



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
OVERHEAD SIGN SUPPORT
HIGHWAY 403 WB COLLECTORS
HIGHWAY 401/403/410 INTERCHANGE AREA
MISSISSAUGA, ONTARIO
G.W.P. NO. 2207-16-00**

GEOCRES No. 30M12-428

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted for the proposed Overhead Sign Supports (OHS) to be located on Highway 403 south of the Hwy 401/Hwy 403/Hwy 410 interchange in Mississauga, Ontario.

The purpose of this investigation was to explore the subsurface conditions near the proposed location of the overhead sign supports and, based on this data, to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

During the preparation of this report, reference has been made to information on subsurface conditions contained in previous geotechnical investigations, which were conducted close to this site. The titles of these reports are listed as follows:

- Foundation Investigation Report for Highway 403 EB Collector over Matheson Boulevard, W.P.127-66-67, Site 24-81-354A, Highway 403, District 6, Toronto, GEOCRES No. 30M12-150, dated December 1982, Pavement & Foundation Design Section (Reference 1).
- Foundation Investigation Report for Highway 403 WB Collector over Matheson Boulevard, W.P.127-66-68, Site 24-81-354B, Highway 403, District 6, Toronto,



GEOCRES No. 30M12-151, dated March 1982, Pavement & Foundation Design Section, (Reference 2).

Thurber was retained by AECOM to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 2016-E-0091.

2. SITE DESCRIPTION

The overhead sign will be located on the Highway 403 Westbound (WB) Collector lanes, 1.3 km south of the Hwy 401/Hwy 403/Hwy 410 interchange, near Station 3+100, in Mississauga, Ontario. The overhead supports will be approximately 140 m north of the Highway 403 crossing over Matheson Boulevard.

The site lies within an area of industrial and commercial lands and the surface terrain is generally flat to undulating. The Highway 403 grade is at approximate Elevation 168.6 m.

Photographs of the site and surrounding areas are presented in Appendix C.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Peel Plain. The Peel Plain contains deep river and stream valleys, and is characterized by cohesive glacial till with shale and limestone fragments. The soil deposit is underlain at relatively shallow depths by grey shale bedrock of the Georgian Bay Formation.

3. INVESTIGATION PROCEDURES

A geotechnical investigation was conducted on August 14 and 15, 2018 and consisted of drilling two boreholes (numbered OH18-01 and OH18-02) near the proposed location of the overhead sign. The boreholes were located on the east and west shoulders of the Highway 403 WB Collector. Borehole OH18-01 was drilled on the west side of the Highway 403 WB Collector lanes and terminated within bedrock at 6.0 m depth (Elevation 162.6), following recovery of approximately 3.4 m of rock cores. Borehole OH18-02 was drilled on the east side of the Highway 403 WB Collector lanes and terminated at 9.1 m depth (Elevation 159.7).



The Record of Borehole sheets are included in Appendix A. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendix A.

Prior to commencing the site investigation, utility clearances were obtained for both borehole locations. Road occupancy permit was also obtained to facilitate the site investigation.

A track mounted drill rig was used in conjunction with solid stem augers and NQ rock coring equipment. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. All rock cores were logged and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and Fracture Indices (FI) were determined.

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling of the investigation are presented on the Record of Borehole sheets in Appendix A.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling in Borehole OH18-01 may have been affected by water used for the coring operations. In Borehole OH18-01 a standpipe piezometer consisting of a 19 mm diameter PVC pipe with a slotted screen was installed and enclosed in filter sand to permit longer term groundwater level monitoring. The decommissioning of the boreholes and the standpipe piezometer were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07). The borehole completion details are also shown in Table 3.1.



Table 3.1 – Borehole Completion Details

| Borehole | Borehole Depth / Base Elevation (m) | Piezometer Tip Depth / Elevation (m) | Completion Details |
|-----------------|--------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| OH18-01 | 6.0/162.6 | 6.0/162.6 | Piezometer with 1.5 m slotted screen installed with sand filter from 6.0 m to 3.8 m, bentonite holeplug from 3.8 m to 0.6 m, then flush mount to surface. |
| OH18-02 | 9.1/159.7 | None installed | Borehole backfilled with bentonite holeplug and auger cuttings from 9.1 m to 0.1 m, then asphalt to surface. |

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A, and also presented on the figures included in Appendix B.

Bedrock core samples were subjected to geological logging. Point load tests were carried out on selected samples of intact bedrock in the laboratory for estimating the unconfined compressive strength (UCS) of the bedrock. The UCS values of the rock assessed from the point load test data are reported on the borehole logs in Appendix A and in the Point Load Test Sheet in Appendix B.

A photograph of the bedrock cores is included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However,



the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the site is underlain by sand and gravel fill and silty sand fill overlying a layer of native sand and gravel or shale bedrock. Descriptions of the individual strata are presented below.

5.1 Asphalt

Asphalt was encountered on the highway surface in both boreholes. The asphalt was 150 to 250 mm in thickness.

5.2 Sand and Gravel Fill and Silty Sand Fill

Brown sand and gravel fill, containing trace to some silt and clay, was contacted below the asphalt in both boreholes. The thickness of the sand and gravel fill ranged from 1.1m to 2.4 m.

Brown silty sand fill containing some gravel was contacted below the sand and gravel fill in Borehole OH18-02. The thickness of the silty sand fill was 800 mm.

The cohesionless fill is in a compact to dense condition, based on typical SPT 'N' values ranging from 19 to 42 blows for 0.3 m of penetration. In Borehole OH18-01, an SPT 'N' value of 65 blows per 0.275 m of penetration, indicating a very dense state, was measured near Elevation 166.0 at the top of bedrock. The natural moisture content of this fill ranged from 2 percent to 13 percent.



Grain size distribution curves of the sand and gravel fill are presented on the Record of Borehole sheets in Appendix A, and on Figure B1 of Appendix B. The results of laboratory tests carried out on a select sample are as follows:

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 42 |
| Sand | 42 |
| Silt and Clay | 16 |

5.3 Sand and Gravel to Gravelly Sand

Native brown sand and gravel to gravelly sand containing trace to some silt and clay was contacted at 2.2 m (Elevation 166.6) in Borehole OH18-02. Resistance to augering inferred the presence cobbles and boulders below 8.3 m depth.

Borehole OH18-02 was terminated within the sand and gravel at 9.1 m depth (Elevation 159.7).

The sand and gravel layer is in a compact to dense condition, based on SPT 'N' values ranging from 21 to 37 blows for 0.3 m of penetration. The natural moisture contents ranged from 9 percent to 14 percent.

Grain size distribution curves of the sand and gravel are presented on the Record of Borehole sheets in Appendix A, and on Figure B2 of Appendix B. The results of laboratory tests are summarized as follows:

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 27 to 49 |
| Sand | 39 to 59 |
| Silt and Clay | 12 to 14 |



5.4 Bedrock

Bedrock was encountered in Borehole OH18-01 at 2.6 m depth (Elevation 166.0) and proven by recovery of 3.4 m of rock cores. The bedrock is a grey and thinly bedded shale of the Georgian Bay Formation, and it was in a highly to moderately weathered state. The shale bedrock typically contains interbeds of limestone that is significantly harder than the shale itself. These limestone interbeds also exhibit less pronounced weathering than the shale.

In previous investigations (References 1 and 2) conducted approximately 140 m south of the site, at the crossing of Matheson Boulevard and Highway 403, the shale bedrock was encountered near Elevations 166.6 to 165.4.

The Total Core Recovery (TCR) of rock cores ranged from 67% to 92%. The measured Rock Quality Designation (RQD) ranged from 21% to 24%, indicating a very poor rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m core, was generally greater than 10.

The unconfined compressive strength of the limestone interbeds correlated from point load tests conducted on the recovered cores ranged from 102 MPa to 158 MPa indicating a very strong rock. A strength value of 11 MPa was assessed in the shale.

5.5 Groundwater Conditions

Groundwater conditions were observed during drilling operations, and groundwater levels were measured in the open boreholes upon completion of drilling. A standpipe piezometer was installed in Borehole OH18-01 to monitor the groundwater level at the site. Water levels will be obtained from the piezometer shortly and the readings will be included in the final report. The groundwater levels measured in the open boreholes and in the standpipe piezometer are summarized below.



Table 5.1 – Water Level Measurements

| Borehole | Date | Water Level (m) | | Remark |
|----------|--------------------|-----------------|-----------|-----------------------------|
| | | Depth | Elevation | |
| OH18-01 | August 14, 2018 | 1.5 | 167.1 | Open borehole Piezometer |
| | September 30, 2018 | 1.8 | 166.8 | |
| OH18-02 | August 15, 2018 | 2.1 | 166.7 | Open borehole |

The groundwater levels above are short-term readings, and seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. MISCELLANEOUS

Walker Drilling of Utopia, Ontario supplied a track mounted drill rig and conducted the drilling, sampling and in-situ testing operations for the present investigation.

The coordinates for the boreholes were obtained with GPS equipment by Thurber, and the elevations were provided by AECOM.

The drilling and sampling operations in the field for the current investigation, were supervised on a full-time basis by Thurber field technicians.

Geotechnical laboratory testing was carried out at Thurber's MTO approved geotechnical laboratory.

Overall supervision of the field program for the investigation was conducted by Mr. Stephane Loranger, C.E.T.

Overall project management was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Ms. Rocío Palomeque Reyna, P.Eng. The report was reviewed by Dr. Sydney Pang, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report presents foundation recommendations for the design of the proposed Overhead Sign Support (OHS).

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction contractor. The contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

This project includes one overhead sign which is understood to be of the tri-chord type structure with two supports located on both sides of the Highway 403 Westbound Collector lanes near Station 3+100.

Information on the proposed location of the sign was provided to Thurber by AECOM. Based on the proposed design layout, two boreholes, one near each sign support, were used to evaluate the soil and groundwater conditions. The Record of Borehole sheets for these boreholes are presented in Appendix A. Table 1 immediately following the text of



this report presents a simplified subsurface stratigraphy and the recommended foundation parameters for the design of the OHS.

It is important to note that the sign support on the west side will be partially founded within shale bedrock (Borehole OH18-01), while the sign support on the east side (Borehole OH-18-02) will be founded within compact to dense sand and gravel.

7.1 Foundation Design Parameters

Design of the sign support foundations should be carried out in accordance with the following document.

- Ministry of Transportation, Ontario (2015) "Sign Support Manual", Highway Standards Branch, Bridge Office (Reference 3).

Reference should also be made to the following documents.

- Ministry of Transportation, Ontario (2004) "Guidelines for the Design of High Mast Pole Foundations", Fourth Edition, BRO-009, Engineering Standards Branch, Bridge Office (Reference 4).
- Canadian Highway Bridge Design Code and Commentary (2014). CAN/CSA-S6-14 and S6.1-14 (Reference 5).

It is understood that the OHS at Station 31+100 consists of two legs each to be supported on an augered caisson. The differing subsurface conditions require that the two caissons be designed using their respective sets of foundation design parameters as recommended in Table 1.

It is recommended that MTO's standard drawings for the appropriate sign type and other relevant foundation design recommendations in Reference 3 be used as a basis for the sign support design. The foundation design parameters in Table 1 should be used in conjunction with Reference 4 to confirm that the standard design is adequate. At the west foundation support, the caisson should be socketted into the weathered shale.



In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of a caisson within the upper 1.2 m below final grade should be neglected in the foundation design. It is recommended that all topsoil and organics be neglected in determining lateral resistance.

Where downward sloping fill or native soil exists in front of a caisson, reduction of lateral passive resistance should be taken into consideration during design. For foundation design of the caissons, it should 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 four (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 pile, and full passive resistance at the level where the slope face is at a horizontal distance equal to or greater than four (4) times the diameter of the caisson.

When designing for portions of the caissons below the groundwater level in cohesionless sands and silts, the submerged soil unit weight, γ' , should be used. The required depth of the drilled shaft will be governed by lateral loads, including wind loads, acting on the sign. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces. For weathered shale containing multiple fractures, parameters pertaining to frictional materials have been provided for foundation design.

An equivalent caisson width equal to 2 times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

7.2 Caisson Installation

Caisson installation should generally be carried out in accordance with OPSS.PROV 903.

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 E.



Caisson installation equipment must be able to dislodge, handle, remove cobbles and boulders, to penetrate obstructions within the fill and to drill through the very dense sand and gravel layer, where encountered. This equipment should also be capable of coring or otherwise penetrating the shale which contains hard limestone interbeds to form the shale socket and reach the design caisson base.

The stabilized groundwater level is assumed to be at 1 m depth below existing ground surface. Soil sloughing and water seepage will occur in unsupported holes especially in sands and gravel below the groundwater level. Temporary liners must be available to support the caisson sidewalls and to provide partial seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it be considered impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.

7.3 Construction Concerns

Concerns during caisson construction mainly involve the handling and removal of cobbles or boulders, or other obstructions in the fill, drilling through very dense soils, soil sloughing and water seepage from caisson sidewalls, basal instability and rock coring especially through the hard limestone interbeds. Recommendations on how to address these issues have been outlined in the previous section.

7.4 Construction Inspection and Testing

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



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TABLE 1
FOUNDATION DESIGN PARAMETERS
OVERHEAD SIGN NEAR STATION 3+100
HIGHWAY 401/403/410 INTERCHANGE AREA

| Stationing of OHS | Reference Borehole | Reference Simplified Subsurface Stratigraphy For Design | Depth Below Existing Ground Surface (m) | Foundation Design Parameters | | | | | | |
|-------------------|---------------------------|----------------------------------------------------------------|-----------------------------------------|------------------------------|-------------------|-------------------------------|-------------------|----------------------------------|-----------------------------------|-----------------------------|
| | | | | q_u (kPa) | ϕ' (deg.) | n_h (MN/m ³) | K_p | γ (kN/m ³) | γ' (kN/m ³) | Groundwater Depth (m) |
| 3+100 | OH18-01 (west caisson) | Sand and Gravel (Fill) Shale (weathered) | 0.2 – 2.6 2.6 – 6.0 | - - | 30 40 | 3.0 15.0 | 3.0 4.6 | 20 23 | - 13 | 1 (below existing grade) |
| | OH18-02 (east caisson) | Sand and Gravel (Fill) Silty Sand (Fill) Sand and Gravel | 0.3 – 1.4 1.4 – 2.2 2.2 – 9.1 | - - - | 30 30 34 | 3.0 3.0 5.5 | 3.0 3.0 3.5 | 20 20 21 | - - 11 | 1 (below existing grade) |
| All Locations | - | New Fill – SSM (see Note 3) | Variable height above ground surface | - | 30 | 3.0 | 3.0 | 20 | - | Below base of new fill |

Notes:

1. This table must be read in conjunction with the text of this report.
2. 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.
3. If new fill is placed, some caissons may be partially embedded within the new fill.



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 |

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


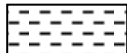



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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

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

| <u>DISCONTINUITY SPACING</u> | | <u>STRENGTH CLASSIFICATION</u> | | | |
|------------------------------|-----------------------|--------------------------------|-------------------------------------------|---------------------|-----------------------------------------------------------|
| Bedding | Bedding Plane Spacing | Rock Strength | Approximate Uniaxial Compressive Strength | | Field Estimation of Hardness* |
| | | | (MPa) | (psi) | |
| Very thickly bedded | Greater than 2m | Extremely Strong | Greater than 250 | Greater than 36,000 | Specimen can only be chipped with a geological hammer |
| Thickly bedded | 0.6 to 2m | | | | |
| Medium bedded | 0.2 to 0.6m | Very Strong | 100-250 | 15,000 to 36,000 | Requires many blows of geological hammer to break |
| Thinly bedded | 60mm to 0.2m | Strong | 50-100 | 7,500 to 15,000 | Requires more than one blow of geological hammer to break |
| Very thinly bedded | 20 to 60mm | | | | |
| Laminated | 6 to 20mm | Medium Strong | 25.0 to 50.0 | 3,500 to 7,500 | Breaks under single blow of geological hammer. |
| Thinly Laminated | Less than 6mm | | | | |

| <u>TERMS</u> | | | | | |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------|--------------|--------------------------------------------------------------------------------|
| Total Core Recovery: (TCR) | Core recovered as a percentage of total core run length. | Weak | 5.0 to 25.0 | 750 to 3,500 | Can be peeled by a pocket knife with difficulty |
| Solid Core Recovery: (SCR) | Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run. | Very Weak | 1.0 to 5.0 | 150 to 750 | Can be peeled by a pocket knife, crumbles under firm blows of geological pick. |
| 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. | Extremely Weak (Rock) | 0.25 to 1.0 | 35 to 150 | Indented by thumbnail |
| Uniaxial Compressive Strength (UCS) | Axial stress required to break the specimen | | | | |
| Fracture Index: (FI) | Frequency of natural fractures per 0.3m of core run. | | | | |

RECORD OF BOREHOLE No OH18-01

1 OF 1

METRIC

W.P. 2207-16-00 LOCATION HWY 403 Overhead Sign Support , MTM NAD83-10 N 4 832 328.9 E 292 722.5 ORIGINATED BY BL
DIST HWY 403 BOREHOLE TYPE Solid Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2018.08.14 - 2018.08.14 LATITUDE 43.630802 LONGITUDE -79.649671 CHECKED BY RPR

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|------|--------------|----------------------------|-----------------|---------------------------------------------|--|--|--|---------------------------------------------------------|---------------------------------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | |
| 168.6 | GROUND SURFACE | | | | | | | | | | | | |
| 0.0 | ASPHALT: (150mm) | | | | | | | | | | | | |
| 0.2 | SAND and GRAVEL, trace to some silt and clay Compact Brown Moist to Wet (FILL) | | 1 | GS | | | | | | | | | |
| | | | 1 | SS | 27 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 2 | SS | 19 | | | | | | | | |
| | Occasional shale pieces Very Dense Wet | | | | | | | | | | | | |
| 166.0 | | | 3 | SS | 65/ 0.275 | | | | | | | | |
| 2.6 | SHALE highly to moderately weathered, thinly bedded, grey, with limestone interbeds and clayey silt infilling Clayey silt infilling from 2.9m to 3.1m Clayey silt infilling from 3.7m to 4.5m Sub-vertical fracture at 4.5m Clayey silt infilling from 4.7m to 5.2m | | 1 | RUN | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 2 | RUN | | | | | | | | | |
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





(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OH18-02

1 OF 2

METRIC

W.P. 2207-16-00 LOCATION HWY 403 Overhead Sign Support , MTM NAD83-10 N 4 832 344.6 E 292 738.8 ORIGINATED BY BL
DIST HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2018.08.15 - 2018.08.15 LATITUDE 43.630944 LONGITUDE -79.649469 CHECKED BY RPR

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------|------|------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------|--|--|-------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | |
| 168.8 | GROUND SURFACE | | | | |  |  | | | |  | | | | |
| 0.0 168.5 | ASPHALT: (250mm) | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | WATER CONTENT (%) | | | | |
| 0.3 | SAND and GRAVEL, trace to some silt and clay Dense Brown (FILL) |  | 1 | GS | | | 168 | | | | | | | | |
| | | | 1 | SS | 42 | | | | | | | | | | |
| 167.4 | | | | | | | 167 | | | | | | | | |
| 1.4 | Silty SAND, some gravel Dense Brown Moist (FILL) |  | 2 | SS | 34 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| 166.6 | | | | | | | 166 | | | | | | | | |
| 2.2 | SAND and GRAVEL, trace to some silt and clay Compact to Dense Brown Wet |  | 3 | SS | 29 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | 4 | SS | 21 | | | | | | | | | | |
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| | | | 5 | SS | 29 | | | | | | | | | | |
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| | | | | | | 165 | | | | | | | | | |
| | | | | | | 164 | | | | | | | | | |
| | | | | | | 163 | | | | | | | | | |
| | | | | | | 162 | | | | | | | | | |
| | | | | | | 161 | | | | | | | | | |
| | Gravelly sand Cobbles and boulders at 8.3m Augers grinding from 8.4m to 9.1m | | | | | 160 | | | | | | | | | |
| 159.7 | | | | | | | | | | | | | | | |
| 9.1 | END OF BOREHOLE AT 9.1m. BOREHOLE CAVED TO 2.4m AND WATER LEVEL AT 2.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT PATCH TO | | 2 | GS | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OH18-02 2 OF 2 METRIC

W.P. 2207-16-00 LOCATION HWY 403 Overhead Sign Support , MTM NAD83-10 N 4 832 344.6 E 292 738.8 ORIGINATED BY BL
DIST HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2018.08.15 - 2018.08.15 LATITUDE 43.630944 LONGITUDE -79.649469 CHECKED BY RPR

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|------------------------------------------|------------|---------|------|------------|----------------------------|-----------------|---------------------------------------------|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|------------------------------------------|------------------------------------------------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| | Continued From Previous Page SURFACE. | | | | | | | | | | | | | | | | |

ONTMT452 MTO-19402.GPJ 2017TEMPLATE(MTO).GDT 10/1/18

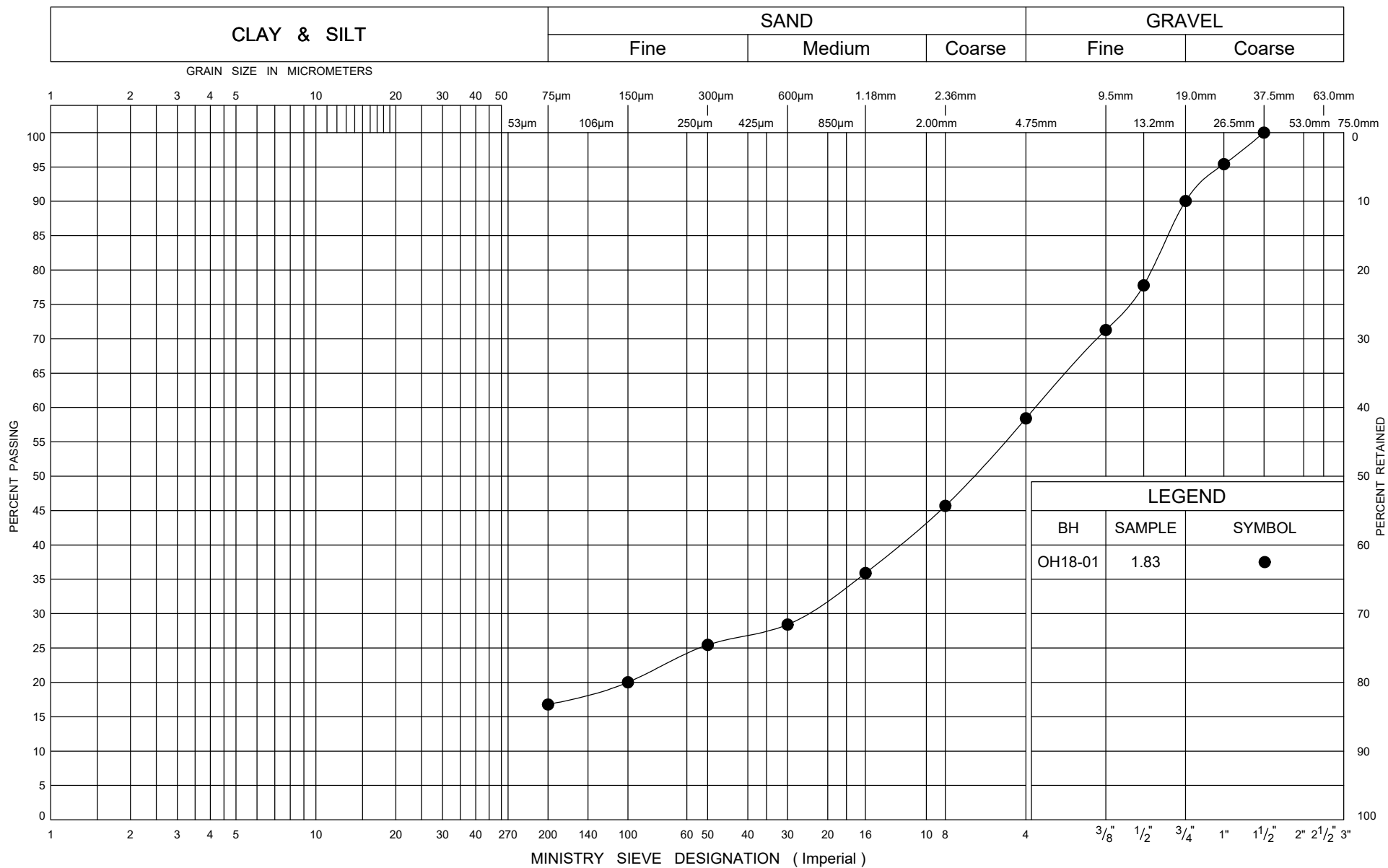


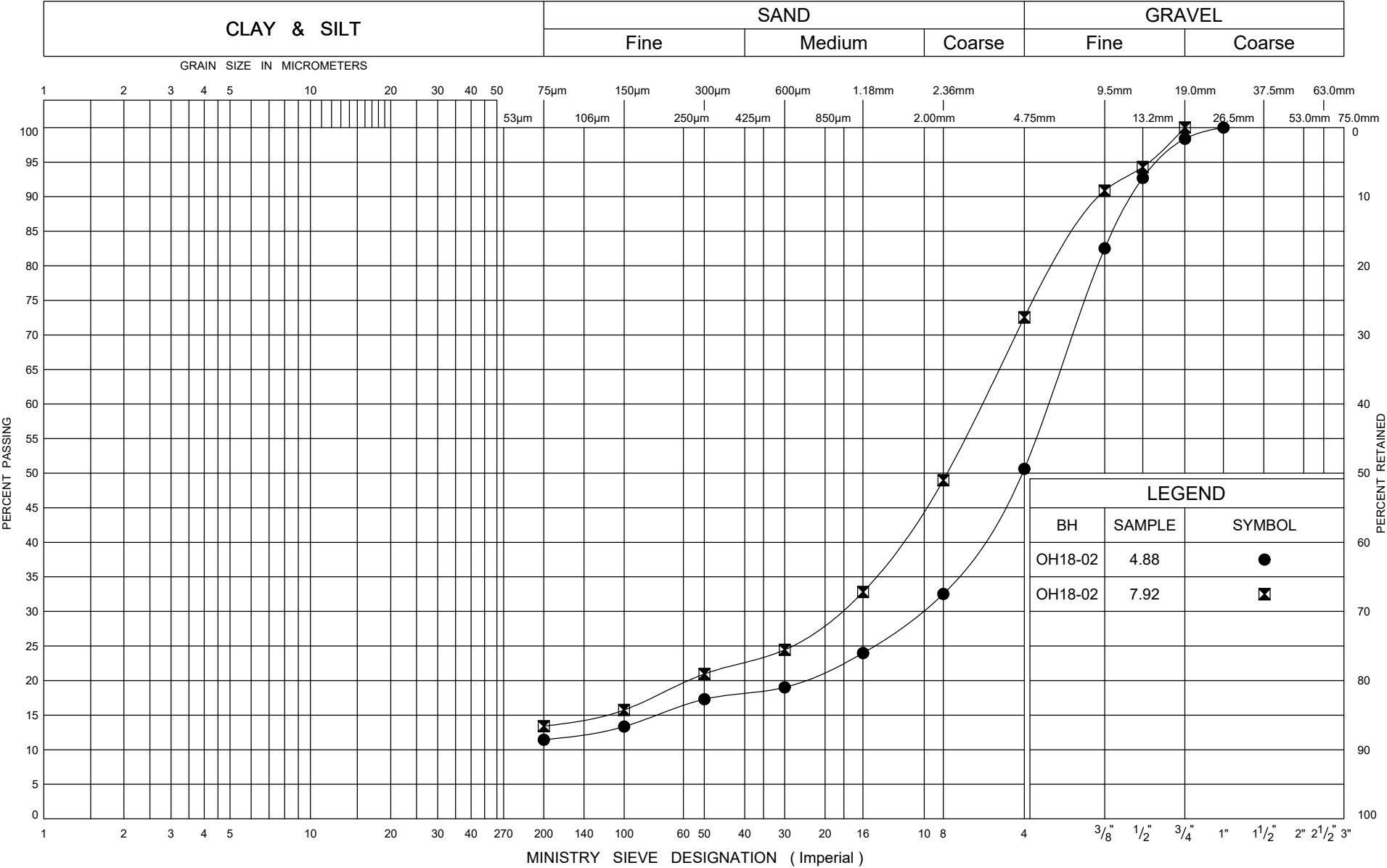
Appendix B

Laboratory Test Results

And

Rock Core Photos







POINT LOAD TEST SHEET

ASTM D5731-08

| | |
|----------------------|---------------------------|
| Job No: | 19402 |
| Client: | AECOM |
| Project Name: | OVERHEAD SIGN SUPPORT |
| Core Size: | NQ BH No : OH18-01 |

| | |
|---------------|-----------|
| Date Drilled: | 14-Aug-18 |
| Date Tested: | 17-Aug-18 |
| Tester: | BS |
| Reviewed by: | |

[illegible]



Photo B1– Bedrock core, Borehole OH18-01



Appendix C

Selected Site Photographs



Photo C1 – West side of the Highway 403 WBL Collector



Photo C2 – East side of the Highway 403 WBL Collector



Appendix D

Borehole Locations Plan

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 2207-16-00

HIGHWAY 403
OVERHEAD
SIGN SUPPORT
BOREHOLE LOCATIONS PLAN

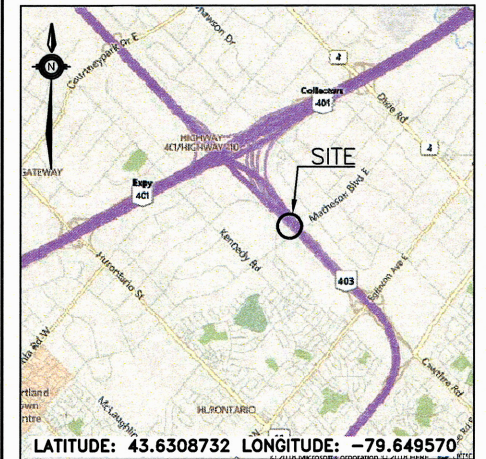


SHEET

AECOM



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

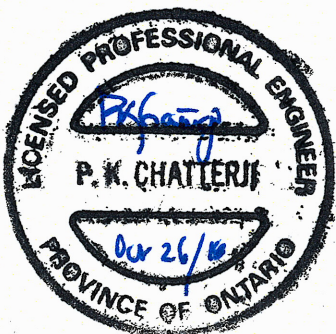
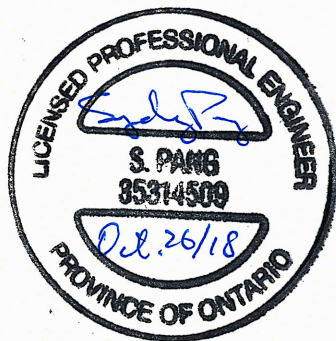
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|--|---------------------------------------|
| | Borehole |
| | Borehole and Cone |
| | Blows /0.3m (Std Pen Test, 475J/blow) |
| | Blows /0.3m (60' Cone, 475J/blow) |
| | Pressure, Hydraulic |
| | Water Level |
| | Head Artesian Water |
| | Piezometer |
| | Rock Quality Designation (RQD) |
| | Auger Refusal |

| NO | ELEVATION | NORTHING | EASTING |
|---------|-----------|-------------|-----------|
| OH18-01 | 168.6 | 4 832 328.9 | 292 722.5 |
| OH18-02 | 168.8 | 4 832 344.6 | 292 738.8 |

-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.
- 3) Coordinate system is MTM NAD 83 Zone 10.

GEOCREs No. 30M12-428



| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|---------|-------------|
| DESIGN | RPR | CHK SKP | CODE |
| DRAWN | AN | CHK RPR | SITE |
| STRUCT | | | |
| DWG | 1 | | |



Appendix E

List of OPSS Documents and Nssp Wording



1. List of Special Provisions and OPSS Documents Referenced in this Report

OPSS.PROV 903 Construction specification for deep foundations

2. Suggested text for a NSSP on:

“Augered Caisson Construction for OHS Foundations”

Caisson installation should generally be carried out in accordance with OPSS.PROV 903.

The Contractor is advised that variable types of subsurface materials may be encountered at the location 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. Cobbles, boulders and rock fragments may be encountered within the native sand and gravel deposit. The soil is anticipated to become denser or harder with depth. Obstructions including rubble, cobbles and boulders may also be present within the fill. The strength of the shale bedrock may also increase with depth, and hard limestone interbeds are frequently present in the shale. Caisson installation equipment must be capable of dislodging, handling, removing or otherwise penetrating these obstructions and very dense/hard layers.



3. Weathered shale bedrock with hard limestone interbeds was encountered on the west side of the Highway 403 WBL Collector lanes. The Contractor's caisson installation equipment must be capable of drilling/coring through the bedrock to form the rock socket and reach the design depth of the caisson.
4. The groundwater levels observed are very short term. Higher groundwater levels must be expected during installation especially through the wet seasons. Water seepage and/or soil sloughing into the caisson hole will occur from existing fill and cohesionless soils 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. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it be considered impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.

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