TECHNICAL MEMORANDUM

To	**Biljana Rajlic** **Hatch Mott MacDonald**	AMEC File No.	**WEP-0189**
From	**Dan Dimitriu** **Narendra S. Verma** **AMEC Earth and Environmental**	Project No.	**SW8801**
Tel	**905-568-2929**	HMM DOC. No.	**285380-04-126-0042 RevA**
Email	dan.dimitriu@amec.com narendra.verma@amec.com	cc	**Philip Murray (HMM)** **Nazmur Rahman (AMEC)** **Zuhtu Ozden (Coffey)** **Andrew Smith (Coffey)**
Date	**July 7, 2011**		

Subject **Windsor Essex Parkway Project**
Box Structure B-8: Preliminary 60% Geotechnical Design

Revision History					
Revision	**Date**	**Status**	**Prepared By**	**Reviewed By**	**Approved By**
A	7/07/2011	Information	NR	DD	NV

	Name, Title	Signature	Date
Prepared By	**Nazmur Rahman**		7/07/2011
Reviewed By	**Dan Dimitriu, Ph.D., P.Eng.**		7/07/2011
Approved By	**Narendra Verma, Ph.D., P.Eng.**		7/07/2011

TABLE OF CONTENTS

LIST OF DRAWINGS

(To be included in final report)

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

This memo provides preliminary 60% geotechnical design for the single span Concrete Box B-8 structure (Highway 3 underpass carrying WBR 5) located between Sta. 9+775.140 and Sta. 9+874.417 (WBR5).

The original proposal design for Bridge B-8 structure (in WEMG proposal) involved a rigid frame structure founded on deep end bearing piles. An alternative option involving a box structure founded on native soil was being considered as shown in Figure 1[1]. High Walls (HRW 27L, HRW 28L and HRW 29L) will be constructed close to this structure. A preliminary geotechnical assessment of the alternative design option had been performed based on geotechnical data and interpretation reports provided with the background geotechnical information[2] available at time of WEMG proposal (March 2010).

The present memo represents 60% design that involves more in depth review of the alternative design solution based on the available soil condition information (from pre-bid investigations and the recent AMEC test holes). The 60% designs for the individual bridge, tunnel and other structures were to be developed after completion of the proposed additional geotechnical investigation at structure specific locations. However, due to delays in the start up of the additional investigation fieldwork and the need to advance the design work for a select group of structures, the so called "60% geotechnical design" for this structure is be based mostly on soil data obtained prior to the submission of WEMG proposal. The additional geotechnical investigation has been partly completed at the time of preparation of this memo, and the available information has been included. In this regard, the soil data interpretations, design assessments and design recommendations given hereafter for the Box Structure B-8 location are considered preliminary and subject to revision at a later stage when the soil and groundwater data are updated following completion of the proposed additional investigation.

The locations of the previously executed and the proposed additional investigation test holes are shown in Figure 2. Instrumentation for monitoring pore water pressures and excavation base heave during excavation is planned at strategic locations.

Based on the recent information provided to us, it is understood that the proposed box structure will be a single rigid frame box with 11.9 m inside width and 4.9 to 5.3 m inside height. The top elevation of the base slab will vary between elevations 173.7 and 174.5[3] (excluding the asphalt and waterproofing system). The structure will be cast-in-place construction. Box structure B-8 construction is expected to involve the following earthwork, design elements and loading stages:

- Temporary excavations to about 9 m depth below grade
- Construction of the concrete structure of an approximate weight of 1150 kN/linear meter
- Completion of side drainage and backfill behind the box walls
- Completion of the pavement layer over the bottom slab

[1] Figures are included at the end of the memo text.
[2] Subsurface Conditions Interpretation Report, Golder Associates, Revised December 2009: Soil properties were assessed over large (1000 to 1200 m long) segments of the parkway.
[3] All elevations are referred to geodetic datum and are in metres. The ground surface elevations at borehole locations for this memo were estimated from the drawings included in Golder report (Subsurface Conditions Interpretation Report, 2009) and will be revised after they are verified.

- Completion of pavement for Highway 3 over the box structure
- Excavation for permanent cuts for depressed Highway 401
- Completion of the pavements over the Highway 401.

2.0 SIMPLIFIED SOIL CONDITIONS AND DESIGN SOIL PARAMETERS

1. The closest test holes to Box Structure B-8 site included in the current assessment are:
   - Boreholes BH-132, CPT-133, CPT-134 and CPT-330, Cone Penetration Test profiles CPT-133, CPT-134 and CPT-330 and Nilcon vane test profiles at BH 132 from pre-bid investigations, and
   - Boreholes B8-1, B8-2, Cone Penetration Test profiles CPT B8-1, CPT-31RW and CPT-33RW, Dilatometer test profile DMT B8-1, and Nilcon vane test profile at BH B8-1 from investigation currently underway.

   The borehole logs are included in Appendix A.
2. An approximate excavation profile for this structure is shown in Figure 3 which was developed on the basis of the roadway cross section at Sta. 14+350W.
3. The successive soil strata encountered beneath the thin surficial topsoil, fill and granular layers at box structure B-8 site comprised a 3 to 4 m thick mottled grey brown desiccated clayey silt crust deposit, about 7 to 8 m of a transition layer and then an unweathered grey silty clay to clayey silt deposit between about elevations 171 and 161 followed by about 11 m thick relatively coarser lower clayey silt deposit. The clay stratum is underlain by increasingly coarser silt to sand and gravel material (lower granular deposit) overlying limestone bedrock at about elevations 148 to 149.

   The design soil parameters were interpreted from the CPT, DMT and Nilcon vane test profiles, and the available laboratory test results. The approximate natural moisture content (w_N), plasticity index (PI) and liquidity index (LI) for the silty clay crust layer (elevation 181.5 to 171) are 10 to 35%, 13 to 21% and 0.5 to 0.8, respectively (Figure 4). The approximate w_N, PI and LI value variations with depth for the grey silty clay layer (elevation 171 to 161) are 11 to 37%, 11 to 20% and 0.3 to 0.8, respectively.
4. The Nilcon vane undrained shear strength (Su) profile was corrected for plasticity index, where applicable, and the Su-profiles from the CPTs were estimated using cone resistance (q_t-σ_{vo}) and an empirical factor (N_{kt}, dependent on the soil type) (Ladd and DeGroot, 2004). The Su-profiles inferred from the CPTs, DMT and Nilcon vane test profiles are shown in Figure 4, which shows whereas most of the Su profiles are greater than the 0.18 x σ'_{vo} line, part of the Su-values measured in CPT-31RW (between elevations 161 and 168, and elevations 156 and 159) are located below the 0.18 x σ'_{vo} line implying an apparent under-consolidated condition. The applicable Su in this zone was assumed to follow the 0.18 x σ'_{vo} line. Notwithstanding, careful consideration should be given to potential for large variability of the soil conditions and strength over relatively short distances.
5. Other relevant soil properties required for the analysis of stress and deformation response of the soils are provided in the calculation sections (Figures 5 and 6).

6. Groundwater elevations varied between elevations 177.5 and 178.6 in deep piezometers (near bedrock surface) and between elevations 179.2 and 180.2 in shallow piezometers, suggest a downward gradient. The observed piezometric levels were probably not stabilized.
7. 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 adverse conditions, the perched groundwater levels can rise to near the ground surface.

3.0 EXCAVATION AND TEMPORARY CUT SLOPES

- The discussion of the temporary slopes in this memo relates to analytical assessment of the slopes as they interact with the stability and design of the structure foundation. The shapes and slopes of the temporary excavations shown do not constitute the actual 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 (PA) criteria and the needs to accommodate the construction of the structure as per design.
- Excavations are expected to encounter topsoil, fill materials and surficial granular soils, and will be extended into the firm to stiff grey clayey silt to silty clay deposit. All excavation works should be carried out in accordance with the guidelines outlined in Occupational Health and Safety Act (OHSA) and OPSS 902. The native soils may be classified as Type 3 soils if appropriate dewatering has been carried out. The excavations may intersect water bearing backfill within trenches of active and/or abandoned utilities. In such cases Type 4 soil conditions may occur and should be addressed accordingly.
- Temporary groundwater control will be required based on timing of construction and prevailing weather conditions.
- Slope buttressing and other ground stabilizing measures may be required if ground softening due to presence of gases is encountered.
- The maximum depth of temporary excavation required at the both sides of the box structure is expected to be about 9 m (including the sub-excavation required to accommodate the base of the structure).
- The slope stability analyses for temporary open cut slopes were carried out using Slope/W Version 2007, the Morgenstern-Price method of analysis and circular failure surfaces. A minimum calculated factor of safety (FS) value of 1.3 has been adopted as the criterion. The calculated factor of safety (FS) for 9 m deep temporary excavations at 1H:1V slope inclination with a 4 to 5 m bench was 1.3 with soil properties shown in Figure 5.
- The recommendations provided herein are based on the assumptions that (a) the temporary slopes are properly protected at all times against surface erosion due to runoff, desiccation, freeze-thaw effects, gas release, etc., and (b) the duration of the

slope exposure is in general limited to 4 to 5 months. To protect the subgrade integrity, 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 same day as exposed and approved. No construction traffic should be permitted over subgrade without approved protective covers.

- Based on the analysis, an initial basal heave of up to 60 mm at completion of the excavation for construction was estimated. This heave should have no impact on the performance of the structure base; however, this data provides an indication of the anticipated geotechnical response and is expected to be monitored during construction.
- The calculated FS against basal uplift instability at the excavation bottom (due to hydrostatic pressure in the lower granular deposits) was greater than 2.0, which is considered acceptable.

4.0 FOUNDATIONS

4.1 General

- 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.
- Based on the available subsurface information and the proposed structure invert, the box structure may be founded in the firm to stiff grey silty clay at elevation 173.
- Any low areas should be brought to grade using lean concrete fill. The footing excavations should be inspected in accordance with OPSS 902.
- Structural deflections of raft type foundations (base slab of the box) may be modeled using the modulus of subgrade reaction (MSR) method or other recognized approach. The MSR is a theoretical parameter and is not a unique property of the soil. Its value depends on many factors, such as the size and shape of the foundation, the type and thickness of the underlying soil, the relative stiffness of the foundation and the soil, the duration of loading relative to the hydraulic conductivity of the loaded soil, and the like. The value of modulus of subgrade reaction can also vary from one point to another beneath a foundation (i.e., centre, edge or corner) and can change with time, in particular for soil with low hydraulic conductivity. Therefore, both geometry and time scale effects are important and need to be appropriately taken into account. In general, the value of subgrade reaction modulus decreases with increasing size of the loaded area on a soil subgrade.
- Based on the stress-deformation analysis results summarized in Section 4.3, a value of vertical modulus of subgrade reaction of about 5 MPa/m may be used for preliminary structural analyses. This MSR is only for the structural slab design under permanent distributed loads. In the case of point live loads, a MSR of 25 MPa/m may be considered for the base slab design. These modulus values should be reviewed once the proposed structural design details are available to ensure that the recommended

values remain consistent with the structure geometry, applied loadings and upcoming new information from proposed geotechnical investigation at the structure site.

4.2 ULS Bearing Resistance

- The grey silty clay within the zone of influence below elevation 173 has firm to stiff consistency and is considered to be suitable for supporting the proposed box structure.
- The following net factored geotechnical resistance values (q_u) at ULS were determined for the native subgrade soils at box structure at subgrade elevation 173:

Condition	q_u (kPa)
Short-Term (Undrained)	130
Long-Term (Drained)	250

- At the end of construction when backfill is in place, a gross factored geotechnical resistance at ULS 300 kPa may be used.

4.3 SLS Performance

- A net geotechnical reaction (net soil stress increase) of 100 kPa at Serviceability Limit States (SLS), based on a 25 mm allowable post-construction settlement, may be used in the preliminary structural design.
- A preliminary stress and deformation analysis was conducted on a structure – subgrade soils model illustrated in Figure 6. The estimated values of heaves/settlements at base of box structure and at top of the Highway 3 near the box structure for different loading conditions are as follows:

Loading Stage	Settlement/Heave at Base of Box Structure (mm)	Settlement/Heave at Top of Highway 3 near Box Structure (mm)
End of Temporary Excavation(*)	± 60	N/A
End of Construction(*)	± 0	(-)45(**)
Long-term Post-construction	± 10	(-)65 (***)

(*) Reported values are cumulative.

(*) The Highway 3 settlement indicated above for the end of construction will be compensated by additional fill during preparation of the subgrade surface.

(**) Stabilised within approximately 10 to 15 years after end of construction.

(-) Indicates settlement.

- The deformations and settlements discussed above do not include deformations caused by seasonal temperature and moisture variations. Also, they do not include the effects of the long-term compression of the backfill materials that may occur further to inadequate compaction.

5.0 FROST PROTECTION

- Frost treatment is to be symmetrical about the box structure centreline and provided in accordance with Ontario Provincial Standard Drawing (OPSD) 803.010.

6.0 BACKFILLING

- The backfill at the cast-in-place box structure is to be in accordance with OPSD 803.010 and under direction of the geotechnical engineer. Granular fill should be placed behind the walls in accordance with the Canadian Highway Bridge Design Code CAN/CSA-S6-06 (CHBDC). Beyond this granular backfill a select clay backfill may be used. The granular backfill materials should consist of free-draining, non-frost susceptible granular materials. A synthetic insulation with drainage blanket and site generated clay fill behind the walls may be an alternative option to the granular backfilling.
- The fill should be compacted in maximum 200 mm thick loose lifts in accordance with SP 105S10. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the wall granular 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 the walls of the structure. The height of backfill adjacent the structure walls should be maintained at approximately the same level on both sides of the walls during all stages of backfill placement. 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 the Canadian Highway Bridge Design Code CAN/CSA-S6-06.

7.0 LATERAL EARTH PRESSURE

- The lateral pressures acting on the box structure walls will depend on the type and method of placement of the backfill materials behind the walls, the nature of soil behind the backfill, the magnitude of surcharge including construction loadings, the drainage conditions behind the walls and the subsequent lateral movement of the structure.

- Compaction equipment should be used in accordance with Special Provision 105S10. Other surcharge loadings should be accounted for in the design, as required.

- The earth pressures on walls are based on the backfill and may be calculated on the basis of the following parameters:

Parameter	Group I Soils(*)	Group II Soils(*)	Group III Soils(*)
Fill unit weight:	22 kN/m^3	21 kN/m^3	20.5 kN/m^3
Coefficients of static lateral earth pressure:			
• 'active' or unrestrained, K_a	0.27-0.30	0.30-0.35	0.35-0.45
• 'at rest' or restrained, K_o	0.45-0.50	0.50-0.55	0.60-0.70
• 'passive'	3.3-3.7	2.8-3.3	2.2-2.8

(*) Compacted to > 95% Standard Proctor maximum dry density
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).

- If the wall support allows lateral yielding (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. If the wall support does not allow lateral yielding, then at-rest earth pressures should be assumed for geotechnical design.
- In accordance with Canadian Highway Bridge Design Code CAN/CSA-S6-06, Section 6.7.5, the following relationship shall be used to calculate the factored geotechnical horizontal resistance within the soil close to the soil-structure interface:

$$H_f < 0.8\ A'c' + 0.8 V \tan\varphi'$$

Where, H_f = Factored Horizontal Load
A' = Effective contact area
c' = Effective cohesion
V = Unfactored vertical force
φ' = Effective angle of internal friction

8.0 DEWATERING

- Further details of temporary and permanent dewatering needs will be determined when updated soil information becomes available for this particular box structure site.
- The design of the dewatering system should comply with the OPSS 517 and 518 provisions.

9.0 TAF INSERTS

9.1 Design/Assessment Criteria

- The designs are as per Project Agreement – Schedule 15-2, Part 2 – Design and Construction Requirements, Article 5.
- The foundations' designs are as per the principles of Limit States Design (LS Method) based on Load and Resistance Factors (CHBDC and Canadian Foundation Engineering Manual).
- Working Stress Design (WS Method) is employed for global stability of the earthworks.

- The stability of the soil mass of the temporary excavations was checked for all potential surfaces of sliding and has a minimum factor of safety 1.3.
- Long-term creep is not a factor since the soil stress increases at this structure are maintained below the pre-consolidation stresses.

9.2 Ground Conditions

- The soil and groundwater condition data provided in the Baseline Report (from previous geotechnical investigations) are considered valid and applicable. The soil stratigraphic conditions and soil properties will be interpreted and updated from the results of the geotechnical investigations carried out previously by others and the available additional investigations carried out for detailed designs.
- The soil conditions and design parameters will be based on investigation data at the structure location with due consideration for the data in the vicinity.
- As noted in Section 1.0, the geotechnical analyses and design recommendations provided in this memo are preliminary and are subject to change based on interpretation of the updated soil data (combined results of the previous and proposed additional geotechnical investigations).
- Test holes relating to the previously executed and proposed geotechnical investigations are listed as follows:

	Borehole	CPT	Nilcon Vanes	DMT	Consolidation & Triaxial Tests	Instrumentation
Background Investigations (Golder, 2009 & 2010)	BH 132 BH 132A BH CPT133 BH CPT134 BH CPT 330	CPT 133 CPT 134 CPT 330	BH 132	na	3 one point CIUC 2 CIUE 1 CAUE 1 CT	1 br OW 1 sh OW
Proposed Additional Investigation	B8-1 B8-2	CPT B8-1 CPT 31RW CPT 33RW	B8-1	DMT B8-1	1 DSS 1 CT	1 set of 2 VWP & 2 MHSR 1 set of 1 VWP & 2 MHSR

Legend:
(sh) – Shallow ; (br) – Bedrock;
MHSR – Magnetic Heave/Settlement Rings; VWP – Vibrating Wire Piezometer;
OW – Observation Well; SI – Slope Indicator

9.3 Differential Settlement to be allowed for in Design of Structure

The allowable settlement is 5 mm to 100 mm measured at 0 m to 100 m distances from the back of the abutment stub at the Expiry Date.

9.4 Anticipated Ground Movements due to Loading, Flowing Water

Total post-construction settlement of about 20 mm is anticipated at the top of Highway 3 near the box structure due to the weight of the concrete box, additional surcharge, drawdown of the groundwater table and nearby permanent cuts for Highway 401. This long-term ground settlement is expected to occur substantially (over 80 %) within 2 to 5 years and essentially stabilise within 10 to 15 years following completion of construction.

9.5 List of Drawings

- 285380-04-090-WIP0-0008 Location Plan and Profile Sta. 14+000W to Sta. 14+700W
- 285380-04-090-WIP2-0802 Location Plan and Sections at Box Structure B-8
- 285380-04-090-WIP2-0803 Stratigraphic Sections at Box Structure B-8.

NR/dd/nsv/fs
W:\Correspondence \\WEP-0189-Rev A -2011_07_07- Box B-8-Preliminary 60% Geotechnical Design-Draft.docx

FIGURES

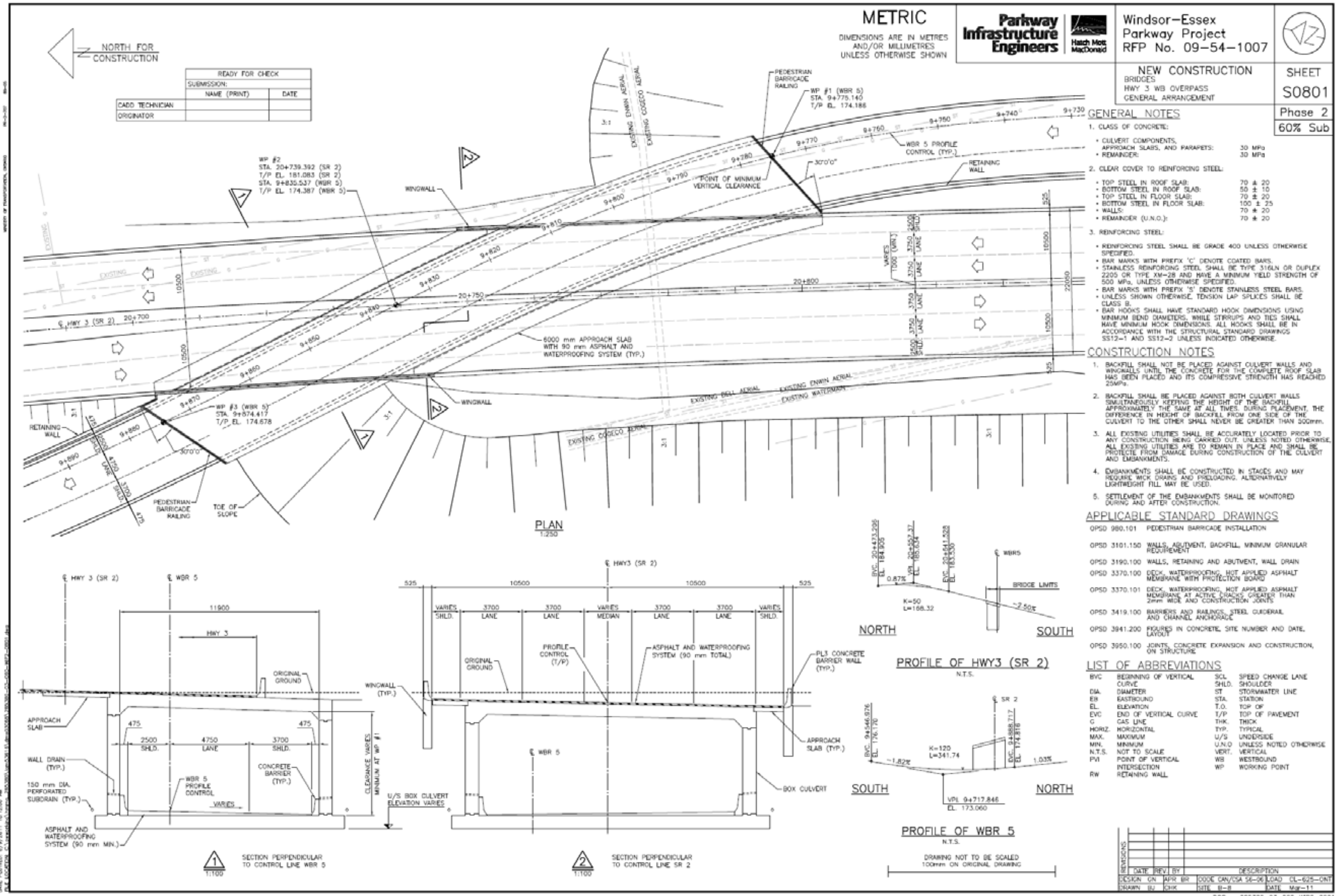


Figure 1: Structural Layout of Proposed Box Structure B-8

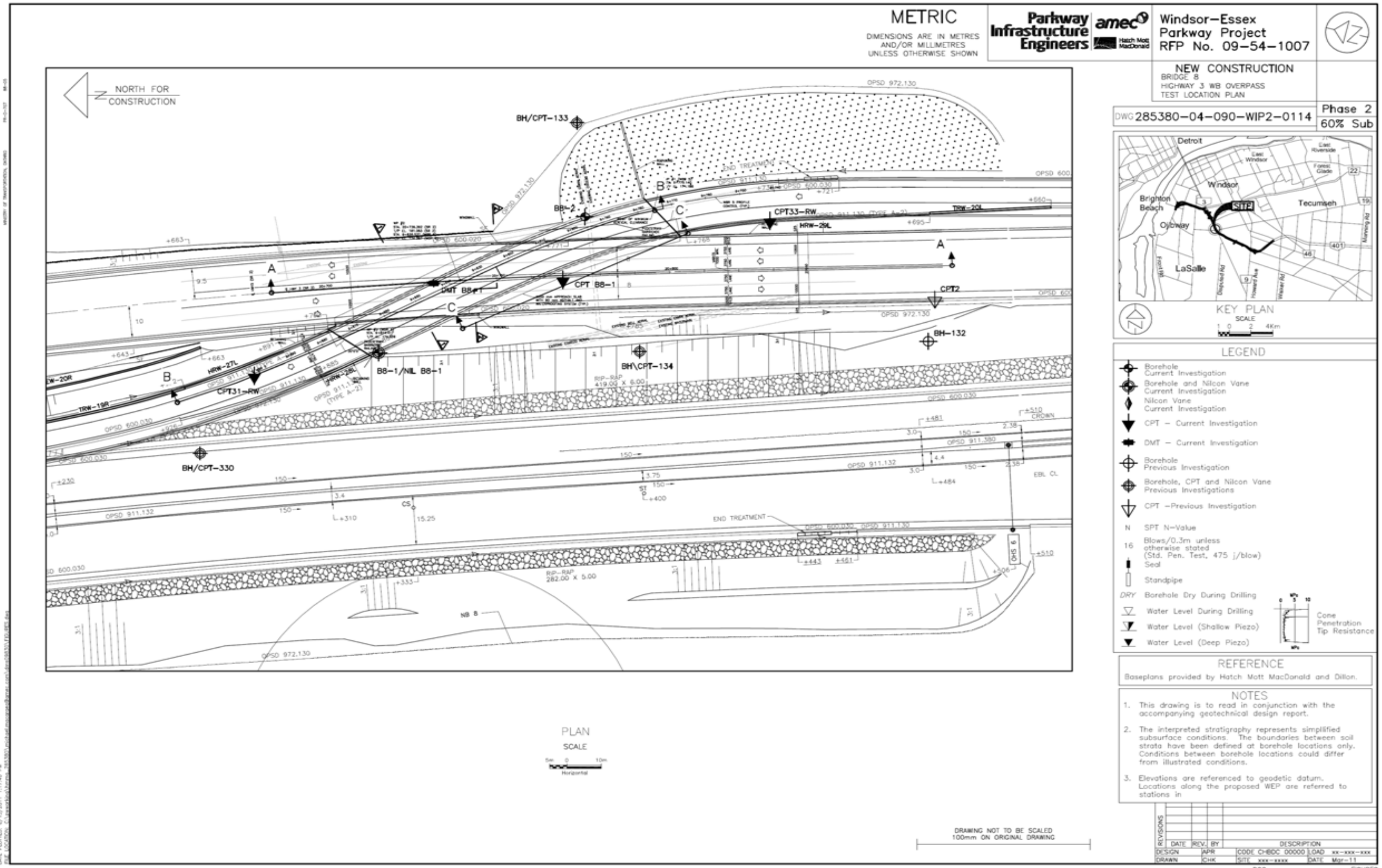


Figure 2: Previous and Proposed Test Hole Locations

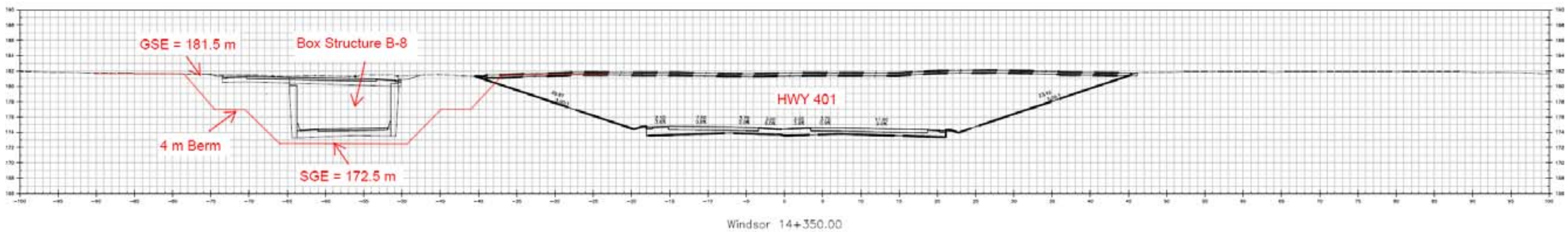


Figure 3: Temporary Excavation Profile for Box Structure B-8 at Station Windsor 14+350

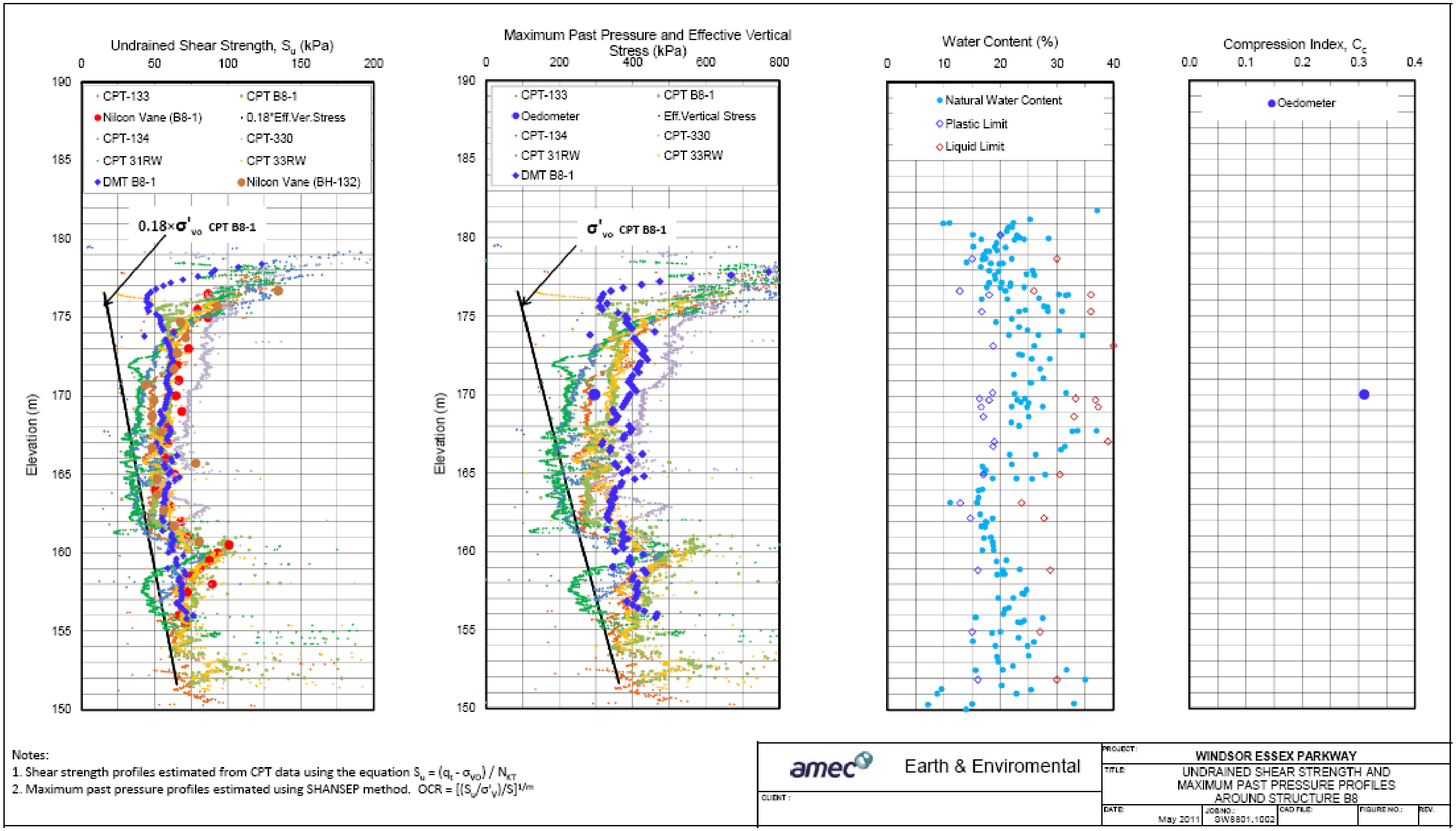


Figure 4: Soil Property Profile at Box Structure B-8 Site

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

File Name: Box Structure B8 - 9 m H Temp Exc - 4 m Berm - ST.gsz

WEP - SW8801.1002.101

Date : 6/9/2011

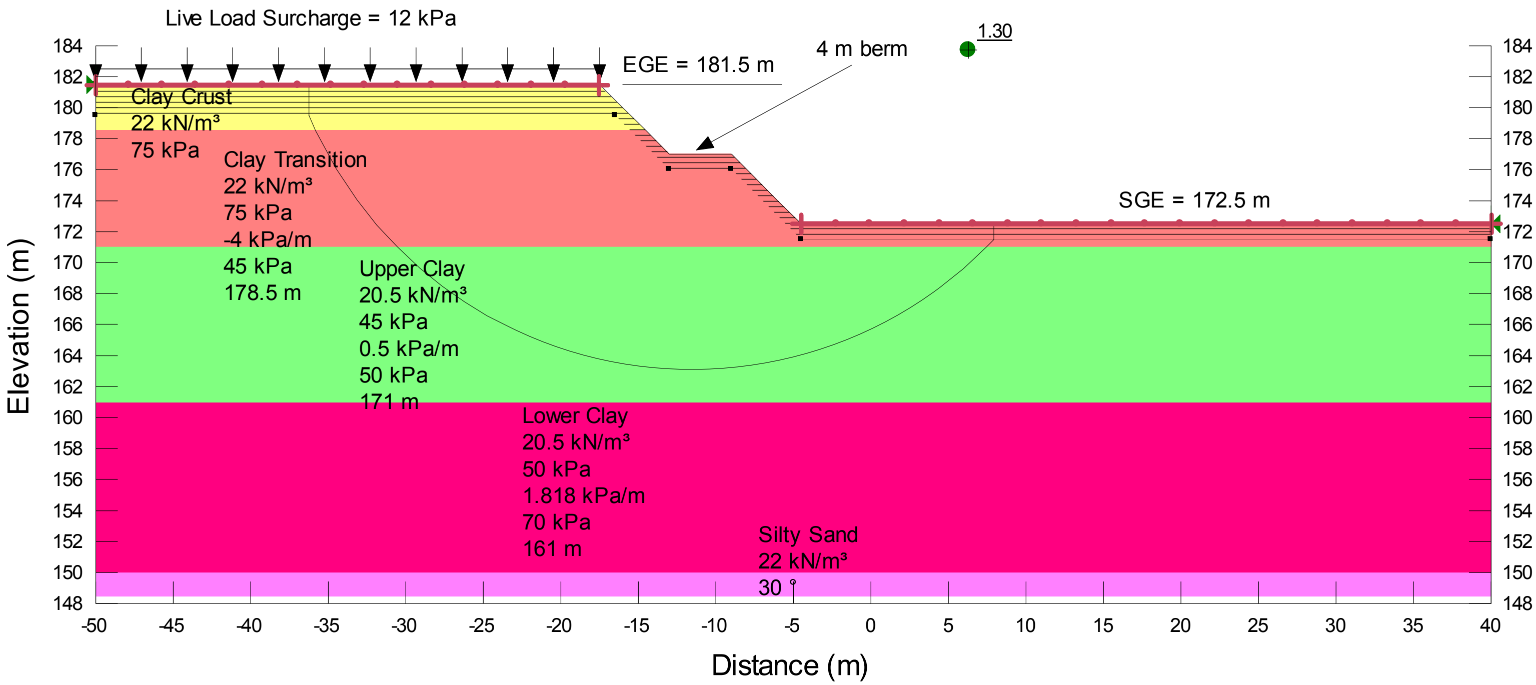


Figure 5: Stability Analysis of Temporary Excavation Slope

WEP
Stress-Deformation Analyses for Box Structure B-8
Date: June 17, 2011

Name: Clay Crust Young's Modulus (E): 35000 kPa Poisson's Ratio: 0.49 Cohesion: 75 kPa Phi: 0 ° Unit Weight: 22 kN/m³
Name: Clay Transition Young's Modulus (E): 21000 kPa Poisson's Ratio: 0.49 Cohesion: 70 kPa Phi: 0 ° Unit Weight: 22 kN/m³
Name: Upper Clay Young's Modulus (E): 19500 kPa Poisson's Ratio: 0.49 Cohesion: 65 kPa Phi: 0 ° Unit Weight: 20.5 kN/m³
Name: Lower Clay Young's Modulus (E): 22500 kPa Poisson's Ratio: 0.49 Cohesion: 75 kPa Phi: 0 ° Unit Weight: 20.5 kN/m³
Name: Silty Sand Effective Young's Modulus (E'): 40000 kPa Poisson's Ratio: 0.35 Phi': 30 ° Unit Weight: 22 kN/m³
Name: HWY 401 Pavement Young's Modulus (E): 50000 kPa Unit Weight: 15 kN/m³ Poisson's Ratio: 0.25
Name: Concrete Box Young's Modulus (E): 3500000 kPa Unit Weight: 10 kN/m³ Poisson's Ratio: 0.2
Name: Clay Backfill Young's Modulus (E): 21000 kPa Poisson's Ratio: 0.49 Cohesion: 70 kPa Phi: 0 ° Unit Weight: 21 kN/m³

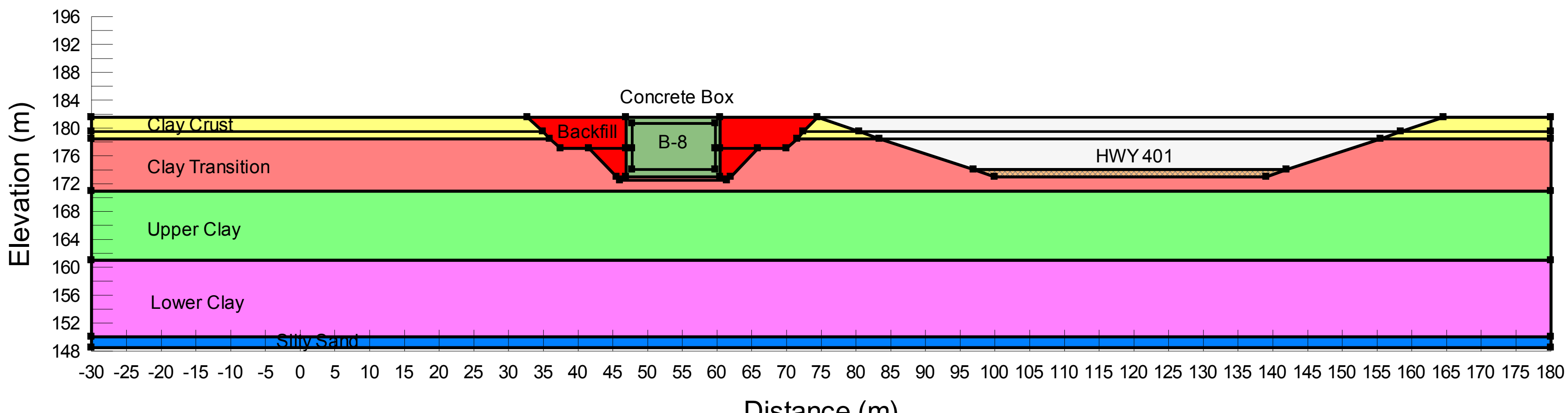


Figure 6: Stress-Deformation Analysis Model of Structure-Soil Configuration at Box Structure B-8

APPENDIX A

BOREHOLE LOGS IN THE VICINITY OF BOX STRUCTURE B-8

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Foundation Design

RECORD OF BOREHOLE No B8-1

1 OF 3 **METRIC**

W.P. RFP No.09-54-1001	LOCATION		ORIGINATED BY LEC
DIST	HWY WEP	BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers	COMPILED BY SS
DATUM Geodetic		DATE May 7, 11 - May 8, 11	CHECKED BY MSO

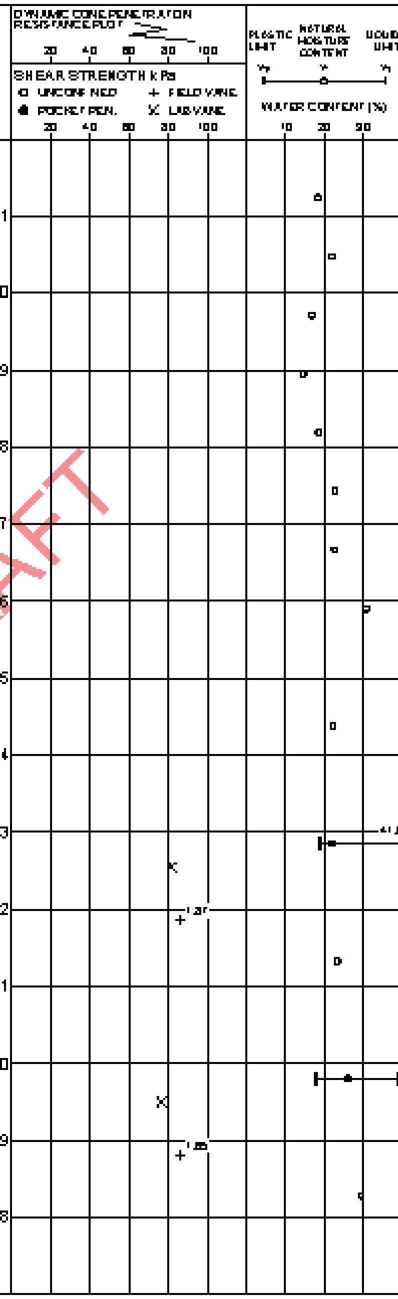
SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
182.0	Pavement Surface
181.7 / 0.0	325mm CONCRETE
0.3	Crushed limestone, sand and gravel FILL
181.0 / 1.0	Brown-Grey Fine SAND some silt, wet
180.5 / 1.5	SILTY CLAY trace sand, some gravel -weathered brown-grey grey stiff -wet, sand-filled fissures and sandy clay seams from 4.5m to 6m -pink clay nodules below about 8m
168.4 / 13.6	Grey-Pink Medium Plasticity CLAY trace embedded sand and gravel

Continued Next Page

SAMPLES

NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
1	SS	14					
2	SS	9	20.4				
3	SS	14	22.01				
4	SS	14	22.29				
5	SS	10	21.78				
6	SS	7	21.59				
7	SS	8	20.90				
8	SS	4	19.08				
9	TW						
10	TW		20.70	1	14	40	45
	VT						
11	TW						
12	TW		20.05	2	14	35	49
	VT						
13	TW						



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

ONTARIO MOT SW8801_1984_101.GPJ ONTARIO MOT.GDT 7/6/11

DRAFT

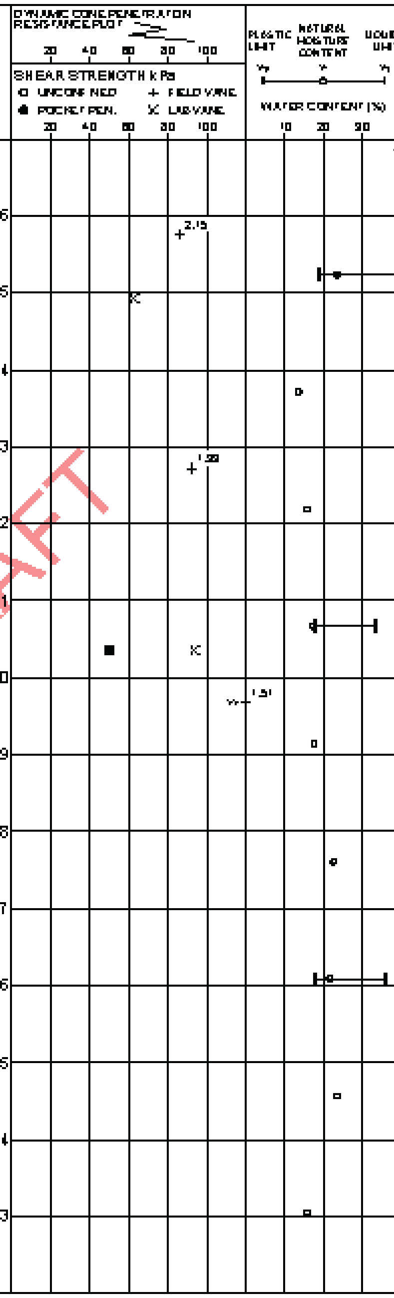
Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Foundation Design

RECORD OF BOREHOLE No B8-1 — 2 OF 3 — METRIC

W.P. RFP No. 09-54-1007	LOCATION		ORIGINATED BY LEC
DIST / HWY WEP	BOREHOLE TYPE	CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers	COMPILED BY SS
DATUM Geodetic	DATE	May 7, 11 - May 8, 11	CHECKED BY MSO

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	UNIT WEIGHT (kN/m³)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Grey-Pink Medium Plasticity CLAY trace embedded sand and gravel (continued)	14	TW			
			VT			
165.5 / 16.5	Grey CLAYEY SILT some sand, trace gravel	15	TW		19.03	1 15 38 46
		16	TW			
			VT			
		17	TW			-Borehole remained open and dry during augering, switch to wash boring with HW casing.
	-infused sand and gravel layer (some sample retained on TW18)	18	TW		21.75	
			VT			-end of drilling May 7, continue May 8
		19	TW			
		20	SS	9	20.79	
		21	SS	7	21.33	16
154.9 / 27.[illegible]	Grey SILTY SAND to CLAYEY SAND with seams of clay (including near vertical), some gravel	22	SS	31		
		23	SS	14	22.33	37 32 15



Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity   ○ 3% STRAIN AT FAILURE

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Foundation Design

RECORD OF BOREHOLE No B8-1

3 OF 3 **METRIC**

W.P. RFP No.09-54-1007 LOCATION ORIGINATED BY LEC
DIST HWY WEP BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers COMPILED BY SS
DATUM Geodetic DATE May 7, 11 - May 8, 11 CHECKED BY MSO

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	UNIT WEIGHT (kN/m³)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Grey SILTY SAND to CLAYEY SAND with seams of clay (including near vertical), some gravel (continued)	24	SS	14	23.78	
	-interbedded with layers of coarse sand and gravel	25	SS	49	23.72	Pocket Penetrometer > 225 kPa
149.7 / 32.9	Medium-Grained LIMESTONE laminated and highly porous, weathered	26	RC			RQD=48
147.7 / 34.9	-Void detected during coring from approx. 34.26m to 34.53m Light grey, fine-grained LIMESTONE fractured with calcite crystals, stylolites, highly porous	27	RC			RQD=100
		28	RC			RQD=100
145.9 / 36.7	END OF BOREHOLE (no refusal)					

ELEVATION SCALE: 151, 150, 149, 148, 147, 146, 145, 144, 143, 142, 141, 140, 139, 138

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30
GR SA SI CL

DRAFT

ONTARIO MOT SW8801_1904_101.GPJ ONTARIO MOT.GDT 7/6/11

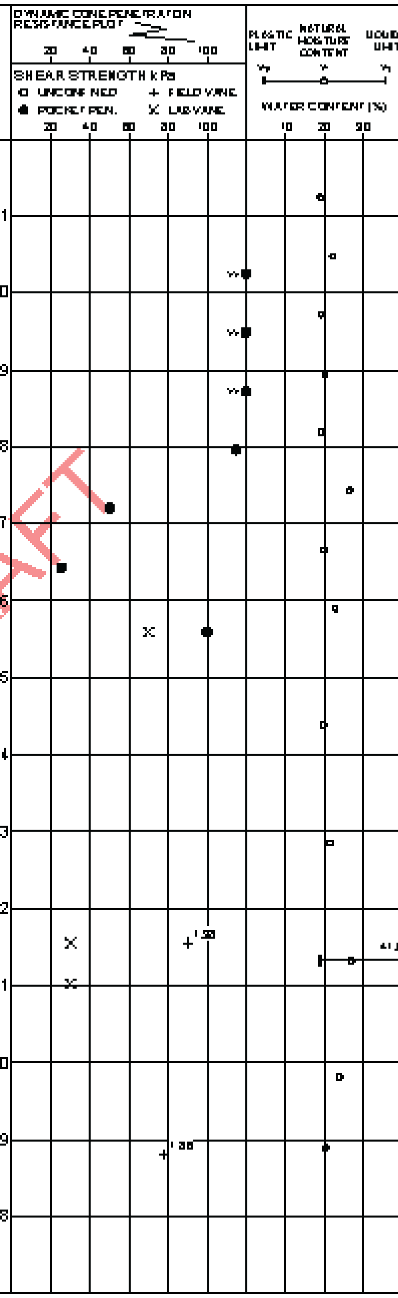
+3, ×3: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

Foundation Design

RECORD OF BOREHOLE No B8-2 — 1 OF 3 — METRIC

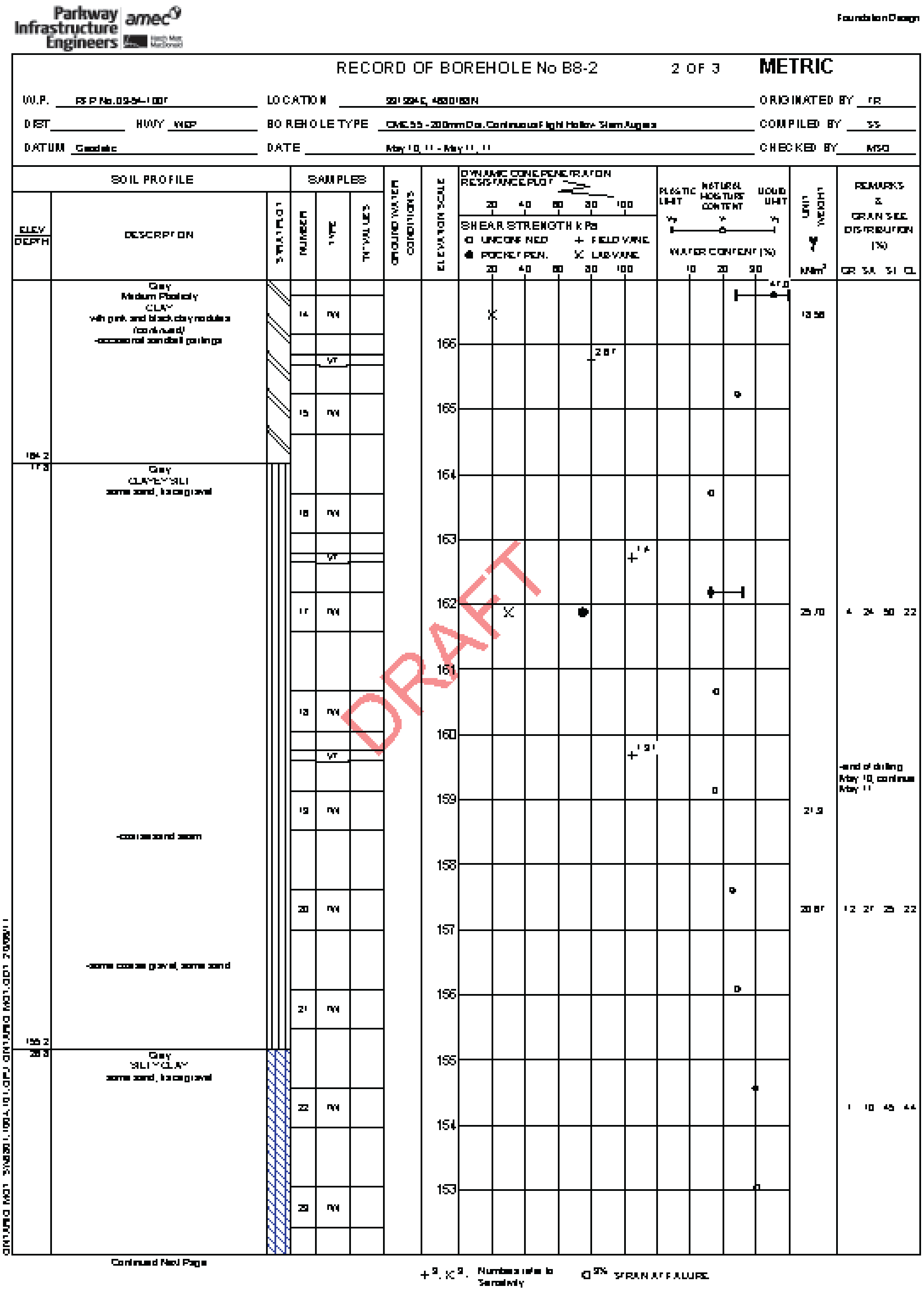
W.P. RFP No.09-54-1007 | LOCATION 331334E, 4680183N | ORIGINATED BY TR
DIST | HWY WEP | BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers | COMPILED BY SS
DATUM Geodetic | DATE May 10, 11 - May 11, 11 | CHECKED BY MSO

ELEV DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT (kN/m³)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.0	Pavement Surface						
	50mm ASPHALT						
	50mm Crushed limestone, sand and gravel FILL						
	100mm Brown poorly graded sand fill	1	SS	13	181	20.38	
180.5 / 1.5	275mm Crushed limestone, sand and gravel FILL						
	Brown SILTY Fine SAND	2	SS	10	180	20.85	
	Grey SILTY CLAY some sand, trace gravel stiff	3	SS	12	179	21.70	
		4	SS	13		21.78	
	some pink clay nodules below about 3.3m	5	SS	7	178	21.35	-bulk auger sample retained
		6	SS	4	177	20.70	
		7	SS	5	176	21.21	-split spoon sank 200mm under weight of hammer and rods
		8	TW		175	20.35	
		9	TW		174		
		10	TW		173		
			VT		172		
		11	TW		171	19.38	3 15 44 38
		12	TW		170		
			VT		169		
168.4 / 13.6	Grey Medium Plasticity CLAY with pink and black clay nodules	13	TW		168		



Continued Next Page

+³, X³: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE


Foundation Design
RECORD OF BOREHOLE No B8-2
2 OF 3
METRIC
W.P.
LOCATION
ORIGINATED BY
DIST
HWY
BOREHOLE TYPE
COMPILED BY
DATUM Geodetic
DATE
CHECKED BY
SOIL PROFILE
SAMPLES
ELEV DEPTH
DESCRIPTION
STRAT PLOT
NUMBER
TYPE
"N" VALUES
GROUND WATER CONDITIONS
ELEVATION SCALE
DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH kPa
UNCONFINED
FIELD VANE
POCKET PEN.
LAB VANE
PLASTIC LIMIT
NATURAL MOISTURE CONTENT
LIQUID LIMIT
WATER CONTENT (%)
10 20 30
UNIT WEIGHT
REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL
Grey
Medium Plasticity
CLAY
with pink and black clay nodules
(continued)
-occasional sand/silt partings
Grey
CLAYEY SILT
some sand, trace gravel
-coarse sand seam
-some coarse gravel, some sand
Grey
SILTY CLAY
some sand, trace gravel
14 SS
VT
15 SS
16 SS
VT
17 SS
18 SS
VT
19 SS
20 SS
21 SS
22 SS
23 SS
166
165
164
163
162
161
160
159
158
157
156
155
154
153
-end of drilling May 10, continue May 11
Continued Next Page
Numbers refer to Sensitivity
STRAIN AT FAILURE
DRAFT

Foundation Design

RECORD OF BOREHOLE No B8-2   3 OF 3   METRIC

W.P. RFP No.09-54-1001	LOCATION [illegible]		ORIGINATED BY TR
DIST	HWY WEP	BOREHOLE TYPE CME 55 - 200mm Dia. Continuous Flight Hollow Stem Augers	COMPILED BY SS
DATUM Geodetic		DATE May 10, 11 - May 11, 11	CHECKED BY MSO

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLES – NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
	Grey SILTY CLAY some sand, trace gravel (continued)				
		24	TW		151
150.5 / 21.5	-trace gravel				
	Grey SILT some sand, some gravel, frequent limestone fragments very dense	25	SS	60	150
148.9 / 23.1	Brown LIMESTONE medium grained, laminated some fossils and stylolites, semi-hard, very porous	26	RC		149
147.7 / 24.3	Light grey to white LIMESTONE fine grained, laminated stylolites, semi-hard	27	RC		148
146.9 / 25.1	END OF BOREHOLE (no refusal)				147
					146
					145
					144
					143
					142
					141
					140
					139
					138

Other column headings: STRAT PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE 20 40 60 80 100; PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

DRAFT

ONTARIO MOT SW8801.1994.101.GPJ ONTARIO MOT.GDT 29/06/11

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 132

1 OF 4 **METRIC**

PROJECT 07-1130-207-0
W.P.
DIST WEST HWY 401/3
DATUM GEODETIC
LOCATION N 4680070.8 ;E 331910.3
BOREHOLE TYPE POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC
DATE July 28, 2008 - July 29, 2008
ORIGINATED BY CC
COMPILED BY BRS
CHECKED BY SJB

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION
181.47	GROUND SURFACE
0.00	TOPSOIL, silty sand Black
181.11 / 0.36	SILTY FINE SAND, with clayey silt layers Compact Brown
180.25 / 1.22	CLAYEY SILT, some sand Firm Mottled brown and grey
179.49 / 1.98	SILTY CLAY, some sand, trace gravel, with silty sand pockets and partings from about elev. 152.6m to about elev. 152.0 Firm to stiff Grey

SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	10	
2	SS	5	
3	TO	PH	
4	SS	13	
5	TO	PH	
6	SS	6	
7	TO	PH	3 19 41 37 CIUC
8	SS	2	
9	TO	PH	
10	TO	PH	
11	TO	PH	0 15 40 45 CIUE, Oedometer
12	TO	PH	0 16 42 42 CAUE, CIUE
13	TO	PH	0 16 41 43 CIUC
14	SS	5	

Ground water conditions: Concrete; Bentonite; Grout

ELEVATION SCALE: 181, 180, 179, 178, 177, 176, 175, 174, 173, 172, 171, 170, 169, 168, 167

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE; 20 40 60 80 100

Field vane sensitivity values plotted: 6.7 (approx. elev. 176), 3.8 (approx. elev. 174.5), 1.9 (approx. elev. 173), 2.0 (approx. elev. 171.5), 2.3 (approx. elev. 168), 5.0 (approx. elev. 167)

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; 42

UNIT WEIGHT γ kN/m³

Continued Next Page

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

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 5/29/09

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 132

2 OF 4 **METRIC**

PROJECT 07-1130-207-0			
W.P.	LOCATION	N 4680070.8 ;E 331910.3	ORIGINATED BY CC
DIST WEST HWY 401/3	BOREHOLE TYPE	POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC	COMPILED BY BRS
DATUM GEODETIC	DATE	July 28, 2008 - July 29, 2008	CHECKED BY SJB

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH (field vane, sensitivity)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY, some sand, trace gravel, with silty sand pockets and partings from about elev. 152.6m to about elev. 152.0 Firm to stiff Grey	15	TO	PH		166		
						165	+ 3.2	
		16	SS	5				
						164	+ 1.4	
163.72 / 17.75	CLAYEY SILT to SILTY CLAY, some sand, trace gravel Firm to stiff Grey				Grout			
		17	TO	PH		163		4 26 47 23 CIUC
						162	+ 1.3	
		18	SS	6				
						161	+ 1.7	
		19	TO	PH		160		
						159	+ 1.6	
		20	SS	7				
						158	+ 1.9	
		21	TO	PH		157		
						156	+ 2.3	
		22	SS	8				
						155	+ 1.6	
		23	TO	PH		154		
						153	+ 1.6	
		24	SS	6				
						152	(>95.76) +	

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 6/29/09

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 132

3 OF 4 **METRIC**

PROJECT 07-1130-207-0			ORIGINATED BY CC
W.P.	LOCATION N 4680070.8 ;E 331910.3		COMPILED BY BRS
DIST WEST HWY 401/3	BOREHOLE TYPE POWER AUGER, MUD ROTARY WITH HQ TRICONE, NQRC		CHECKED BY SJB
DATUM GEODETIC	DATE July 28, 2008 - July 29, 2008		

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT to SILTY CLAY, some sand, trace gravel Firm to stiff Grey	25	TO	PH	Bentonite	151	(>95.76) +			
149.46 32.01	SILTY SAND, trace gravel Very dense Grey	26	SS	78	Sand; Screen	149		o		(47)
148.04 33.43	LIMESTONE, fresh, medium strong, weakly laminated to laminated, very fine to fine grained, faintly porous to porous Brown to grey (FOR DETAILED DESCRIPTIONS REFER TO RECORD OF DRILLHOLE)	27	NQ RC		Screen	148	T.C.R. (%) 100; S.C.R. (%) 65; R.Q.D. (%) 33			
		28	NQ RC		Bentonite; Sand	147, 146	T.C.R. (%) 98; S.C.R. (%) 95; R.Q.D. (%) 95			UC
		29	NQ RC		Sand	145, 144	T.C.R. (%) 100; S.C.R. (%) 99; R.Q.D. (%) 82			
143.67 37.80	END OF BOREHOLE									

Water level in borehole at about elev. 178.6m during drilling on July 28, 2008.

Water level measured in deep piezometer at elev. 177.97m on September 19, 2008.

Water level measured in deep piezometer at elev. 177.57m on November 11, 2008.

Water level measured in deep piezometer at elev. 177.48m on January 28, 2009.

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 6/30/09

$+^3, \times^3$: Numbers refer to Sensitivity $\bigcirc^{3\%}$ STRAIN AT FAILURE

Parkway Infrastructure Engineers amec Hatch Mott MacDonald

PROJECT: 07-1130-207-0

RECORD OF DRILLHOLE: 132

SHEET 4 OF 4

LOCATION: N 4680070.8 ;E 331910.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: July 28, 2008 - July 29, 2008

DRILL RIG: MUD ROTARY WITH HQ TRICONE, NQRC

DRILLING CONTRACTOR: AARDVARK DRILLING INC

DATUM: GEODETIC

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

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION
		ROCK SURFACE	148.04		
	MUD ROTARY / NQ ROCK CORE	LIMESTONE, fresh, medium strong, laminated, fine grained, faintly porous, brown	33.43 / 147.63	1	Broken Core
34		LIMESTONE, fresh, medium strong, thinly laminated, very fine to fine grained, faintly porous, light brown	33.84 / 147.20		
		LIMESTONE, fresh, medium strong, thinly laminated, very fine grained, faintly porous, occasional stylolite, whitish grey	34.27 / 146.63		
35		LIMESTONE, fresh, medium strong, thinly laminated, very fine to fine grained, faintly porous, occasional stylolites, whitish grey to grey	34.84 / 145.63	2	JN,IR,Ro CI; JN,CU,Ro CI
36		LIMESTONE, fresh, medium strong, weakly laminated, very fine to fine grained, faintly porous, tannish grey	35.84 / 144.82		
37		LIMESTONE, fresh, medium strong, weakly laminated, fine grained, porous with zones of pitting, occasional stylolites, fossiliferous, light grey	36.65 / 143.67	3	
38		END OF DRILLHOLE	37.80		

Other columns: SYMBOLIC LOG; PENETRATION RATE (m/min); FLUSH; COLOUR % RETURN; ELEVATION (148, 147, 146, 145, 144); RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.3 5 10 15 20; DIP w.r.t. CORE AXIS 0 30 60 90; HYDRAULIC CONDUCTIVITY k, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 39, 40, 41, 42, 43, 44, 45, 46, 47, 48

LDN_ROCK_03 07-1130-207-0-ROCK.GPJ GLDR_LDN.GDT 6/29/09 DATA INPUT: WDF

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: SG
CHECKED: SJB

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 132A

1 OF 1 **METRIC**

PROJECT 07-1130-207-0
W.P.
LOCATION N 4680070.8 ;E 331910.3
ORIGINATED BY CC
DIST WEST HWY 401/3
BOREHOLE TYPE POWER AUGER, HOLLOW STEM
COMPILED BY BRS
DATUM GEODETIC
DATE July 29, 2008
CHECKED BY SJB

ELEV DEPTH	SOIL PROFILE: DESCRIPTION (SOIL CONDITIONS INFERRED FROM BOREHOLE No. 132)	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.47	GROUND SURFACE										
0.00	TOPSOIL, silty sand Black					Concrete					
181.11 0.36	SILTY FINE SAND, with clayey silt layers Compact Brown						181				
180.25 1.22	CLAYEY SILT, some sand Firm Mottled brown and grey						180				
179.49 1.98	SILTY CLAY, some sand, trace gravel, with silty sand pockets and partings from about elev. 152.6m to about elev. 152.0m Firm to stiff Grey					Grout	179 178 177 176 175				
						Bentonite	174				
						Sand Piezometer	173				
172.33 9.14	END OF BOREHOLE Water level measured in shallow piezometer at elev. 179.19m on September 19, 2008. Water level measured in shallow piezometer at elev. 180.19m on January 28, 2009.										

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 6/29/09

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

Parkway Infrastructure Engineers amec Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No CPT-133

1 OF 1 **METRIC**

PROJECT 07-1130-207-0
W.P.
LOCATION N 4680184.7 ;E 331953.4
ORIGINATED BY CC
DIST WEST HWY 401/3
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY LMK
DATUM GEODETIC
DATE September 30, 2008
CHECKED BY SJB

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.64	GROUND SURFACE									
0.00	FILL, crushed gravel and recycled aggregate Grey									
0.30	SAND, fine, some silt Loose to dense Brown	1	SS	31	∇	181				
180.57 / 1.14	CLAYEY SILT, some sand, with silt partings Soft Mottled brown and grey	2	SS	4						
	SILTY CLAY, trace sand, trace gravel Firm to very stiff Brown	3	SS	19		180				
179.51 / 2.13	END OF BOREHOLE									

Water level in borehole at about elev. 180.7m during drilling on September 30, 2008.

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 5/29/09

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

Parkway Infrastructure Engineers | amec | Hatch Mott MacDonald

Golder Associates
London, Ontario

RECORD OF BOREHOLE No CPT-134

1 OF 1

METRIC

PROJECT 07-1130-207-0
W.P.
DIST WEST HWY 401/3
DATUM GEODETIC
LOCATION N 4680151.4 ;E 331888.7
BOREHOLE TYPE POWER AUGER, SOLID STEM
DATE September 4, 2008
ORIGINATED BY CC
COMPILED BY SJL
CHECKED BY SJB

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.36	GROUND SURFACE										
0.00	FILL, silty sand, some gravel, trace organics Dense Brown		1	SS	35		181		o		
180.75 0.61	FILL, crushed sand and gravel, trace silt Compact Brown		2	SS	10				o		
180.14 1.22	CLAYEY SILT, trace sand Stiff Mottled brown and grey		3	SS	14		180		o		
179.53 1.83	END OF BOREHOLE Borehole dry during drilling on September 4, 2008.										

LDN_MTO_01 07-1130-207-0.GPJ LDN_MTO.GDT 6/29/09

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No CPT-330

1 OF 1 **METRIC**

PROJECT 09-1132-0080
W.P.
LOCATION N 4680268.1 ;E 331829.9
ORIGINATED BY TA
DIST WEST HWY 401 / 3
BOREHOLE TYPE POWER AUGER, SOLID STEM
COMPILED BY DMB
DATUM GEODETIC
DATE December 17, 2009
CHECKED BY

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
182.05	ROAD SURFACE					
0.00	ASPHALT PAVEMENT					
0.13 / 181.59	FILL, limestone gravel, crushed Grey					
0.46	SILTY FINE SAND Loose Brown	1	SS	6		181
180.68 / 1.37	CLAYEY SILT, some sand, trace gravel, with occasional silt partings Firm to very stiff Grey	2	SS	8	∇	180
		3	SS	29		
179.15 / 2.90	END OF BOREHOLE. Groundwater encountered at about elev. 180.5m during drilling on December 17, 2009.					

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE — 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ kN/m³
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+³, ×³: Numbers refer to Sensitivity   O³% STRAIN AT FAILURE

LDN_MTO_06 09-1132-0080.GPJ LDN_MTO.GDT 11/03/10