# FOUNDATION INVESTIGATION AND DESIGN REPORT
# OVERHEAD SIGN SUPPORTS
# FROM DIXIE ROAD TO MCLAUGHLIN ROAD
# HWY 401 WIDENING, HWY 410 TO CREDIT RIVER
# MISSISSAUGA, ONTARIO
# G.W.P. 2107-05-00

**Geocres Number: 30M12-277**

**Report to**

**MMM Group Limited**

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## PART 1: FACTUAL INFORMATION

## 1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation for the detailed design of overhead sign supports (OHS) along Highway 401 from Dixie Road to McLaughlin Road, which is part of the Highway 401 widening from Highway 410 to the Credit River in Mississauga, Ontario.

The purpose of the investigation was to explore the subsurface conditions in the general vicinity of the proposed OHS foundations and, based on the data obtained, to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000347.

## 2 SITE DESCRIPTION

The lands north of Highway 401 between McLaughlin Road and Hurontario Street are generally vacant and undeveloped. Vegetation is moderate consisting mainly of tall grass and shrubs. To the east of Hurontario Street to Dixie Road and throughout the length of the project limits south of Highway 401, the lands have been developed for commercial and industrial uses. The topography is generally level though slopes gently towards Lake Ontario to the south.

The general site area is located within the physiographic region known as the Peel Clay Plain. The Peel plain is of glacial origin. The overburden materials typical to this area were deposited by either glacial or pro-glacial sediments. The region is characterized by a level to undulating cohesive glacial till typically less than 1 m to 7 m in thickness.

Bedrock in the area is comprised of the reddish brown shale of the Queenston Formation, grey shales and limestones of the Georgian Bay Formation.

## 3 SITE INVESTIGATION AND FIELD TESTING

Site investigation and field testing for the proposed OHS foundations consisted of drilling and sampling a total of 11 boreholes at selected locations in the vicinities of the poles. This report compiles the boreholes drilled and sampled for the OHS foundations. A summary of the borehole designations for the OHS foundations is provided in Table 3.1.

**Table 3.1 – Borehole Designations**

| Borehole | Location | Drilling Date (2009) | Borehole Termination Depth (m) | Stratum at Termination Depth |
|---|---|---|---|---|
| OHS-01 | South side of Highway 401, east of McLaughlin Road; Near Sta. 18+075 | March 12 | 9.4 | Silty Clay Till |
| OHS-02 | South side of Highway 401, west of the Hurontario Street E-S interchange Near Sta. 18+750 | March 12 | 5.8 | Shale Bedrock |
| OHS-03 | Northwest quadrant of Highway 401 and Hurontario Street interchange; Near Sta. 18+900 | March 6 | 5.8 | Shale Bedrock |
| OHS-05 | South side of Highway 401, approx. 800 m east of the Hurontario Street N-E interchange; Near Sta. 19+750 | March 9 | 6.0 | Shale Bedrock |
| OHS-06 | North side of Highway 401, approx. 400 m west of the Kennedy Road; Near Sta. 20+175 | March 11 | 5.7 | Shale Bedrock |
| OHS-07 | South side of Highway 401, approx. 375 m west of the Kennedy Road; Near Sta. 20+200 | March 9 | 6.0 | Shale Bedrock |
| OHS-08 | South side of Highway 401, approx. 300 m west of Kennedy Road; Near Sta. 20+300 | March 6 | 5.8 | Shale Bedrock |
| OHS-09 | North side of Highway 401, approx. 100 m west of Kennedy Road; Near Sta. 20+460 | March 11 | 7.0 | Shale Bedrock |
| OHS-10 | North side of Highway 401, approx. 40 m east of Kennedy Road; Near Sta. 20+600 | March 11 | 5.8 | Shale Bedrock |
| OHS-11 | South side of Highway 401, approx. 160 m east of Kennedy Road; Near Sta. 20+750 | March 10 | 5.8 | Shale Bedrock |
| OHS-12 | Northwest quadrant of Highway 401 and Highway 410 S-E interchange Near Sta. 20+920 | March 10 | 7.0 | Shale Bedrock |

The approximate borehole locations are shown on the Borehole Location Drawings in Appendix D. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A.

Prior to commencement of drilling, utility clearances were obtained for each borehole location.

Solid stem augers were used to advance the boreholes in the overburden and into the shale. Samples of the overburden material were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). HQ2 rock coring equipment was used to recover core samples of the bedrock in the boreholes.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and transported them in air tight containers to Thurber's laboratory for further examination and testing.

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Four standpipe piezometers consisting of 19 mm PVC pipes with screens were installed in the boreholes to permit longer monitoring of groundwater levels. Details of the piezometer installations and other borehole completion details are as shown in Table 3.2.

**Table 3.2 – Borehole Completion Details**

| Borehole | Piezometer Installations | | | Completion Details |
|---|---|---|---|---|
| | Screen Tip (m) | Screen El. (m) | Sand Filter Stratum | |
| OHS-05 | 6.0 | 189.2 | Shale Bedrock | Sand filter from 6.0 to 4.0 m, bentonite holeplug to surface. |
| OHS-06 | 5.7 | 186.9 | Shale Bedrock | Sand filter from 5.7 to 3.7 m, bentonite holeplug to surface. |
| OHS-10 | 5.8 | 183.4 | Shale Bedrock | Sand filter from 5.8 to 3.7 m, bentonite holeplug to surface. |
| OHS-12 | 7.0 | 179.4 | Shale Bedrock | Sand filter from 7.0 to 5.1 m, bentonite holeplug to surface. |

## 4 LABORATORY TESTING

All recovered soil and rock samples were subjected to Visual Identification (VI) and geological logging. Moisture content determinations were carried out on all soil samples. At least 25% of the recovered soil samples were subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are presented on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Core samples of the shale bedrock were carefully protected to minimize drying during transport to the laboratory. Point load tests were carried out on selected samples of intact shale, limestone and

siltstone upon arrival at the laboratory to assist evaluation of the compressive strength of the bedrock. The results of point load tests on the selected rock core samples are shown on the Record of Borehole sheets and in Table 1, immediately following the text.

## 5 DESCRIPTION OF SUBSURFACE CONDITIONS

This section presents a generalized summary of the subsurface conditions encountered at the borehole locations drilled specifically for the OHS foundations (Boreholes OHS-01 to OHS-12). Reference is made to the Records of Borehole sheets in Appendix A. An overall description of the stratigraphy encountered in Boreholes OHS-01 to OHS-12 is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general terms, the soil stratigraphy encountered at this site consists of topsoil or a heterogeneous fill which is underlain by native silty clay/clayey silt till deposits. Though not encountered in any of the current boreholes, previous investigations in the area have shown that the cohesive till deposits are occasionally interbedded with cohesionless formations of variable gradation. Weathered shale bedrock was contacted below the till deposits. More detailed descriptions of the individual stratum are presented below.

### 5.1 Topsoil

Topsoil was identified at the ground surface in all boreholes except Boreholes OHS-07 and OHS-08. Where encountered, the topsoil thickness was observed to range from 50 to 100 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

### 5.2 Fill

Fill was encountered from ground surface in Boreholes OHS-07 and OHS-08 and below the topsoil in Boreholes OHS-01, OHS-09, OHS-10 and OHS-11. In Boreholes OHS-01 and OHS-11, the fill consists of brown silty clay containing trace to some sand and trace of gravel. In Borehole OHS-09 the fill consists of a reddish brown shale. The remaining boreholes (Boreholes OHS-07, OHS-08 and OHS-10) encountered a fill layer that was composed of a sand to a sand and gravel material. The thickness of the fill ranged from 0.8 to 1.5 m. The base of the fill layers were encountered between El. 186.3 to 194.1 m.

The SPT N-values recorded in the cohesive fill layers were observed to range from 9 to 18 blows for 0.3 m of penetration, corresponding with a stiff to very stiff consistency. The SPT N-values recorded in the shale fill ranged from 6 to 9 blows for 0.3 m of penetration, indicating a firm to stiff consistency. SPT N-values in the cohesionless fill were observed to range from 15 to 25 blows for 0.3 m of penetration indicating a compact relative density.

Grain size analyses conducted on samples of the fill are presented on Figure B1 in Appendix B. The results of grain size analyses carried out on two (2) samples are tabulated below.

| Cohesionless Fill | |
|---|---|
| Gravel % | 37 to 40 |
| Sand % | 46 to 48 |
| Silt and Clay % | 12 to 17 |

The natural moisture contents of the various fill samples recovered ranged from approximately 13 to 18% in the clay fill, from approximately 16 to 19% in the shale fill and from approximately 6 to 8% in the cohesionless fill.

### 5.3 Silty Clay

A layer of silty clay with trace sand and occasional rootlets was encountered below the shale fill in Borehole OHS-09. The thickness of the silty clay was observed to be 0.8 m and was encountered at a depth of 1.5 m below the ground surface (El. 189.6 m). The base of the cohesive deposit was contacted at a depth of 2.3 m below the ground surface (El. 188.8 m).

The SPT N-value in the silty clay was observed as 7 blows for 0.3 m of penetration indicating a firm consistency.

Grain size analyses conducted on one (1) sample of the cohesive silty clay are presented on Figure B2 in Appendix B.

The result of the laboratory gradation test is summarized as follows:

| | |
|---|---|
| Gravel % | 0 |
| Sand % | 14 |
| Silt % | 46 |
| Clay % | 40 |

Natural moisture content was measured to be 23% in the sample recovered from the silty clay material.

### 5.4 Silty Clay Till

Deposits of native brown/reddish brown to grey silty clay till with trace to some sand and trace of gravel were contacted at depths ranging from 50 mm to 2.3 m below the ground surface (El. 186.0 to 195.2 m). The silty clay till was not encountered in Boreholes OHS-07, OHS-08 and OHS-10. The base of the glacial till was encountered at depths ranging from 0.9 to deeper than 9.4 m below the ground surface (El. 178.4 to 193.1 m). The thickness of the till deposit ranged from 0.8 to 7.9 m.

SPT N-values ranged widely from 6 to 51 blows for 0.3 m of penetration. One SPT test indicated an N-value greater than 50 blows for 0.15 m of penetration. Based on the observed N-values, the silty clay till is described as firm to hard, though were typically stiff to very stiff.

The natural moisture contents of the samples recovered from the silty clay till layers ranged widely from 5 to 22%.

Grain size distribution curves for ten (10) samples tested are presented on the Record of Borehole sheets and on Figures B3 to B4 of Appendix B. Atterberg Limit test results for five (5) samples are presented on Figure B5 of Appendix B.

The results of laboratory gradation and Atterberg Limits tests are summarized as follows:

| | |
|---|---|
| Gravel % | 0 to 4 |
| Sand % | 12 to 48 |
| Silt % | 38 to 56 |
| Clay % | 9 to 24 |
| Liquid Limit % | 23 to 48 |
| Plastic Limit % | 13 to 22 |

The above results show that the silty clay till IS of low to intermediate plasticity with a USCS group symbol of CL to CI.

Although not encountered in the boreholes, glacial tills inherently contain cobbles and boulders and the lower part of the till may contain pieces and slabs of the shale and limestone bedrocks which may account for some high blow counts and resistance to augering.

### 5.5 Bedrock

The soils described above were found to be underlain by shale bedrock of the Queenston and Georgian Bay Formations. The shale encountered in the boreholes is described as fine-grained, thinly bedded and contains numerous strong to very strong interbedded layers of siltstone and limestone. The shale bedrock is typically highly weathered within the upper zone with the degree of weathering decreasing with depth. SPT N-values obtained in the upper highly weathered portion of the shale bedrock ranged from 14 to 74 blows for 0.3 m of penetration corresponding with a stiff to hard consistency. Three SPT N-values were measured to be greater than 50 blows for less than 0.05 m penetration.

In general the rock core samples in the vicinity of Hurontario Road are comprised of the Queenston Formation. The bedrock core samples recovered from the easternmost limit of the investigation near the Highway 410 interchange was composed of the Georgian Bay Formation.

Moisture contents of disturbed shale samples ranged from 4 to 19%.

Elevations of the top of bedrock are shown in Table 5.1.

**Table 5.1 – Elevation of Top of Weathered Bedrock**

| Borehole | Depth to Weathered Bedrock (m) | Top of Weathered Bedrock Elevation (m) |
|---|---|---|
| OHS-01 | Not encountered | - |
| OHS-02 | 0.9 | 185.1 |
| OHS-03 | 1.2 | 189.4 |
| OHS-05 | 2.1 | 193.1 |
| OHS-06 | 2.1 | 190.5 |
| OHS-07 | 1.5 | 192.6 |
| OHS-08 | 0.8 | 194.1 |
| OHS-09 | 3.7 | 187.4 |
| OHS-10 | 0.8 | 188.4 |
| OHS-11 | 2.1 | 185.4 |
| OHS-12 | 4.0 | 182.4 |

Bedrock cores were collected using HQ2 sized coring equipment. Total Core Recovery (TCR) in the bedrock ranged from 43% to 100% in most core runs. Values of TCR between less than 60 occurred but were relatively rare.

The RQD values recorded in all of the core runs ranged from 13 to 100% indicating very poor to excellent rock quality. Fracture Index (FI) of the rock, expressed as fractures for 0.3 m of core, ranged from 0 to greater than 10.

The results of Point Load tests conducted on rock layers/interbeds of intact core samples are shown on Table 1 immediately following this report and are tabulated below as follows:

**Table 5.2 – Inferred Unconfined Compressive Strength in Bedrock Cores**

| Rock Type | Inferred Unconfined Compressive Strength (UCS) (MPa) |
|---|---|
| Shale or shale/siltstone | 2 to 60 |
| Siltstone | 3 to 62 |
| Limestone | 18 to 101 |

It must be noted, however, that point load tests were possible only on less weathered shale or higher strength limestone and siltstone interbed samples as the more typically weathered shale cores tended to disintegrate during point load testing, which rendered the results of the test unreliable. Fractured zones were observed within the cores at various depths and are noted on the respective borehole log sheets.

In general, the strength of the shale bedrock increases with depth. The shale bedrock typically contains layers of siltstone and limestone that can be significantly harder than the shale itself. The distribution, thickness and strength of these layers vary from location to

location, and these layers typically exhibit less pronounced weathering than the shale. The logs indicated that these strong to very strong interbeds range approximately from 10 to 300 mm in thickness. Sampling and interpretation from small diameter boreholes may underestimate the frequency, thickness and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

### 5.6 Groundwater Levels

Water level was observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in four of the boreholes to monitor groundwater levels after completion of drilling. The groundwater levels measured in the piezometers are summarized below in Table 5.3.

**Table 5.3 – Measured Groundwater Levels**

| Borehole | Date (2009) | Water Level (m) | | Comment |
|---|---|---|---|---|
| | | Depth | Elevation | |
| OHS-01 | March 12 | 2.8 | 185.0 | Open Borehole |
| OHS-02 | March 12 | 1.3 | 184.7 | Open Borehole |
| OHS-03 | March 6 | 0.7 | 189.9 | Open Borehole |
| OHS-05 | March 12<br>March 26<br>April 16 | 1.3<br>1.1<br>0.7 | 193.9<br>194.1<br>194.5 | In Piezometer |
| OHS-06 | March 26<br>April 16 | 2.7<br>2.7 | 189.8<br>189.8 | In Piezometer |
| OHS-07 | March 9 | 1.5 | 192.6 | Open Borehole |
| OHS-08 | March 6 | 0.9 | 194.0 | Open Borehole |
| OHS-09 | March 11 | 0.6 | 190.5 | Open Borehole |
| OHS-10 | March 12<br>March 26<br>April 16 | 1.9<br>2.9<br>2.9 | 187.3<br>186.3<br>186.3 | In Piezometer |
| OHS-11 | March 10 | 1.3 | 186.2 | Open Borehole |
| OHS-12 | March 12<br>March 26<br>April 16 | 2.9<br>3.2<br>3.2 | 183.5<br>183.2<br>183.2 | In Piezometer |

The above table indicates that the depth to the groundwater level ranges from 0.6 to 3.2 m below the ground surface (El. 183.2 to 194.1 m).

The above values are shorter term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. Further, perched water may be encountered at higher levels in lenses or zones of more permeable sands and silts interbeds within the heterogeneous tills, or within the fill.

## 6 MISCELLANEOUS

Borehole locations and ground surface elevations were supplied to Thurber by MMM Group Limited.

The drilling and sampling equipment was supplied and operated by Walker Drilling Ltd. of Utopia Ontario. The field work was supervised on a full time basis by Mr. George Azzopardi of Thurber Engineering Ltd.

Laboratory testing was carried out at Thurber's Laboratory in Oakville, Ontario.

Supervision of the field program, was conducted by Ms. R. Palomeque Reyna, P.Eng. Interpretation of the field data and preparation of the investigation report was conducted by Mr. David E. Elwood, P.Eng. Mr. Alastair E. Gorman, P.Eng. and. Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects, reviewed the report.

THURBER ENGINEERING LTD.

David E. Elwood, P.Eng.
Geotechnical Engineer

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## PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

# 7 SIGN SUPPORT DESIGN RECOMMENDATIONS

## 7.1 General

This section of the report presents foundation recommendations for the design of the proposed overhead sign supports (OHS).

A total of eleven (11) boreholes were drilled in close proximity to the proposed Tri-Chord Static sign and Cantilever Static sign supports as provided in the terms of reference.

Records of all the boreholes drilled during this investigation are presented in Appendix A. Table 2 immediately following the text provides a listing of boreholes relevant to the design of each OHS. Table 2 also presents the recommended foundation design parameters for the OHS foundations.

## 7.2 Foundation Design Parameters

The design of the OHS should be carried out in accordance with the following document:

- Ministry of Transportation, Ontario (2007) "Sign Support Manual", Engineering Standards Branch, Bridge Office (Reference 1).

Each proposed OHS will likely be supported on augered caissons. For Cantilever Static signs the signs will be founded on a single caisson installed as described in Table 2 and for Tri-Chord Static signs the signs will be founded on two augered caissons.

Where downward sloping ground exists in front of a caisson, reduction of lateral passive resistance should be taken into account during design. For foundation design at the caissons, it can be assumed that full lateral resistance can only be mobilized where the width of the soil

in front of or behind the caisson is equal to or greater than approximately 4 times the diameter of the caissons. For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the caisson, and full passive resistance at the level where the slope face is equal to or greater than 4 times the diameter of the caisson.

Where an undrained shear strength, $C_u$, is provided for a cohesive soil (silty clay, silty clay till), the ultimate lateral passive resistance should be calculated in conjunction with the total soil unit weight. Though not encountered during this investigation, when designing for portions of the caissons below the groundwater level in cohesionless soils (sands and silts) and fills, the submerged soil unit weight, $\gamma'$, should be used. The required embedment depth of the caisson will be governed by lateral loads, including wind loads, acting on the sign support.

The depth of frost along this stretch of Highway 401 is 1.2 m. Accordingly all adhesion/skin friction or ultimate passive resistance within the upper 1.2 m should be neglected in foundation design.

### 7.3 Caisson Installation

Caisson installation should generally be carried out in accordance with SP 903S01.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for OHS foundation supports at this site. Suggested wordings for this NSSP are provided in Appendix C.

Caisson installation equipment must be able to dislodge, handle and remove cobbles, boulders, and to penetrate other obstructions within the fill and the glacial till such as slavs of bedrock where encountered. Though not encountered during the current investigation, cobbles and boulders and slabs of floating bedrock should be anticipated in the glacial till.

The groundwater levels throughout the site were observed to be at a relatively shallow depth and are present at approximately 0.6 to 3.2 m depth below existing ground surface. Soil sloughing and water seepage may occur in unsupported holes especially in isolated layers of sands and silts below the groundwater level as well as from perched groundwater within the fill materials encountered throughout the site. Temporary liners should be available to support the caisson sidewalls and provide seepage cut-off where required.

### 7.4 Construction Concerns

Concerns during caisson construction mainly involve the handling and removal of cobbles or boulders, or other obstructions in the fill and till, soil sloughing and water seepage from caisson sidewalls. Recommendations on how to address these issues have been outlined in the previous section.

### 7.5 Construction Inspection and Testing

Caisson construction should be monitored by qualified geotechnical personnel (as per SP 903S01) to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

## 8 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. David E. Elwood, P.Eng. The report was reviewed by Mr. Alastair E. Gorman, P.Eng. and Dr. P. K. Chatteriji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

David E. Elwood, P.Eng.
Geotechnical Engineer

Alastair E. Gorman, P.Eng.
Senior Foundations Engineer

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

# TABLE 1 -Point Load and Unconfined Compression Test Results
## Highway 401 Widening – OVERHEAD SIGNS (OHS)

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-2 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #1 | 9 | 0 | 2.74 | 21.0 | D | 79.00 | OK | 101.51 | Limestone |
| | 11 | 0 | 3.35 | 0.5 | D | 49.00 | OK | 4.95 | Siltstone |
| RUN #2 | 15 | 3 | 4.65 | 0.0 | A | 57.00 | LOW | 3.00 | Shale |
| | 17 | 2 | 5.23 | 0.5 | A | 73.50 | OK | 3.62 | Shale |
| | 18 | 0 | 5.49 | 4.5 | D | 88.00 | OK | 0.00 | Siltstone |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | | | |
| Siltstone | 4.95 | 4.95 | 4.95 |
| Shale/Siltstone | | | |
| Limestone | 101.51 | 101.51 | 101.51 |
| RUN #2: | | | |
| Shale | 3.31 | 0.00 | 0.00 |
| Siltstone | 0.00 | 0.00 | 0.00 |
| Shale/Siltstone | | | |
| Limestone | | | |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.31 | 3.62 | 3.00 |
| Siltstone | 2.47 | 4.95 | 0.00 |
| Shale/Siltstone | | | |
| Limestone | 101.51 | 101.51 | 101.51 |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-3 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #2 | 15 | 0 | 4.57 | 0.0 | A | 77.00 | LOW | 3.00 | Shale |
| | 15 | 8 | 4.78 | 1.5 | D | 42.50 | OK | 18.38 | Shale, Siltstone |
| | 16 | 5 | 5.00 | 0.0 | D | 108.50 | LOW | 3.00 | Shale, Siltstone |
| | 17 | 4 | 5.28 | 0.0 | A | 53.00 | LOW | 3.00 | Siltstone |
| | 18 | 10 | 5.74 | 1.0 | D | 112.50 | OK | 2.84 | |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | 3.00 | 3.00 | 3.00 |
| Shale/Siltstone | 10.69 | 18.38 | 3.00 |
| Limestone | | | |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | 3.00 | 3.00 | 3.00 |
| Shale/Siltstone | 10.69 | 18.38 | 3.00 |
| Limestone | | | |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-5 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #2 | 15 | 8 | 4.78 | 0.0 | A | 42.50 | LOW | 3.00 | Shale, Siltstone |
| | 16 | 7 | 5.05 | 0.0 | A | 48.00 | LOW | 3.00 | Shale |
| | 17 | 5 | 5.31 | 0.0 | A | 69.00 | LOW | 3.00 | Shale |
| | 19 | 6 | 5.94 | 0.0 | A | 63.50 | LOW | 3.00 | Shale |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | | | |
| Shale/Siltstone | 3.00 | 3.00 | 0.00 |
| Limestone | | | |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | | | |
| Shale/Siltstone | 3.00 | 3.00 | 3.00 |
| Limestone | | | |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-6 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #2 | 9 | 1 | 2.77 | 0.5 | D | 58.00 | OK | 3.84 | Siltstone |
| | 10 | 0 | 3.05 | 0.0 | A | 53.00 | LOW | 3.00 | Shale |
| | 11 | 7 | 3.53 | 0.0 | A | 68.50 | LOW | 3.00 | Shale |
| | 13 | 4 | 4.06 | 0.0 | A | 61.50 | LOW | 3.00 | Siltstone |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | 3.42 | 3.84 | 3.00 |
| Shale/Siltstone | | | |
| Limestone | | | |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.00 | 3.00 | 3.00 |
| Siltstone | 3.42 | 3.84 | 3.00 |
| Shale/Siltstone | | | |
| Limestone | | | |

## TABLE 1 -Point Load and Unconfined Compression Test Results
## Highway 401 Widening – OVERHEAD SIGNS (OHS)

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type | UC Test Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OHS-7 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | | | | | |
| RUN #2 | 15 | 9 | 4.80 | 0.0 | A | 68.50 | LOW | 3.00 | Shale | RUN #1: | | | |
| | 17 | 5 | 5.31 | 0.0 | A | 69.00 | LOW | 3.00 | Shale, Siltstone | | AVERAGE | MAX | MIN |
| | 18 | 1 | 5.51 | 0.5 | A | 68.50 | OK | 3.43 | Shale | Shale | 8.05 | 17.72 | 3.00 |
| | 18 | 11 | 5.77 | 1.0 | D | 50.00 | OK | 12.93 | Siltstone | Siltstone | 12.93 | 12.93 | 12.93 |
| | 19 | 5 | 5.92 | 2.0 | A | 41.00 | OK | 17.72 | Shale | Shale/Siltstone | 3.00 | 3.00 | 3.00 |
| | | | | | | | | | | Limestone | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | SUMMARY | AVERAGE | MAX | MIN |
| | | | | | | | | | | Shale | 8.05 | 17.72 | 3.00 |
| | | | | | | | | | | Siltstone | 12.93 | 12.93 | 12.93 |
| | | | | | | | | | | Shale/Siltstone | 3.00 | 3.00 | 3.00 |
| | | | | | | | | | | Limestone | | | |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type | UC Test Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OHS-8 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | | | | | |
| RUN #1 | 12 | 6 | 3.81 | 0.0 | A | 75.50 | LOW | 3.00 | shale | RUN #1: | | | |
| | 13 | 2 | 4.01 | 3.0 | D | 40.00 | OK | 40.25 | Siltstone | | AVERAGE | MAX | MIN |
| | | | | | | | | | | Shale | 3.00 | 3.00 | 3.00 |
| | | | | | | | | | | Siltstone | 40.25 | 40.25 | 40.25 |
| | | | | | | | | | | Shale/Siltstone | | | |
| | | | | | | | | | | Limestone | | | |
| | | | | | | | | | | | | | |
| RUN #2 | 14 | 0 | 4.27 | 1.0 | A | 87.50 | OK | 6.06 | Shale | RUN #2: | | | |
| | 15 | 8 | 4.78 | 0.0 | A | 68.50 | LOW | 3.00 | Limestone | Shale | 6.06 | 3.91 | 0.00 |
| | 16 | 9 | 5.11 | 15.0 | D | 56.00 | OK | 135.34 | Limestone | Siltstone | 1.96 | 3.91 | 0.00 |
| | 17 | 9 | 5.41 | 0.5 | A | 69.50 | OK | 3.91 | Siltstone | Shale/Siltstone | | | |
| | 18 | 9 | 5.72 | 1.5 | D | 92.00 | OK | 0.00 | Siltstone | Limestone | 69.17 | 135.34 | 3.00 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | SUMMARY | AVERAGE | MAX | MIN |
| | | | | | | | | | | Shale | 4.53 | 6.06 | 3.00 |
| | | | | | | | | | | Siltstone | 14.72 | 40.25 | 0.00 |
| | | | | | | | | | | Shale/Siltstone | | | |
| | | | | | | | | | | Limestone | 69.17 | 135.34 | 3.00 |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type | UC Test Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OHS-9 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | | | | | |
| RUN #1 | 17 | 6 | 5.33 | 11.5 | D | 122.50 | OK | 28.79 | Siltstone | RUN #1: | | | |
| | | | | | | | | | | | AVERAGE | MAX | MIN |
| | | | | | | | | | | Shale | | | |
| | | | | | | | | | | Siltstone | 28.79 | 28.79 | 28.79 |
| | | | | | | | | | | Shale/Siltstone | | | |
| | | | | | | | | | | Limestone | | | |
| | | | | | | | | | | | | | |
| RUN #2 | 18 | 5 | 5.61 | 16.0 | D | 165.00 | OK | 25.62 | Siltstone | RUN #2: | | | |
| | 19 | 11 | 6.07 | 3.5 | A | 48.50 | OK | 31.31 | Siltstone | Shale | 1.50 | 31.31 | 25.62 |
| | 21 | 3 | 6.48 | 0.0 | A | 58.50 | LOW | 3.00 | Shale | Siltstone | 28.46 | 31.31 | 25.62 |
| | 22 | 3 | 6.78 | 20.0 | D | 78.00 | OK | 0.00 | Shale | Shale/Siltstone | | | |
| | | | | | | | | | | Limestone | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | SUMMARY | AVERAGE | MAX | MIN |
| | | | | | | | | | | Shale | 1.50 | 3.00 | 0.00 |
| | | | | | | | | | | Siltstone | 28.57 | 31.31 | 25.62 |
| | | | | | | | | | | Shale/Siltstone | | | |
| | | | | | | | | | | Limestone | | | |

# TABLE 1 -Point Load and Unconfined Compression Test Results
## Highway 401 Widening – OVERHEAD SIGNS (OHS)

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-10 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #1 | 10 | 4 | 3.15 | 15.0 | A | 68.50 | OK | 102.79 | Siltstone |
| | 10 | 8 | 3.25 | 14.0 | D | 67.00 | OK | 86.64 | Limestone |
| | 11 | 6 | 3.51 | 16.0 | D | 74.50 | OK | 84.45 | Siltstone |
| | 13 | 5 | 4.09 | 0.5 | A | 84.00 | OK | 3.09 | Shale |
| RUN #2 | 14 | 7 | 4.45 | 0.0 | A | 72.00 | LOW | 3.00 | Shale |
| | 15 | 9 | 4.80 | 0.0 | A | 57.00 | LOW | 3.00 | Shale |
| | 16 | 9 | 5.11 | 9.0 | D | 118.50 | OK | 19.46 | Limestone |
| | 18 | 9 | 5.72 | 11.5 | D | 80.00 | OK | 0.00 | Siltstone |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 3.09 | 3.09 | 3.09 |
| Siltstone | 93.62 | 102.79 | 84.45 |
| Shale/Siltstone | | | |
| Limestone | 86.64 | 86.64 | 86.64 |
| RUN #2: | | | |
| Shale | 3.00 | 0.00 | 0.00 |
| Siltstone | 0.00 | 0.00 | 0.00 |
| Shale/Siltstone | | | |
| Limestone | 19.46 | 19.46 | 19.46 |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.03 | 3.09 | 3.00 |
| Siltstone | 62.42 | 102.79 | 0.00 |
| Shale/Siltstone | | | |
| Limestone | 53.05 | 86.64 | 19.46 |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-11 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #1 | 10 | 5 | 3.18 | 9.0 | A | 73.50 | OK | 59.54 | Shale, Siltstone |
| | 13 | 3 | 4.04 | 3.5 | A | 84.00 | OK | 21.66 | Shale |
| RUN #2 | 14 | 6 | 4.42 | 21.5 | D | 165.00 | OK | 34.43 | Limestone |
| | 16 | 7 | 5.05 | 16.0 | D | 142.00 | OK | 18.56 | Limestone |
| | 17 | 0 | 5.18 | 5.5 | A | 47.50 | OK | 59.29 | Siltstone |
| | 18 | 9 | 5.72 | 24.5 | D | 81.50 | OK | 0.00 | Limestone |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 21.66 | 21.66 | 21.66 |
| Siltstone | | | |
| Shale/Siltstone | 59.54 | 59.54 | 0.00 |
| Limestone | | | |
| RUN #2: | | | |
| Shale | | | |
| Siltstone | 59.29 | 59.29 | 59.29 |
| Shale/Siltstone | | | |
| Limestone | 17.66 | 34.43 | 0.00 |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 21.66 | 21.66 | 21.66 |
| Siltstone | 59.29 | 59.29 | 59.29 |
| Shale/Siltstone | 59.54 | 59.54 | 59.54 |
| Limestone | 17.66 | 34.43 | 0.00 |

| BH | DEPTH | | | FORCE | AXIAL / | DISTANCE | | UCS | Rock Type |
|---|---|---|---|---|---|---|---|---|---|
| OHS-12 | FT. | IN. | (m) | (kN) | DIAMETRIC | (mm) | BREAK | (Mpa) | |
| RUN #1 | 13 | 7 | 4.14 | 11.5 | A | 125.50 | OK | 58.22 | Limestone |
| | 14 | 8 | 4.47 | 14.0 | A | 168.00 | OK | 61.26 | Limestone |
| | 16 | 8 | 5.08 | 0.0 | A | 67.50 | LOW | 3.00 | Shale |
| | 17 | 8 | 5.38 | 1.5 | A | 86.50 | OK | 9.15 | Shale |
| RUN #2 | 18 | 4 | 5.59 | 21.0 | D | 165.00 | OK | 33.63 | Limestone |
| | 19 | 2 | 5.84 | 15.0 | D | 121.50 | OK | 37.78 | Limestone |
| | 20 | 7 | 6.27 | 12.5 | A | 120.00 | OK | 64.85 | Limestone |
| | 21 | 3 | 6.48 | 9.5 | D | 120.50 | OK | 17.27 | Limestone |
| | 21 | 7 | | 15.0 | | 60.50 | | | Shale |
| | 21 | 8 | 6.60 | 0.0 | D | 69.00 | LOW | 3.00 | Shale |

| UC Test Average | | | |
|---|---|---|---|
| RUN #1: | | | |
| | AVERAGE | MAX | MIN |
| Shale | 6.07 | 9.15 | 3.00 |
| Siltstone | | | |
| Shale/Siltstone | | | |
| Limestone | 59.74 | 61.26 | 58.22 |
| RUN #2: | | | |
| Shale | 1.50 | 0.00 | 0.00 |
| Siltstone | | | |
| Shale/Siltstone | | | |
| Limestone | 38.38 | 64.85 | 17.27 |
| SUMMARY | AVERAGE | MAX | MIN |
| Shale | 3.79 | 9.15 | 0.00 |
| Siltstone | | | |
| Shale/Siltstone | | | |
| Limestone | 45.50 | 64.85 | 17.27 |

**TABLE 2**
**GEOTECHNICAL DESIGN PARAMETERS**
**OVERHEAD SIGN SUPPORTS (OHS)**
**HIGHWAY 401 FROM DIXIE ROAD TO McLAUGHLIN ROAD**
**MISSISSAUGA, ONTARIO**

| Site Number and Approximate Location | Borehole Number | Reference Simplified Subsurface Stratigraphy for Design | Depth Below Existing Grade (m) | Geotechnical Design Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $q_u$ (kPa) | $\phi'$ (deg.) | $\gamma$ (kN/m$^3$) | $\gamma'$ (kN/m$^3$) | $K_p$ | Groundwater Depth (m) |
| South side of Highway 401, east of McLaughlin Road Near Sta. 18+075 | OHS-01 | Silty Clay Fill (Stiff to Very Stiff) | 0.0 – 1.5 | 70 | - | 19 | - | - | 2.8 |
| | | Silty Clay Till (Very Stiff to Hard) | 1.5 – 2.8<br>2.8 – 9.4 | 175<br>175 | -<br>- | 21<br>21 | -<br>11 | -<br>- | |
| South side of Highway 401, west of the Hurontario Street E-S interchange Near Sta. 18+750 | OHS-02 | Silty Clay Till (Stiff) | 0.0 – 0.9 | 150 | - | 21 | 11 | - | 1.3 |
| | | Shale (weathered)<br>Shale | 0.9 – 3.9<br>3.9 – 5.8 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| Northwest quadrant of Highway 401 and Hurontario Street interchange (Near Sta. 18+900) | OHS-03 | Silty Clay Till (Stiff to Very Stiff) | 0.0 – 0.7<br>0.7 – 1.2 | 120<br>120 | -<br>- | 21<br>21 | -<br>11 | -<br>- | 0.7 |
| | | Shale (weathered)<br>Shale | 1.2 – 4.1<br>4.1 – 5.8 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| South side of Highway 401, approximately 800 m east of the Hurontario Street N-E interchange (Near Sta. 19+750) | OHS-05 | Silty Clay Till (Firm to Very Stiff) | 0.0 – 1.1<br>1.1 – 2.1 | 100<br>100 | -<br>- | 21<br>21 | -<br>11 | -<br>- | 1.1 |
| | | Shale (weathered)<br>Shale | 2.1 – 4.5<br>4.5 – 6.0 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| North side of Highway 401, approximately 400 m west of the Kennedy Road (Near Sta. 20+175) | OHS-06 | Silty Clay Till (Firm to Very Stiff) | 0.0 – 1.5<br>1.5 – 2.1 | 70<br>100 | -<br>- | 21<br>21 | -<br>11 | -<br>- | 2.8 |
| | | Shale (weathered)<br>Shale | 2.1 – 2.7<br>2.7 – 5.7 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |

| Site Number and Approximate Location | Borehole Number | Reference Simplified Subsurface Stratigraphy for Design | Depth Below Existing Grade (m) | Geotechnical Design Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $q_u$ (kPa) | $\phi'$ (deg.) | $\gamma$ (kN/m$^3$) | $\gamma'$ (kN/m$^3$) | $K_p$ | Groundwater Depth (m) |
| South side of Highway 401, approximately 375 m west of the Kennedy Road (Near Sta. 20+200) | OHS-07 | Sand and Gravel Fill (Compact) | 0.0 – 1.5 | - | 30 | 20 | - | 3.0 | 1.5 |
| | | Shale (weathered)<br>Shale | 1.5 – 4.4<br>4.4 – 6.0 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| South side of Highway 401, approximately 300 m west of Kennedy Road (Near Sta. 20+300) | OHS-08 | Sand and Gravel Fill (Compact) | 0.0 – 0.8 | - | 30 | 20 | - | 3.0 | 0.9 |
| | | Shale (weathered)<br>Shale | 0.8 – 4.3<br>4.3 – 5.8 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| North side of Highway 401, approximately 100 m west of Kennedy Road (Near Sta. 20+460) | OHS-09 | Shale Fill (Stiff to Firm) | 0.0- 1.5 | - | 30 | 20 | - | 3.0 | 0.6 |
| | | Silty Clay (Firm) | 1.5 – 2.3 | 75 | - | 19 | 9 | - | |
| | | Silty Clay Till (Very Stiff) | 2.3 – 3.7 | 200 | - | 21 | 11 | - | |
| | | Shale (weathered)<br>Shale | 3.7 – 5.5<br>5.5 – 7.0 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| North side of Highway 401, approximately 40 m east of Kennedy Road (Near Sta. 20+600) | OHS-10 | Sand (FILL) (Compact) | 0.0 – 0.8 | - | 30 | 20 | - | 3.0 | 1.9 |
| | | Shale (weathered)<br>Shale | 0.8 – 2.7<br>2.7 – 5.8 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| South side of Highway 401, approximately 160 m east of Kennedy Road (Near Sta. 20+750) | OHS-11 | Silty Clay Fill (Stiff) | 0.0 – 0.8 | 70 | - | 19 | - | - | 1.3 |
| | | Silty Clay Till (Stiff to Very Stiff) | 0.8 – 1.3<br>1.3 – 2.1 | 120<br>150 | -<br>- | 21<br>21 | -<br>11 | -<br>- | |
| | | Shale (weathered)<br>Shale | 2.1 – 3.6<br>3.6 – 5.8 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |

| Site Number and Approximate Location | Borehole Number | Reference Simplified Subsurface Stratigraphy for Design | Depth Below Existing Grade (m) | Geotechnical Design Parameters | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $q_u$ (kPa) | $\phi'$ (deg.) | $\gamma$ (kN/m$^3$) | $\gamma'$ (kN/m$^3$) | $K_p$ | Groundwater Depth (m) |
| Northwest quadrant of Highway 401 and Highway 410 S-E interchange (Near Sta. 20+920) | OHS-12 | Silty Clay Till (Firm to Hard) | 0.1 – 2.4<br>2.4 – 4.0 | 120<br>200 | -<br>- | 21<br>21 | -<br>11 | -<br>- | 3.0 |
| | | Shale (weathered)<br>Shale | 4.0 – 5.4<br>5.4 – 7.0 | -<br>800 | 40<br>- | 23<br>24 | 13<br>- | 4.6<br>- | |
| All Locations | - | New Fill – SSM (see Note 4) | Variable height above ground surface | - | 30 | 20 | - | 3.0 | Below base of new fill |

Legend:

$C_u$ = undrained shear strength = unconfined compressive strength, $q_u / 2$

$\phi'$ = angle of internal friction

$\gamma$ = bulk unit weight

$\gamma'$ = submerged unit weight

$K_p$ = coefficient of passive earth pressure

Notes:

- This table must be read in conjunction with the report. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.2 m below final grade should be neglected in the foundation design.
- All groundwater levels are reported as the depth below the ground surface in meters at the time of the borehole investigation.

# Appendix A

## Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

| CLASSIFICATION | PARTICLE SIZE | VISUAL IDENTIFICATION |
|---|---|---|
| Boulders | Greater than 200mm | same |
| Cobbles | 75 to 200mm | same |
| Gravel | 4.75 to 75mm | 5 to 75mm |
| Sand | 0.075 to 4.75mm | Not visible particles to 5mm |
| Silt | 0.002 to 0.075mm | Non-plastic particles, not visible to the naked eye |
| Clay | Less than 0.002mm | Plastic particles, not visible to the naked eye |

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

| TERMINOLOGY | PROPORTION |
|---|---|
| Trace or Occasional | Less than 10% |
| Some | 10 to 20% |
| Adjective (e.g. silty or sandy) | 20 to 35% |
| And (e.g. sand and gravel) | 35 to 50% |

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

| DESCRIPTIVE TERM | UNDRAINED SHEAR STRENGTH (kPa) | APPROXIMATE SPT[1] 'N' VALUE |
|---|---|---|
| Very Soft | 12 or less | Less than 2 |
| Soft | 12 to 25 | 2 to 4 |
| Firm | 25 to 50 | 4 to 8 |
| Stiff | 50 to 100 | 8 to 15 |
| Very Stiff | 100 to 200 | 15 to 30 |
| Hard | Greater than 200 | Greater than 30 |

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

| DESCRIPTIVE TERM | SPT "N" VALUE |
|---|---|
| Very Loose | Less than 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | Greater than 50 |

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample  WS Wash Sample  AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample  TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure  PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight  RC Rock Core  SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\overline{\blacktriangledown}$ Water Level

$C_{pen}$ Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value  Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT  Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

| MAJOR DIVISIONS | | GROUP SYMBOL | TYPICAL DESCRIPTION |
|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GW | Well-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GP | Poorly-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SAND AND SANDY SOILS | SW | Well-graded sands or gravelly sands, little or no fines. |
| | | SP | Poorly-graded sands or gravelly sands, little or no fines. |
| | | SM | Silty sands, sand-silt mixtures. |
| | | SC | Clayey sands, sand-clay mixtures. |
| FINE GRAINED SOILS | SILTS AND CLAYS $W_L < 50\%$ | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$). |
| | | CI | Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$). |
| | | OL | Organic silts and organic silty-clays of low plasticity. |
| | SILTS AND CLAYS $W_L > 50\%$ | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |
| | | OH | Organic clays of medium to high plasticity, organic silts. |
| HIGHLY ORGANIC SOILS | | Pt | Peat and other highly organic soils. |
| CLAY SHALE | | | |
| SANDSTONE | | | |
| SILTSTONE | | | |
| CLAYSTONE | | | |
| COAL | | | |

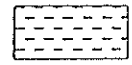
# EXPLANATION OF ROCK LOGGING TERMS

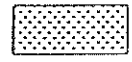
## ROCK WEATHERING CLASSIFICATION

| | |
|---|---|
| Fresh (FR) | No visible signs of weathering. |
| Fresh Jointed (FJ) | Weathering limited to the surface of major discontinuities. |
| Slightly Weathered (SW) | Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material. |
| Moderately Weathered (MW) | Weathering extends throughout the rock mass, but the rock material is not friable. |
| Highly Weathered (HW) | Weathering extends throughout the rock mass and the rock is partly friable. |
| Completely Weathered (CW) | Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved. |

## SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

## DISCONTINUITY SPACING

| Bedding | Bedding Plane Spacing |
|---|---|
| Very thickly bedded | Greater than 2m |
| Thickly bedded | 0.6 to 2m |
| Medium bedded | 0.2 to 0.6m |
| Thinly bedded | 60mm to 0.2m |
| Very thinly bedded | 20 to 60mm |
| Laminated | 6 to 20mm |
| Thinly Laminated | Less than 6mm |

## TERMS

| | |
|---|---|
| Total Core Recovery: (TCR) | Core recovered as a percentage of total core run length. |
| Solid Core Recovery: (SCR) | Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run. |
| Rock Quality Designation: (RQD) | Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length. |
| Uniaxial Compressive Strength (UCS) | Axial stress required to break the specimen |
| Fracture Index: (FI) | Frequency of natural fractures per 0.3m of core run. |

## STRENGTH CLASSIFICATION

| Rock Strength | Approximate Uniaxial Compressive Strength (MPa) | (psi) | Field Estimation of Hardness* |
|---|---|---|---|
| Extremely Strong | Greater than 250 | Greater than 36,000 | Specimen can only be chipped with a geological hammer |
| Very Strong | 100-250 | 15,000 to 36,000 | Requires many blows of geological hammer to break |
| Strong | 50-100 | 7,500 to 15,000 | Requires more than one blow of geological hammer to break |
| Medium Strong | 25.0 to 50.0 | 3,500 to 7,500 | Breaks under single blow of geological hammer. |
| Weak | 5.0 to 25.0 | 750 to 3,500 | Can be peeled by a pocket knife with difficulty |
| Very Weak | 1.0 to 5.0 | 150 to 750 | Can be peeled by a pocket knife, crumbles under firm blows of geological pick. |
| Extremely Weak (Rock) | 0.25 to 1.0 | 35 to 150 | Indented by thumbnail |

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-01 1 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION N 4 831 676.8 E 288 985.0 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN
DATUM Geodetic DATE 2009.03.12 - 2009.03.12 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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 40 80 120 160 200 (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.8 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (50mm) | | | | | | | | | | |
| | Silty CLAY, trace to some sand, trace gravel<br>Stiff<br>Brown<br>(FILL) | | 1 | SS | 9 | | | | o | | |
| | | | 2 | SS | 18 | | 187 | | o | | |
| 186.3 | | | | | | | | | | | |
| 1.5 | Silty CLAY, some sand, trace gravel, occasional oxidized staining<br>Very Stiff<br>Brown<br>(TILL) | | 3 | SS | 29 | | 186 | | o | | 2 41 42 15 |
| | | | 4 | SS | 25 | | | | o | | 3 48 40 9 |
| | Grey | | 5 | SS | 20 | | 185 | | o | | |
| | | | | | | | 184 | | | | |
| | | | 6 | SS | 23 | | 183 | | o | | 2 41 38 19 |
| | | | | | | | 182 | | | | |
| | | | 7 | SS | 19 | | | | o | | |
| | | | | | | | 181 | | | | |
| | | | 8 | SS | 32 | | 180 | | o | | 1 39 41 19 |
| | | | | | | | 179 | | | | |
| 178.4 | | | 9 | SS | 50/ 0.150 | | | | o | | |
| 9.4 | END OF BOREHOLE AT 9.4m.<br>BOREHOLE OPEN AND WATER LEVEL AT 2.8m UPON COMPLETION | | | | | | | | | | |

Continued Next Page

+ 3 , × 3 Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-01 2 OF 2 METRIC

G.W.P. 2107-05-00 LOCATION N 4 831 676.8 E 288 985.0 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN

DATUM Geodetic DATE 2009.03.12 - 2009.03.12 CHECKED BY RPR

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 40 80 120 160 200 (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | |
| | Continued From Previous Page | | | | | | | | | | |
| | OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

ONTMT4S 2311HML.GPJ 6/4/09

$+^{3}$, $\times^{3}$ Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-02 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 831 985.0 E 289 564.3 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN

DATUM Geodetic DATE 2009.03.12 - 2009.03.12 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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) (40 80 120 160 200) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 186.0 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (100mm) | | | | | | 186 | | | | |
| 0.1 | Silty CLAY, some sand, trace gravel<br>Stiff<br>Brown<br>(TILL) | | 1 | SS | 8 | | | | o | | |
| 185.1 | | | | | | | | | | | |
| 0.9 | SHALE, highly weathered<br>Reddish Brown | | 2 | SS | 14 | | 185 | | o | | |
| | | | 3 | SS | 74 | | | | o | | |
| | | | | | | | 184 | | | | |
| | Coring started at 2.7m<br>Slightly weathered, very weak to weak, occasional mechanical fractures<br>Clay seam at 2.8m.<br>Siltstone interbeds at 2.7, 2.9, 3.0, 3.3, 3.5, 3.6 and 4.0m.<br>Limestone interbeds at 3.3m.<br>Horizontal joints at 2.8, 3.0, 3.4, 3.9, 4.0 and 4.1m.<br>Rubble zone at 3.8 and 3.9m. | | 1 | RUN | | | 183 | | | | UCS = 101 MPa (Limestone)<br>RUN 1#<br>TCR=100%,<br>SCR=95%,<br>RQD=68%,<br>UCS=5MPa (Siltstone) |
| | | | | | | | 182 | | | | |
| | Slightly weathered, very weak, occasional mechanical fractures siltstone interbeds at 4.4, 4.5, 4.8, 5.3, 5.4, 5.5 and 5.7m. | | 2 | RUN | | | 181 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=3MPa (Shale)<br>UCS = 4 MPa (Shale) |
| 180.2 | | | | | | | | | | | |
| 5.8 | END OF BOREHOLE AT 5.8m.<br>BOREHOLE OPEN AND WATER LEVEL AT 1.3m UPON COMPLETION OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

$+^3$ $\times^3$ Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-03 1 OF 1 METRIC

G.W.P. 2107-05-00 | LOCATION N 4 832 130.7 E 289 746.8 | ORIGINATED BY GA
HWY 401 | BOREHOLE TYPE Solid Stem Augers/HO2 Coring Equipment | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.06 - 2009.03.06 | CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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) (40 80 120 160 200) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 190.6 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (50mm) | | | | | | | | | | |
| 0.0 | Silty CLAY, some sand, trace gravel<br>Stiff<br>Reddish Brown<br>(TILL) | | 1 | SS | 10 | | 190 | | O | | |
| 189.4 | | | 2 | SS | 23 | | | | O | | 4 18 56 22 |
| 1.2 | SHALE, highly weathered<br>Reddish Brown | | | | | | 189 | | | | |
| | Coring started at 2.7m<br>Highly to moderately weathered, very weak<br>Rubble zone at 2.7 to 2.8m, 3.4m to 3.5m, 3.7m to 3.8m and 4.0m to 4.1m.<br>Green siltstone interbeds at 2.7 and 3.3m.<br>Horizontal joints at 2.7, 3.0, 3.1, 3.3, 3.5, 3.6 and 3.7m. | | 1 | RUN | | | 188 | | | | RUN 1#<br>TCR=100%,<br>SCR=75%,<br>RQD=46%,<br>UCS=3MPa<br>(Shale) |
| | Moderately to slightly weathered, very weak to weak<br>Occasional mechanical fractures<br>Siltstone interbeds at 4.4, 4.5, 4.7, 4.8, 5.0, 5.2, 5.4 and 5.7m.<br>Limestone interbeds at 5.3 and 5.5m. | | 2 | RUN | | | 187 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=18MPa<br>(Shale/Siltstone)<br>UCS = 3 MPa<br>(Siltstone)<br>UCS = 3 MPa<br>(Shale/Siltstone) |
| 184.8 | | | | | | | 186 | | | | |
| 5.8 | END OF BOREHOLE AT 5.8m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.7m UPON COMPLETION OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | 185 | | | | |

$+^{3}$ , $\times^{3}$ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

THURBER

# RECORD OF BOREHOLE No OHS-05 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 562.0 E 290 592.5 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN

DATUM Geodetic DATE 2009.03.09 - 2009.03.09 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE, 40 80 120 160 200 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 195.2 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (50mm) | | | | | | | | | | |
| | Silty CLAY, some sand, trace gravel<br>Firm to Very Stiff<br>Brown<br>(TILL) | | 1 | SS | 6 | | 195 | | | | |
| | | | 2 | SS | 11 | | 194 | | o — ⊢ | | 2 38 38 22 |
| 193.1 | | | 3 | SS | 24 | | | | o | | |
| 2.1 | SHALE, highly weathered<br>Reddish Brown | | | | | | 193 | | | | |
| | Coring started at 3.0m.<br>Highly to moderately weathered, very weak<br>Occasional mechanical fractures | | 1 | RUN | | | 192 | | | | RUN 1#<br>TCR=60%,<br>SCR=23%,<br>RQD=20%,<br>UCS=3MPa<br>(Shale/Siltstone) |
| | | | | | | | 191 | | | | |
| | Medium to slightly weathered, very weak to weak<br>Limestone interbeds at 4.7, 5.0, 5.1 and 5.2m.<br>Siltstone interbeds at 4.5, 4.7, 4.8, 5.0, 5.1, 5.2 and 5.3m.<br>Rubble zone at 5.0 to 5.2m. | | 2 | RUN | | | 190 | | | | RUN 2#<br>TCR=100%,<br>SCR=92%,<br>RQD=92%,<br>UCS=3MPa<br>(Shale) |
| 189.2 | | | | | | | | | | | UCS = 3 MPa (Shale) |
| 6.0 | END OF BOREHOLE AT 6.0m.<br>BOREHOLE OPEN AND WATER LEVEL AT SURFACE.<br>Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. | | | | | | | | | | |

WATER LEVEL READINGS:

| DATE | DEPTH (m) | ELEV. (m) |
|---|---|---|
| 2009.03.12 | 1.3 | 193.9 |
| 2009.03.26 | 1.1 | 194.1 |
| 2009.04.16 | 0.7 | 194.5 |

+ 3 , × 3 Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 4/20/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-06 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 762.8 E 290 815.9 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN
DATUM Geodetic DATE 2009.03.11 - 2009.03.11 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 192.6 Geodetic | | | | | | | | 20 40 60 80 100 / 40 80 120 160 200 | 20 40 60 | | |
| 0.0 | TOPSOIL (75mm) | | | | | | | | | | |
| 0.1 | Silty CLAY, some sand, trace gravel, occasional oxidized staining<br>Firm to Very Stiff<br>Brown<br>(TILL) | | 1 | SS | 6 | | 192 | | | | |
| | | | 2 | SS | 7 | | | | | | 2 31 43 24 |
| | | | 3 | SS | 23 | | 191 | | | | |
| 190.5 | | | | | | | | | | | |
| 2.1 | SHALE, highly weathered<br>Reddish Brown | | | | | | 190 | | | | |
| | Coring started at 2.7m<br>Slightly weathered, very weak to weak, occasional mechanical fractures<br>Horizontal joints at 2.8, 2.9, 3.0, 3.9, 4.0 and 4.1m.<br>Siltstone interbeds at 2.7, 2.9 and 3.3m.<br>Limestone interbeds at 2.7 and 2.8m. | | 1 | RUN | | | 189 | | | | RUN 1#<br>TCR=100%,<br>SCR=89%,<br>RQD=78%,<br>UCS=4MPa<br>(Siltstone) |
| | Slightly weathered to medium weathered, weak<br>Siltstone interbeds at 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7m.<br>Rubble zone at 4.2, 4.4, 4.5 and 4.6m. | | 2 | RUN | | | 188 | | | | RUN 2#<br>TCR=43%,<br>SCR=16%,<br>RQD=13%,<br>UCS=3MPa<br>(Shale) |
| 186.9 | | | | | | | 187 | | | | |
| 5.7 | END OF BOREHOLE AT 5.7m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.3m UPON COMPLETION OF DRILLING.<br>Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.<br>WATER LEVEL READINGS:<br>DATE DEPTH (m) ELEV. (m)<br>2009.03.26 2.7 189.8<br>2009.04.16 2.7 189.8 | | | | | | | | | | |

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 4/20/09

Ministry of Transportation
Ontario

THURBER

# RECORD OF BOREHOLE No OHS-07 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 725.4 E 290 852.1 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN

DATUM Geodetic DATE 2009.03.09 - 2009.03.09 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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) (40 80 120 160 200) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) (20 40 60) | UNIT WEIGHT $\gamma$ kN/m$^3$ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 194.1 | Geodetic | | | | | | | | | | |
| 0.0 | SAND and GRAVEL, trace silt<br>Compact<br>Brown<br>Moist<br>(FILL) | | 1 | SS | 25 | | 194 | | o | | |
| | | | 2 | SS | 19 | | 193 | | o | | 37 46 17<br>(SI+CL) |
| 192.6 | | | | | | | | | | | |
| 1.5 | SHALE, highly weathered, thinly bedded<br>Reddish Brown | | 3 | SS | 35 | | 192 | | o | | |
| | Coring started at 3.0m.<br>Highly to moderately weathered, very weak<br>Rubble zone at 3.1 to 3.2m, 3.4 to 3.5m, 3.8 to 3.9m and 4.3 to 4.4m.<br>Siltstone interbeds at 3.4, 3.8, 3.9, 4.0, 4.4 and 4.5m.<br>Horizontal joints at 3.1, 3.6, 3.7 and 3.9m. | | 1 | RUN | | | 191 | | | | RUN 1#<br>TCR=100%,<br>SCR=73%,<br>RQD=51%,<br>UCS=3MPa<br>(Shale/Siltstone) |
| | Moderately to slightly weathered, very weak<br>Siltstone interbeds at 4.5 to 4.6m, 4.8, 5.0, 5.2, 5.3, 5.4, 5.6, 5.7 and 5.9m.<br>Highly mechanical fractured zone at 4.6 to 4.7m, 4.8 to 4.9m, 5.0 to 5.1m and 5.7 to 5.8m. | | 2 | RUN | | | 190<br>189 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=13MPa<br>(Siltstone) |
| 188.1 | | | | | | | | | | | UCS = 18 MPa<br>(Siltstone) |
| 6.0 | END OF BOREHOLE AT 6.0m.<br>BOREHOLE OPEN AND WATER LEVEL AT 1.5m UPON COMPLETION OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

$+^3$, $\times^3$ Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-08 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 772.6 E 290 976.3 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN
DATUM Geodetic DATE 2009.03.06 - 2009.03.06 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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 ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 40 80 120 160 200 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 194.9 | Geodetic | | | | | | | | | | |
| 0.0 | SAND and GRAVEL, trace silt<br>Compact<br>Brown<br>Wet<br>(FILL) | | 1 | SS | 20 | | | | ○ | | 40 48 12 (SI+CL) |
| 194.1 | | | | | | | 194 | | | | |
| 0.8 | SHALE, highly weathered<br>Reddish Brown | | 2 | SS | 43 | | | | ○ | | |
| | | | 3 | SS | 60/.100 | | 193 | | ○ | | |
| | Coring started at 2.7m.<br>Highly to moderately weathered, very weak<br>Rubble zone at 2.7 to 2.9m, 3.2 to 3.5 and 4.2 to 4.3m.<br>Siltstone interbeds at 2.8, 3.0, 3.2, 3.6, 3.9, 4.2, 4.3 and 4.4m. | | 1 | RUN | | | 192 | | | | RUN 1#<br>TCR=100%,<br>SCR=40%,<br>RQD=32%,<br>UCS=40MPa<br>(Limestone) |
| | | | | | | | 191 | | | | UCS = 6 MPa<br>(Shale) |
| | Slightly moderately to fresh, very weak to weak<br>Limestone interbeds at 4.6 and 5.1m.<br>Siltstone interbeds at 4.6, 4.8, 4.9, 5.0, 5.2, 5.4, 5.5, 5.6, 5.7 and 5.8m. | | 2 | RUN | | | 190 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=135MPa<br>(Limestone)<br>UCS = 4 MPa<br>(Siltstone) |
| 189.1 | | | | | | | | | | | |
| 5.8 | END OF BOREHOLE AT 5.8m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.9m UPON COMPLETION OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

+ ³ , × ³ : Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-09 1 OF 1 METRIC

G.W.P. 2107-05-00 | LOCATION N 4 832 860.5 E 291 099.7 | ORIGINATED BY GA
HWY 401 | BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment | COMPILED BY AN
DATUM Geodetic | DATE 2009.03.11 - 2009.03.11 | CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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 (40 80 120 160 200): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 191.1 | Geodetic | | | | | | | | | | |
| 0.0 / 0.1 | TOPSOIL (75mm) | | | | | | 191 | | | | |
| | SHALE, highly weathered<br>Stiff to Firm<br>Reddish Brown<br>Moist<br>(FILL) | | 1 | SS | 9 | | | | o | | |
| | | | 2 | SS | 6 | | 190 | | o | | |
| 189.6 | | | | | | | | | | | |
| 1.5 | Silty CLAY, trace sand, occasional rootlets<br>Firm<br>Brown | | 3 | SS | 7 | | | | o | | 0 14 46 40 |
| 188.8 | | | | | | | 189 | | | | |
| 2.3 | Silty CLAY, some sand, trace gravel<br>Very Stiff<br>Brown<br>(TILL) | | 4 | SS | 21 | | | | o | | |
| | | | 5 | SS | 48 | | 188 | | o⊢ | | 2 31 46 22 |
| 187.4 | | | | | | | | | | | |
| 3.7 | SHALE, highly weathered<br>Reddish Brown<br>Coring started at 3.9m.<br>Medium to slightly weathered, very weak to weak<br>Occasional mechanical fractures<br>Siltstone interbeds at 3.9, 4.1, 4.2, 4.4, 4.6, 4.8, 4.9, 5.2, 5.4 and 5.5m.<br>Horizontal joints at 4.0 and 4.1m.<br>Rubble zone at 4.0 and 4.1m.<br>Limestone interbeds from 5.5 to 5.6m. | | 1 | RUN | | | 187 | | | | RUN 1#<br>TCR=100%,<br>SCR=95%,<br>RQD=95%,<br>UCS=29MPa (Siltstone) |
| | Slightly weathered to fresh, weak to strong<br>Siltstone interbeds at 5.4, 5.7, 6.0, 6.1, 6.2, 6.5 and 6.6m.<br>Limestone interbeds at 6.7 and 6.8m. | | 2 | RUN | | | 186 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=26MPa (Siltstone)<br>UCS = 31 MPa (Siltstone)<br>UCS = 3 MPa (Shale) |
| 184.1 | | | | | | | 185 | | | | |
| 7.0 | END OF BOREHOLE AT 7.0m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.6m.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

$+^{3}$ $\times^{3}$ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-10 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 953.0 E 291 210.0 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN
DATUM Geodetic DATE 2009.03.11 - 2009.03.11 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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 (40 80 120 160 200) O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 189.2 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (50mm) | | | | | | 189 | | | | |
| 0.6 | SAND, trace gravel<br>Compact<br>Brown<br>Wet | | 1 | SS | 15 | | | | | | |
| 188.4 | (FILL) | | 2 | SS | 50/ | | | | | | |
| 0.8 | SHALE, highly weathered<br>Reddish Brown<br><br>Layer of siltstone | | | | 0.100 | | 188 | | | | |
| | | | 3 | SS | 50/ | | | | | | |
| | | | | | 0.050 | | 187 | | | | |
| | Coring started at 2.7m.<br>Slightly weathered to fresh, weak to strong<br>Occasional mechanical fractures<br>Siltstone interbeds at 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.8 and 4.2m.<br>Limestone interbeds at 3.2 and 3.3m.<br>Horizontal joints at 2.7, 2.8 and 2.9m. | | 1 | RUN | | | 186 | | | | RUN 1#<br>TCR=100%,<br>SCR=100%,<br>RQD=83%,<br>UCS=103MPa (Siltstone)<br>UCS = 87 MPa (Limestone)<br>UCS = 85 MPa (Siltstone) |
| | Fresh, thinly bedded, weak to strong<br>Limestone interbeds at 4.4, 5.0, 5.1 and 5.2m.<br>Siltstone interbeds at 4.4, 4.7, 4.9, 5.4 and 5.7m.<br>Rubble zone from 5.3 to 5.4m. | | 2 | RUN | | | 185 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=20MPa (Limestone) |
| 183.4 | | | | | | | 184 | | | | |
| 5.8 | END OF BOREHOLE AT 5.8m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.6m UPON COMPLETION OF DRILLING.<br>Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. | | | | | | | | | | |

WATER LEVEL READINGS:

| DATE | DEPTH (m) | ELEV. (m) |
|---|---|---|
| 2009.03.12 | 1.9 | 187.3 |
| 2009.03.26 | 2.9 | 186.3 |
| 2009.04.16 | 2.9 | 186.3 |

+ 3 , × 3 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 4/20/09

Ministry of Transportation
Ontario

# RECORD OF BOREHOLE No OHS-11 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 832 950.7 E 291 376.7 ORIGINATED BY GA
HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN
DATUM Geodetic DATE 2009.03.10 - 2009.03.10 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ / WATER CONTENT (%) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.5 | Geodetic | | | | | | | 20 40 60 80 100 / 40 80 120 160 200 | 20 40 60 | | |
| 0.0 | TOPSOIL (50mm) | | | | | | | | | | |
| | Silty CLAY, trace to some sand, trace gravel<br>Stiff<br>Brown | | 1 | SS | 10 | | | | ○ | | |
| 186.7 | | | | | | | 187 | | | | |
| 0.8 | (FILL) | | | | | | | | | | |
| | Silty CLAY, some sand, trace gravel, occasional rootlets<br>Stiff to Very Stiff<br>Brown<br>(TILL) | | 2 | SS | 10 | | | | ○ | | 3 33 43 20 |
| | | | 3 | SS | 24 | | 186 | | ○ | | |
| 185.4 | | | | | | | | | | | |
| 2.1 | SHALE, highly weathered<br>Reddish Brown | | | | | | | | | | |
| | Coring started at 2.7m.<br>Highly to slightly weathered, weak to very weak<br>Rubble zone at 2.9 to 3.0m and 3.4 to 3.6m.<br>Siltstone interbeds at 3.0, 3.2, 3.4, 3.5, 3.6 and 3.8m.<br>Horizontal joints at 3.0, 3.1, 3.2, 3.4 and 3.6m. | | 1 | RUN | | | 185 | | | | RUN 1#<br>TCR=100%,<br>SCR=86%,<br>RQD=66%,<br>UCS=60MPa (Shale/Siltstone)<br>UCS = 22 MPa (Shale) |
| | | | | | | | 184 | | | | |
| | Slightly weathered to fresh, weak to strong, occasional mechanical fractures<br>Limestone interbeds at 4.3, 4.5, 5.0, 5.3, 5.6 and 5.7m<br>Siltstone interbeds at 4.5 to 4.7m. | | 2 | RUN | | | 183 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=35MPa (Limestone)<br>UCS = 19 MPa (Limestone)<br>UCS = 59 MPa (Limestone) |
| 181.7 | | | | | | | 182 | | | | |
| 5.8 | END OF BOREHOLE AT 5.8m.<br>BOREHOLE OPEN AND WATER LEVEL AT 1.3m UPON COMPLETION OF DRILLING.<br>BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE. | | | | | | | | | | |

$+^{3}$, $\times^{3}$ Numbers refer to Sensitivity

$15 \overset{20}{\oplus} 5$ $\overset{}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 6/4/09

Ministry of Transportation
Ontario

THURBER

# RECORD OF BOREHOLE No OHS-12 1 OF 1 METRIC

G.W.P. 2107-05-00 LOCATION N 4 833 070.2 E 291 489.8 ORIGINATED BY GA

HWY 401 BOREHOLE TYPE Solid Stem Augers/HQ2 Coring Equipment COMPILED BY AN

DATUM Geodetic DATE 2009.03.10 - 2009.03.10 CHECKED BY RPR

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | 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) 40 80 120 160 200 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 186.4 | Geodetic | | | | | | | | | | |
| 0.0 | TOPSOIL (75mm) | | | | | | | | | | |
| 0.1 | Silty CLAY, trace to some sand, trace gravel<br>Frim to Hard<br>Brown<br>(TILL) | | 1 | SS | 7 | | 186 | | o | | |
| | | | 2 | SS | 10 | | | | o | | |
| | | | 3 | SS | 12 | | 185 | | o—— | | 0 12 43 45 |
| | | | 4 | SS | 30 | | 184 | | o | | |
| | | | 5 | SS | 51 | ▼ | 183 | | o | | |
| 182.4 | | | | | | | | | | | |
| 4.0 | **SHALE**, slightly weathered to fresh<br>Grey<br>Coring started at 3.9m<br>Horizontal joints at 4.1, 4.2 and 4.4m.<br>Limestone interbeds at 4.0 to 4.1m and 4.7 to 4.8m.<br>Rubble zone at 4.9 to 5.0m, 5.3 to 5.4m. | | 1 | RUN | | | 182 | | | | RUN 1#<br>TCR=100%,<br>SCR=95%,<br>RQD=83%,<br>UCS=58MPa (Limestone)<br>UCS = 61 MPa (Limestone)<br>UCS = 9 MPa (Shale) |
| | Slightly weathered to fresh, weak to strong<br>Limestone interbeds at 5.5, 5.6, 5.7, 5.9, 6.2, 6.3, 6.4, 6.5, 6.7, 6.8 and 6.9m.<br>Horizontal joints at 6.8m. | | 2 | RUN | | | 181 | | | | RUN 2#<br>TCR=100%,<br>SCR=100%,<br>RQD=100%,<br>UCS=34MPa (Limestone)<br>UCS = 38 MPa (Limestone)<br>UCS = 65 MPa (Limestone)<br>UCS = 17 MPa (Limestone) |
| 179.4 | | | | | | | 180 | | | | |
| 7.0 | END OF BOREHOLE AT 7.0m.<br>BOREHOLE OPEN AND WATER LEVEL AT 0.9m UPON COMPLETION OF DRILLING.<br>Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.<br><br>WATER LEVEL READINGS:<br>DATE DEPTH (m) ELEV. (m)<br>2009.03.12 2.9 183.5<br>2009.03.26 3.2 183.2<br>2009.04.16 3.2 183.2 | | | | | | | | | | |

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2311HML.GPJ 4/20/09

# Appendix B

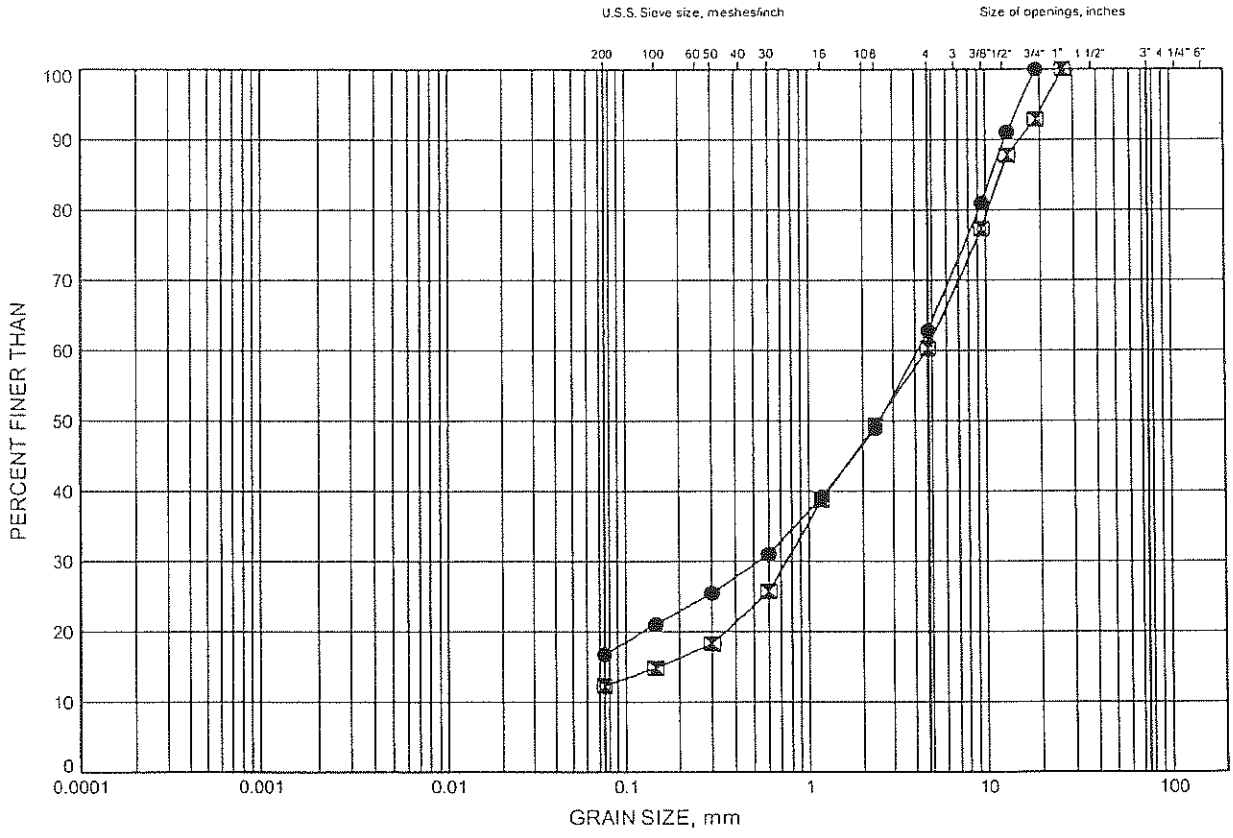
## Laboratory Test Results

Hwy 401 Widening

# GRAIN SIZE DISTRIBUTION

FIGURE B1

## COHESIONLESS FILL




| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
|---|---|---|---|---|---|---|
| FINE GRAINED | SAND | | | GRAVEL | | |

### LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|---|---|---|---|
| ● | OHS-07 | 1.07 | 193.03 |
| ⊠ | OHS-08 | 0.30 | 194.60 |

W.P.# 2107-05-00
Prepared By MFA
Checked By DEE

THURBER

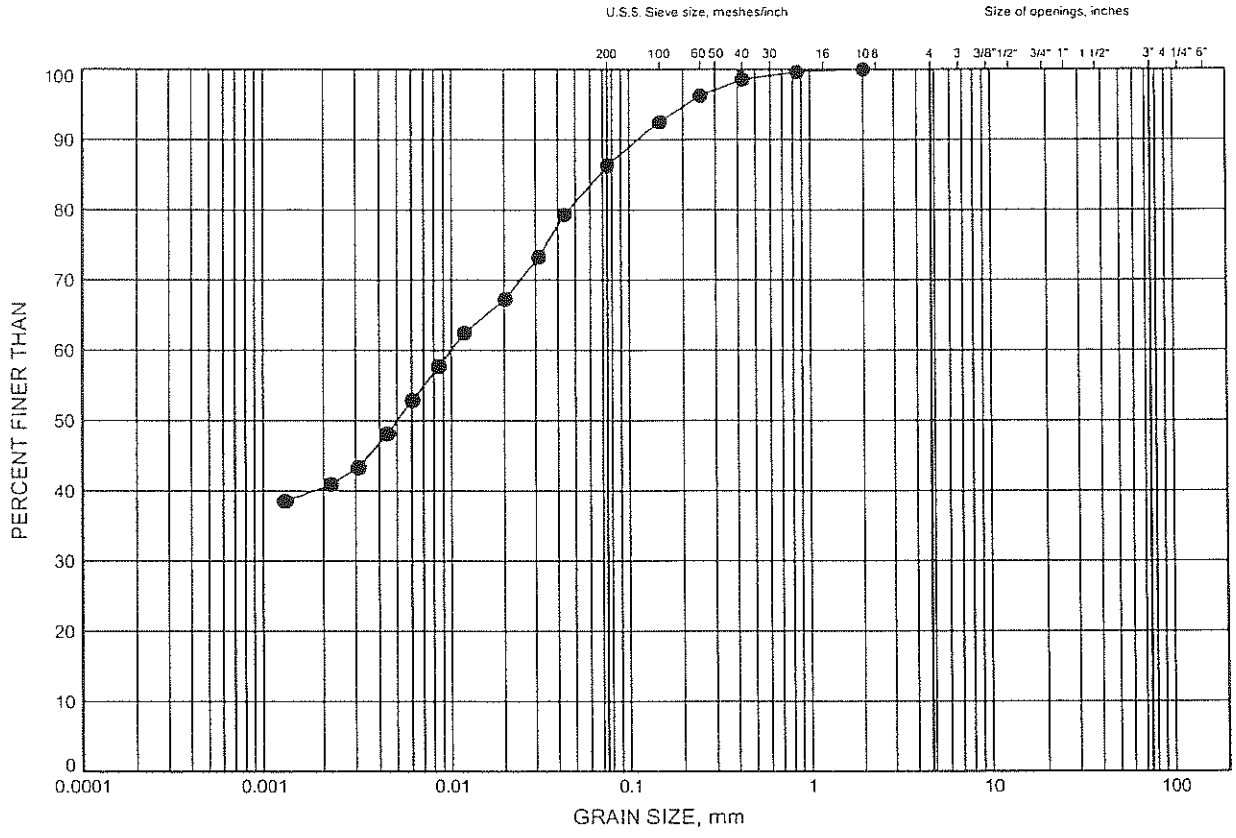
GRAIN SIZE DISTRIBUTION - THURBER 2311HWL.GPJ 8/4/09

Hwy 401 Widening

# GRAIN SIZE DISTRIBUTION

FIGURE B2

## SILTY CLAY




| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
|---|---|---|---|---|---|---|
| FINE GRAINED | SAND | | | GRAVEL | | |

### LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|---|---|---|---|
| ● | OHS-09 | 1.83 | 189.27 |

W.P.# 2107-05-00
Prepared By MFA
Checked By DEE

THURBER

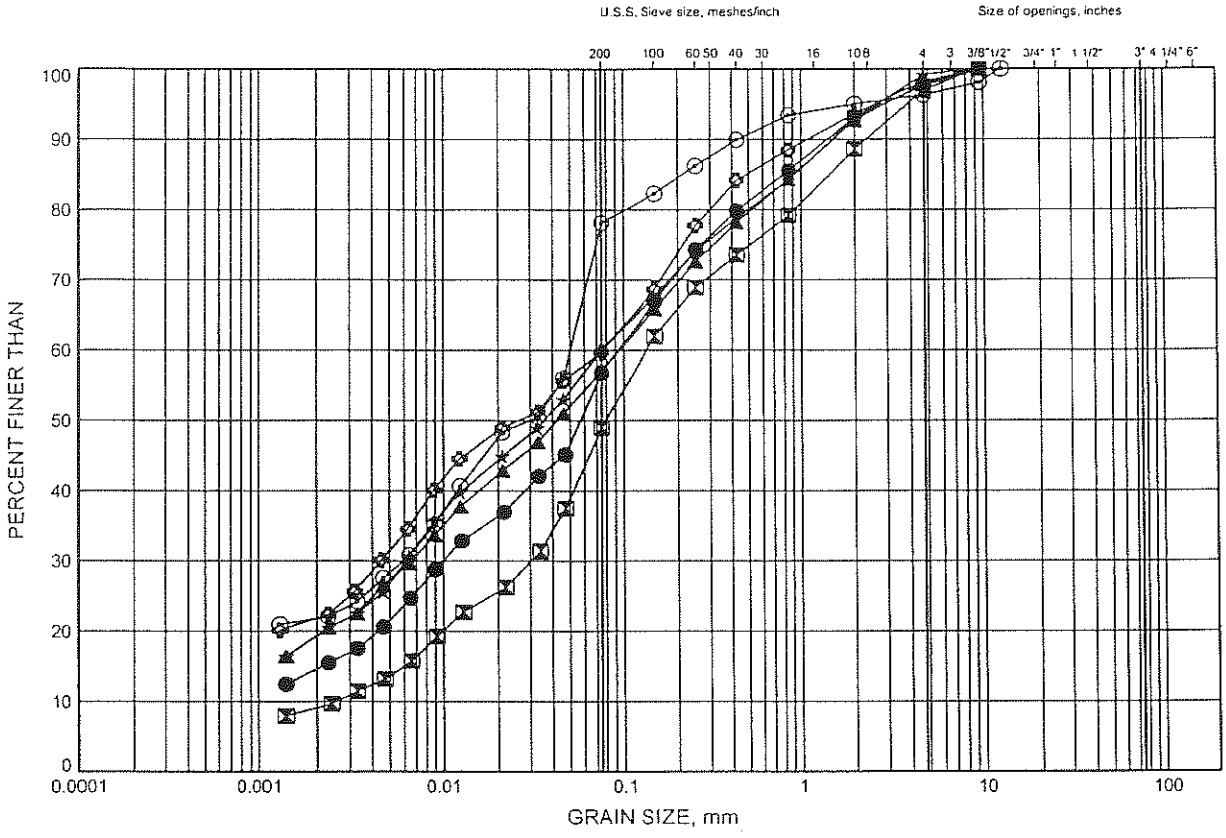
GRAIN SIZE DISTRIBUTION - THURBER 2311HML.GPJ 8/4/09

Hwy 401 Widening

# GRAIN SIZE DISTRIBUTION

FIGURE B3

## SILTY CLAY TILL




| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
|---|---|---|---|---|---|---|
| FINE GRAINED | SAND | | | GRAVEL | | |

### LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|---|---|---|---|
| ● | OHS-01 | 1.83 | 185.97 |
| ◪ | OHS-01 | 2.59 | 185.21 |
| ▲ | OHS-01 | 4.88 | 182.92 |
| ★ | OHS-01 | 7.92 | 179.88 |
| ⊙ | OHS-03 | 1.07 | 189.53 |
| ✪ | OHS-05 | 1.07 | 194.13 |

W.P.# 2107-05-00
Prepared By MFA
Checked By DEE

THURBER

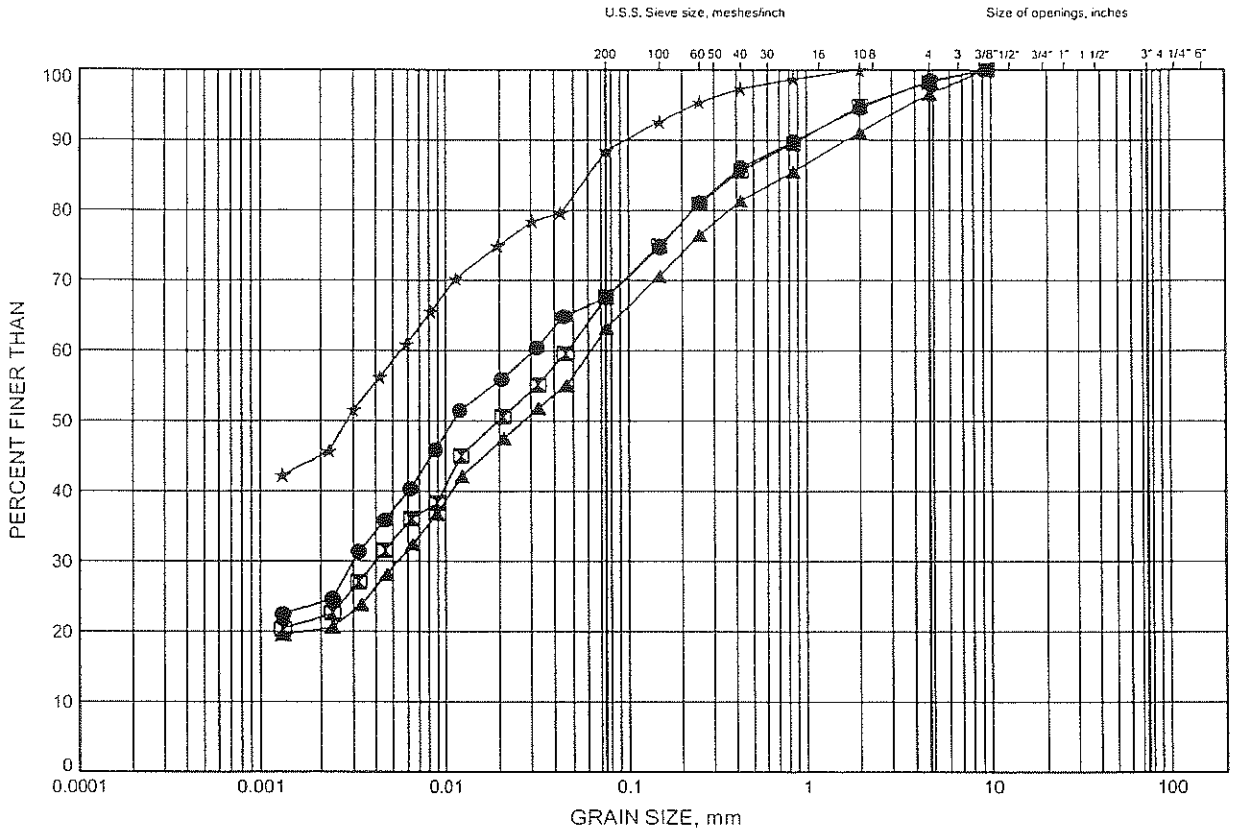
GRAIN SIZE DISTRIBUTION - THURBER 2311HWL.GPJ 8/4/09

Hwy 401 Widening

# GRAIN SIZE DISTRIBUTION

FIGURE B4

## SILTY CLAY TILL




| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
|---|---|---|---|---|---|---|
| FINE GRAINED | SAND | | | GRAVEL | | |

### LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|---|---|---|---|
| ● | OHS-06 | 1.07 | 191.53 |
| ⊠ | OHS-09 | 3.35 | 187.75 |
| ▲ | OHS-11 | 1.07 | 186.43 |
| ★ | OHS-12 | 1.83 | 184.57 |

W.P.# 2107-05-00
Prepared By MFA
Checked By DEE

THURBER

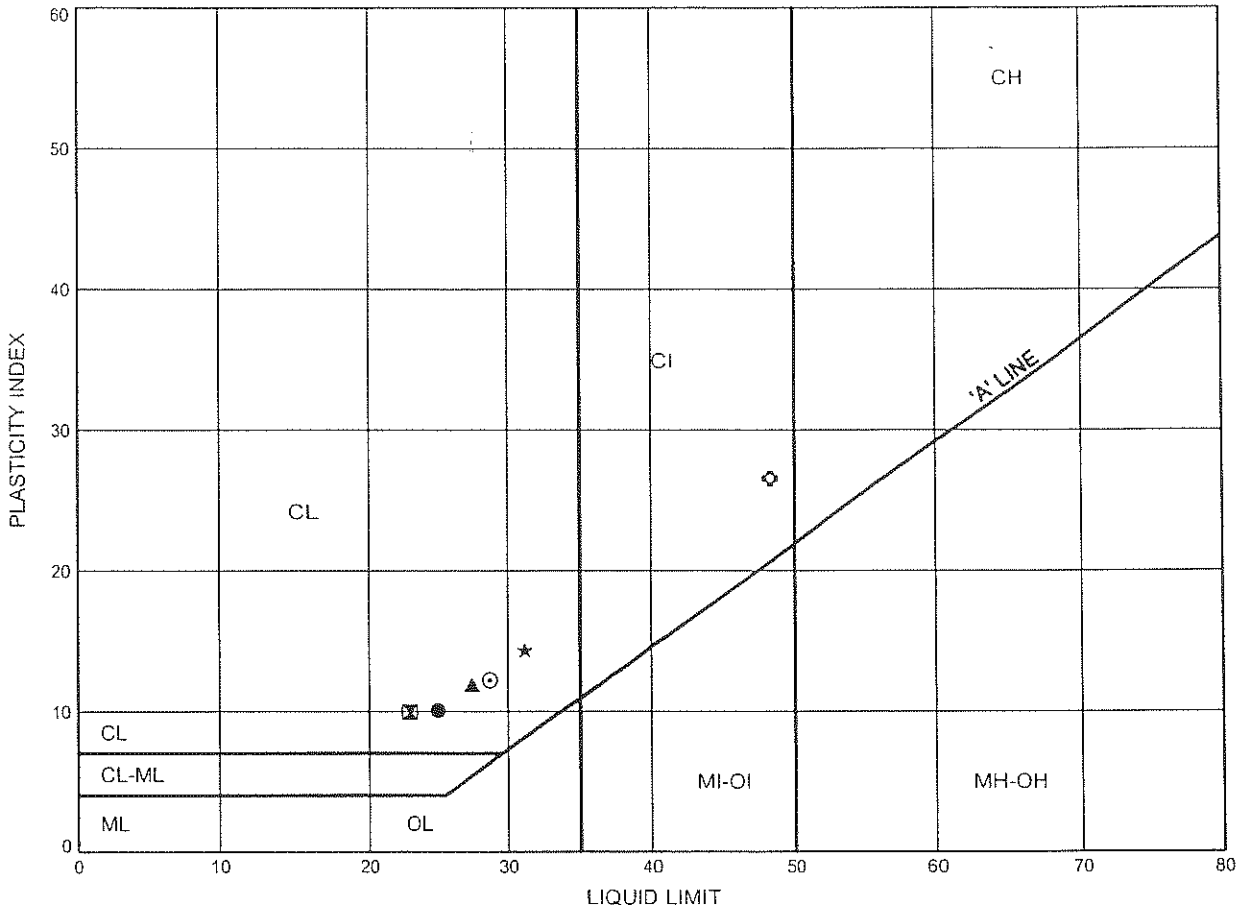
GRAIN SIZE DISTRIBUTION - THURBER 2311HML.GPJ 8/4/09

Hwy 401 Widening

# ATTERBERG LIMITS TEST RESULTS

FIGURE B5

## SILTY CLAY TILL




| SYMBOL | BH | DEPTH (m) | ELEV. (m) |
|---|---|---|---|
| ● | OHS-01 | 1.83 | 185.97 |
| ⊠ | OHS-01 | 4.88 | 182.92 |
| ▲ | OHS-05 | 1.07 | 194.13 |
| ★ | OHS-06 | 1.07 | 191.53 |
| ⊙ | OHS-09 | 3.35 | 187.75 |
| ✿ | OHS-12 | 1.83 | 184.57 |

Date April 2009

Project 2107-05-00

THURBER

Prep'd MFA

Chkd. DEE

THURBALT 2311HML.GPJ 8/4/09

# Appendix C

## List of Special Provisions

## and

## Suggested Text for NSSP

**List of Special Provisions Referenced in this Report**

SP 903S01

**Suggested Text for NSSP on:**
**"Augered Caisson Construction for Overhead Sign Supports (OHS) Foundations"**

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the OHS foundations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

For bidding purposes, the Contractor shall assume the following:

1. The subsurface conditions at an augered caisson location are the same as those encountered in the borehole closest to the subject caisson location.

2. There is a probability that occasional cobbles and boulders may be encountered within the glacial till deposits. Obstructions may also be present within the fill. The strength of the shale bedrock increases with depth below the upper 1 to 2 m (weathered) zone, and hard limestone and siltstone interbeds are present in the shale. Caisson installation equipment must be able to penetrate these obstructions and hard layers in the shale and limestone bedrock.

3. The depth to the top of weathered shale bedrock is variable across the site and may be encountered at a higher elevation at an OHS location than that shown in the nearest borehole logs. Contractor's caisson installation equipment must be capable of drilling/coring through the bedrock to the design depth of the caisson.

4. Water seepage and/or soil sloughing into the caisson hole may occur from existing fill at some locations. The cohesionless soils would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site, or be made available on very short notice, to support the caisson sidewalls and provide seepage cut-off where required.

The Contractor is responsible for constructing the OHS foundations without disturbing the material at the sides or bases of the foundations.

# Appendix D

## Borehole Location Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

# METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

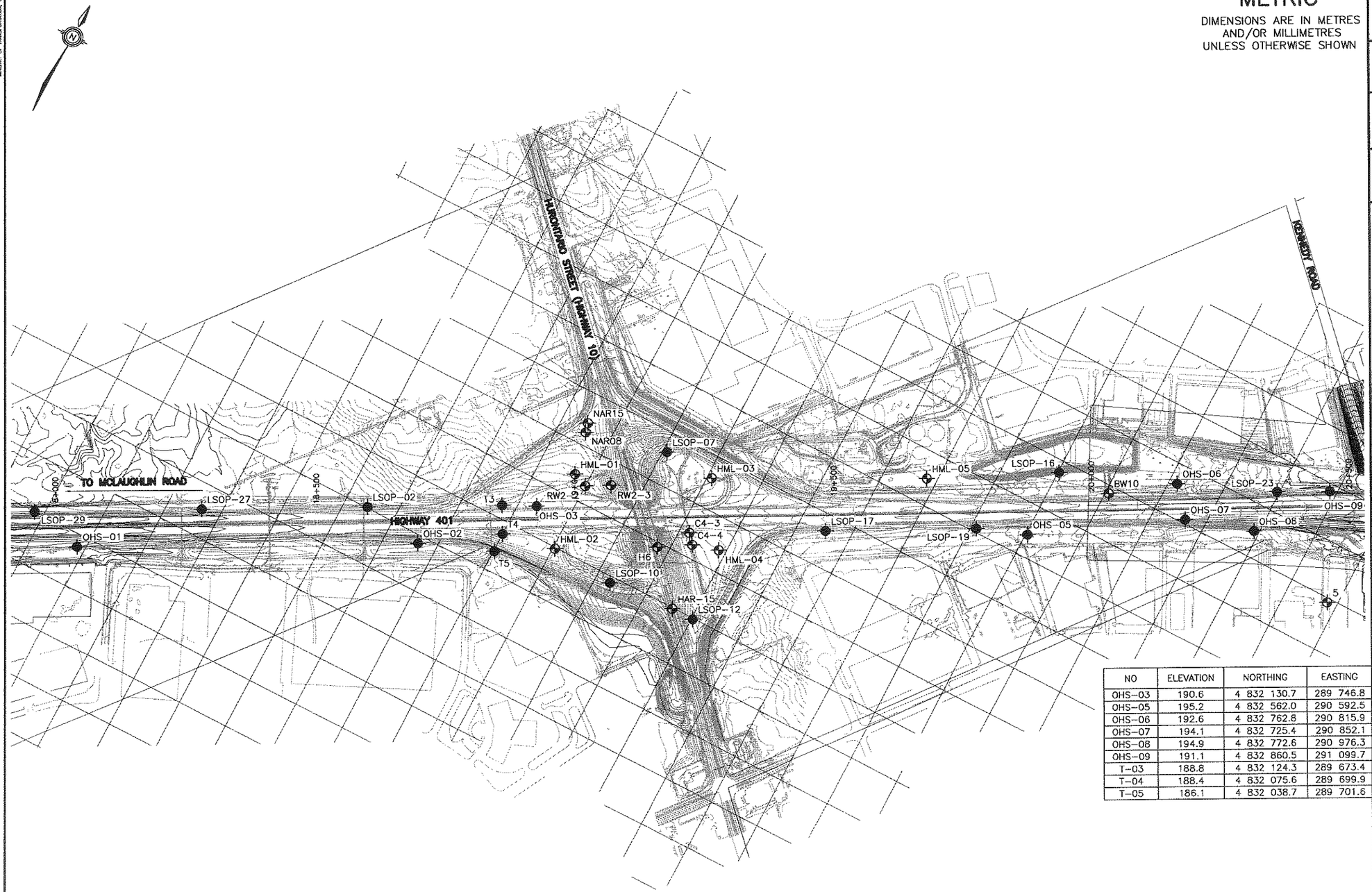
CONT No
GWP No

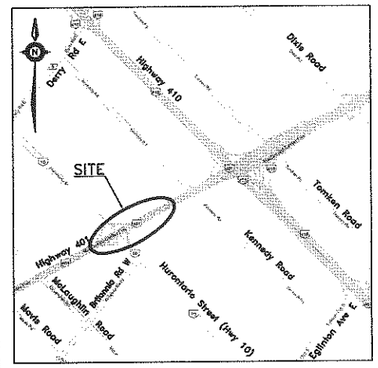
HIGHWAY 401
OVERHEAD SIGN SUPPORTS
WEST OF KENNEDY ROAD
BOREHOLE LOCATION PLAN

SHEET

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS




KEYPLAN

## LEGEND

| | |
|---|---|
| ⊕ | Borehole (Present Investigation) |
| ⊕ | Borehole (Previous Investigation) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
| ▽ | Water Level |
| ▼ | Head Artesian Water |
| | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

| NO | ELEVATION | NORTHING | EASTING |
|---|---|---|---|
| OHS-03 | 190.6 | 4 832 130.7 | 289 746.8 |
| OHS-05 | 195.2 | 4 832 562.0 | 290 592.5 |
| OHS-06 | 192.6 | 4 832 762.8 | 290 815.9 |
| OHS-07 | 194.1 | 4 832 725.4 | 290 852.1 |
| OHS-08 | 194.9 | 4 832 772.6 | 290 976.3 |
| OHS-09 | 191.1 | 4 832 860.5 | 291 099.7 |
| T-03 | 188.8 | 4 832 124.3 | 289 673.4 |
| T-04 | 188.4 | 4 832 075.6 | 289 699.9 |
| T-05 | 186.1 | 4 832 038.7 | 289 701.6 |

| NO | ELEVATION | NORTHING | EASTING |
|---|---|---|---|
| LSOP-02 | 187.7 | 4 832 002.1 | 289 444.2 |
| LSOP-07 | 193.2 | 4 832 362.2 | 289 908.1 |
| LSOP-10 | 194.8 | 4 832 087.8 | 289 929.3 |
| LSOP-12 | 192.7 | 4 832 097.9 | 290 102.7 |
| LSOP-16 | 194.6 | 4 832 676.7 | 290 601.9 |
| LSOP-17 | 194.6 | 4 832 368.2 | 290 252.0 |
| LSOP-19 | 195.4 | 4 832 507.4 | 290 511.1 |
| LSOP-23 | 192.2 | 4 832 837.6 | 290 995.3 |
| LSOP-27 | 187.8 | 4 831 851.6 | 289 163.9 |
| LSOP-29 | 189.0 | 4 831 700.1 | 288 882.1 |
| OHS-01 | 187.8 | 4 831 676.8 | 288 985.0 |
| OHS-02 | 186.0 | 4 831 985.0 | 289 564.3 |

## -NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 30M12-277

80 0 100 200m
SCALE 1:8000

| REVISIONS | | |
|---|---|---|
| DATE | BY | DESCRIPTION |
| | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DESIGN | RPR | CHK AEG | CODE | LOAD | DATE | APR. 2009 |
| DRAWN | MFA | CHK PKS | SITE | STRUCT | DWG | 1 |

FILENAME: H:\Drafting\191\1423\11 Hwy 401\let2311-BoreholePlan(OHS).dwg

MINISTRY OF TRANSPORTATION, ONTARIO

# METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

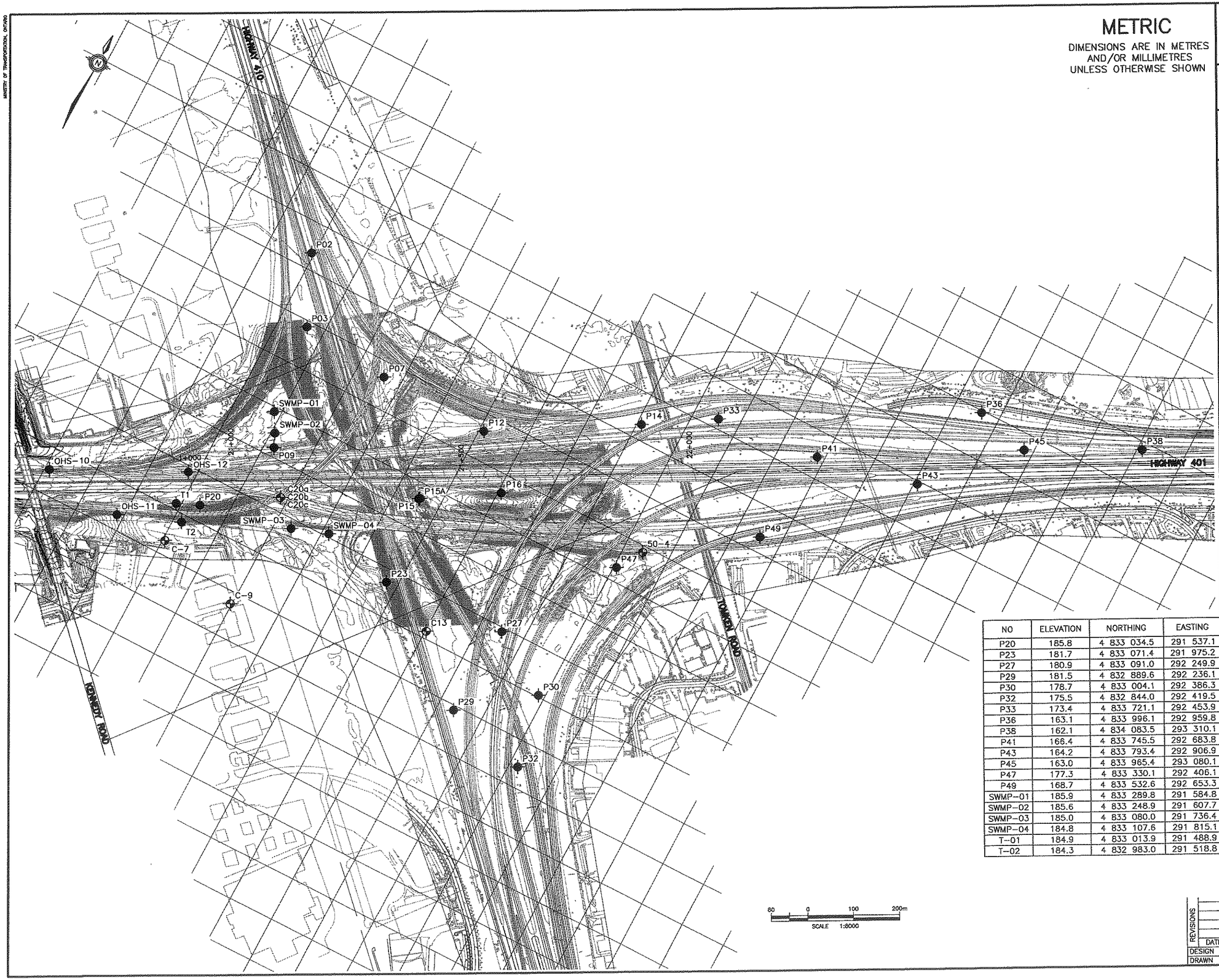
CONT No
GWP No

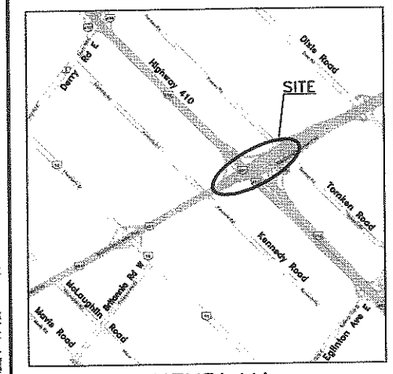
HIGHWAY 401
OVERHEAD SIGN SUPPORTS
EAST OF KENNEDY ROAD
BOREHOLE LOCATION PLAN

SHEET

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS




KEYPLAN

## LEGEND

| | |
|---|---|
| ⊕ | Borehole (Present Investigation) |
| ⊖ | Borehole (Previous Investigation) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
| ▽ | Water Level |
| ▼ | Head Artesian Water |
| | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

| NO | ELEVATION | NORTHING | EASTING |
|---|---|---|---|
| P20 | 185.8 | 4 833 034.5 | 291 537.1 |
| P23 | 181.7 | 4 833 071.4 | 291 975.2 |
| P27 | 180.9 | 4 833 091.0 | 292 249.9 |
| P29 | 181.5 | 4 832 889.6 | 292 236.1 |
| P30 | 178.7 | 4 833 004.1 | 292 386.3 |
| P32 | 175.5 | 4 832 844.0 | 292 419.5 |
| P33 | 173.4 | 4 833 721.1 | 292 453.9 |
| P36 | 163.1 | 4 833 996.1 | 292 959.8 |
| P38 | 162.1 | 4 834 083.5 | 293 310.1 |
| P41 | 166.4 | 4 833 745.5 | 292 683.8 |
| P43 | 164.2 | 4 833 793.4 | 292 906.9 |
| P45 | 163.0 | 4 833 965.4 | 293 080.1 |
| P47 | 177.3 | 4 833 330.1 | 292 406.1 |
| P49 | 168.7 | 4 833 532.6 | 292 653.3 |
| SWMP-01 | 185.9 | 4 833 289.8 | 291 584.8 |
| SWMP-02 | 185.6 | 4 833 248.9 | 291 607.7 |
| SWMP-03 | 185.0 | 4 833 080.0 | 291 736.4 |
| SWMP-04 | 184.8 | 4 833 107.6 | 291 815.1 |
| T-01 | 184.9 | 4 833 013.9 | 291 488.9 |
| T-02 | 184.3 | 4 832 983.0 | 291 518.8 |

| NO | ELEVATION | NORTHING | EASTING |
|---|---|---|---|
| OHS-10 | 189.2 | 4 832 953.0 | 291 210.0 |
| OHS-11 | 187.5 | 4 832 950.7 | 291 376.7 |
| OHS-12 | 186.4 | 4 833 070.2 | 291 489.8 |
| P02 | 176.3 | 4 833 635.5 | 291 494.6 |
| P03 | 180.8 | 4 833 487.1 | 291 561.2 |
| P07 | 178.1 | 4 833 467.0 | 291 761.0 |
| P09 | 184.9 | 4 833 220.0 | 291 620.9 |
| P12 | 180.6 | 4 833 462.2 | 292 010.4 |
| P14 | 172.6 | 4 833 633.3 | 292 310.0 |
| P15 | 176.9 | 4 833 265.8 | 291 952.1 |
| P15A | 178.5 | 4 833 267.9 | 291 954.2 |
| P16 | 178.6 | 4 833 359.9 | 292 107.1 |

## -NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

**GEOCRES No. 30M12-277**

| REVISIONS | | | |
|---|---|---|---|
| DATE | BY | DESCRIPTION | |
| DESIGN | RPR | CHK AEG | CODE | LOAD | DATE APR. 2009 |
| DRAWN | MFA | CHK PKS | SITE | STRUCT | DWG 2 |

FILENAME: H:\Drafting\19\1422\11 Hwy 401\tad2311-BoreholePlan(OHS).dwg