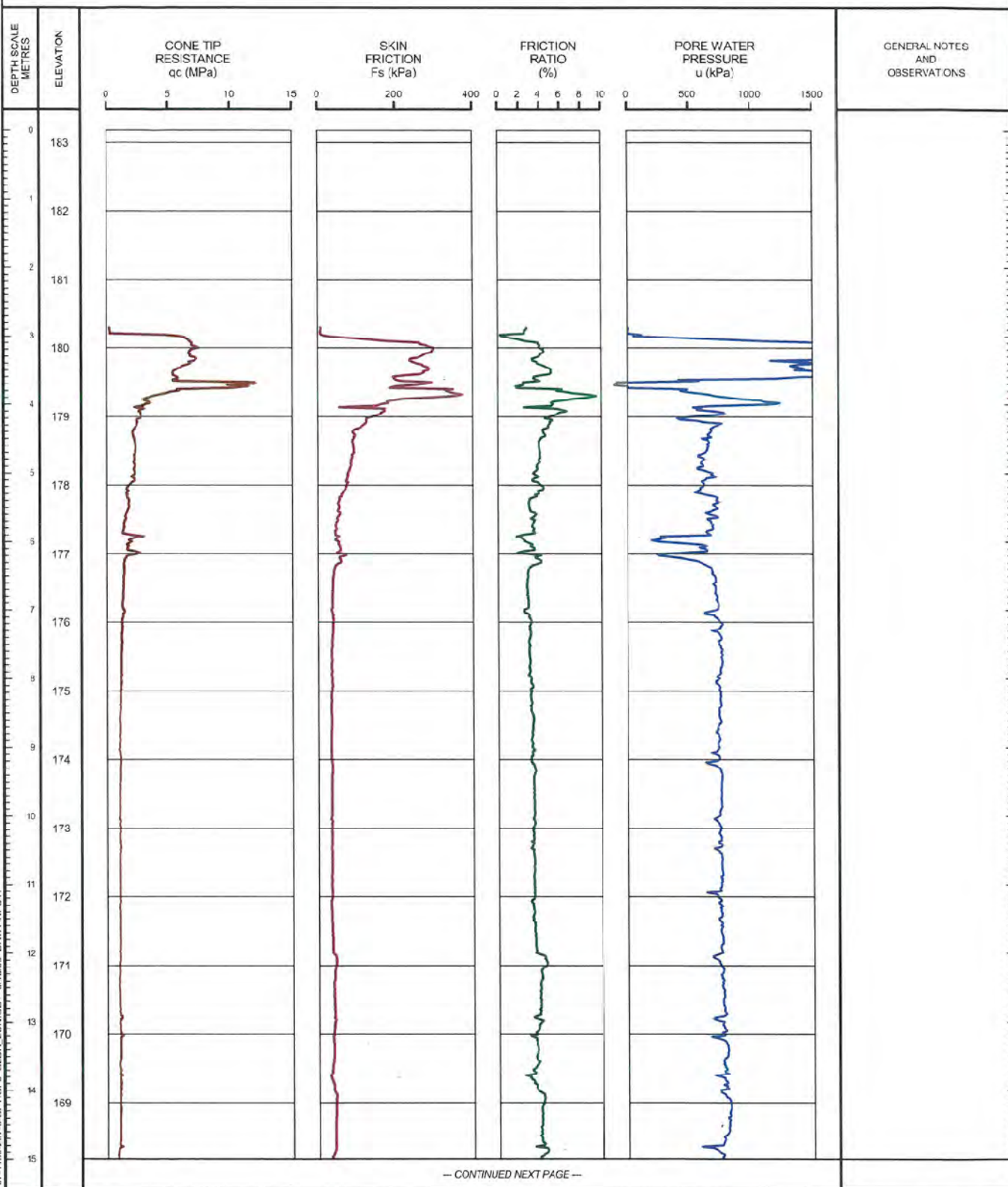
SHEET 1 OF 2

LOCATION: N 4578844.0; E 333327.0

TEST DATE: November 12, 2006

DATUM: GODETIC

GROUND SURFACE ELEVATION: PREDRILL DEPTH: 2.90m CORRECTION FACTOR A: 0.584 CORRECTION FACTOR B: 0.012



LDN CPT 01 07-1130-207-0-CPT GPJ GLDR LON.GDT 61809 DATA INPUT:

DEPTH SCALE

1:75



OPERATOR: CC

CHECKED: SJB

PROJECT: 07-1130-207-0

## RECORD OF CONE PENETRATION TEST CPT-7

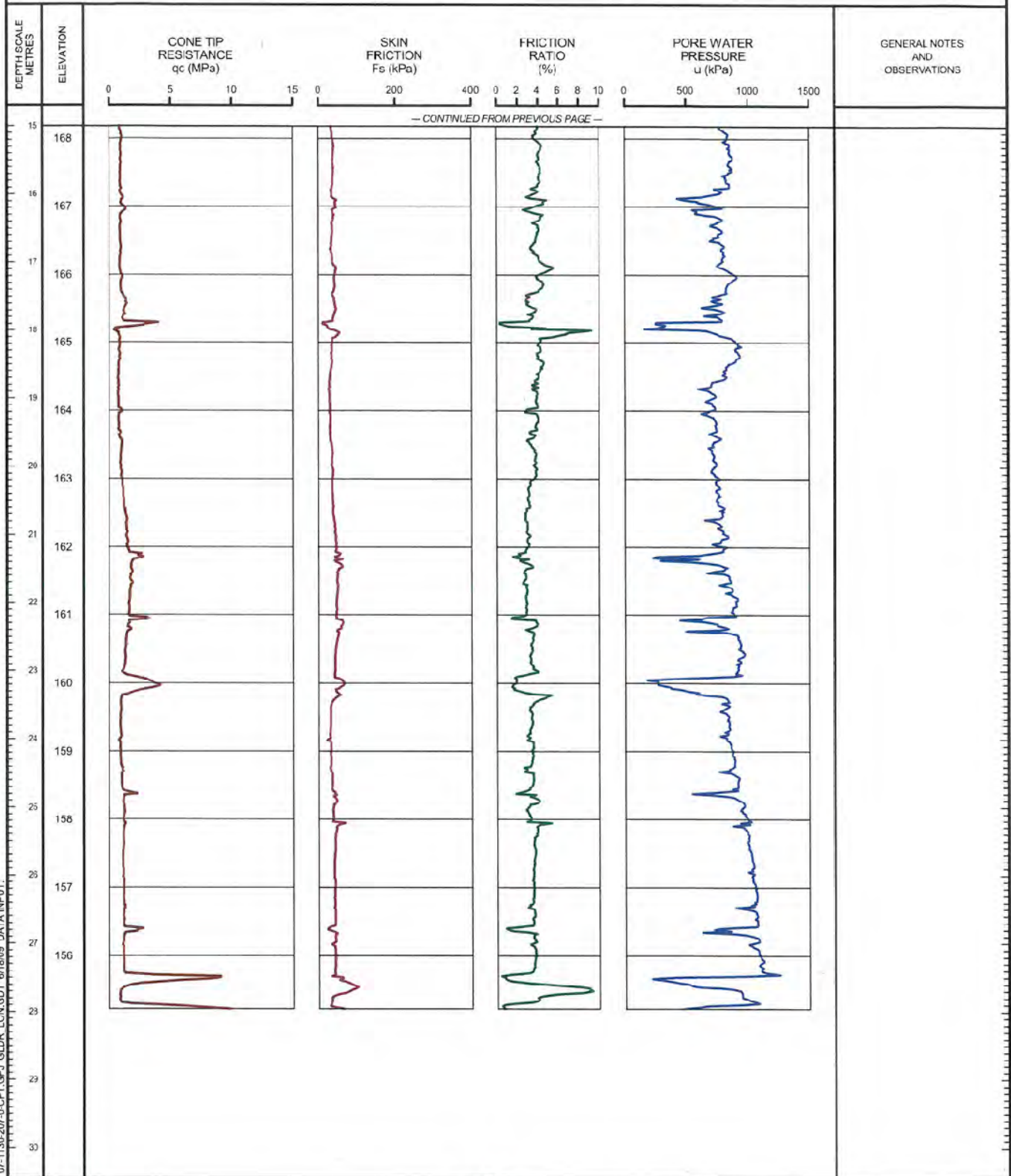
SHEET 2 OF 2

LOCATION: N 4578844.0 ; E 333327.0

TEST DATE: November 12, 2006

DATUM: GEODETIC

GROUND SURFACE ELEVATION: PREDRILL DEPTH: 2.90m CORRECTION FACTOR A: 0.584 CORRECTION FACTOR B: 0.012



LDN CPT 01 07-1130-207-0-CPT.GPJ GLDR LCM.GDT 6/18/09 DATA INPUT:

DEPTH SCALE

1 : 75



OPERATOR: CC

CHECKED:

PROJECT: 09-1132-0080

**RECORD OF CONE PENETRATION TEST CPT-315**

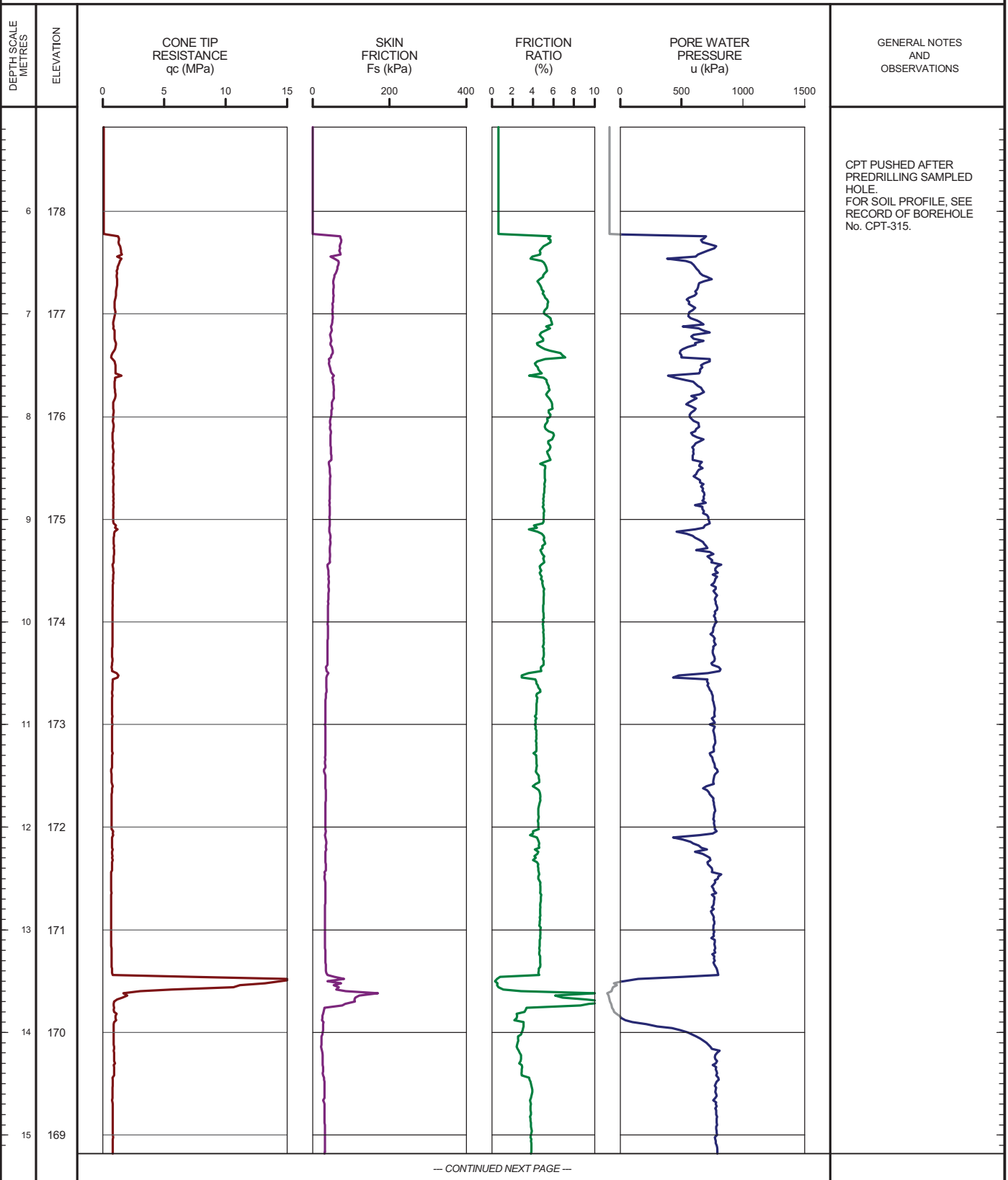
SHEET 1 OF 3

LOCATION: N 4678800.6 ; E 333406.3

TEST DATE: January 22, 2010

DATUM: GEODETIC

GROUND SURFACE ELEVATION: 184.31m PREDRILL DEPTH: 5.18m CORRECTION FACTOR A: 0.584 CORRECTION FACTOR B: 0.012



LDN\_CPT\_01\_09-1132-0080-CPT.GPJ GLDR\_LON.GDT 02/23/10 DATA INPUT:

DEPTH SCALE

1 : 50



OPERATOR: TA

CHECKED:

PROJECT: 09-1132-0080

## RECORD OF CONE PENETRATION TEST CPT-315

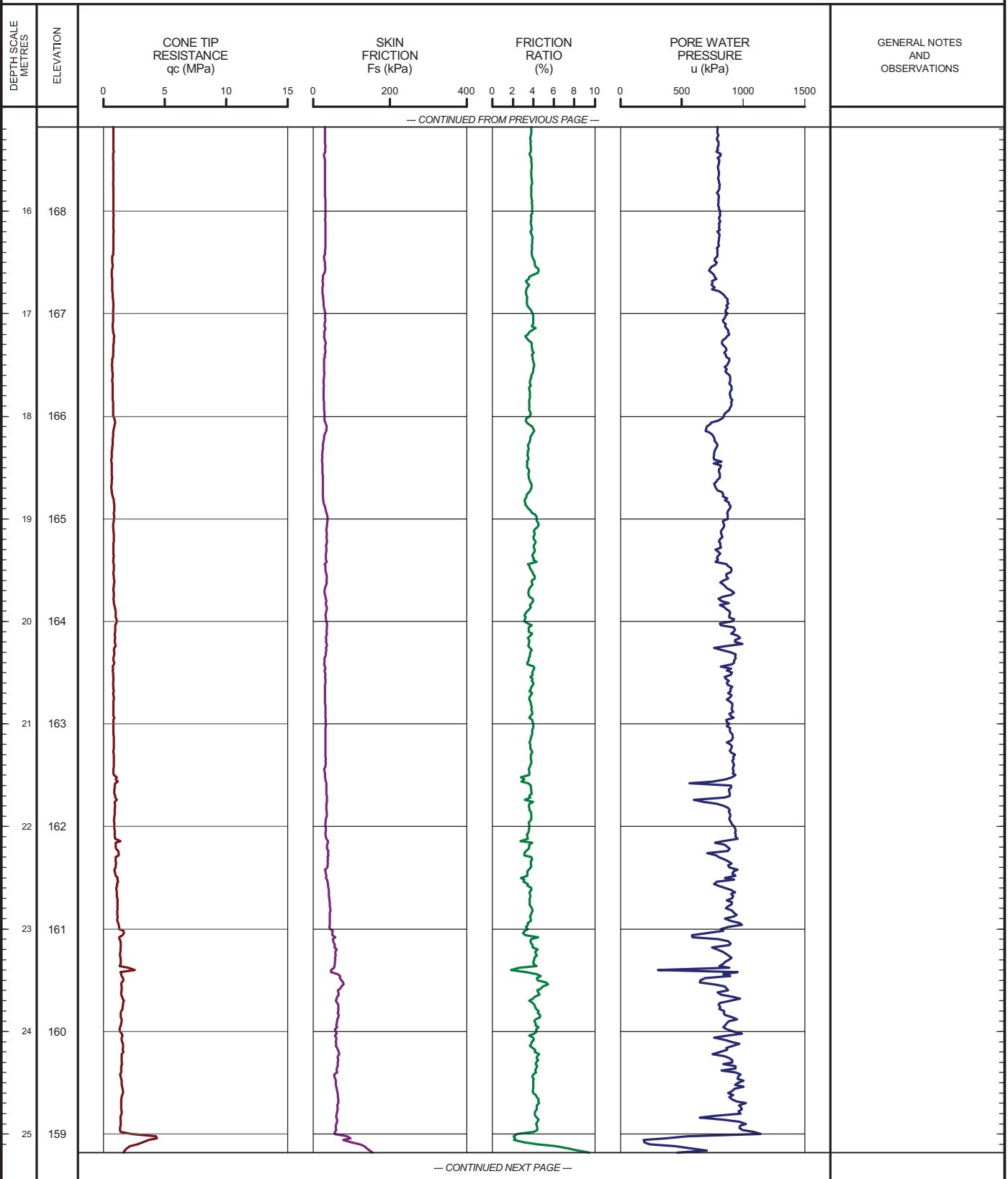
SHEET 2 OF 3

LOCATION: N 4678800.6 ; E 333406.3

TEST DATE: January 22, 2010

DATUM: GEODETIC

GROUND SURFACE ELEVATION: 184.31m PREDRILL DEPTH: 5.18m CORRECTION FACTOR A: 0.584 CORRECTION FACTOR B: 0.012



DEPTH SCALE

1 : 50



OPERATOR: TA

CHECKED:

LDN\_CPT\_01\_09-1132-0080-CPT.GPJ GLDR\_LON.GDT 02/23/10 DATA INPUT:

PROJECT: 09-1132-0080

## RECORD OF CONE PENETRATION TEST CPT-315

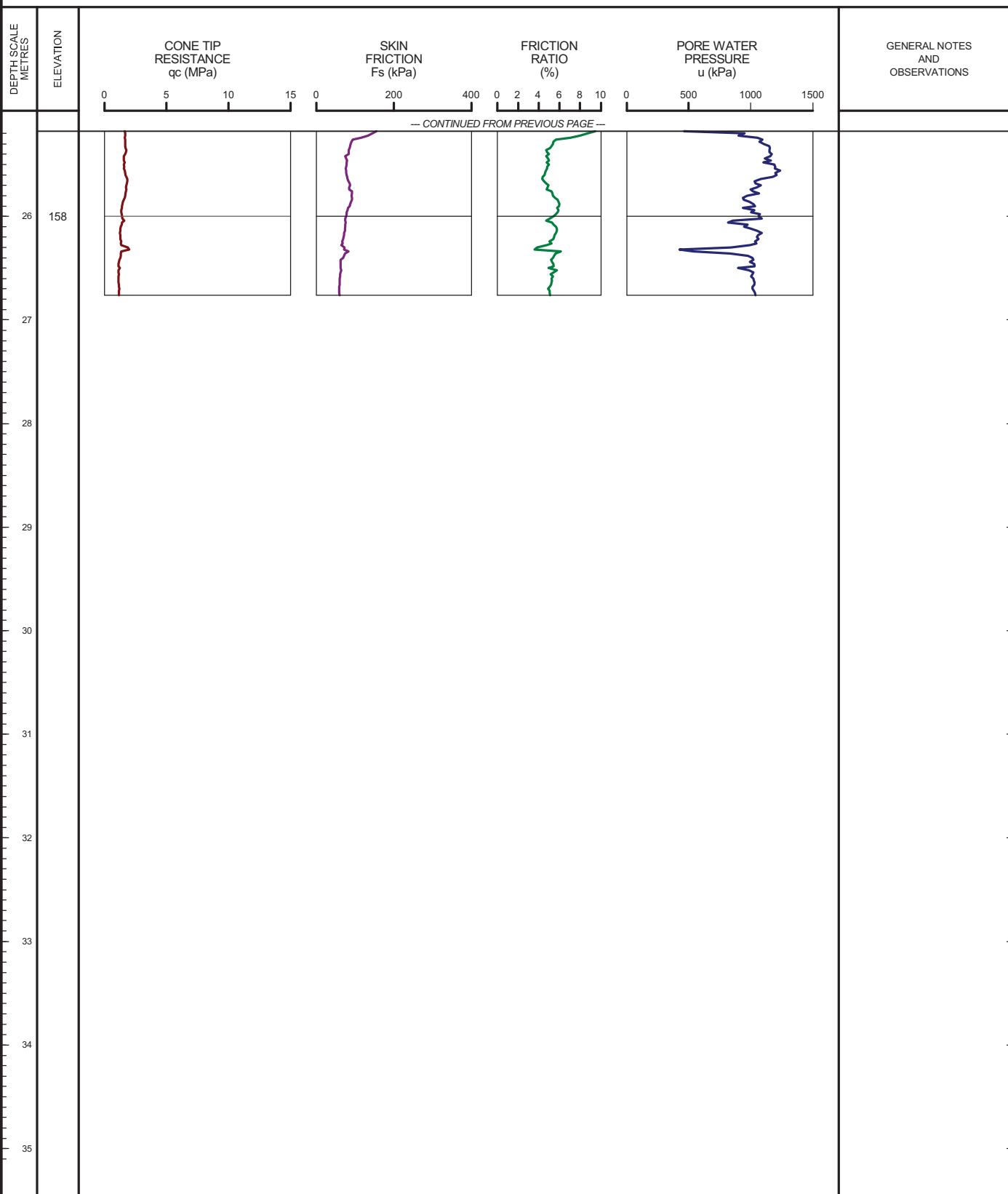
SHEET 3 OF 3

LOCATION: N 4678800.6 ; E 333406.3

TEST DATE: January 22, 2010

DATUM: GEODETIC

GROUND SURFACE ELEVATION: 184.31m PREDRILL DEPTH: 5.18m CORRECTION FACTOR A: 0.584 CORRECTION FACTOR B: 0.012



DEPTH SCALE

1 : 50



OPERATOR: TA

CHECKED:

LDN\_CPT\_01\_09-1132-0080-CPT.GPJ GLDR\_LON.GDT 02/23/10 DATA INPUT:

## Appendix C      Analytical Laboratory Results





AMEC EARTH & ENVIRONMENTAL  
ATTN: SHANE MACLEOD  
11865 County Road 42  
TECUMSEH ON N8N 2M1

Date Received: 25-JUL-11  
Report Date: 29-JUL-11 20:52 (MT)  
Version: FINAL

Client Phone: 519-735-2499

## Certificate of Analysis

<b>Lab Work Order #:</b>	<b>L1035570</b>
Project P.O. #:	NOT SUBMITTED
Job Reference:	SW8801.1004.101
Legal Site Desc:	
C of C Numbers:	112831

Gayle Braun  
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 309 Exeter Road Unit #29, London, ON N6L 1C1 Canada | Phone: +1 519 652 6044 | Fax: +1 519 652 0671  
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1035570-1 SOIL 22-JUL-11  T8-1,SS6@12.5', SILTY CLAY,GREY				
Grouping	Analyte					
SOIL						
Physical Tests	% Moisture (%)	12.5				
	pH (pH units)	7.84				
	Redox Potential (mV)	100				
	Resistivity (ohm cm)	4670				
Leachable Anions & Nutrients	Sulphide (mg/kg)	<0.20				
Anions and Nutrients	Sulphate (mg/kg)	112				

## Reference Information

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A
Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter.			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
RESISTIVITY-WT	Soil	Resistivity	MOEE E3137A
SO4-WT	Soil	Sulphate	EPA 300.0
SULPHIDE-WT	Soil	Sulphide	APHA 4500S2D

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

### Chain of Custody Numbers:

112831

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg ww - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

## Quality Control Report

Workorder: L1035570

Report Date: 29-JUL-11

Page 1 of 3

Client: AMEC EARTH & ENVIRONMENTAL

11865 County Road 42

TECUMSEH ON N8N 2M1

Contact: SHANE MACLEOD

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MOISTURE-WT</b>	<b>Soil</b>							
Batch	R2224277							
<b>WG1318502-2</b>	<b>LCS</b>							
% Moisture			92		%		70-130	25-JUL-11
<b>WG1318502-1</b>	<b>MB</b>							
% Moisture			<0.10		%		0.1	25-JUL-11
<b>PH-WT</b>	<b>Soil</b>							
Batch	R2226613							
<b>WG1321682-1</b>	<b>CVS</b>							
pH			100		%		80-120	27-JUL-11
<b>RESISTIVITY-WT</b>	<b>Soil</b>							
Batch	R2226581							
<b>WG1319414-2</b>	<b>CVS</b>							
Resistivity			99		%		70-130	27-JUL-11
<b>SO4-WT</b>	<b>Soil</b>							
Batch	R2225769							
<b>WG1319770-3</b>	<b>LCS</b>							
Sulphate			101		%		60-140	27-JUL-11
<b>WG1319770-1</b>	<b>MB</b>							
Sulphate			<20		mg/kg		20	27-JUL-11
<b>SULPHIDE-WT</b>	<b>Soil</b>							
Batch	R2224730							
<b>WG1319337-1</b>	<b>CVS</b>							
Sulphide			96		%		50-120	26-JUL-11
<b>WG1319332-1</b>	<b>MB</b>							
Sulphide			<0.20		mg/kg		0.2	26-JUL-11

# Quality Control Report

Workorder: L1035570

Report Date: 29-JUL-11

Page 2 of 3

## Legend:

---

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

---

# Quality Control Report

Workorder: L1035570

Report Date: 29-JUL-11

Page 3 of 3

## Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
<b>Physical Tests</b>							
Redox Potential	1	22-JUL-11	27-JUL-11 14:12	24	122	hours	EHTR

## Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.  
EHTR: Exceeded ALS recommended hold time prior to sample receipt.  
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.  
EHT: Exceeded ALS recommended hold time prior to analysis.  
Rec. HT: ALS recommended hold time (see units).

### Notes\*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.

Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1035570 were received on 25-JUL-11 10:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

**C of C # 00000**

C of C # 00000

60 NORTHLAND ROAD, UNIT 1  
WATERLOO, ON N2V 2B8  
Phone: (519) 886-6910  
Fax: (519) 886-9047  
Toll Free: 1-800-668-9878

CHAIN OF CUSTODY / ANALYTICAL SERVICES REQUEST FORM Page \_\_\_\_ of \_\_\_\_

Note: all TAT Quoted material is in business days which exclude statutory holidays and weekends. TAT samples received past 3:00 pm or Saturday/Sunday begin the next day.

Specify date required

Service requested

5 day (regular)

3-4 day (25%)

2 day TAT (50%)

Next day TAT (100%)

Same day TAT (200%)

COMPANY NAME Amec E+I

CRITERIA

Criteria on report YES NO

OFFICE Windsor

Reg 153/04 ☐

Reg 511/09 ☐

Table 1 2 3 4 5 6 7 8 9

PROJECT MANAGER Shane Macleod

TCLP MISA PWQO

ODWS OTHER

PROJECT # SW6601.1004.101

PHONE 519-735-2499 FAX 519-735-6990

ACCOUNT #

QUOTATION # @26G43 PO #

REPORT FORMAT/DISTRIBUTION

EMAIL ☒ FAX BOTH

SELECT: PDF DIGITAL BOTH

EMAIL 1 Shane.Macleod@Amec.com

EMAIL 2 com

SAMPLING INFORMATION

Sample Date/Time

TYPE

MATRIX

Date (dd-mm-yy)

Time (24hr)  
(hh:mm)

COMP

GRAB

WATER

SOIL

OTHER

SAMPLE DESCRIPTION TO APPEAR ON REPORT

NUMBER OF CONTAINERS

Corrosion Package

ANALYSIS REQUEST

PLEASE INDICATE FILTERED,  
PRESERVED OR BOTH

<--- (F, P, F/P)

SUBMISSION #:

L 1035570

ENTERED BY:

P. Stastny

DATE/TIME ENTERED:

25 July - 11

BIN #:

COMMENTS

LAB ID

SPECIAL INSTRUCTIONS/COMMENTS

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (CHECK Yes OR No)

SAMPLE CONDITION

Are any samples taken from a regulated BW System?

Yes ☐ No ☐

If yes, an authorized drinking water COC MUST be used for this submission.

Is the water sampled intended to be potable for human consumption?

Yes ☐ No ☐

FROZEN ☐

COLD ☐

COOLING INITIATED ☐

AMBIENT ☐

OBSERVATIONS

Yes ☐ No ☐

If yes add SIF

UNIT

100

Notes  
1. Quote number must be provided to ensure proper pricing

2. TAT may vary dependent on complexity of analysis and lab workload at time of submission.  
Please contact the lab to confirm TATs.

3. Any known or suspected hazards relating to a sample must be noted on the chain of custody in comments section.





AMEC EARTH & ENVIRONMENTAL  
ATTN: SHANE MACLEOD  
11865 County Road 42  
TECUMSEH ON N8N 2M1

Date Received: 13-JUL-11  
Report Date: 19-JUL-11 13:51 (MT)  
Version: FINAL

Client Phone: 519-735-2499

## Certificate of Analysis

<b>Lab Work Order #:</b>	<b>L1030731</b>
Project P.O. #:	NOT SUBMITTED
Job Reference:	SW8801.1004.101
Legal Site Desc:	
C of C Numbers:	092959

Gayle Braun  
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 309 Exeter Road Unit #29, London, ON N6L 1C1 Canada | Phone: +1 519 652 6044 | Fax: +1 519 652 0671  
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>		L1030731-1 SOIL 09-JUL-11 TB6-1 SA#10				
Grouping	Analyte					
<b>SOIL</b>						
<b>Physical Tests</b>	% Moisture (%)	14.5				
	pH (pH units)	7.86				
	Redox Potential (mV)	125				
	Resistivity (ohm cm)	3700				
<b>Leachable Anions &amp; Nutrients</b>	Sulphide (mg/kg)	<0.20				
<b>Anions and Nutrients</b>	Sulphate (mg/kg)	100				

## Reference Information

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A
Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter.			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
RESISTIVITY-WT	Soil	Resistivity	MOEE E3137A
SO4-WT	Soil	Sulphate	EPA 300.0
SULPHIDE-WT	Soil	Sulphide	APHA 4500S2D

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

### Chain of Custody Numbers:

092959

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg ww - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

## Quality Control Report

Workorder: L1030731

Report Date: 19-JUL-11

Page 1 of 3

Client: AMEC EARTH & ENVIRONMENTAL

11865 County Road 42

TECUMSEH ON N8N 2M1

Contact: SHANE MACLEOD

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MOISTURE-WT</b>								
	<b>Soil</b>							
Batch	R2218341							
<b>WG1311854-3</b>	<b>DUP</b>	<b>L1030731-1</b>						
% Moisture		14.5	14.4		%	0.49	30	13-JUL-11
<b>WG1311854-2</b>	<b>LCS</b>							
% Moisture			93		%		70-130	13-JUL-11
<b>WG1311854-1</b>	<b>MB</b>							
% Moisture			<0.10		%		0.1	13-JUL-11
<b>PH-WT</b>								
	<b>Soil</b>							
Batch	R2220797							
<b>WG1315023-1</b>	<b>CVS</b>							
pH			99		%		80-120	19-JUL-11
<b>RESISTIVITY-WT</b>								
	<b>Soil</b>							
Batch	R2220855							
<b>WG1315028-1</b>	<b>CVS</b>							
Resistivity			99		%		70-130	19-JUL-11
<b>SO4-WT</b>								
	<b>Soil</b>							
Batch	R2219765							
<b>WG1312668-3</b>	<b>LCS</b>							
Sulphate			103		%		60-140	15-JUL-11
<b>WG1312668-1</b>	<b>MB</b>							
Sulphate			<20		mg/kg		20	15-JUL-11
<b>SULPHIDE-WT</b>								
	<b>Soil</b>							
Batch	R2218729							
<b>WG1312664-1</b>	<b>CVS</b>							
Sulphide			106		%		50-120	14-JUL-11
<b>WG1312662-1</b>	<b>MB</b>							
Sulphide			<0.20		mg/kg		0.2	14-JUL-11

# Quality Control Report

Workorder: L1030731

Report Date: 19-JUL-11

Page 2 of 3

## Legend:

---

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

---

# Quality Control Report

Workorder: L1030731

Report Date: 19-JUL-11

Page 3 of 3

## Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
<b>Physical Tests</b>							
Redox Potential	1	09-JUL-11	19-JUL-11 14:12	24	242	hours	EHTR
Resistivity	1	09-JUL-11	19-JUL-11 14:32	7	10	days	EHT

## Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.  
EHTR: Exceeded ALS recommended hold time prior to sample receipt.  
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.  
EHT: Exceeded ALS recommended hold time prior to analysis.  
Rec. HT: ALS recommended hold time (see units).

### Notes\*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.  
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1030731 were received on 13-JUL-11 10:30.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

From: To: London Office 07/13/2011 14:35 #036 P.007/010

60 NORTHLAND ROAD, UNIT 1  
WATERLOO, ON N2V 2B8  
Phone: (519) 886-8910  
Fax: (519) 886-9047  
CANADA TOLL FREE: 1-800-658-9873



# CHAIN OF CUSTODY / ANALYTICAL SERVICES REQUEST FORM

C of C # 092959  
PAGE 1 OF 1

Note: all TAT Quoted material is in business days which exclude statutory holidays and weekends. TAT samples received past 3:00 pm or Saturday/Sunday begin the next day.

Specify date required Service requested  
5 day (Regular) ☒ 2 day TAT (50%)  
3-4 day TAT (25%) ☐ Next day TAT (100%)  
Same day TAT (200%)

COMPANY NAME Amel E+I

CRITERIA Criteria on report Yes ☐ No ☐

OFFICE Windsor

PROJECT MANAGER

Shane Macleod

PROJECT # SW88011004101

PHONE 519 735-2499 FAX 519 735-9669

ACCOUNT #

QUOTATION # 028643 PO#

## SAMPLING INFORMATION

Sample Date/Time TYPE MATRIX

Date (dd-mm-yy)	Time (24 hr) (hh:mm)	COMP	GRAB	WATER	SOIL	OTHER
July 9, 11					X	

SAMPLE DESCRIPTION TO APPEAR ON REPORT

TB6-1 SA#10

NUMBER OF CONTAINERS

Corrosion Package

## ANALYSIS REQUEST

PLEASE INDICATE FILTERED, PRESERVED OR BOTH

☐ (F, P, F/P)

SUBMISSION #

L1030731

ENTERED BY:

MB

DATE/TIME ENTERED:

13 July 11

BIN #

COMMENTS

LAB ID

-1

## SPECIAL INSTRUCTIONS/COMMENTS

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (CHECK Yes OR No)

Are any samples taken from a regulated DW System? Yes ☐ No ☒  
If yes, an authorized drinking water COC MUST be used for this submission.  
Is the water sampled intended to be potable for human consumption? Yes ☐ No ☒

## SAMPLE CONDITION

FROZEN ☐ MEAN TEMP  
COLD ☐  
COOLING INITIATED ☐  
AMBIENT ☐

18.30°C

SAMPLED BY: DATE & TIME

RECEIVED BY:

DATE & TIME

RELINQUISHED BY: DATE & TIME

RECEIVED AT LAB BY:

DATE & TIME

OBSERVATIONS  
Yes ☐ No ☐  
If yes add SIF

## NOTES AND CONDITIONS:

1. Quote number must be provided to ensure proper pricing.

2. TAT may vary dependent on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs.

3. Any known or suspected hazards relating to a sample must be noted on the chain of custody in comments section.

White - Report copy

YELLOW - File copy

PINK - Customer copy

Per COC Rev 4.00





AMEC EARTH & ENVIRONMENTAL-  
WINDSOR

ATTN: SHANE MACLEOD  
11865 County Road 42  
TECUMSEH ON N8N 2M1

Date Received: 16-SEP-11  
Report Date: 23-SEP-11 06:20 (MT)  
Version: FINAL

Client Phone: 519-735-2499

## Certificate of Analysis

**Lab Work Order #:** L1059696  
**Project P.O. #:** NOT SUBMITTED  
**Job Reference:** SW8801.1004.101  
**C of C Numbers:** 112774  
**Legal Site Desc:**

Gayle Braun  
Senior Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 309 Exeter Road Unit #29, London, ON N6L 1C1 Canada | Phone: +1 519 652 6044 | Fax: +1 519 652 0671  
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

		<b>Sample ID</b> <b>Description</b> <b>Sampled Date</b> <b>Sampled Time</b> <b>Client ID</b>	L1059696-1 SOIL 25-AUG-11  PS5- 1,SS23@90',GREY SILTY CLAY				
Grouping	Analyte						
<b>SOIL</b>							
<b>Physical Tests</b>	% Moisture (%)	16.6					
	pH (pH units)	7.90					
	Redox Potential (mV)	230					
	Resistivity (ohm cm)	2580					
<b>Leachable Anions &amp; Nutrients</b>	Sulphide (mg/kg)	<0.20					
<b>Anions and Nutrients</b>	Sulphate (mg/kg)	486					

## Reference Information

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A
Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter.			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
RESISTIVITY-WT	Soil	Resistivity	MOEE E3137A
SO4-WT	Soil	Sulphate	EPA 300.0
SULPHIDE-WT	Soil	Sulphide	APHA 4500S2D

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

### Chain of Custody Numbers:

112774

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg ww - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

## Quality Control Report

Workorder: L1059696

Report Date: 23-SEP-11

Page 1 of 3

Client: AMEC EARTH & ENVIRONMENTAL-WINDSOR

11865 County Road 42

TECUMSEH ON N8N 2M1

Contact: SHANE MACLEOD

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MOISTURE-WT</b>								
	Soil							
Batch	R2254382							
WG1351428-2	LCS							
% Moisture			94		%		70-130	19-SEP-11
WG1351428-1	MB							
% Moisture			<0.10		%		0.1	19-SEP-11
<b>PH-WT</b>								
	Soil							
Batch	R2254003							
WG1351581-1	CVS							
pH			101		%		80-120	19-SEP-11
<b>RESISTIVITY-WT</b>								
	Soil							
Batch	R2255410							
WG1353108-1	CVS							
Resistivity			102		%		70-130	21-SEP-11
<b>SO4-WT</b>								
	Soil							
Batch	R2255430							
WG1352527-3	LCS							
Sulphate			101		%		60-140	20-SEP-11
WG1352527-1	MB							
Sulphate			<20		mg/kg		20	20-SEP-11
<b>SULPHIDE-WT</b>								
	Soil							
Batch	R2254650							
WG1352442-1	CVS							
Sulphide			107		%		50-120	20-SEP-11
WG1352431-1	MB							
Sulphide			<0.20		mg/kg		0.2	20-SEP-11

# Quality Control Report

Workorder: L1059696

Report Date: 23-SEP-11

Page 2 of 3

## Legend:

---

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

---

# Quality Control Report

Workorder: L1059696

Report Date: 23-SEP-11

Page 3 of 3

## Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
<b>Physical Tests</b>							
% Moisture	1	25-AUG-11	19-SEP-11 10:40	14	25	days	EHTR
Redox Potential	1	25-AUG-11	21-SEP-11	24	651	hours	EHTR
Resistivity	1	25-AUG-11	21-SEP-11	7	27	days	EHTR
<b>Leachable Anions &amp; Nutrients</b>							
Sulphide	1	25-AUG-11	20-SEP-11 13:10	7	26	days	EHTR

## Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.  
EHTR: Exceeded ALS recommended hold time prior to sample receipt.  
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.  
EHT: Exceeded ALS recommended hold time prior to analysis.  
Rec. HT: ALS recommended hold time (see units).

### Notes\*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.  
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1059696 were received on 16-SEP-11 09:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

C of C # 00000

CHAIN OF CUSTODY / ANALYTICAL SERVICES REQUEST FORM Page 1 of 1[illegible]

## Notes

**1. Quote number must be provided to ensure proper pricing**

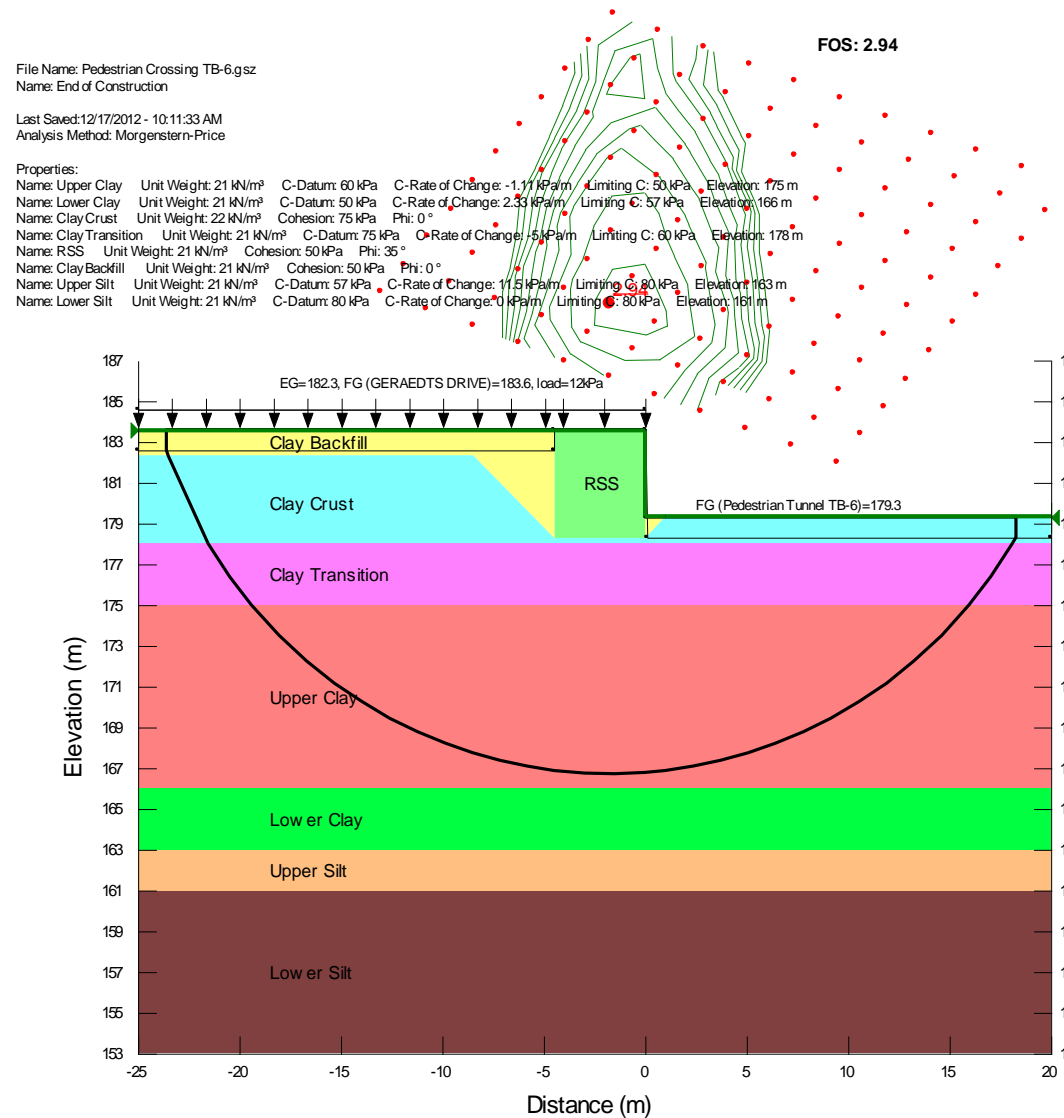
2. TAT may vary dependent on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs.

3. Any known or suspected hazards relating to a sample must be noted on the chain of custody in comments section.

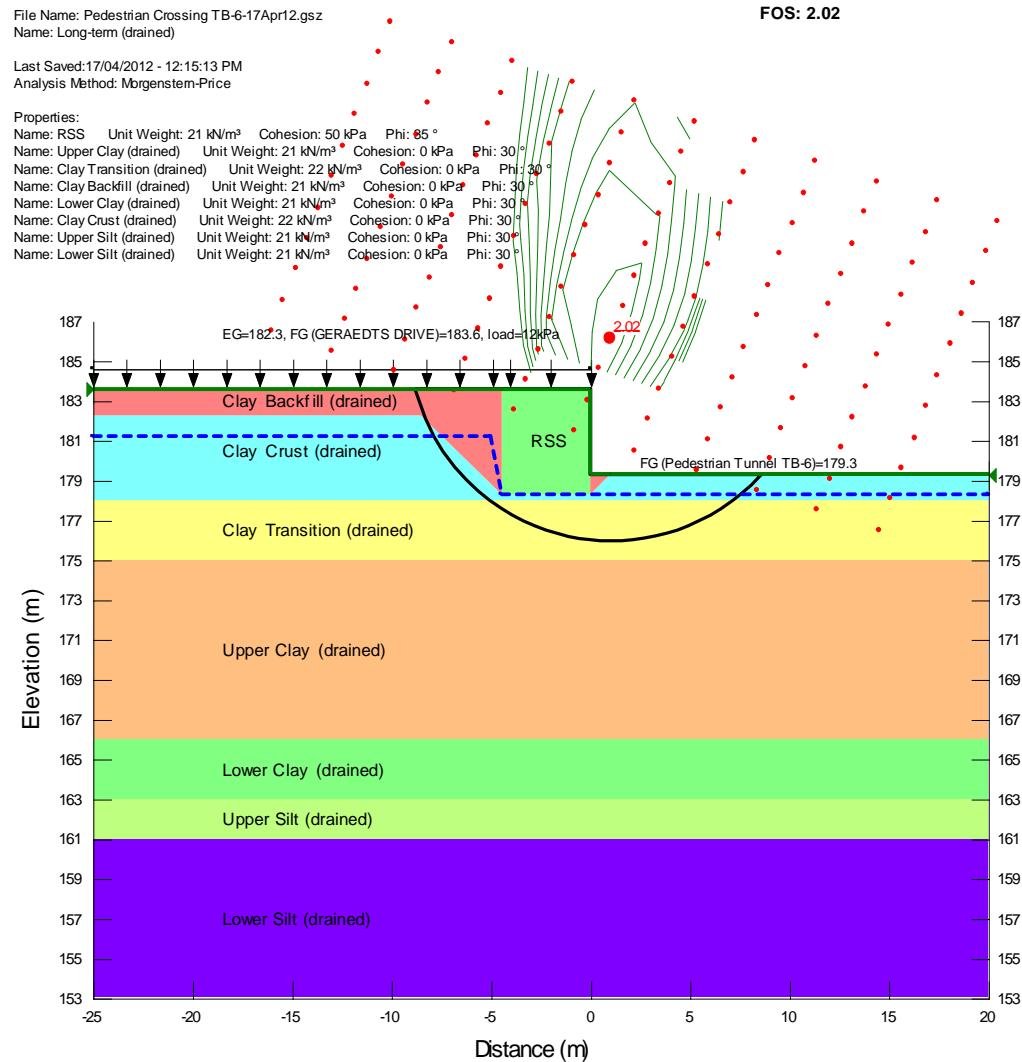
## Appendix D      Slope Stability Analyses



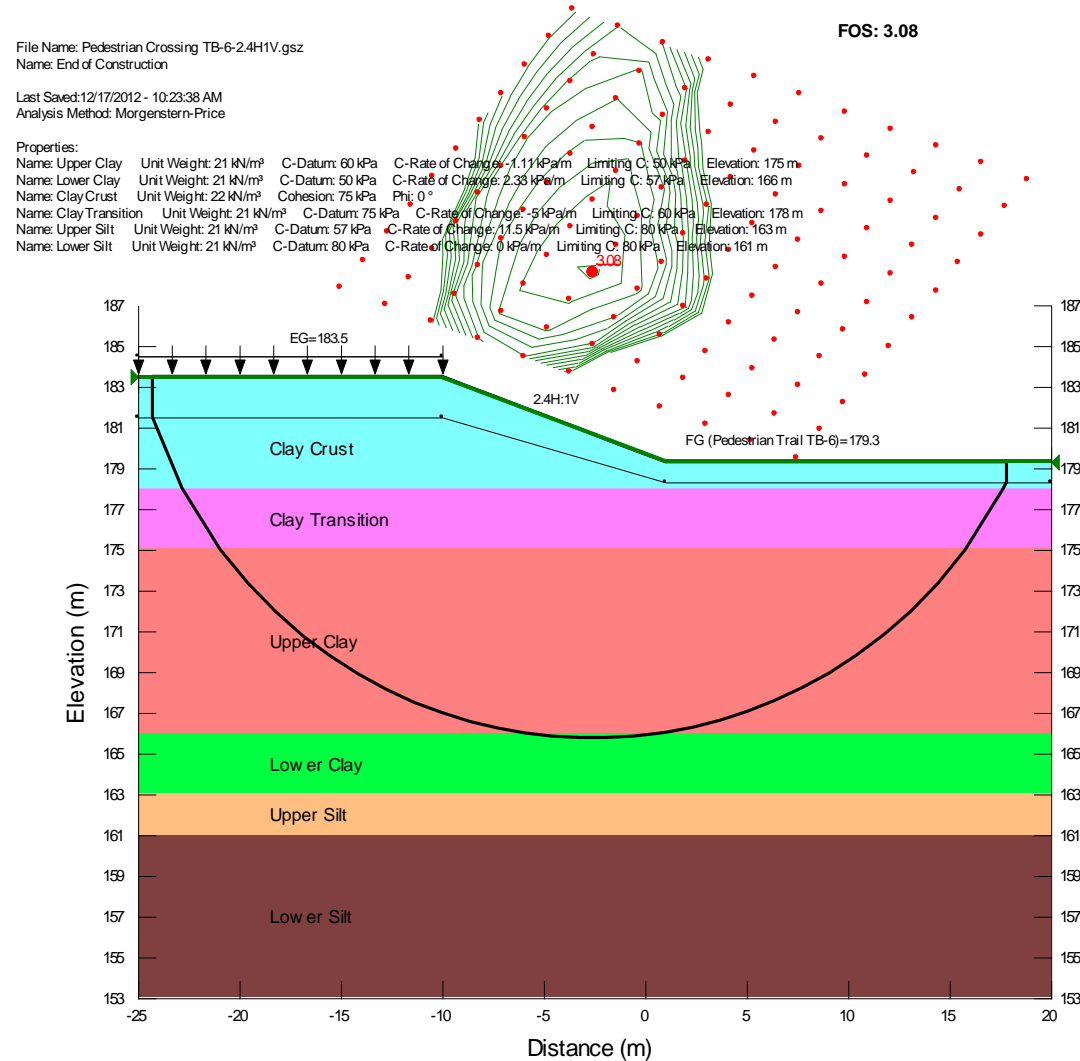
**Figure D-1: Global Stability Result – Wing Wall (Maximum Section) – End of Construction (Undrained) Loading**



**Figure D-2: Global Stability Result – Wing Wall (Maximum Section) – Long Term (Drained) Loading**



**Figure D-3: Global Stability Result – Trench Stability– End of Construction (Undrained) Loading**



**Figure D-4: Global Stability Result – Trench Stability- Long Term (Drained) Loading**

File Name: Pedestrian Crossing TB-6-17Apr12 - 2.4H:1V.gsz  
Name: Long-term (drained)

**FOS: 1.62**

Last Saved: 17/04/2012 - 12:41:14 PM  
Analysis Method: Morgenstern-Price

**Properties:**

Name: Upper Clay (drained)	Unit Weight: 21 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°
Name: Clay Transition (drained)	Unit Weight: 22 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°
Name: Lower Clay (drained)	Unit Weight: 21 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°
Name: Clay Crust (drained)	Unit Weight: 22 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°
Name: Upper Silt (drained)	Unit Weight: 21 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°
Name: Lower Silt (drained)	Unit Weight: 21 kN/m <sup>3</sup>	Cohesion: 0 kPa	Phi: 30°

