

**FOUNDATION INVESTIGATION REPORT  
REPLACEMENT OF HIGHWAY 401 UNDERPASS  
AT HIGHWAY 19, TOWN OF INGERSOLL  
TOWNSHIP OF SOUTHWEST OXFORD  
SITE No. 23-210, G.W.P. 3079-09-00  
Geocres Number: 40P2-77**

**Submitted to  
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December 8, 2015  
File: 19-5161-224

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Foundations\Reports & Memos\Highway 19\1-  
Underpass\Final - Underpass\Final FIR\Hwy 401 at Hwy 19  
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**FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the location of a proposed replacement of the Highway 401 Underpass at Highway 19 in the Town of Ingersoll, Ontario. The replacement of the Highway 19 structure constitutes part of the Highway 401 improvement project. It is noted that Highway 19 is also known as Harris Street to the north of Highway 401 and Plank Line to the south of Highway 401.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation (MTO) Agreement Number 3013-E-0027.

A previous foundation investigation carried out at this site for the preliminary design of the Highway 401 / Highway 19 Interchange improvements was documented in the report "Preliminary Foundation Investigation and Design Report – Highway 19 Underpass, Site 23-210, Highway 401 Structure Replacements and Interchange Improvements" prepared by Stantec, dated February 2013, Geocres No. 40P2-74. The information presented in the above report was reviewed and incorporated in this report.

**2 SITE DESCRIPTION**

The existing underpass structure carries Highway 19 (Harris Street/Plank Line) over Highway 401 in the Town of Ingersoll. The structure is located approximately 29 km east of the intersection of Highway 401 and Highbury Avenue in London, Ontario. At the project site, Highway 401 runs approximately in the southwest-northeast direction, while Highway 19 runs generally northwest-southeast. For the purpose of this report, Highway 401 is assumed to run west-east, and Highway 19 is assumed to run north-south.

The existing underpass is a single span structure approximately 42 m in length between abutments (or 57 m in length from end-to end of wingwalls) and consists of one lane of traffic in each direction. Highway 401 is a six-lane (three lanes in each direction) divided freeway.

The surrounding land is gently undulating. The land use generally consists of a mixed agricultural land with a commercial property to the north and a parking lot directly west of the structure. The developed area of the Town of Ingersoll lies a short distance to the north. Selected photographs of the site are enclosed in Appendix D.

Based on the Quaternary Geology Map, the site is situated in the till plain characterized by the Tavistock Till (Huron-Georgian Bay lobe) consisting of sandy silt to silt matrix with variable amounts of clay and sand and moderate to high carbonate content. Bedrock of the Detroit River Group, Onondaga Formation consisting of limestone, dolostone and shale underlies the site. Limestone is quarried at the Carmeuse Lime, Beachville operation approximately 4.5 km northeast of the bridge.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project was carried out in two stages. The first stage of the investigation carried out between November 5 and 28, 2014 consisted of drilling and sampling a total of seven boreholes denoted as 14-01 to 14-07. Boreholes 14-02 and 14-03 were drilled in the vicinity of the north bridge abutment, Boreholes 14-04 and 14-05 were advanced in the vicinity of the south abutment, and Boreholes 14-01 and 14-06 were drilled within each approach embankment. Borehole 14-07 was advanced within the median of Highway 401, in proximity to the pier of the existing structure. Boreholes were extended to depths ranging from 10.8 to 21.9 m below the existing ground surface. To supplement the existing information, the second stage of the investigation was carried out between June 22 and 25, 2015, when a total of three boreholes denoted as Borehole 14-08 to 14-10 were advanced at the site to depths ranging from 20.3 m to 24.7 m. Borehole 14-08 was drilled at the pier and Boreholes 14-09 and 14-10 were advanced at the north and south abutments, respectively. The borehole completion information is summarized in Table 3-1. The approximate borehole locations are shown on the attached Borehole Location and Soil Strata Drawings included in Appendix E.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. Drilling was carried out using a truck mounted CME 75 drill rig with hollow stem augers during the 2014 investigation and a D56 drill rig with solid and hollow stem augers was used during the 2015 investigation. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations and again at later dates. Two standpipe piezometers, consisting of 25 mm diameter Schedule 40 PVC pipes with a 1.5 m long slotted screens, were installed at alternate corners of the structure within Boreholes 14-02 and 14-05. The standpipe piezometers installed in Boreholes

14-08 to 14-10 comprised 19 mm diameter Schedule 40 PVC pipe with a 4.6 m long slotted screen. The piezometer screens were enclosed in filter sand to permit groundwater level monitoring. Boreholes with piezometers were decommissioned following the final water level readings. All boreholes, were backfilled in general accordance with MOE Regulation 903 upon completion, and the details are provided in Table 3-1.

**Table 3-1. Piezometer Installation and Backfilling Details**

Borehole Number	Drilling Depth/ Elevation (m)	Piezometer Tip Depth/ Elevation (m)	Borehole Backfilling Details
14-01	11.3 / 284.4	N/A	Bentonite holeplug and cuttings from 11.3 to 0.5 m, concrete from 0.5 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-02	16.9 / 278.8	16.8 / 278.9	Piezometer with 1.5 m slotted screen installed, sand filter from 16.9 to 14.9 m, bentonite seal from 14.9 to 14.0 m, bentonite holeplug and cuttings from 14.0 to 0.6 m, concrete from 0.6 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-03	21.9 / 273.9	N/A	Bentonite holeplug and cuttings from 21.9 to 1.0 m, concrete from 1.0 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-04	12.3 / 283.9	N/A	Bentonite holeplug and cuttings from 12.3 to 0.6 m, concrete from 0.6 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-05	14.0 / 282.3	12.2 / 284.1	Piezometer with 1.5 m slotted screen installed, sand filter from 14.0 to 10.4 m, bentonite seal from 10.4 to 9.8 m, bentonite holeplug and cuttings from 9.8 to 0.9 m, concrete from 0.9 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-06	11.0 / 285.4	N/A	Bentonite holeplug and cuttings from 11.0 to 0.6 m, concrete from 0.6 to 0.2 m, asphalt patch from 0.2 m to ground surface
14-07	10.8 / 278.2	N/A	Bentonite holeplug and cuttings from 10.8 to 0.5 m, concrete from 0.5 to 0.2 m, asphalt patch from 0.2 m to ground surface.
14-08	20.3 / 268.7	16.8 / 272.2	Piezometer with 4.6 m slotted screen installed, sand filter from 16.8 m to 11.9 m, bentonite seal from 11.9 m to ground surface.
14-09	21.7 / 274.0	21.0 / 274.7	Piezometer with 4.6 m slotted screen installed, sand filter from 21.0 to 16.0 m, bentonite seal from 16.0 to ground surface.
14-10	24.7 / 271.6	24.4 / 271.9	Piezometer with 4.6 m slotted screen installed, sand filter from 24.4 to 18.0 m, bentonite seal from 18.0 to ground surface.

The drilling and sampling 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 samples for transport to Thurber's laboratory for further examination and testing.

#### **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 distribution analysis (hydrometer and/or sieve) and Atterberg Limits testing, where appropriate. The results of these testing are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures 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 and on the Borehole Locations and Soil Strata Drawing included in Appendix E. 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 interpretation of the site conditions. It should be recognised and expected that soil conditions may vary between and beyond borehole locations.

Subsurface information obtained from the existing Preliminary Foundation Investigation (Geocres No. 40P2-72) was reviewed during preparation of this report. The subsurface conditions documented in the noted report are generally consistent with those observed during the present investigations. Record of Borehole sheets and the Borehole Locations and Soil Strata drawing from that report are enclosed in Appendix F, for reference.

The subsurface stratigraphy below the pavement structure and the existing embankment fill generally consisted of a cohesionless till comprising various proportions of sand and silt underlain by a cohesive till comprising silty clay to clayey silt. Beneath the upper tills was a layers of silty clay underlain by a silt layer. Another layer of cohesionless till, consisting of sand and silt, was encountered on the north side of the site below the silty clay till. Bedrock was not encountered during the investigation. Descriptions of the individual strata are presented below.

##### **5.1 Pavement Structure**

Boreholes 14-01 to 14-06, 14-09 and 14-10 were drilled through the existing Highway 19 embankment and Boreholes 14-07 and 14-08 were drilled through the inside shoulder of Highway 401. All boreholes, except for Borehole 14-10, encountered a pavement structure consisting of approximately 100 mm to 150 mm of asphalt overlying granular road base fill.

In Boreholes 14-01 to 06 and 14-09, advanced from Highway 19, the granular road base fill was predominantly sand with significant proportions of gravel and was classified as sand with some gravel to sand and gravel with trace silt and trace clay. The granular fill extended to a depth of 0.7 to 1.7 m below the ground surface (Elev. 294.0 to 295.4).

SPT tests performed in the granular fill gave N-Values between 19 and 47 blows per 0.3 m of penetration, indicating a compact to dense relative density. Moisture contents within this fill varied from 1 to 9%.

In Boreholes 14-07 and 14-08 drilled on Highway 401, the granular road base consisted of sandy gravel and gravelly sand with some silt. This layer extended to a depth of 1.5 m and 1.7 m below the highway grade to Elev. 287.5 and 287.3. In Borehole 14-08, the road base material was placed directly on the native sand and silt till.

SPT tests performed in this fill gave N-Values of 29, 50 and 92 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

Grain size distribution analyses were completed on selected samples of this material. The results are summarized on the Record of Borehole sheets in Appendix A, and the grain size distribution curves for three samples of this fill are included in Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	18 to 54
Sand	31 to 57
Silt and Clay	10 to 25

Moisture contents within the granular fill varied from 2 to 5%.

## 5.2 Embankment Fill

A layer of silty sand fill with trace to some gravel and trace to some clay was encountered below the road base or extending from ground surface in the boreholes drilled from Highway 19, except in Boreholes 14-06. The fill extended to depths of ranging from 1.5 m to 4.5 m below the existing ground surface (Elev. 291.2 to 294.3). In Borehole 14-07 advanced from the shoulder of Highway 401, the road base was underlain by approximately 0.8 m of sand fill extending to a depth of 2.3 m (Elev. 286.7).

SPT tests performed in the silty sand fill under Highway 19 produced N-Values between 0 and 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density. The majority of the N-values ranged from 8 to 24 blows per 0.3 m penetration, with the exception of Borehole 14-09, where N-values of 0 to 7 blows per 0.3 m of penetration were obtained indicating a very loose to loose relative density. Moisture contents within the fill under Highway 19 varied from 2 to 22%.

In Boreholes 14-07, drilled under Highway 401, the SPT N-Value in the fill was 79 blows per 0.3 m of penetration, indicating a very dense relative density. The moisture content of the fill under Highway 401 was 7%.

A grain size distribution analyses were completed on a selected samples of this fill. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves are included in Figure B2 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 10
Sand	33 to 55
Silt	23 to 51
Clay	12 to 17

### 5.3 Upper Cohesionless Till

The fill was underlain by a cohesionless glacial till consisting of a heterogeneous mixture of sand and silt with trace to some clay and trace to some gravel. Silty clay lenses were noted occasionally throughout the deposit. Cobbles and boulders do inherently occur in glacial tills and should be assumed to be present at this site. The thickness of this layer ranged from 6.3 m to 10.7 m in Boreholes 14-02 to 14-05, 14-09 and 14-10, where the deposit was fully penetrated. The base of the deposit was encountered between a depth of 10.4 m (Elev. 285.9) and 12.2 m (Elev. 283.6). In Boreholes 14-07 and 14-08 advanced from Highway 401 grade, which at this location is constructed in a cut, the sand and silt till layer was 2.3 m to 4.1 m thick and extended to a depth of 4.6 m (Elev. 284.4) and 5.8 m (Elev. 283.2). Boreholes 14-01 and 14-06 were terminated in this deposit at 11.3 m depth (Elev. 284.4) and 11.0 m (Elev. 285.4).

SPT tests performed in this till gave N-values from 6 and to in excess of 100 blows per 0.3 m of penetration, indicating a loose to very dense state.

Grain size distribution analyses were completed on selected samples of this deposit. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for selected samples are included in Figures B3 to B5 of Appendix B. The results of the grain size distribution testing are summarized below:

Soil Particles	Percentage (%)
Gravel	0 to 14
Sand	12 to 58
Silt	28 to 78
Clay	7 to 22



Atterberg Limits testing was also completed on four cohesive samples of this deposit. The results are presented on the Record of Borehole sheets in Appendix A and the Atterberg Limits plot is included in Figure B11 of Appendix B. The results of the laboratory test indicate silts of low plasticity.

Parameter	Value (%)
Plastic Limit	11 to 19
Liquid Limit	15 to 27
Plasticity Index	4 to 8

Moisture contents measured on samples of the deposit ranged from 2 to 22%, being typically between 5% and 15%.

#### 5.4 Cohesive Till

A deposit of low plasticity silty clay to clayey silt till with sand and trace gravel was encountered below the upper silty sand to sand and silt till in Boreholes 14-02 to 14-05 and in Boreholes 14-07 to 14-10. The till deposit was comprising a significant percentage of sand fraction and at some locations was classified as sandy or with sand. Where fully penetrated in Boreholes 14-02, 14-03 and 14-08 to 14-10, the thickness of the silty clay till ranged from 4.5 to 9.0 m with the lower boundary of the deposit between 15.2 m (Elev. 280.5) and 19.4 m (Elev. 276.9). Boreholes 14-04, 14-05 and 14-07 were terminated within the silty clay/clayey silt till between depths of 10.8 and 14.0 m (Elev. 278.2 to 283.9) below the ground surface.

It should be noted that cobbles and boulders inherently occur in glacial till deposits, and they should be expected within the soil matrix.

SPT N-Values in the till ranged from 25 blows per 0.3 m of penetration to in excess of 100 blows per 0.3 m of penetration indicating a very stiff to hard consistency. The high blow counts may represent presence of cobbles and boulders.

Grain size distribution analyses were completed on selected samples of this deposit. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for the samples are included in Figures B6 and B7 of Appendix B. The results of the laboratory tests are summarized below:

Soil Particles	Percentage (%)
Gravel	0 to 6
Sand	9 to 41
Silt	37 to 53
Clay	16 to 50

Atterberg Limits tests completed on selected samples of the silty clay till are summarized on the Record of Borehole sheets in Appendix A and in the table, below. The results are also presented in Figure B12 of Appendix B. The results of the laboratory tests indicate low plasticity of the till deposit.

Parameter	Value (%)
Plastic Limit	10 to 16
Liquid Limit	15 to 31
Plasticity Index	4 to 14

The moisture content of the silty clay till varied between 4% and 22%.

### 5.5 Lower Cohesionless Till

A deposit of till consisting of silt to sand and silt with trace to some clay and trace gravel was encountered below the silty clay till in Boreholes 14-02, 14-03 and 14-09 between 15.2m (Elev. 280.5) and 18.3 m depth (Elev. 277.5). All three boreholes were terminated within this till deposit between 16.9 m and 21.9 m depth (Elev. 273.9 to 278.8) below the ground surface.

It should be noted that cobbles and boulders inherently occur in glacial till deposits, and they should be expected within the soil matrix.

SPT tests performed in this deposit gave N-values between 37 blows per 0.3 m of penetration and more than 100 blows per 0.3 m of penetration, indicating a dense to very dense relative density. Moisture contents in this layer ranged from 6 to 22%.

Grain size analysis was completed on selected samples of this deposit. The results are presented on the Record of Borehole sheets in Appendix A and the grain size distribution curves are included in Figure B8 of Appendix B. The results of the laboratory test are presented below:

Soil Particles	Percentage (%)
Gravel	0 to 1
Sand	0 to 43
Silt	47 to 86
Clay	9 to 24

## 5.6 Silty Clay

A layer of silty clay with trace sand was encountered below the cohesive till in Boreholes 14-08 and 14-10. The thickness of the silty clay ranged from 1.8 m to 2.4 m with the lower boundary of the deposit between 13.4 m (Elev. 275.6) and 21.8 m (Elev. 274.5).

SPT N-Values in the clay ranged from 72 blows per 0.3 m of penetration to in excess of 100 blows per 0.3 m of penetration indicating a hard consistency. The moisture content of the silty clay layer varied between 20% and 23%.

Grain size distribution analyses were completed on two samples of this deposit. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for the samples are included in Figure B9 of Appendix B. The results of the laboratory tests are summarized below:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 5
Silt	43 to 45
Clay	52 to 55

Atterberg Limits tests completed on two samples of the silty clay are summarized on the Record of Borehole sheets in Appendix A and in the table, below. The results are also presented in Figure B13 of Appendix B. The results of the laboratory tests indicate low to medium plasticity of the till deposit.

Parameter	Value (%)
Plastic Limit	16 to 18
Liquid Limit	31 to 37
Plasticity Index	15 to 19

## 5.7 Silt

A deposit of silt with trace sand and trace to some clay was encountered below the silty clay layer in Boreholes 14-08 and 14-10. Occasional clayey silt lenses were noted in this deposit. Boreholes 14-08 and 14-10 were terminated within this layer at depths of 20.3 m and 24.7 m below the ground surface (Elev. 268.7 to 271.6 m).

SPT tests performed in this deposit gave N-Values between 31 blows per 0.3 m of penetration and more than 100 blows per 0.3 m of penetration, indicating a dense to very dense relative density, typically being very dense.

Grain size analyses were completed on selected samples of this deposit. The results are presented on the Record of Borehole sheets in Appendix A and the grain size distribution curves are illustrated in Figure B10 of Appendix B. The results of the laboratory test are presented below:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 3
Silt	90
Clay	7 to 10

Moisture contents in this layer ranged from 14% to 25%.

### 5.8 Groundwater Levels

Water levels were observed during drilling operations and in the open boreholes upon completion of the drilling. As outlined in Table 3-1, standpipe piezometers were installed in Boreholes 14-02, 14-05 and 14-08 to 14-10 to monitor groundwater levels after drilling. The measured groundwater levels are summarized in Table 5-1.

The groundwater level in the piezometer installed into the cohesive till and silt on the south side of the bridge was measured at 6.0 m depth (Elev. 290.3) and 14.0 m depth (Elev. 282.3). The water level in the piezometer sealed into the lower cohesionless till on the north side of the bridge indicated on the upward groundwater flow with the water level raising slowly from 4.5 m below the ground surface to reaching the ground surface (Elev. 295.7) approximately four weeks following the installation of the piezometer. The piezometer was inspected again on June 23, 2015, and the water was removed from the pipe to 16.5 m depth. On July 15, 2015, the water level in the piezometer rose again to 4.3 m depth. In the piezometer installed in Borehole 14-09, located some 12 m to the east on the east side of the embankment, the water level in the piezometer was measured at 10.1 m depth (Elev. 285.6), and seemed to be relatively stable.

The water level in Borehole 14-08 located within the Highway 401 inside shoulder was measured at 7.8 m depth (Elev. 281.2) shortly after the installation of the piezometer in the silt deposit, and three weeks later, the water level was recorded at 1.8 m depth (Elev. 287.2).

The measurements indicate different hydraulic heads at the piezometer locations.

The values shown in Table 5-1 are short-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 periods of significant or prolonged precipitation events.

**Table 5-1. Measured Groundwater Levels**

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
14-01	Nov. 5, 2014	10.7	285.0	Open Borehole
14-02	Nov. 24, 2014	9.8	285.9	Open Borehole
	Nov. 28, 2014	4.5	291.2	Piezometer * On June 23, 2015, water from the pipe was removed to 16.5 m depth below the ground surface; on July 15, 2015, the water level rose to 4.3 m depth.
	Dec. 19, 2014	0.0	295.7	
	Jun. 23, 2015	0.0*	295.7*	
	Jul. 15, 2015	4.3	291.4	
14-03	Nov. 5, 2014	9.1	286.7	Open Borehole
14-04	Nov. 7, 2014	Dry to 12.3 m	-	Open Borehole
14-05	Nov. 28, 2014	6.0	290.3	Piezometer
	Dec. 19, 2014	6.4	289.9	
	Jun. 23, 2015	6.0	290.3	
	Jul. 15, 2015	6.1	290.2	
14-06	Nov. 7, 2014	Dry to 11.0 m	-	Open Borehole
14-07	Nov. 28, 2014	9.5	279.5	Open Borehole
14-08	Jun. 25, 2015	7.8	281.2	Piezometer
	Jul. 15, 2015	1.8	287.2	
14-09	Jun. 23, 2015	10.0	285.7	Piezometer
	Jul. 15, 2015	10.1	285.6	
14-10	Jun. 24, 2015	13.9	282.4	Piezometer
	Jul. 15, 2015	14.0	282.3	

## 5.9 Analytical Testing

Two representative samples retrieved from the soils at the site were submitted to AGAT Laboratories in Mississauga, Ontario for analysis of pH and soluble sulphates. The analysis results are presented below in Table 5-2.

**Table 5-2. Results of Analytical Testing**

Location	Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)
North Abutment	14-02	SS-1	0.3	8.1	25
South Abutment	14-04	SS-11	12.5	8.1	33

## 6 MISCELLANEOUS

Borehole locations were selected and marked in the field by an experienced Thurber staff member and were established with a Trimble Pathfinder ProXRT differential GPS unit. The co-ordinates and ground surface elevations at the boreholes were surveyed by MMM Group Limited upon completion of drilling.

Determination Drilling and Soil Investigations Holdings Inc. from Hamilton, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field program. The field investigation was supervised on a full time basis by Mr. George Azzopardi of Thurber. Overall supervision of the investigation program was conducted by Mr. Michael Eastman, EIT and Weiss Mehdawi, P.Eng.

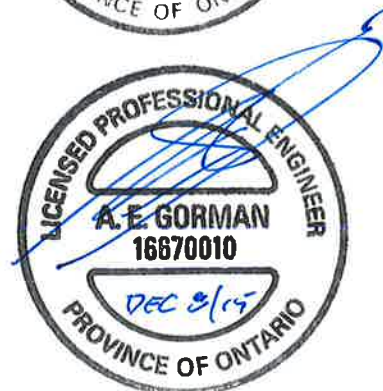
Routine laboratory testing was carried out by Thurber's geotechnical laboratory in Oakville, Ontario. Interpretation of the data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and by Dr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

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## **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 <sup>(1)</sup> '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.



## EXPLANATION OF ROCK LOGGING TERMS


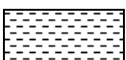

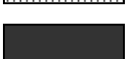

### ROCK WEATHERING CLASSIFICATION

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

### DISCONTINUITY SPACING

<b>Bedding</b>	<b>Bedding Plane Spacing</b>
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

### SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

### STRENGTH CLASSIFICATION

<b>Rock Strength</b>	<b>Approximate Uniaxial Compressive Strength</b>		<b>Field Estimation of Hardness*</b>
	<b>(MPa)</b>	<b>(psi)</b>	
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

### 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 % 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.

# 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			

# RECORD OF BOREHOLE No 14-01

1 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 219.6 E 194 404.7 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.05 - 2014.11.05 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
295.7	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (150mm)							20	40	60	80	100								
0.2	SAND, some gravel, trace silt Dense Brown Dry (FILL)		1	SS	46		295													
294.9																				
0.8	Silty SAND, trace to some gravel, trace to some clay Compact Brown Dry (FILL)		2	SS	29		294													10 55 23 12
			3	SS	19															
293.4																				
2.3	SAND and SILT, trace to some clay, trace gravel Compact to Dense Brown Dry to Moist (TILL)		4	SS	44		293													
			5	SS	13		292													0 12 78 10
			6	SS	13		291													
							290													
			7	SS	12		289													5 44 39 12
			8	SS	13		288													
							287													
			9	SS	15		286													

Continued Next Page

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

# RECORD OF BOREHOLE No 14-01

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 219.6 E 194 404.7 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.05 - 2014.11.05 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
284.4		0 4 0 0 4 0	10	SS	19	▽	285										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND WATER LEVEL AT 10.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No 14-02

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 209.8 E 194 425.3 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.24 - 2014.11.24 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20   40   60   80   100				W P                      W                      W L				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      x LAB VANE								
	Continued From Previous Page															
285.0																
10.7	Silty <b>CLAY</b> , some sand, trace gravel, occasional lenses of clayey silt Hard Grey Wet (TILL)		10	SS	45		285					○				
							284									
			11	SS	55		283					○				
							282					○				
			12	SS	106/ 0.150		281									
280.5							280					○				
15.2	<b>SAND</b> and <b>SILT</b> , trace to some clay, trace gravel Very Dense Grey Wet (TILL)		13	SS	116/ 0.150		279					○				
278.8			14	SS	110/ 0.150							○				
16.9	END OF BOREHOLE AT 16.9m. BOREHOLE OPEN TO 16.9m AND WATER LEVEL AT 9.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) 2014.11.28      4.5      291.2 2014.12.19      0.0      295.7 2015.06.23      16.5*      279.2 2015.07.15      4.3      291.4  * Water observed at ground surface and removed from pipe to 16.5m depth below ground surface.															

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

# RECORD OF BOREHOLE No 14-03

1 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 209.0 E 194 414.5 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.05 - 2014.11.05 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
295.8	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND, some gravel, trace silt Dense Brown Dry (FILL)		1	SS	47								
295.0							295						
0.8	Silty SAND, trace gravel Compact Brown Dry (FILL)		2	SS	24								
294.3													
1.5	SAND and SILT, trace to some gravel, trace clay Compact to Very Dense Brown to Grey Dry to Moist (TILL)		3	SS	21		294						
			4	SS	46		293						14 48 29 9
			5	SS	11		292						
			6	SS	14		291						
			7	SS	20		290						
			8	SS	63		288						7 58 28 7
							287						
			9	SS	46								
							286						

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

SOIL PROFILE												
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	N° VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Continued From Previous Page						0 20 40 60 80 100	w <sub>P</sub>	w	w <sub>L</sub>	γ	GR SA SI C
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				kN/m³	
			10	SS	16							
283.6 12.2	Silty CLAY, some sand, occasional lenses of clayey silt Very Stiff to Hard Grey (TILL)		11	SS	39							
			12	SS	43							
			13	SS	25							
			14	SS	32							
277.5 18.3	SAND and SILT, trace gravel, trace to some clay Dense to Very Dense Grey Moist (TILL)		15	SS	48							

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

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15



# RECORD OF BOREHOLE No 14-03

3 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 209.0 E 194 414.5 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.05 - 2014.11.05 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								20 40 60 80 100							
	Continued From Previous Page							20 40 60 80 100							
	<b>SAND</b> and <b>SILT</b> , trace gravel, trace to some clay Dense to Very Dense Grey Moist (TILL)		16	SS	54		275								
273.9			17	SS	37		274								
21.9	END OF BOREHOLE AT 21.9m. BOREHOLE OPEN TO 21.9m AND WATER LEVEL AT 9.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 1.0m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.														

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No 14-04

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 150.4 E 194 479.9 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.07 - 2014.11.07 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
Continued From Previous Page								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w w <sub>L</sub> WATER CONTENT (%)						
								20 40 60						
285.5							286							
10.7	Silty <b>CLAY</b> , sandy, trace gravel, occasional silty sand and clayey silt lenses Hard Grey Dry (TILL)		10	SS	134		285							0 32 44 24
283.9							284							
12.3	END OF BOREHOLE AT 12.3m. BOREHOLE OPEN TO 12.3m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE.		11	SS	109/	0.150								

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

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No 14-05

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 144.7 E 194 473.6 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.19 - 2014.11.19 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 14-06

1 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 140.3 E 194 489.8 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.07 - 2014.11.07 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
296.4	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND, trace silt, trace clay, trace to some gravel Compact to Dense Dark Grey to Brown Dry (FILL)		1	SS	34		296						
			2	SS	23								
294.9							295						
1.5	SAND and SILT, some clay, trace gravel Loose to Very Dense Brown to Grey Dry to Moist (TILL)		3	SS	10								5 45 36 14
			4	SS	8		294						
			5	SS	6		293						0 32 54 14
	Clayey silt seam at 3.4m depth						292						
			6	SS	15		291						
			7	SS	48		290						5 46 33 16
			8	SS	68		289						
			9	SS	101		288						
							287						

Continued Next Page

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

# RECORD OF BOREHOLE No 14-06

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 140.3 E 194 489.8 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.07 - 2014.11.07 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W P W W L 20 40 60					
285.4	Continued From Previous Page <b>SAND</b> and <b>SILT</b> , some clay, trace gravel Loose to Very Dense Brown to Grey Dry to Moist (TILL)		10	SS	116		286										
11.0	END OF BOREHOLE AT 11.0m. BOREHOLE OPEN TO 11.0m AND DRY. BOREHOLE BACKILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																

# RECORD OF BOREHOLE No 14-07

1 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 186.0 E 194 457.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.28 - 2014.11.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
289.0	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (150mm)							20	40	60	80	100							
0.2	GRAVEL, sandy, some silt: (Crusher Run) Very Dense Brown Dry (FILL)		1	SS	50		288												
			2	SS	92														
287.5																			
1.5	SAND, trace silt, trace clay, trace gravel Very Dense Brown Dry (FILL)		3	SS	79		287												
286.7																			
2.3	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)		4	SS	102/ 0.150		286												
			5	SS	113/ 0.150														
							285												
284.4							284												
4.6	Silty CLAY, sandy, trace gravel, occasional silty sand and clayey silt lenses Hard Grey Moist (TILL)		6	SS	116														
							283												
			7	SS	69														
							282												
			8	SS	104/ 0.300		281												
			9	SS	108/ 0.150		280												

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 14-07

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 186.0 E 194 457.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.28 - 2014.11.28 CHECKED BY AMP


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
278.2	Silty <b>CLAY</b> , sandy, trace gravel Hard Grey Moist (TILL)		10	SS	104/												
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.8m AND WATER LEVEL AT 9.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT COLD PATCH TO SURFACE.				0.150												

# RECORD OF BOREHOLE No 14-08

1 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 173.5 E 194 437.9 ORIGINATED BY AN  
HWY 401/19 BOREHOLE TYPE Solid Stem Augers COMPILED BY AMP  
DATUM Geodetic DATE 2015.06.25 - 2015.06.25 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      x LAB VANE				WATER CONTENT (%) w <sub>P</sub> w      w <sub>L</sub>				GR	SA	SI	CL
289.0	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (100mm)  Gravelly SAND, some silt Compact Brown Dry to Moist (FILL)																		
0.1																			
287.3	SAND and SILT, some clay, trace gravel Compact to Very Dense Grey Moist to Dry (TILL)  																		

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

ELEV DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100		w <sub>p</sub> w w <sub>L</sub>				
								SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						

[illegible]

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

# RECORD OF BOREHOLE No 14-08

3 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 173.5 E 194 437.9 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Solid Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.25 - 2015.06.25 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page		15	SS	131												
268.7 20.3	END OF BOREHOLE AT 20.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 4.6m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.06.25 7.8 281.2 2015.07.15 1.8 287.2																

# RECORD OF BOREHOLE No 14-09

1 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 202.6 E 194 416.4 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.22 - 2015.06.22 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
295.7	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT: (100mm)							20	40	60	80	100						
0.1	Gravelly SAND, some silt Compact Brown Moist (FILL)		1	GS			295											31 53 16 (SI+CL)
			1	SS	19													
294.0							294											
1.7	Silty SAND to SAND and SILT, trace to some clay, trace gravel Very Loose to Loose Brown Moist (FILL)		2	SS	0													
			3	SS	2		293											
			4	SS	7		292											
			5	SS	4													2 45 38 15
291.2							291											
4.5	SAND and SILT, trace to some clay, trace to some gravel Compact Grey Moist (TILL)		6	SS	10		290											
			7	SS	12		289											
			8	SS	19		288											
			9	SS	10		287											10 39 41 10
							286											

Continued Next Page

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

# RECORD OF BOREHOLE No 14-09

2 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 202.6 E 194 416.4 ORIGINATED BY AN  
HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
DATUM Geodetic DATE 2015.06.22 - 2015.06.22 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE				WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>				
	Continued From Previous Page							20 40 60 80 100								
284.0			10	SS	15		285									
11.7	Clayey <b>SILT</b> and <b>SAND</b> , trace gravel Very Stiff to Hard Grey Moist (TILL)		11	SS	25		284									
							283								6 41 37 16	
							282									
	Clay seam (150mm) at 14.0m		12	SS	26		281									
							280									
			13	SS	69		279									
279.5							278									
16.2	<b>SILT</b> , trace sand, trace to some clay, occasional clayey silt lenses Very Dense Grey Moist to Wet (TILL)		14	SS	68		277								0 0 76 24	
							276									
			15	SS	100/ 0.275											

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 14-09

3 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 202.6 E 194 416.4 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.22 - 2015.06.22 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page		16	SS	100/												
					0.300												
274.0			17	SS	100/											0 4 86 10	
21.7	END OF BOREHOLE AT 21.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 4.6m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.06.23 10.0 285.7 2015.07.15 10.1 285.6				0.175												

# RECORD OF BOREHOLE No 14-10

1 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 137.8 E 194 477.3 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.23 - 2015.06.24 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W <sub>P</sub> W      W <sub>L</sub>				GR	SA	SI	CL		
					20   40   60   80   100					20   40   60												
296.3	GROUND SURFACE																					
0.0	Silty <b>SAND</b> , some clay, trace gravel Loose to Compact Brown Dry to Moist (FILL)		1	GS																		
			1	SS	21																0   33   51   16	
			2	SS	24																	
			3	SS	9																	
			4	SS	6																	0   34   49   17
292.2																						
4.1	<b>SAND</b> and <b>SILT</b> , trace to some clay, trace gravel, occasional clayey silt lense Loose to Very Dense Brown to Grey Moist to Wet (TILL)																					
			5	SS	25																	
			6	SS	8																	
			7	SS	27																	3   36   39   22
			8	SS	67																	

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 14-10

2 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 137.8 E 194 477.3 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.23 - 2015.06.24 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
285.9	Continued From Previous Page													
10.4	Clayey <b>SILT</b> to Silty <b>CLAY</b> , trace sand, trace gravel Hard Grey Moist (TILL)		9	SS	39									
			10	SS	54									
			11	SS	51									
			12	SS	56									
			13	SS	99									
			14	SS	60									
276.9														
19.4	Silty <b>CLAY</b> , trace sand Hard Grey Moist													

Continued Next Page

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

20  
15 10 5 0  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 14-10

3 OF 3

METRIC

GWP# 3079-09-00 LOCATION Hwy 19 Underpass N 4 766 137.8 E 194 477.3 ORIGINATED BY AN  
 HWY 401/19 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AMP  
 DATUM Geodetic DATE 2015.06.23 - 2015.06.24 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page		15	SS	72		276							0 0 45 55
274.5			16	SS	103		275							
21.8	SILT, trace sand, trace to some clay Very Dense Grey Moist to Wet		17	SS	100/ 0.175		274							
							273							
							272							
271.6			18	SS	100/ 0.175									0 0 90 10
24.7	END OF BOREHOLE AT 24.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 4.6m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.06.24 13.9 282.4 2015.07.15 14.0 282.3													

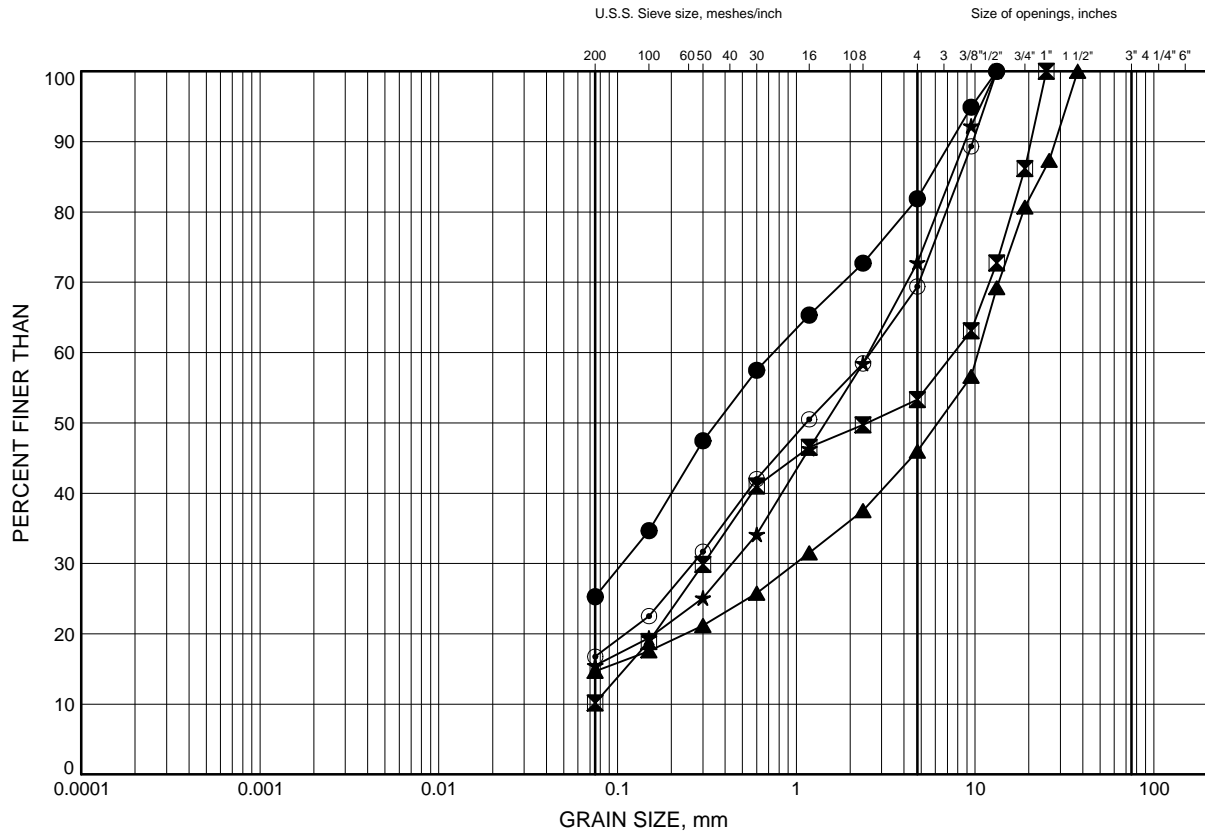
ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

**Appendix B**  
**Laboratory Test Results**

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND to SAND & GRAVEL (FILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-02	0.38	295.32
⊠	14-04	0.38	295.82
▲	14-07	1.07	287.93
★	14-08	1.07	287.93
⊙	14-09	0.38	295.32

Date ..October 2015.....

GWP# ..3079-09-00.....



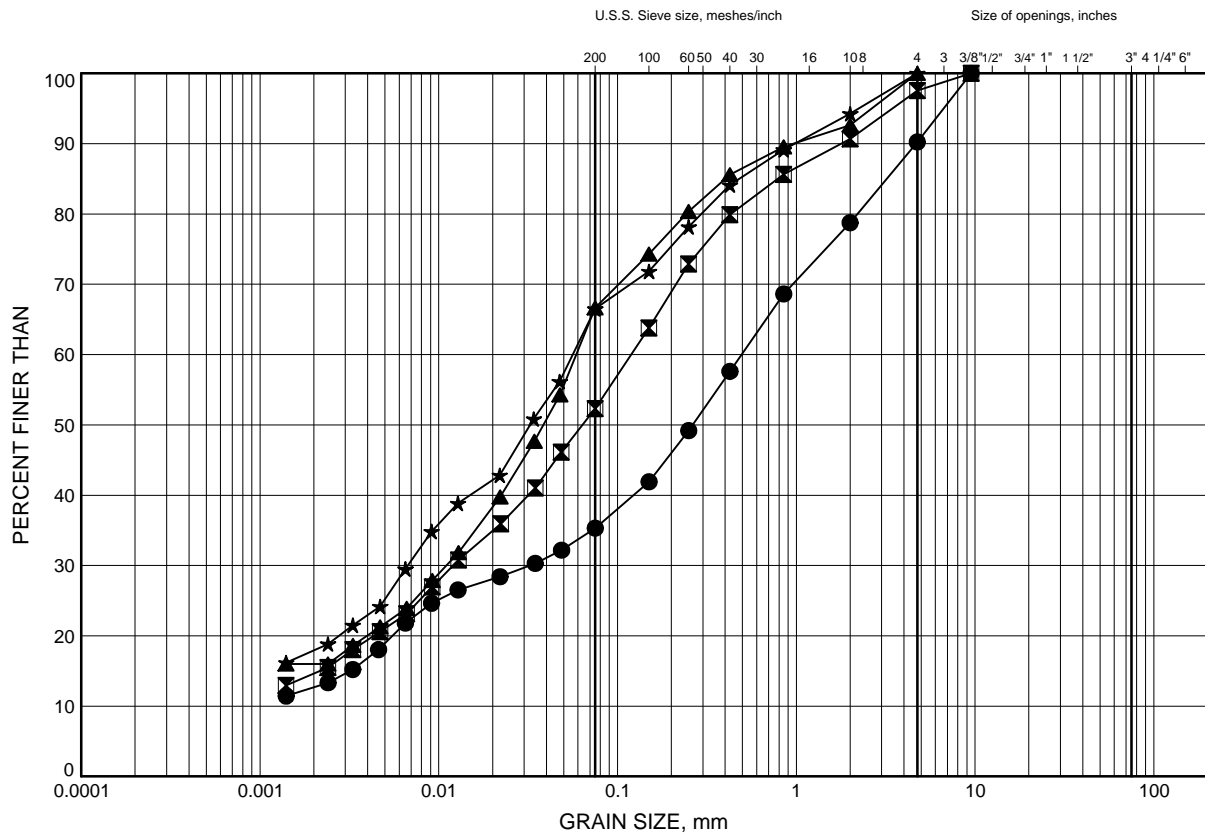
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B2

## Silty SAND to SAND & SILT (FILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	1.07	294.63
⊠	14-09	4.11	291.59
▲	14-10	1.07	295.23
★	14-10	3.35	292.95

Date ..October 2015.....

GWP# ..3079-09-00.....



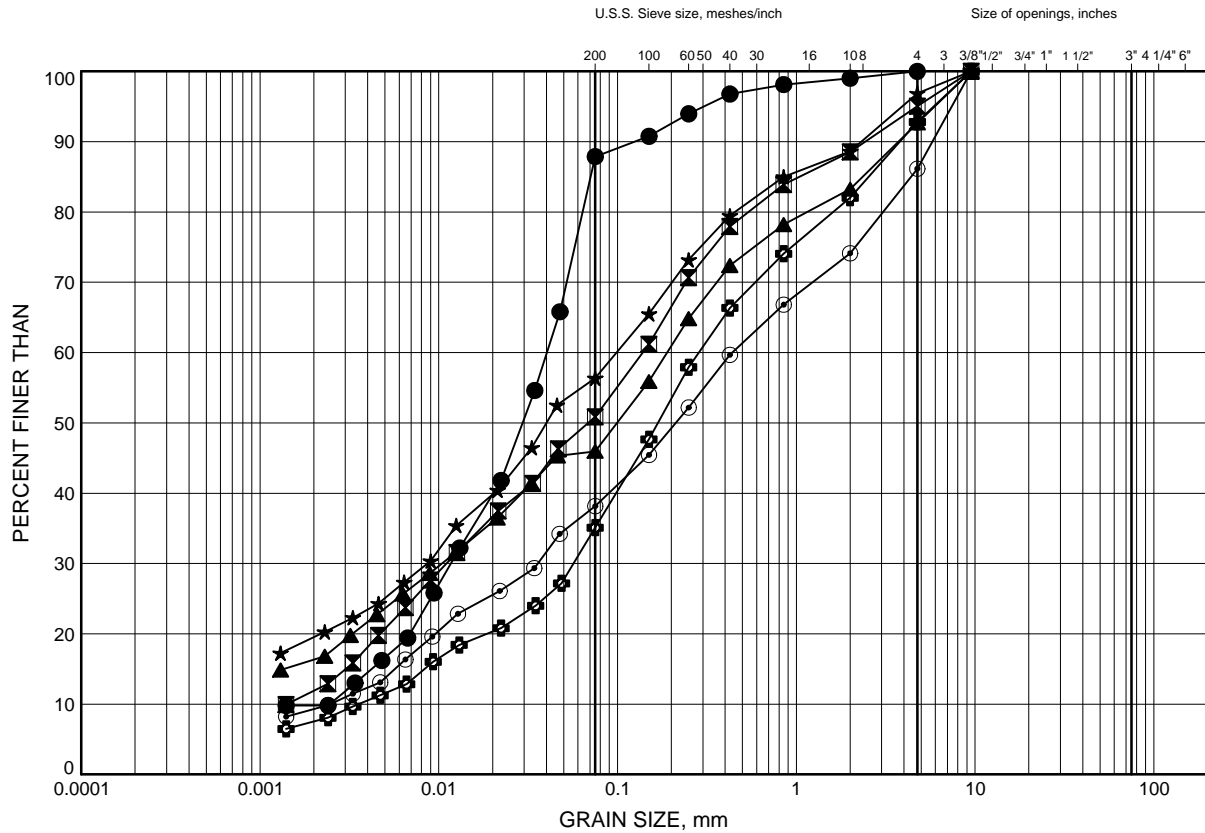
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B3

## Upper Silty SAND to SAND & SILT (TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	3.35	292.35
⊠	14-01	6.40	289.30
▲	14-02	4.88	290.82
★	14-02	9.45	286.25
⊙	14-03	2.59	293.21
⊕	14-03	7.92	287.88

Date ..October 2015.....

GWP# ..3079-09-00.....



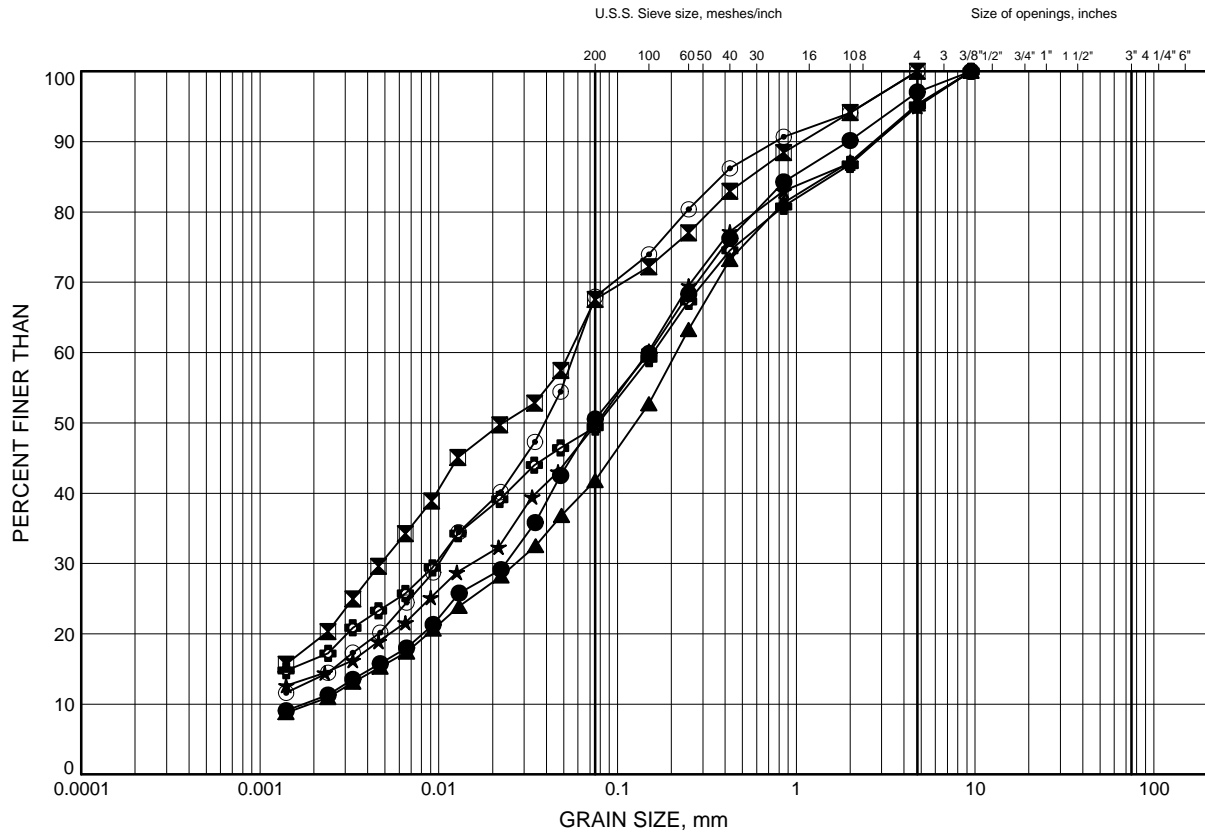
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B4

## Upper Silty SAND to SAND & SILT (TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-04	4.88	291.32
⊠	14-05	3.35	292.95
▲	14-05	9.45	286.85
★	14-06	1.83	294.57
⊙	14-06	3.35	293.05
⊕	14-06	6.40	290.00

Date ..October 2015.....

GWP# ..3079-09-00.....



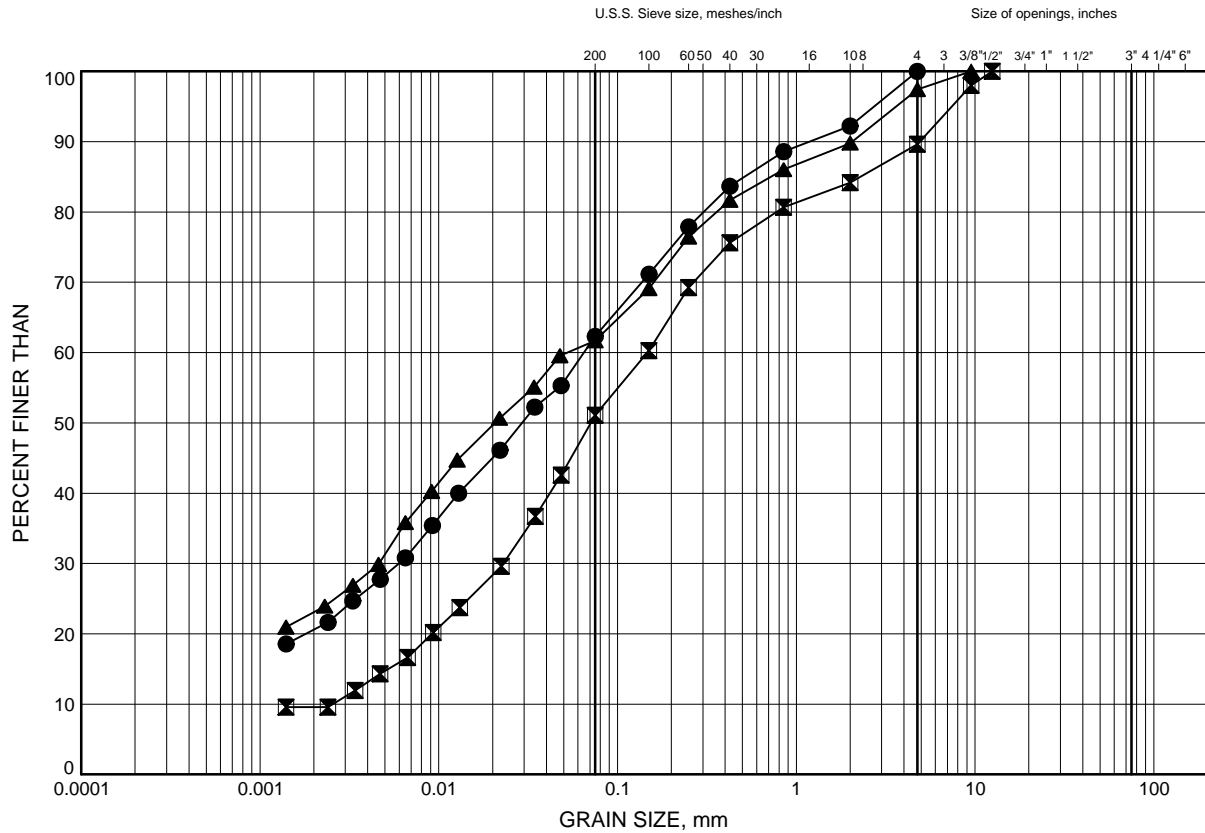
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B5

## Upper Silty SAND to SAND & SILT (TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	2.59	286.41
⊠	14-09	9.45	286.25
▲	14-10	7.92	288.38

Date ..October 2015.....

GWP# ..3079-09-00.....



Prep'd .....AN.....

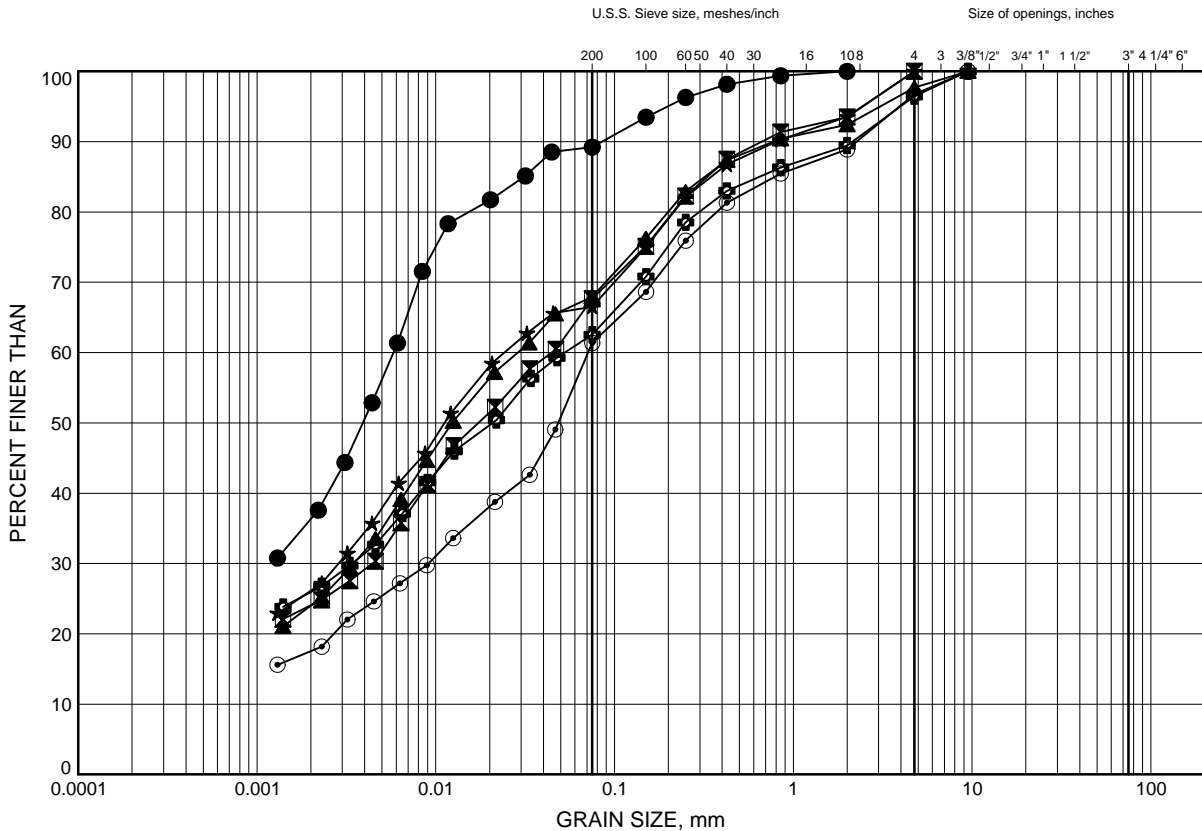
Chkd. ....AMP.....



# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B6

## Clayey SILT / Silty CLAY (TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	15.54	280.26
⊠	14-04	10.97	285.23
▲	14-05	12.50	283.80
★	14-07	4.88	284.12
⊙	14-07	7.92	281.08
⊕	14-08	6.32	282.68

Date ..October 2015.....

GWP# ..3079-09-00.....



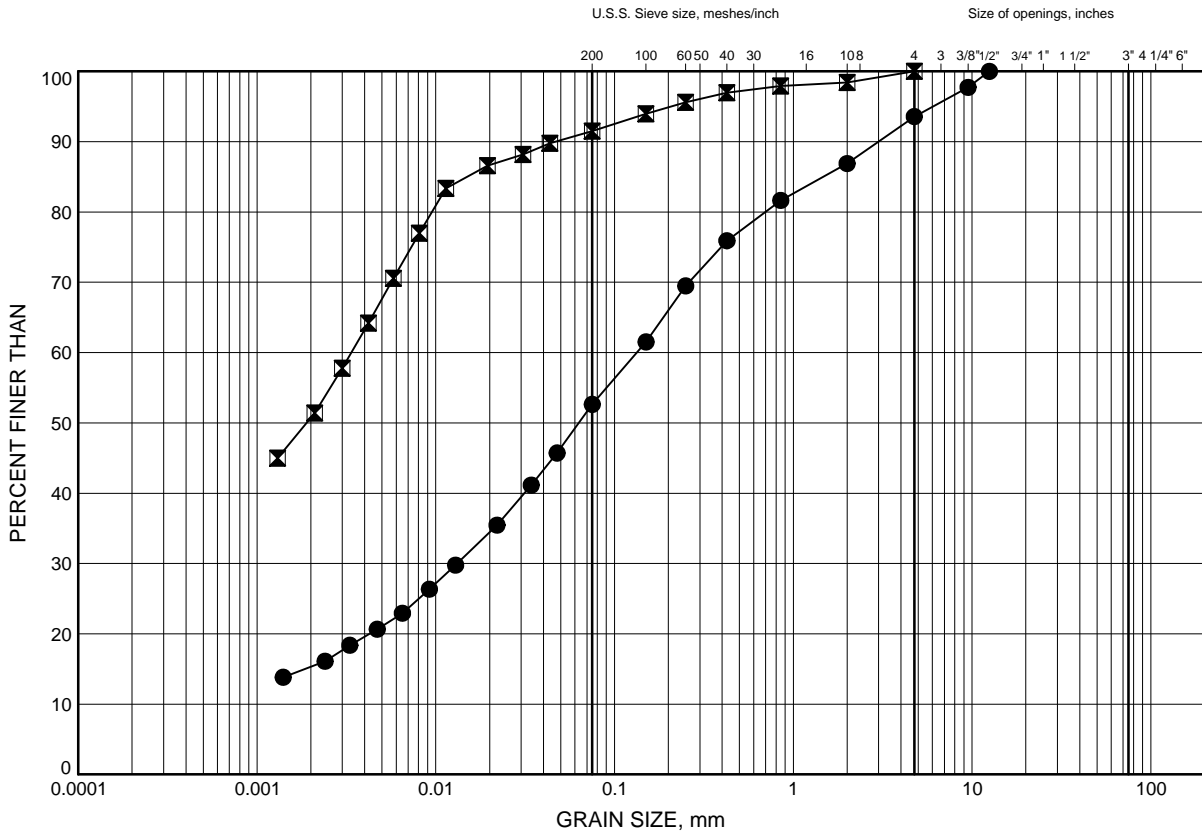
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B7

## Clayey SILT / Silty CLAY (TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-09	12.50	283.20
⊠	14-10	14.02	282.28

Date ..October 2015.....

GWP# ..3079-09-00.....



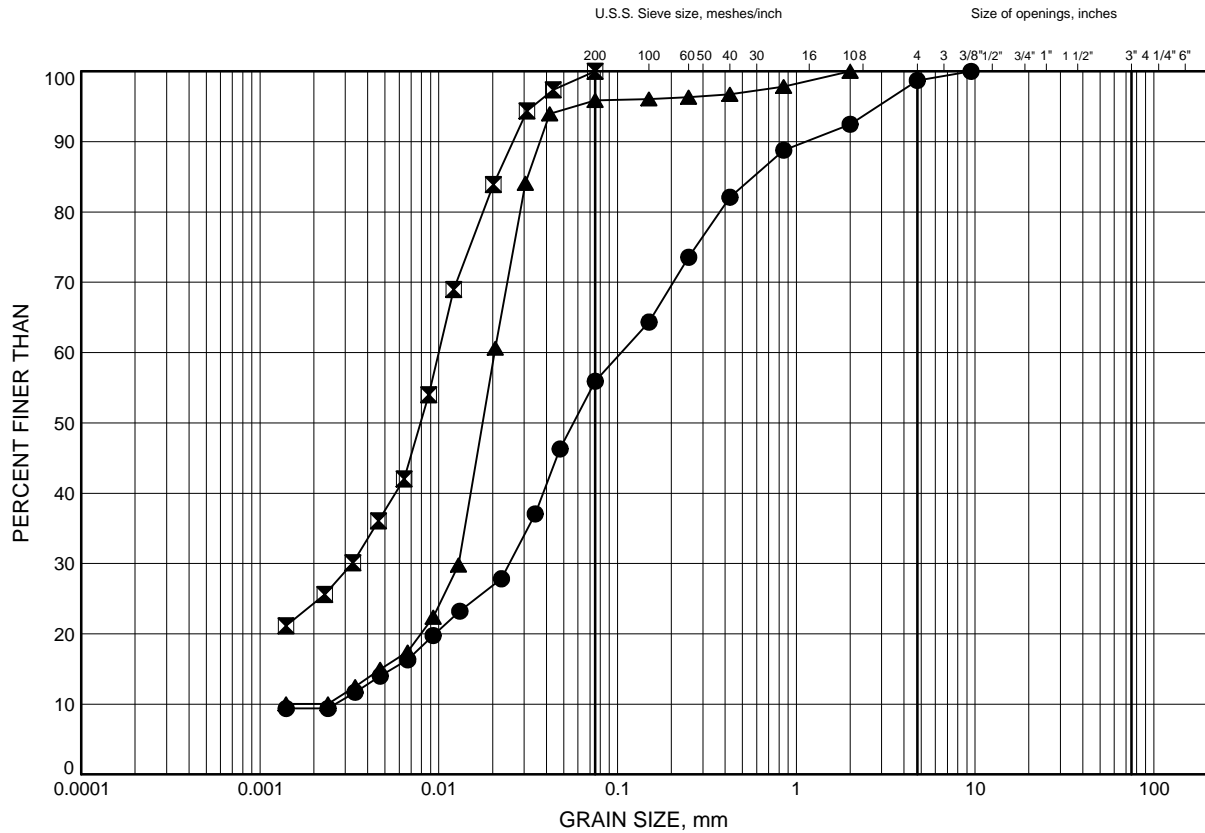
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B8

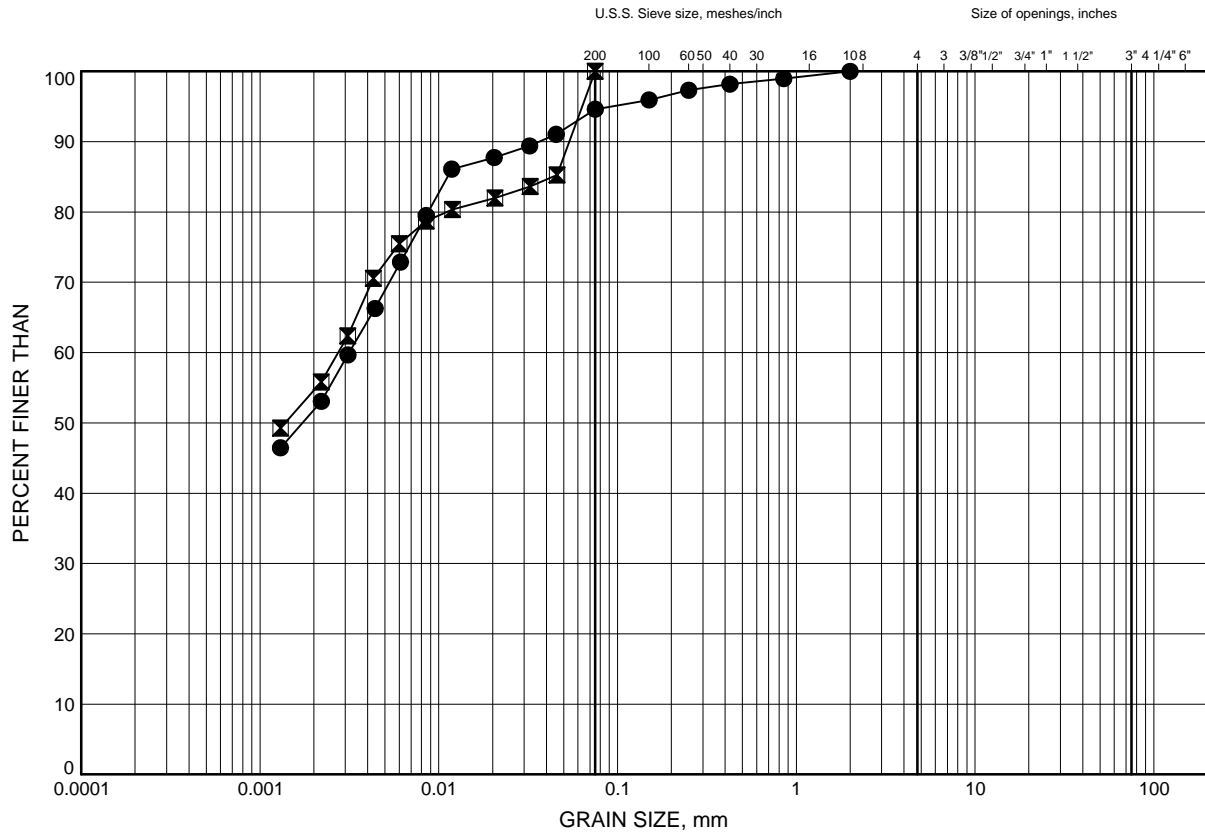
## Lower SAND & SILT (TILL)



# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B9

## Silty CLAY



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	12.42	276.58
⊠	14-10	20.10	276.20

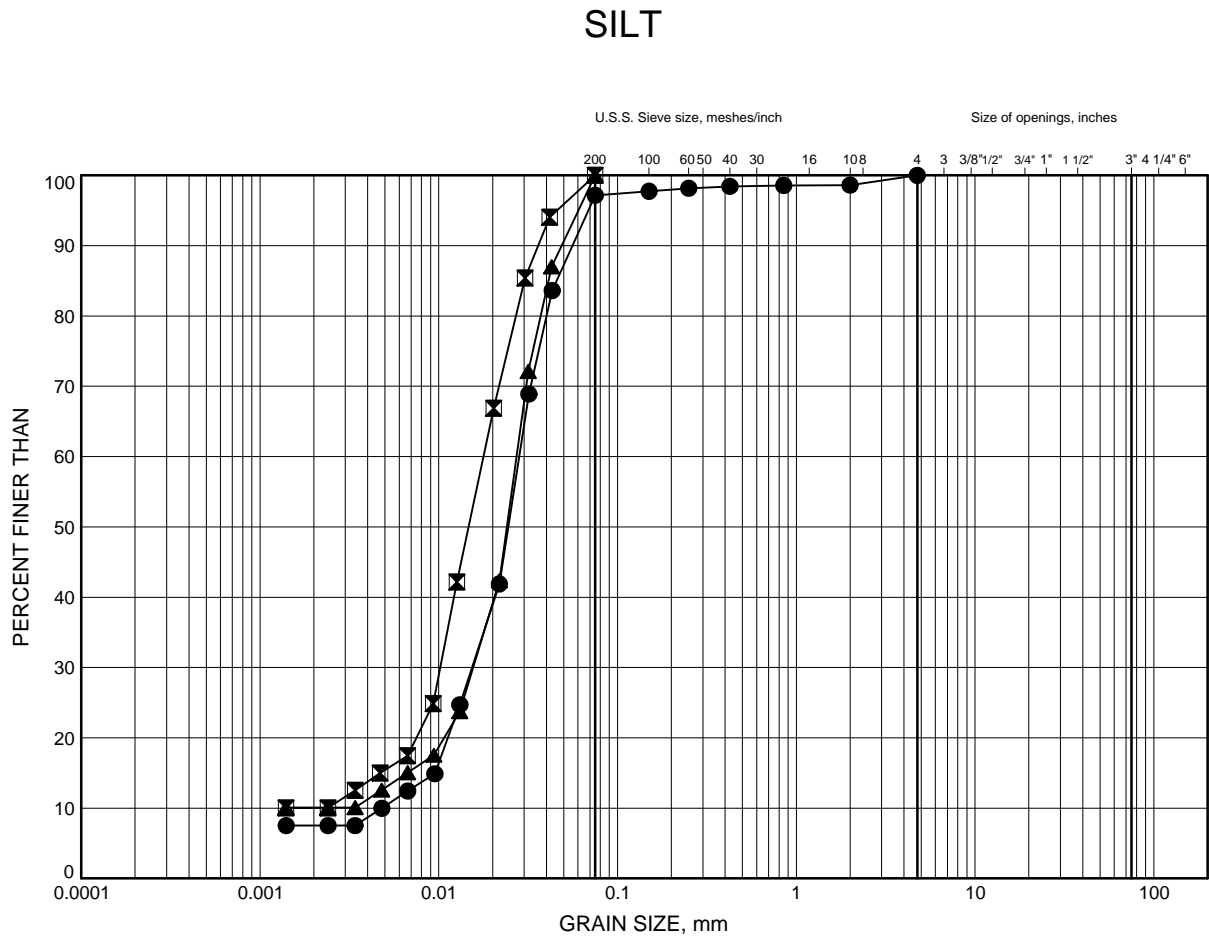
Date ..October 2015.....  
GWP# ..3079-09-00.....



Prep'd .....AN.....  
Chkd. ....AMP.....

# Hwy 19 Underpass GRAIN SIZE DISTRIBUTION

FIGURE B10



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	15.54	273.46
⊠	14-08	18.59	270.41
▲	14-10	24.54	271.76

Date October 2015  
GWP# 3079-09-00

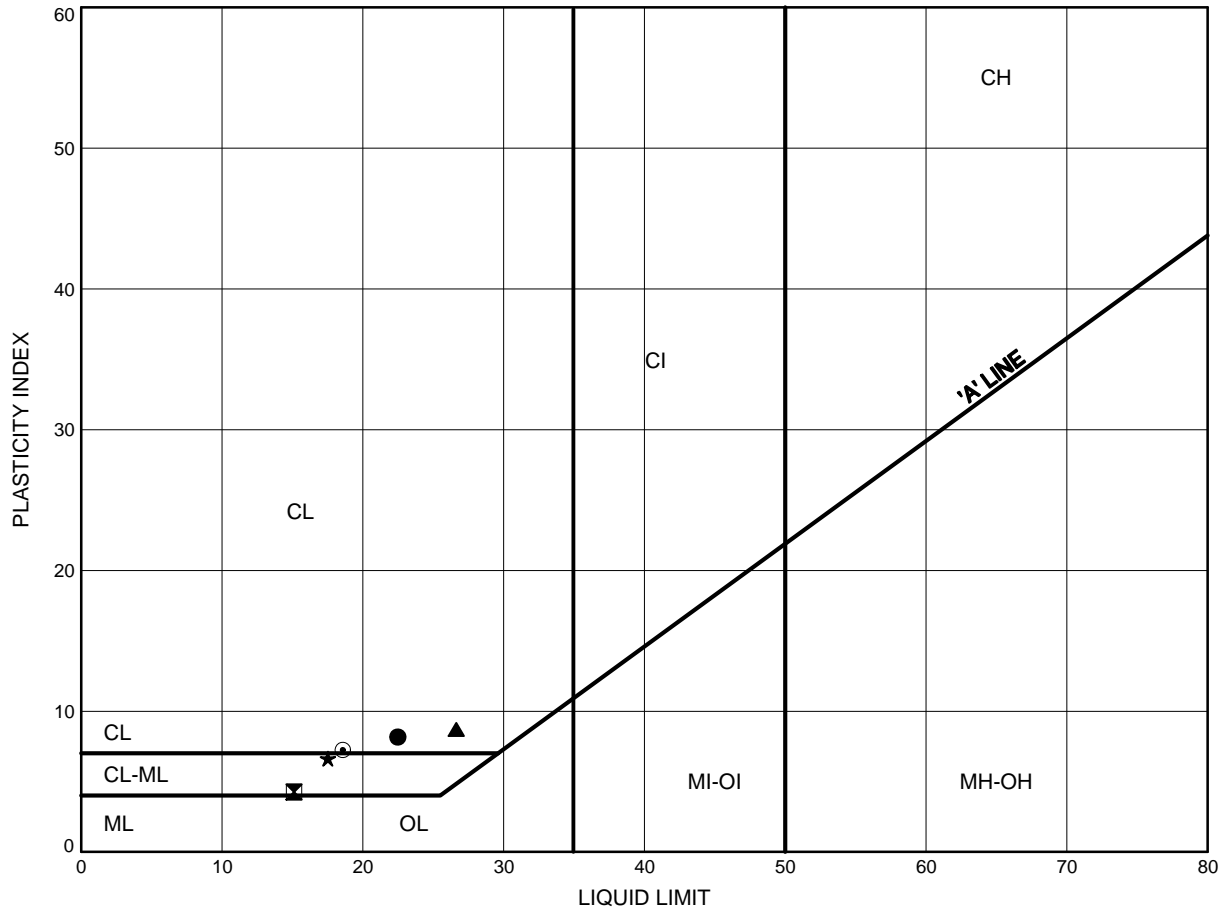


Prep'd AN  
Chkd. AMP

# Hwy 19 Underpass ATTERBERG LIMITS TEST RESULTS

FIGURE B11

## Upper TILL



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	6.40	289.30
⊠	14-02	9.45	286.25
▲	14-06	3.35	293.05
★	14-08	2.59	286.41
⊙	14-10	7.92	288.38

Date ..October 2015.....  
GWP# 3079-09-00.....

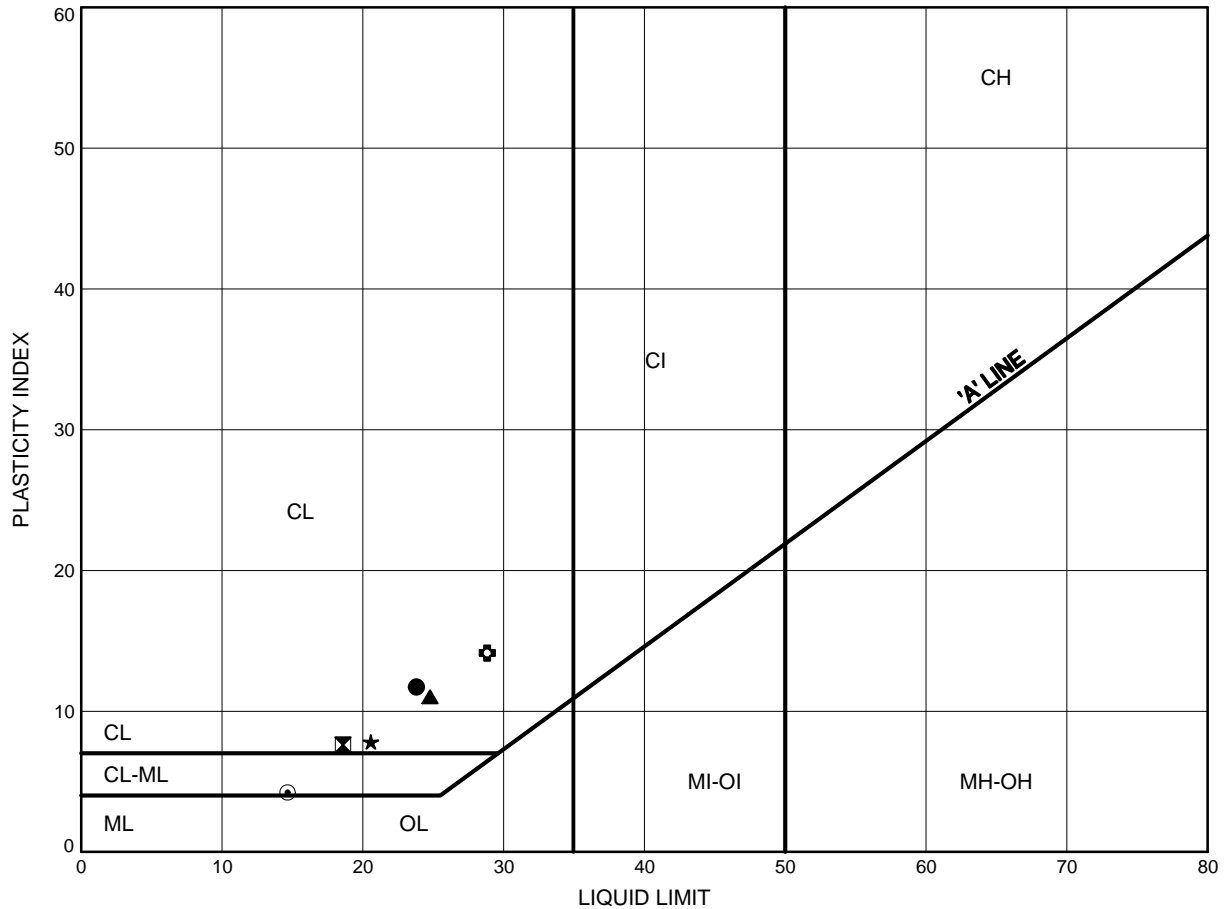


Prep'd .....AN.....  
Chkd. ....AMP.....

# Hwy 19 Underpass ATTERBERG LIMITS TEST RESULTS

FIGURE B12

Clayey SILT / Silty CLAY (TILL)



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	15.54	280.26
⊠	14-04	10.97	285.23
▲	14-05	12.50	283.80
★	14-07	4.88	284.12
⊙	14-09	12.50	283.20
⊕	14-10	14.02	282.28

Date ..October 2015.....

GWP# ..3079-09-00.....



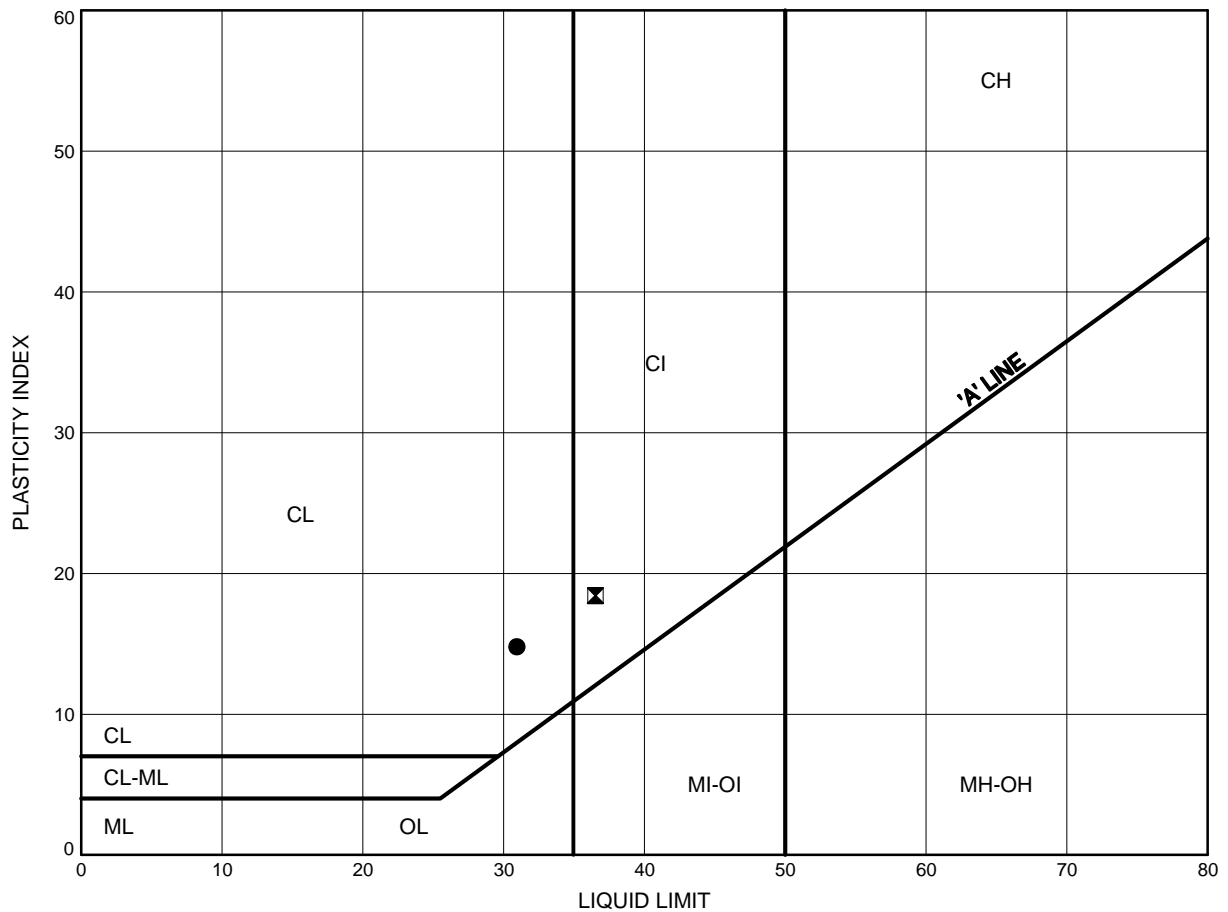
Prep'd .....AN.....

Chkd. ....AMP.....

# Hwy 19 Underpass ATTERBERG LIMITS TEST RESULTS

FIGURE B13

Silty CLAY



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	12.42	276.58
⊠	14-10	20.10	276.20

Date ..October 2015.....  
GWP# ..3079-09-00.....



Prep'd .....AN.....  
Chkd. ....AMP.....



## **Appendix C**

### **Analytical Test Results**



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

5835 COOPERS AVENUE  
MISSISSAUGA, ONTARIO  
CANADA L4Z 1Y2  
TEL (905)712-5100  
FAX (905)712-5122  
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE:

ATTENTION TO: Stephen Peters

SAMPLED BY:

### pH, Sulphate (Soil)

DATE RECEIVED: 2014-12-05

DATE REPORTED: 2014-12-15

		14-04 SS11		14-02 SS1		NW-02 SS11		NW-04 SS1	
SAMPLE DESCRIPTION:		(40'-42')		(6'-2')		(40'-42')		(0'-2')	
SAMPLE TYPE:		Soil		Soil		Soil		Soil	
DATE SAMPLED:		12/4/2014		12/4/2014		12/4/2014		12/4/2014	
Parameter	Unit	G / S	RDL	6157014	6157025	6157026	6157027		
pH, 2:1 CaCl <sub>2</sub> Extraction	pH Units			8.13	8.12	7.91	7.57		
Sulphate (2:1)	µg/g	2		33	25	42	18		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:





## Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

PROJECT: 19-5161-224

SAMPLING SITE:

AGAT WORK ORDER: 14T925116

ATTENTION TO: Stephen Peters

SAMPLED BY:

### Soil Analysis

RPT Date: Dec 15, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
pH, Sulphate (Soil)															
pH, 2:1 CaCl2 Extraction	6157135		7.90	7.91	0.1%	NA	100%	80%	120%	NA			NA		
Sulphate (2:1)	6156506		17	17	3.8%	< 2	99%	80%	120%	103%	80%	120%	102%	70%	130%

Comments: NA signifies Not Applicable.

Certified By: \_\_\_\_\_



## Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

ATTENTION TO: Stephen Peters

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH, 2:1 CaCl <sub>2</sub> Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH

## **Appendix D**

### **Site Photographs**



**Photograph 1 – Looking west onto Highway 401 from bridge deck.**



**Photograph 2 – Looking east onto Highway 401 from bridge deck.**





**Photograph 3 – Highway 19 - looking north onto bridge deck.**



**Photograph 4 – Highway 19 - looking south onto bridge deck.**



**Photograph 5 – East bridge elevation; looking towards north abutment.**



**Photograph 6 – Looking towards north bridge abutment**

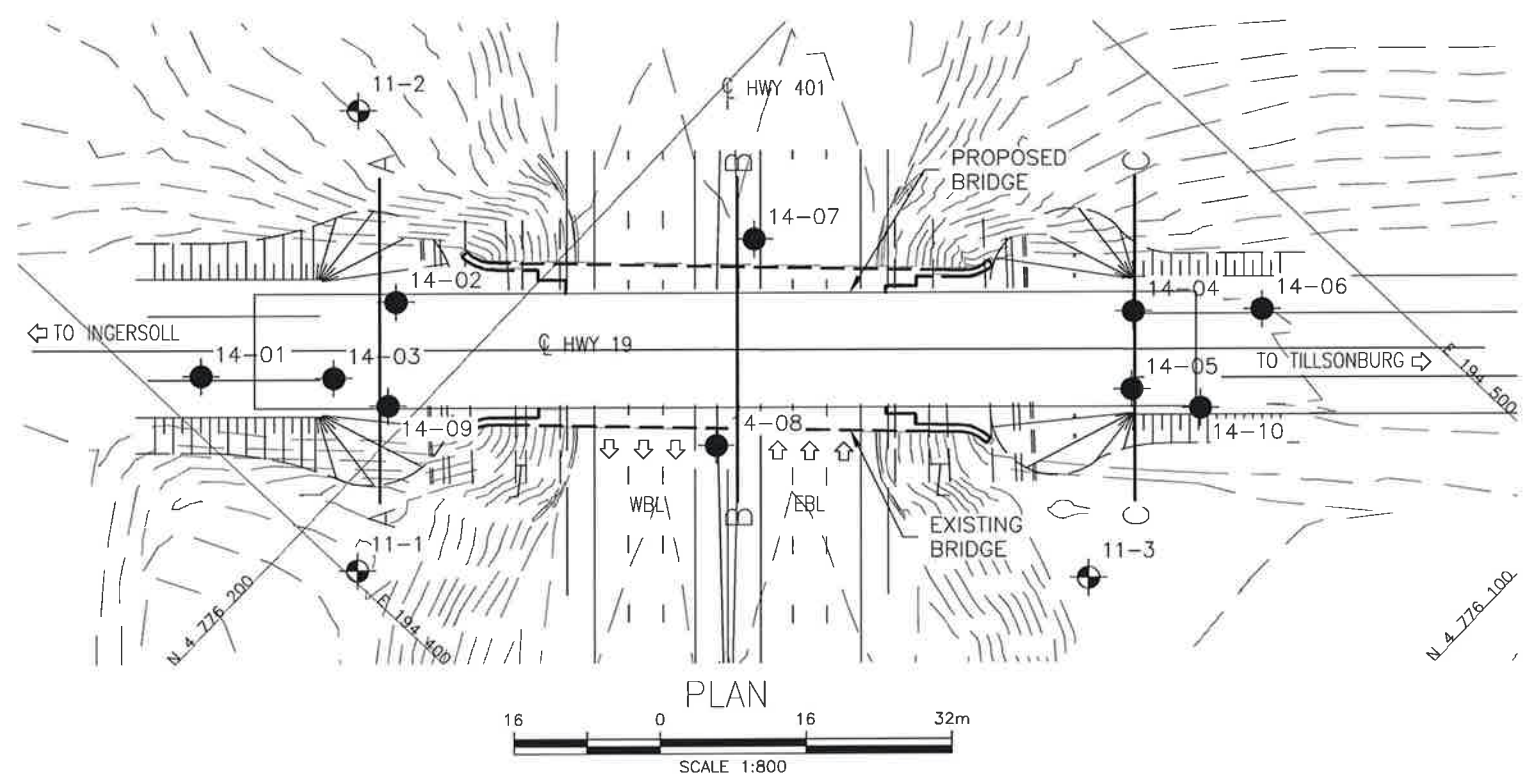


## **Appendix E**

### **Borehole Location and Soil Strata Drawing**

MINISTRY OF TRANSPORTATION, ONTARIO

CAD FILE LOCATION AND NAME: H:\Drawing\19\15\124\19\15\124-BoreholePlan&Profile (Highway 19 Underpass).dwg  
MODIFIED: 10/27/2015 8:30:25 AM BY: DBAFTING02  
DATE PLOTTED: 12/08/2015 10:14:23 AM BY: DBAFTING02



CONT No  
GWP No 3079-09-00

HIGHWAY 401  
HIGHWAY 19 UNDERPASS  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET  
127

METRIC

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND			
	Borehole (Current Investigation)		
	Borehole (Previous Investigation, 2013)		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level In Open Borehole		
	Water Level In Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		
NO	ELEVATION	NORTHING	EASTING
14-01	295.7	4 766 219.6	194 404.7
14-02	295.7	4 766 209.8	194 425.3
14-03	295.8	4 766 209.0	194 414.5
14-04	296.3	4 766 150.4	194 479.9
14-05	296.3	4 766 144.7	194 473.6
14-06	296.4	4 766 140.3	194 489.8
14-07	289.0	4 766 186.0	194 457.2
14-08	289.0	4 766 173.5	194 437.9
14-09	295.7	4 766 202.6	194 416.4
14-10	296.3	4 766 137.8	194 477.3
11-01	293.9	4 766 192.6	194 401.0
11-02	291.7	4 766 227.2	194 437.7
11-03	294.5	4 766 133.9	194 455.4

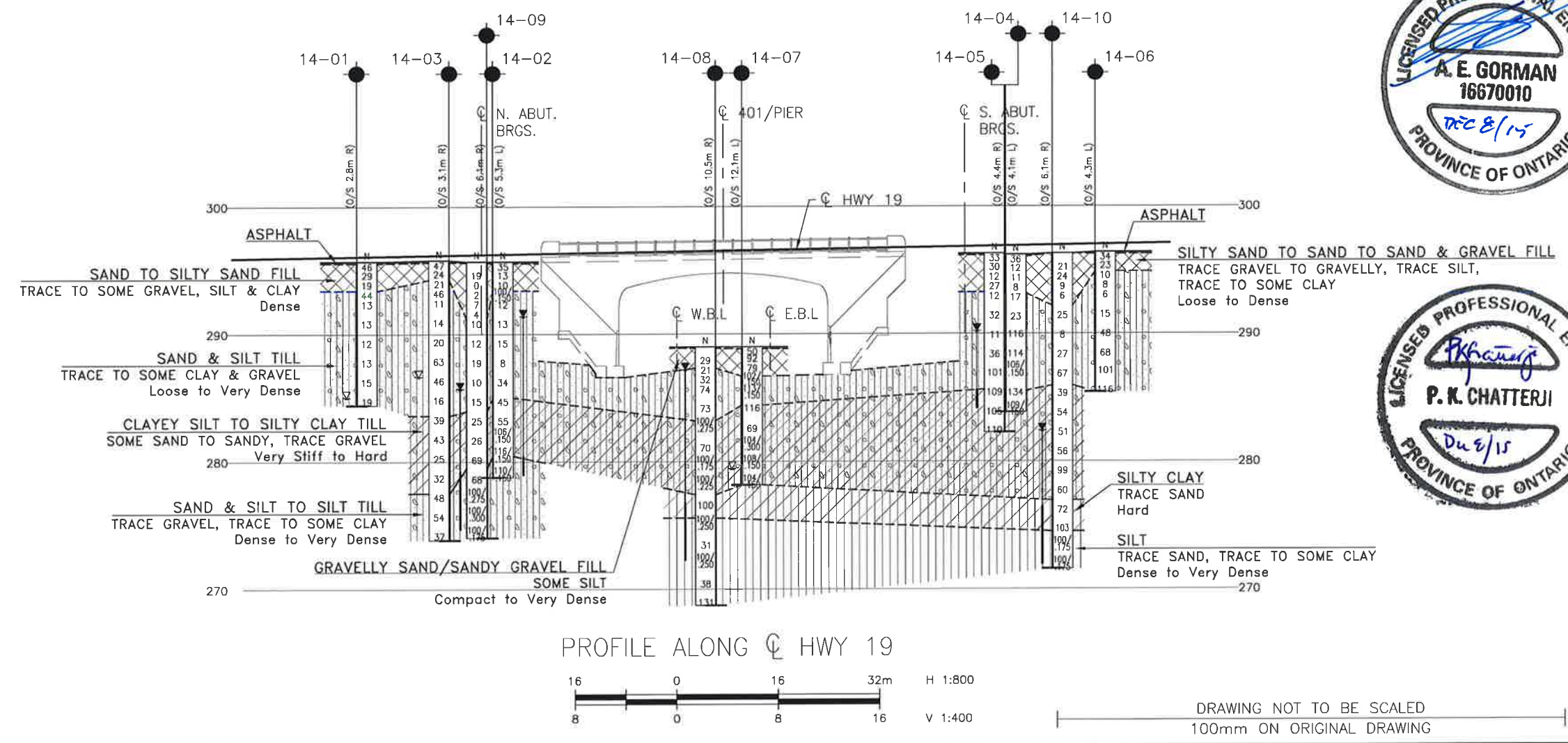
NOTES

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.

GEOCRIS No.

40P2-77



REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MKE	CHK	MKE	CODE
DRAWN	AN	CHK	SITE	23-210 STRUCT
		DATE	DEC 2015	DWG 2

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING









DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

A map showing the location of the site. The site is marked with a circle and the word "SITE" at the intersection of Harris St and Cartier Freeway. Other roads shown include Charles St E, Korn Rd, Whiting St, Ingersoll, Harris St, Cartier Freeway, 401, 15, and Sweaburg Rd. A north arrow is located in the upper right corner.

## KEYPLAN

## LEGEND

- |   |   |
|---|---|
|  | Borehole (Current Investigation)        |
|  | Borehole (Previous Investigation, 2013) |
| N   | Blows /0.3m (Std Pen Test, 475J/blow)   |
| CONE  | Blows /0.3m (60" Cone, 475J/blow)       |
| PH  | Pressure, Hydraulic                     |
|  | Water Level in Open Borehole            |
|  | Water Level in Piezometer               |
| 90%   | Rock Quality Designation (RQD)          |
| A/R   | Auger Refusal                           |

NO	ELEVATION	NORTHING	EASTING
14-01	295.7	4 766 219.6	194 404.7
14-02	295.7	4 766 209.8	194 425.3
14-03	295.8	4 766 209.0	194 414.5
14-04	296.3	4 766 150.4	194 479.9
14-05	296.3	4 766 144.7	194 473.6
14-06	296.4	4 766 140.3	194 489.8
14-07	289.0	4 766 186.0	194 457.2
14-08	289.0	4 766 173.5	194 437.9
14-09	295.7	4 766 202.6	194 416.4
14-10	296.3	4 766 137.8	194 477.3
11-01	293.9	4 766 192.6	194 401.0
11-02	291.7	4 766 227.2	194 437.7
11-03	294.5	4 766 133.9	194 455.4

-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. 40P2-77

REVISIONS									
	DATE	BY	DESCRIPTION						
DESIGN	MKE	CHK	MKE	CODE	LOAD	DATE	DEC 2015		
DRAWN	AN	CHK		SITE 23-210	STRUCT	DWG 3			

## **Appendix F**

### **Previous Investigation Borehole Locations and Soil Strata Drawing and Record of Borehole Sheets Geocres No.: 40P2-74**

165000776-1\_1.dgn

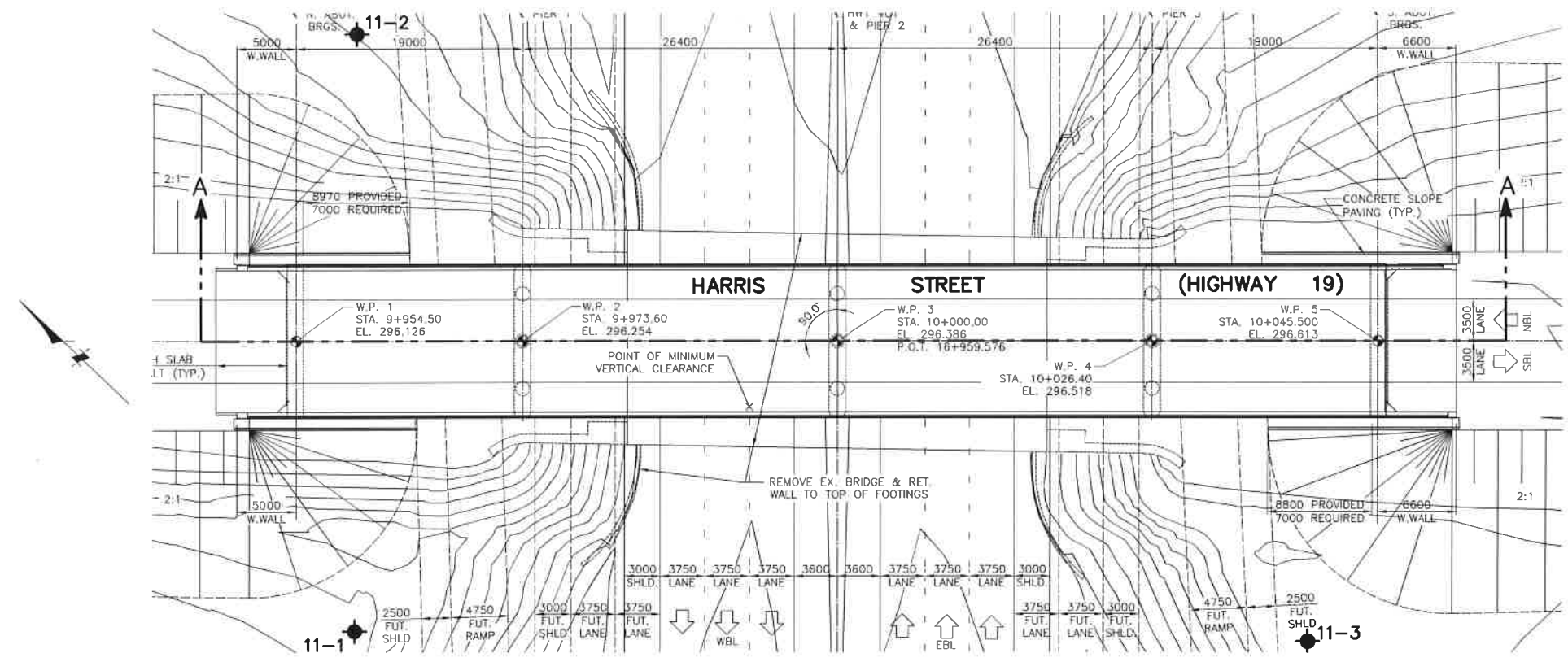
2013/01/10

Printed: Feb 04, 2013

165000776-1\_1.dgn

2013/01/10

165000776-1\_1.dgn



PLAN SCALE 5 m 0 5 10 m

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



PLATE No  
**CONT**  
**WP 3070-09-00**

**HIGHWAY 401**  
**HIGHWAY 19, INGERSOLL, ONTARIO**  
**BOREHOLE LOCATIONS & SOIL STRATA**

**SHEET**



**LEGEND**

- ◆ Borehole (by Stantec)
- ◆ Borehole (by others)
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- ↓ WL at time of investigation March 2011
- (m NORTH) Offset from Cross Section Line in metres

No	ELEVATION	MTM ZONE 11 NORTH	COORDINATES EAST
11-1	293.9	4 766 192.6	194 401.0
11-2	291.7	4 766 227.2	194 437.7
11-3	294.5	4 766 133.9	194 455.4

**NOTES**

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

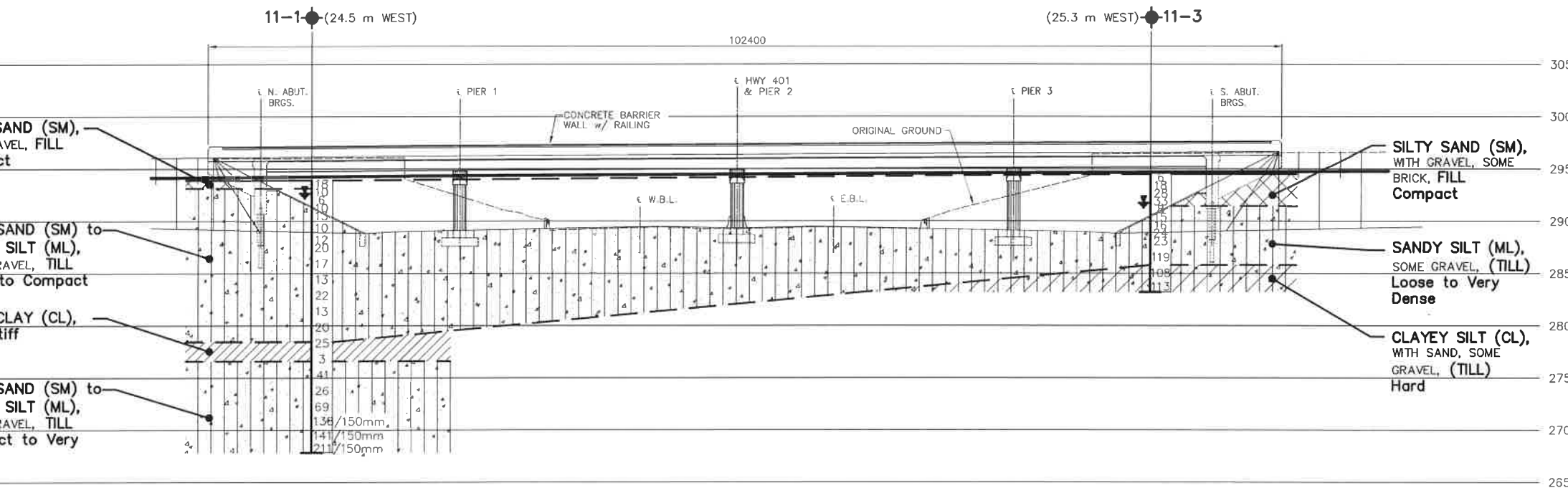
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REVISION	DATE	BY	DESCRIPTION

GEORES No 40P2-74

HWY No 401	CHECKED	DATE 2012-07-12	DIST
SUBM'D SG	CHECKED	SITE 23-210	
DRAWN KDM	CHECKED	DWG 1	



CROSS SECTION A-A' SCALE 5 m 0 5 10 m

# RECORD OF BOREHOLE No BH 11-1

1 OF 3

METRIC

W.P. GWP 3070-09-00

LOCATION Hwy 401 at Hwy 19, Site 23-210, Ingersoll

N: 4 766 193 E: 194 401

ORIGINATED BY DS

DIST HWY 401

BOREHOLE TYPE Hollow Stem Augers, Spillspoon Sampler

COMPILED BY JF

DATUM Geodetic

DATE 2011 04 04 - 2011 04 05

CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT		UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)						
								○ UNCONFINED	✕ FIELD VANE	● QUICK TRIAXIAL	✕ LAB VANE			W <sub>p</sub>	W	W <sub>L</sub>
								20	40	60	80			100	20	40
293.9	Tall Grass													GR SA SI CL		
293.7	Silty sand, some roots, brown, FILL															
0.2	Silty gravel, FILL Compact Brown		1	SS	18											
293.1																
0.8	Silty sand (SM) to sandy silt (ML), some gravel, TILL						293									
	Loose to compact		2	SS	10											
	Brown to grey															
			3	SS	6		292							11 50 (39)		
			4	SS	10		291							Water Flow From Sampler		
			5	SS	13		290							Water Flow From Sampler		
			6	SS	10		289									
	- wet		7	SS	10		288							11 41 (48)		
	- Clayey silt @ 5.6 m		8	SS	12		287									
			9	SS	20		286									
							285									
	- moist to wet		10	SS	17		284							Water Flow From Sampler		
			11	SS	13									7 39 (54)		
														Water Flow From Sampler		
293.0																

Continued Next Page

✕ 3. ✕ 3.

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE







# RECORD OF BOREHOLE No BH 11-2

1 OF 2

METRIC

W.P. GWP 3070-09-00 LOCATION Hwy 401 at Hwy 19, Site 23-210, Ingersoll N: 4 766 227 E: 194 438 ORIGINATED BY DS  
DIST HWY 401 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY JF  
DATUM Geodetic DATE 2011 04 04 - 2011 04 04 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
291.7	Tall Grass						20	40	60	80	100							
290.8	TOPSOIL																	
0.2	Silty sand (SM) to sandy silt (ML), some gravel, TILL		1	SS	9													
	Loose to dense																	
	Brown																	
			2	SS	16											6 42 (52)		
			3	SS	4													
			4	SS	6													
			5	SS	15											13 45 (42)		
			6	SS	15													
			7	SS	42													
			8	SS	33											8 31 (61)		
285.6																		
285.4	SAND (SP), compact, brown																	
6.3	Silty sand (SM) to sandy silt (ML), some gravel, TILL		9	SS	18													
	Very dense																	
	Grey																	
	- with cobbles and boulders																	
	- sand infilling augers @ 7.3 m																	
			10	SS	88													
	- cobbles and boulders																	
283.0	Clayey silt (CL) with sand, some gravel, TILL																	
8.7	Hard																	
	Grey																	
	- with cobbles and boulders		11	SS	103													
281.7																		

Continued Next Page

×<sup>3</sup> ×<sup>3</sup>

Numbers refer to  
Sensitivity

○<sup>3</sup>%

STRAIN AT FAILURE



# RECORD OF BOREHOLE No BH 11-3

1 OF 2

METRIC

W.P. GWP 3070-09-00

LOCATION Hwy 401 at Hwy 19, Site 23-210, Ingersoll

N: 4 766 134 E: 194 455

ORIGINATED BY DS

DIST HWY 401

BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler

COMPILED BY JF

DATUM Geodetic

DATE 2011 04 05 - 2011 04 06

CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
294.5	Tall Grass					▽	294	○ UNCONFINED	✕ FIELD VANE	10	20	30	kN/m³	GR SA SI CL		
294.1	Silty sand, some roots, brown, FILL		1	SS	6			● QUICK TRIAXIAL	✕ LAB VANE	20	40	60			80	100
	Silty sand (SM) with gravel, FILL															
	Compact		2	SS	18											
	Brown to grey															
			3	SS	28											
			4	SS	33											
	- pieces of red brick															
291.5																
3.1	Sandy silt (ML), some gravel, TILL					▽	291						7 40 (53)			
	Loose to very dense		5	SS	8											
	Brown to greyish brown to grey															
			6	SS	15											
			7	SS	16											
			8	SS	24											
			9	SS	23											
	- very dense below 7.0 m															
	- occasional cobbles and boulders															
		</														

Continued Next Page

✕ 3, ✕ 3

Numbers refer to Sensitivity

○ 3%

STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH 11-3

2 OF 2

METRIC

W.P. GWP 3070-09-00 LOCATION Hwy 401 at Hwy 19, Site 23-210, Ingersoll N: 4 766 134 E: 194 455 ORIGINATED BY DS  
DIST HWY 401 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY JF  
DATUM Geodetic DATE 2011 04 05 - 2011 04 06 CHECKED BY SG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
10.0	(continued) Clayey silt (CL) with sand, some gravel, TILL Hard Grey - cobbles and boulders		12	SS	113		284						7 31 41 21
263.2	End of Borehole												
11.3													

✕<sup>3</sup>, ✕<sup>3</sup>: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE