

**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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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.

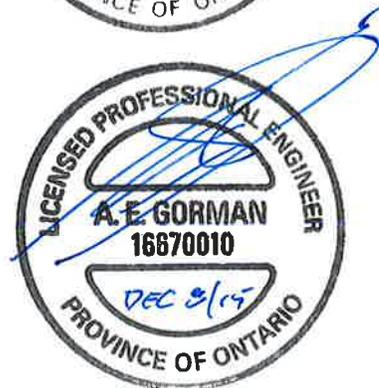
Routine laboratory testing was carried out by Thurber's geotechnical laboratory in Oakville, Ontario. Interpretation of the data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and by Dr. P.K. Chatterji, P.Eng., who is 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 ⁽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
 C_{pen} Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

EXPLANATION OF ROCK LOGGING TERMS

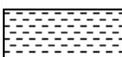
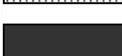
ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
	(MPa)	(psi)	
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			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
295.7	GROUND SURFACE														
0.0	ASPHALT: (150mm)														
0.2	SAND, some gravel, trace silt Dense Brown Dry		1	SS	46										
294.9															
0.8	(FILL) Silty SAND, trace to some gravel, trace to some clay Compact Brown Dry (FILL)		2	SS	29									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										
			5	SS	13									0 12 78 10	
			6	SS	13										
			7	SS	12									5 44 39 12	
			8	SS	13										
			9	SS	15										

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) 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 _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			SHEAR STRENGTH kPa									
	Continued From Previous Page						20	40	60	80	100						
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.																

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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 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	SHEAR STRENGTH kPa								
	Continued From Previous Page						20	40	60	80	100					
285.0																
10.7	Silty CLAY , some sand, trace gravel, occasional lenses of clayey silt Hard Grey Wet (TILL)		10	SS	45											
			11	SS	55											
			12	SS	106/ 0.150											
280.5																
15.2	SAND and SILT , trace to some clay, trace gravel Very Dense Grey Wet (TILL)		13	SS	116/ 0.150											
278.8																
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.		14	SS	110/ 0.150											

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RECORD OF BOREHOLE No 14-03

2 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			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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page														
283.6			10	SS	16		285								
12.2	Silty CLAY , some sand, occasional lenses of clayey silt Very Stiff to Hard Grey (TILL)		11	SS	39		283								
			12	SS	43		282								
			13	SS	25		281								
			14	SS	32		280							0 11 53 36	
277.5			15	SS	48		279								
18.3	SAND and SILT , trace gravel, trace to some clay Dense to Very Dense Grey Moist (TILL)						278								
							277							1 43 47 9	
							276								

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+³, ×³: Numbers refer to Sensitivity
 20
 15
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 (%) STRAIN AT FAILURE

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

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					
	SAND and SILT , trace gravel, trace to some clay Dense to Very Dense Grey Moist (TILL)	0 4 0 4 0 4 0 4 0	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.																

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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 γ kN/m ³	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							
285.5	Silty CLAY , sandy, trace gravel, occasional silty sand and clayey silt lenses Hard Grey Dry (TILL)		10	SS	134									0 32 44 24
283.9			11	SS	109/									
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.				0.150									

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+³, ×³: Numbers refer to Sensitivity
 20
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 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-05

1 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					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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
296.3	GROUND SURFACE																
0.0	ASPHALT: (150mm)																
0.2	SAND, some gravel to gravelly Dense Brown Dry (FILL)	[Cross-hatch pattern]	1	SS	33												
			2	SS	30												
294.9	Silty SAND, trace gravel, occasional clay lenses Compact Brown Dry (FILL)	[Cross-hatch pattern]	3	SS	12												
			4	SS	27												
293.3	SAND and SILT, trace to some clay, trace gravel Compact to Very Dense Brown to Grey Dry to Moist (TILL) Silty clay (700mm) layer at 7.6m depth	[Vertical line with circles]	5	SS	12											0 32 49 19	
			6	SS	32												
			7	SS	11												
			8	SS	36												
			9	SS	101												5 54 32 9

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Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
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 (%) STRAIN AT FAILURE

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					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
285.6	Continued From Previous Page															
10.7	Silty CLAY , sandy, trace gravel, occasional silty sand and clayey silt lenses Hard Grey (TILL)		10	SS	109											
			11	SS	105											2 30 44 24
282.3			12	SS	110											
14.0	END OF BOREHOLE AT 14.0m. BOREHOLE OPEN TO 14.0m AND WATER LEVEL AT 13.7m 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 6.0 290.3 2014.12.19 6.4 289.9 2015.07.15 6.1 290.2															

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+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) 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				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)	
						20	40	60	80	100	20	40	60	GR	SA	SI	CL
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						○						
			2	SS	23						○						
294.9	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						○						
	Clayey silt seam at 3.4m depth		5	SS	6						○	—		0	32	54	14
			6	SS	15						○						
			7	SS	48						○			5	46	33	16
			8	SS	68						○						
			9	SS	101						○						

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+³, ×³: 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 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					
285.4	Continued From Previous Page SAND and SILT , 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.																

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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			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
289.0	GROUND SURFACE														
0.0	ASPHALT: (150mm)														
0.2	GRAVEL, sandy, some silt: (Crusher Run) Very Dense Brown Dry (FILL)	[Hatched Pattern]	1	SS	50										
			2	SS	92										
287.5	SAND, trace silt, trace clay, trace gravel Very Dense Brown Dry (FILL)	[Hatched Pattern]	3	SS	79										
286.7			4	SS	102/	0.150									
286.7	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL)	[Hatched Pattern]	5	SS	113/	0.150									
284.4			6	SS	116										
284.4	Silty CLAY, sandy, trace gravel, occasional silty sand and clayey silt lenses Hard Grey Moist (TILL)	[Hatched Pattern]	7	SS	69										
			8	SS	104/	0.300									
		[Hatched Pattern]	9	SS	108/	0.150									

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Continued Next Page

+³, ×³: 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 _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			SHEAR STRENGTH kPa									
278.2	Silty CLAY , 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												

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

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
289.0	GROUND SURFACE													
0.0	ASPHALT: (100mm)													
0.1	Gravelly SAND, some silt Compact Brown Dry to Moist (FILL)		1	GS							o			
			1	SS	29						o			27 57 16 (SI+CL)
287.3														
1.7	SAND and SILT, some clay, trace gravel Compact to Very Dense Grey Moist to Dry (TILL)		2	SS	21						o			
			3	SS	32						o			0 38 42 20
			4	SS	74						o			
			5	SS	73						o			
	500mm sand layer at 5m depth.													
283.2														
5.8	Clayey SILT, some sand, becoming sandy, trace gravel Hard Grey Moist (TILL)		6	SS	100/ 0.275						o			4 34 37 25
			7	SS	70						o			
			8	SS	100/ 0.175						o			

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+³, x³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

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 γ kN/m ³	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	W _p	W	W _L		
268.7			15	SS	131												
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																

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

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 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	SHEAR STRENGTH kPa								
	Continued From Previous Page		16	SS	100/0.300											
274.0			17	SS	100/0.175											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															

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

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 W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
						20	40	60	80	100	20	40	60		GR SA SI CL
296.3	GROUND SURFACE														
0.0	Silty SAND, 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	SAND and SILT, 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						○				

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15 ⊕ 5
 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 _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	SHEAR STRENGTH kPa							
	Continued From Previous Page					20 40 60 80 100	20 40 60								
285.9															
10.4	Clayey SILT to Silty CLAY, trace sand, trace gravel Hard Grey Moist (TILL)		9	SS	39										
			10	SS	54										
			11	SS	51									0 9 41 50	
			12	SS	56										
			13	SS	99										
			14	SS	60										
276.9															
19.4	Silty CLAY, trace sand Hard Grey Moist														

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

Continued Next Page

+³, ×³: 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					20 40 60				GR SA SI CL		
274.5	Continued From Previous Page		15	SS	72											0 0 45 55	
21.8	SILT , trace sand, trace to some clay Very Dense Grey Moist to Wet		16	SS	103												
271.6			17	SS	100/ 0.175												
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		18	SS	100/ 0.175											0 0 90 10	

ONTMT4S_1224.GPJ 2015TEMPLATE(MTO).GDT 10/27/15

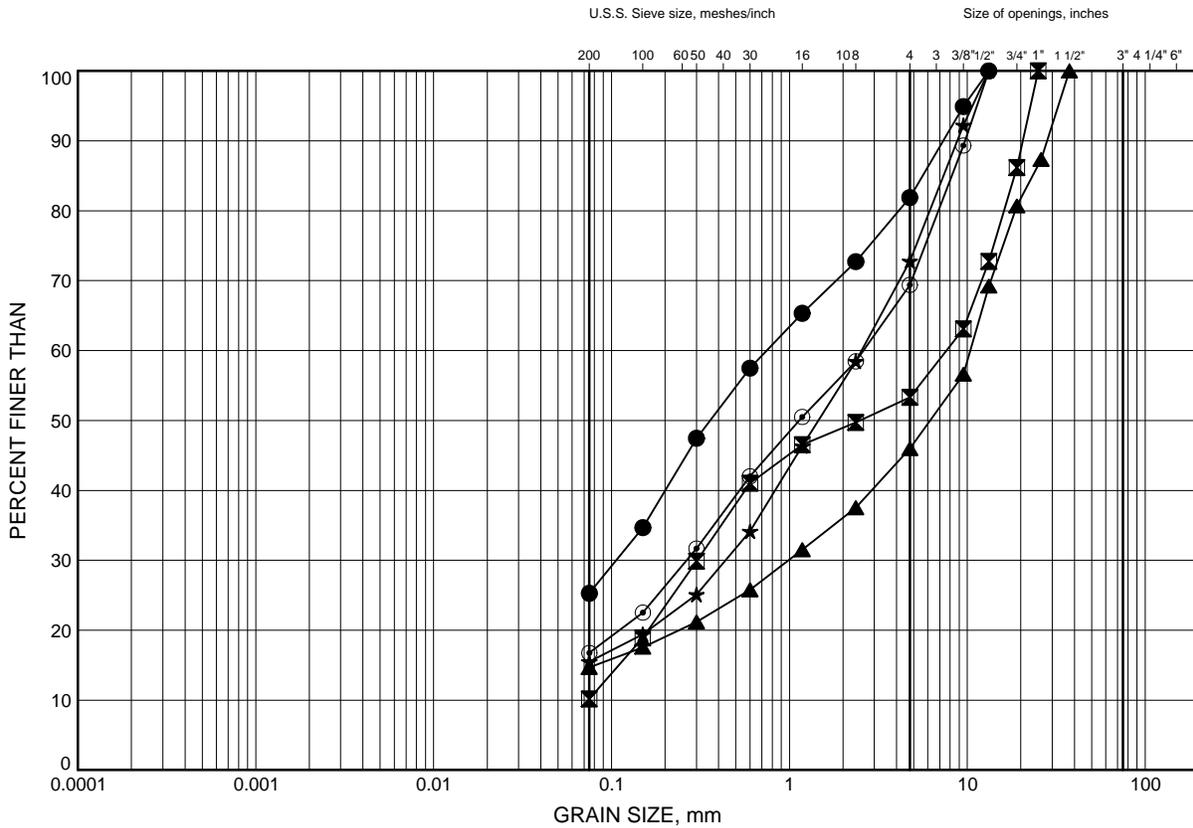
+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

Date October 2015
 GWP# 3079-09-00

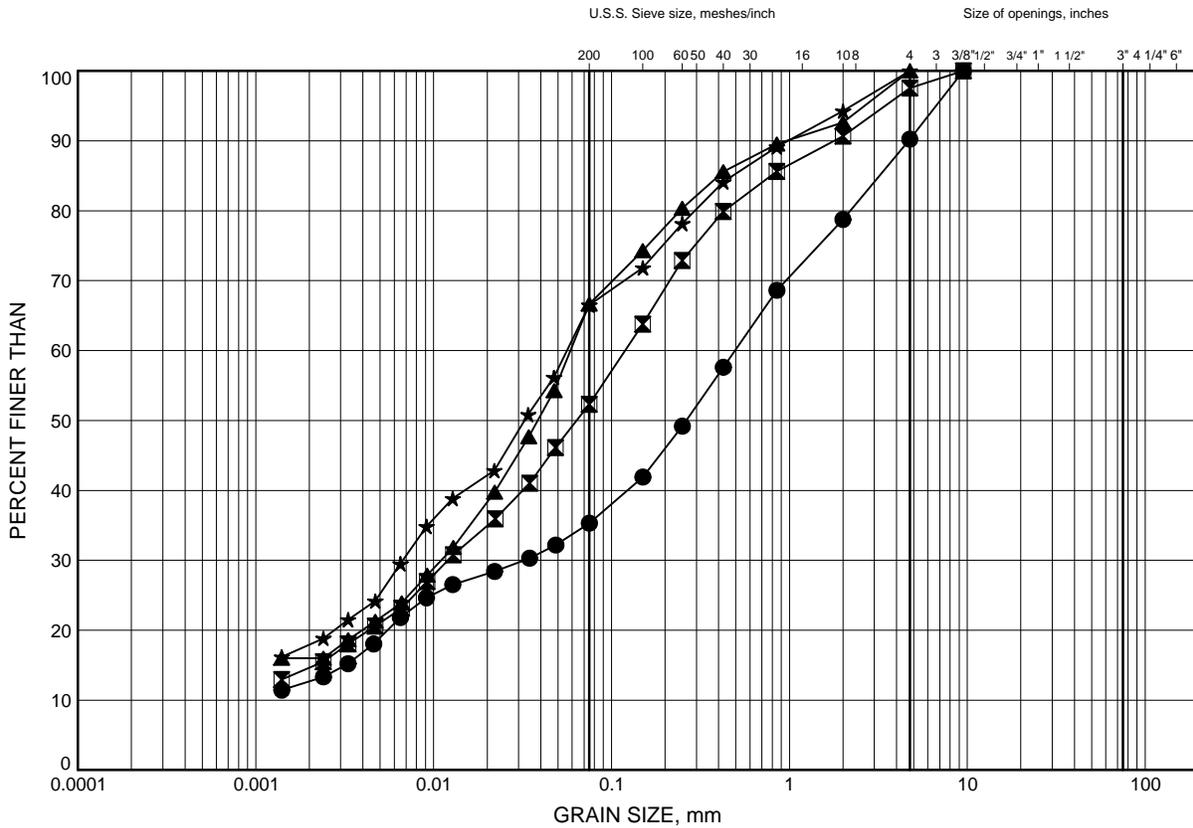


Prep'd AN
 Chkd. AMP

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

Date October 2015
GWP# 3079-09-00

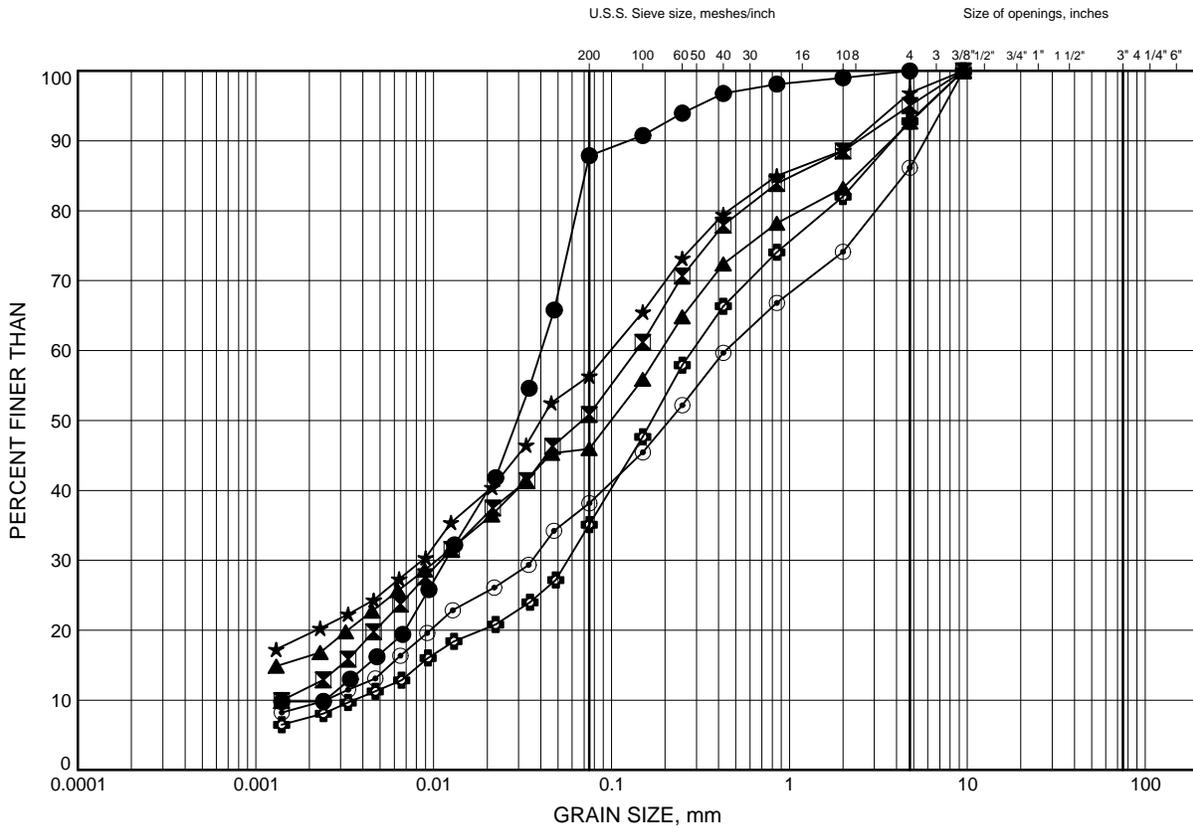


Prep'd AN
Chkd. AMP

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

Date October 2015
GWP# 3079-09-00

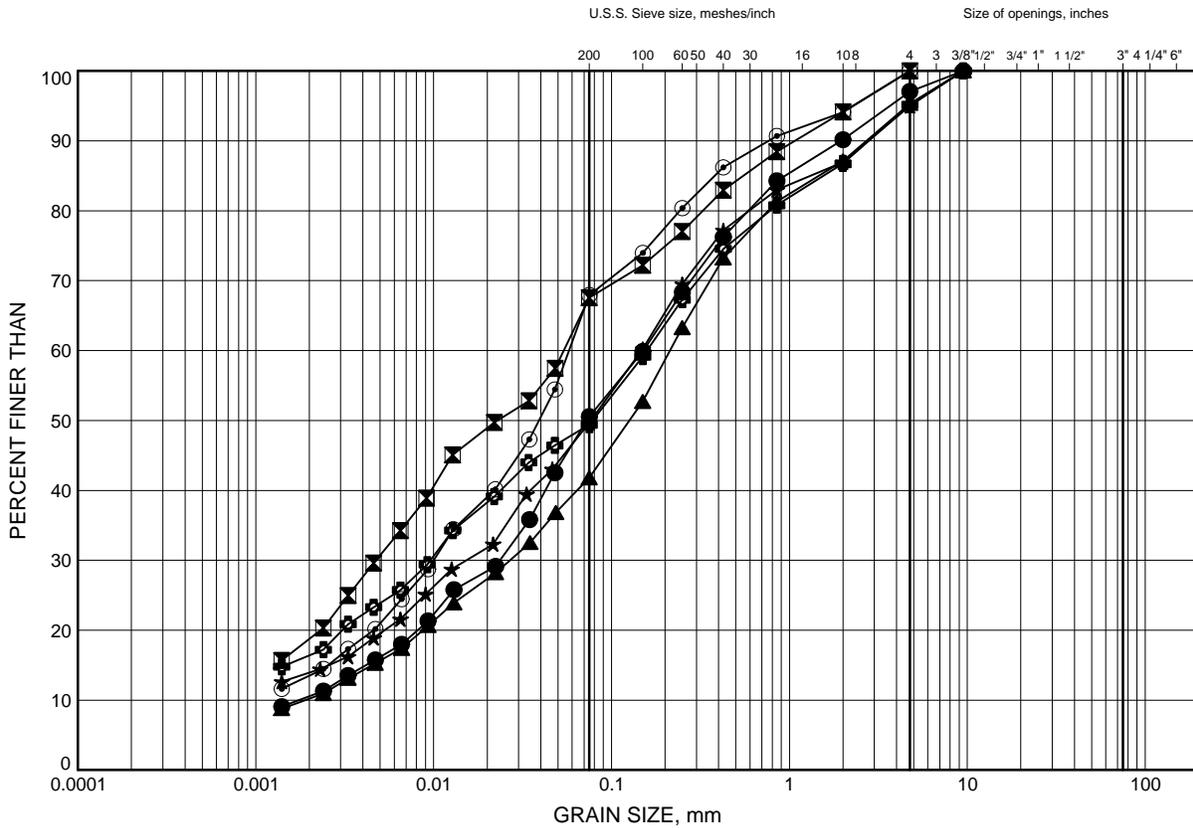


Prep'd AN
Chkd. AMP

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

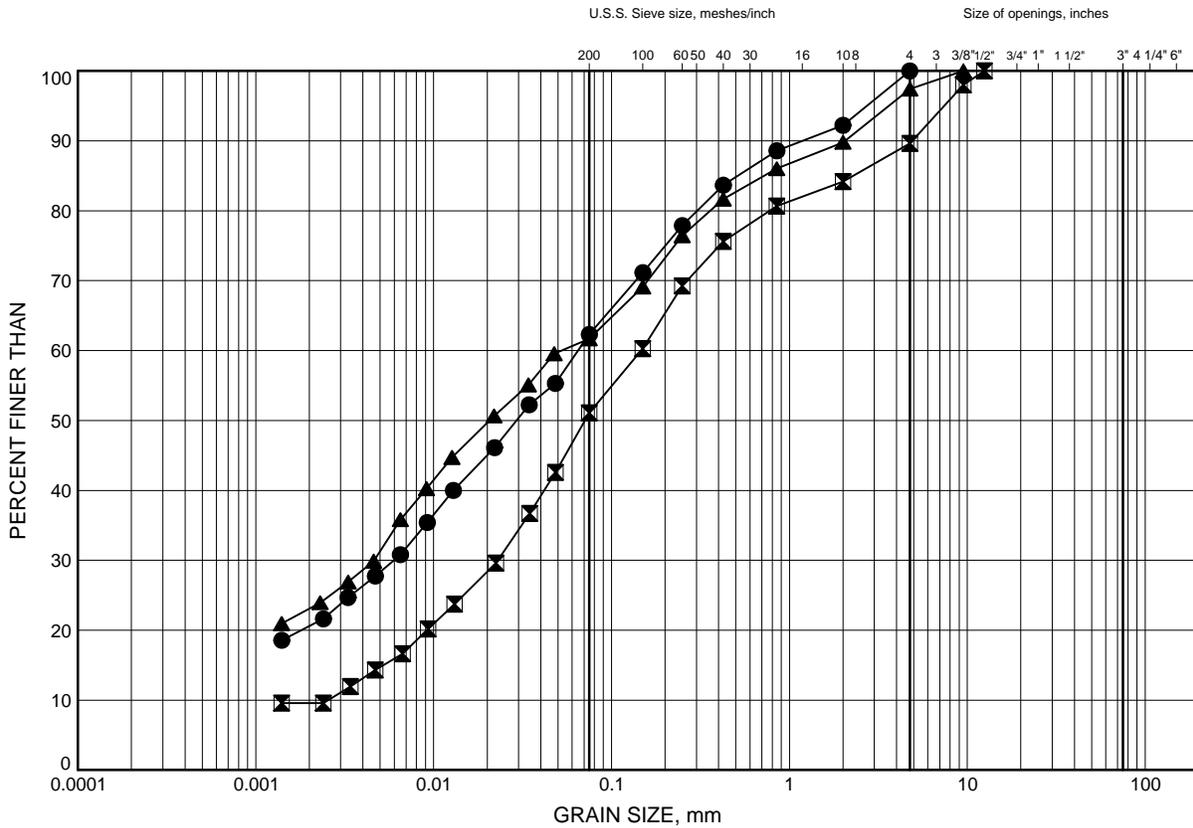


Prep'd AN
Chkd. AMP

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

Date October 2015
GWP# 3079-09-00

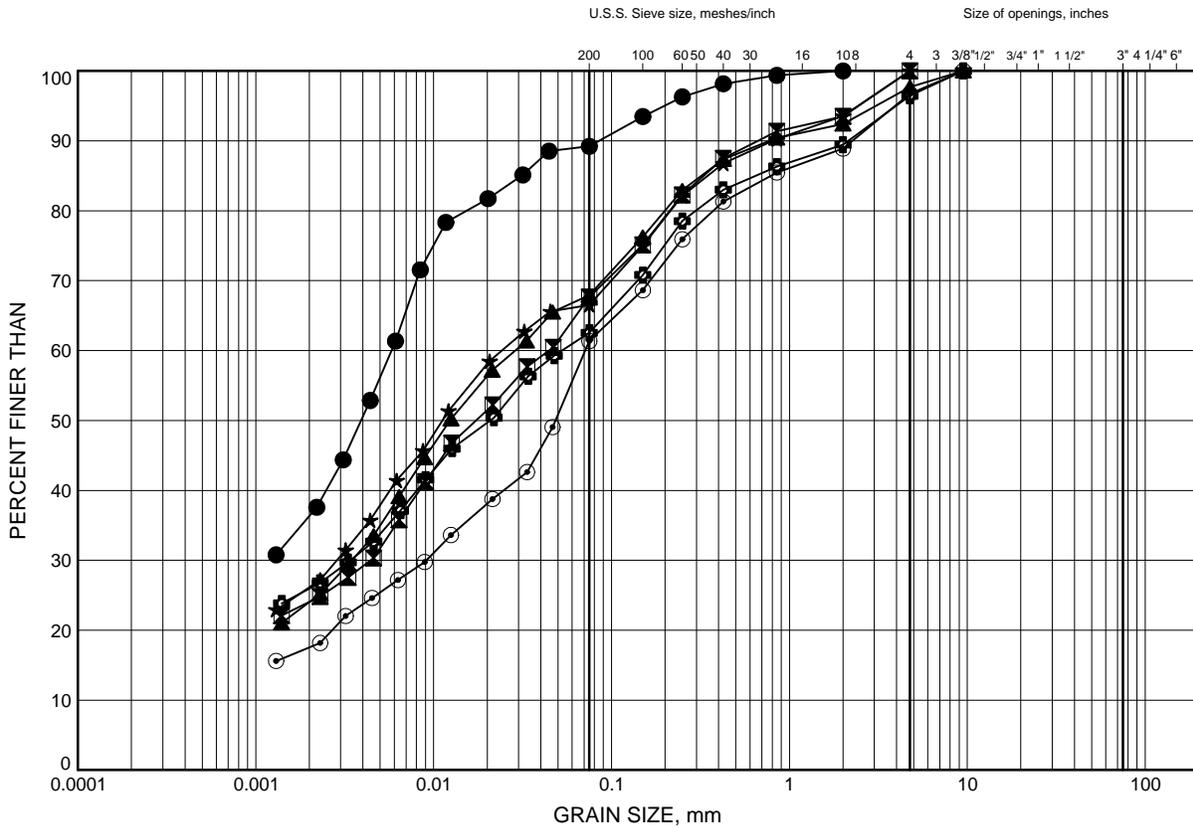


Prep'd AN
Chkd. AMP

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

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

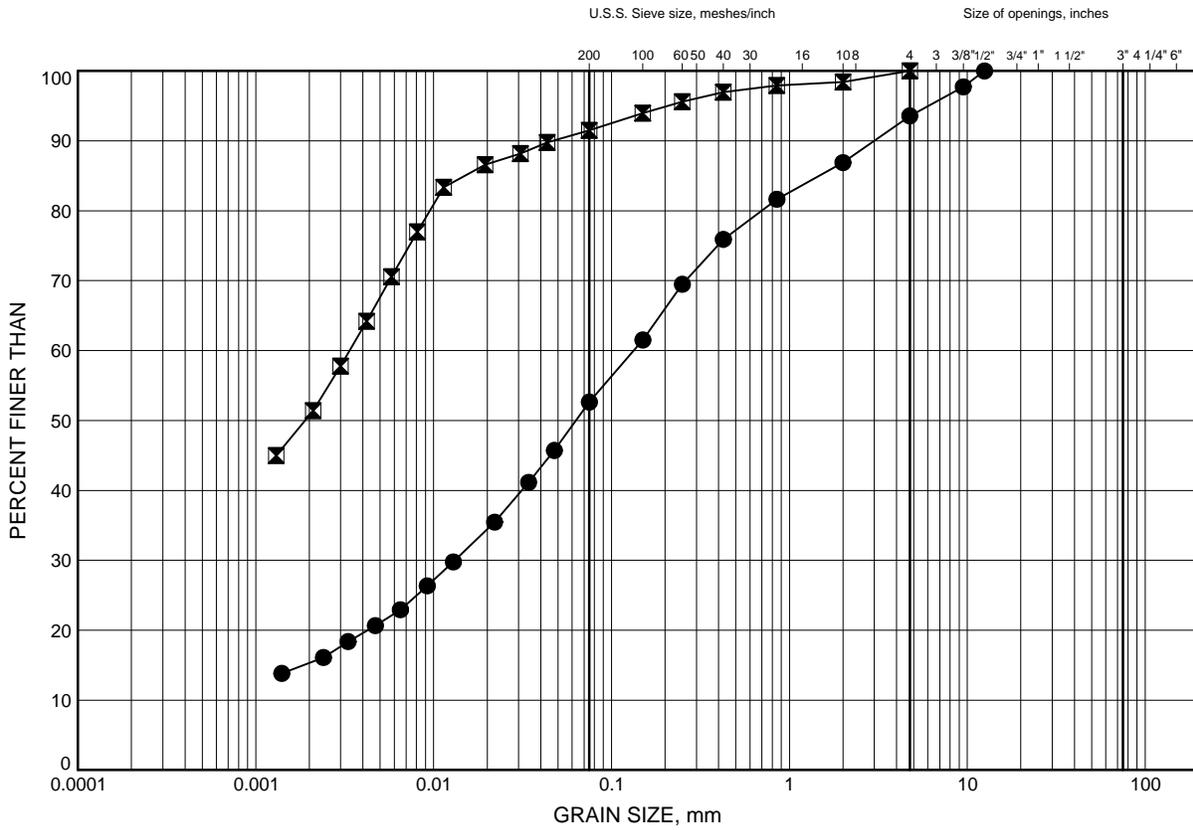


Prep'd .. AN ..
 Chkd. .. AMP ..

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

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

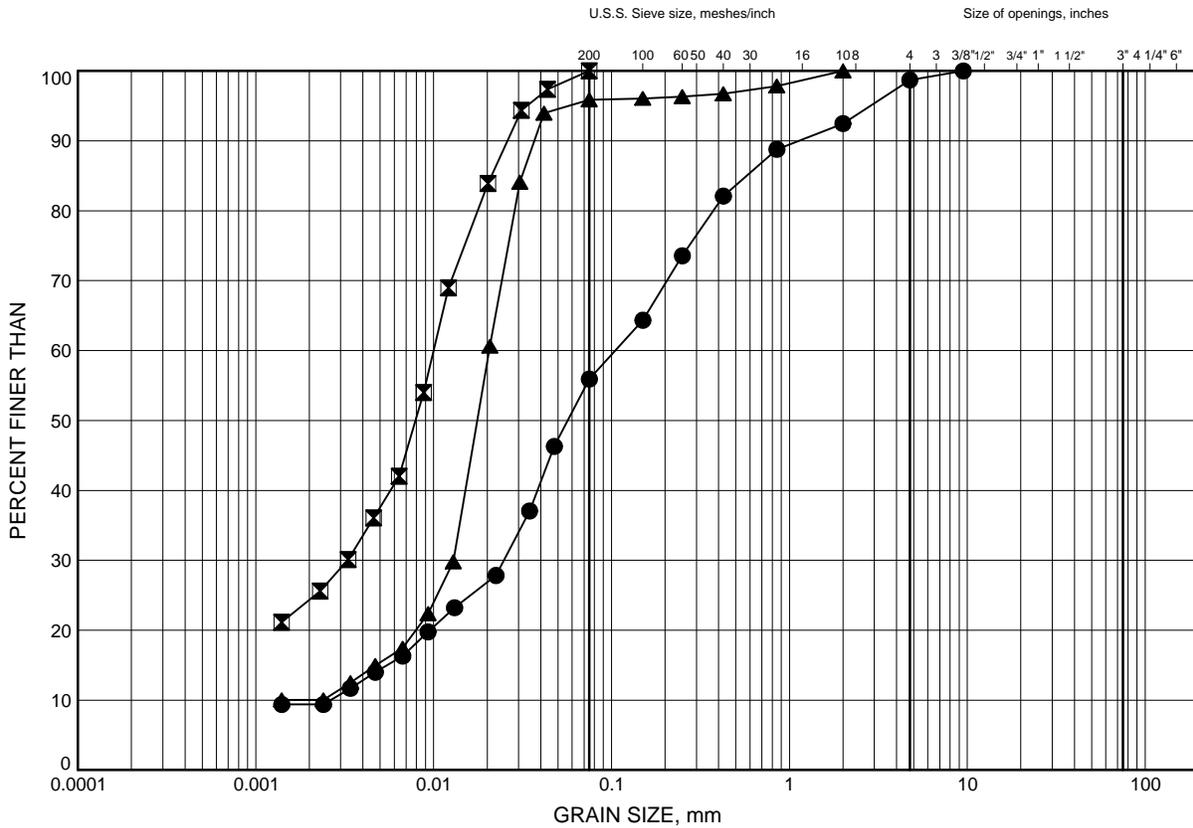


Prep'd .. AN ..
 Chkd. .. AMP ..

Hwy 19 Underpass
GRAIN SIZE DISTRIBUTION

FIGURE B8

Lower SAND & SILT (TILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	18.59	277.21
⊠	14-09	18.52	277.18
▲	14-09	21.49	274.21

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

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

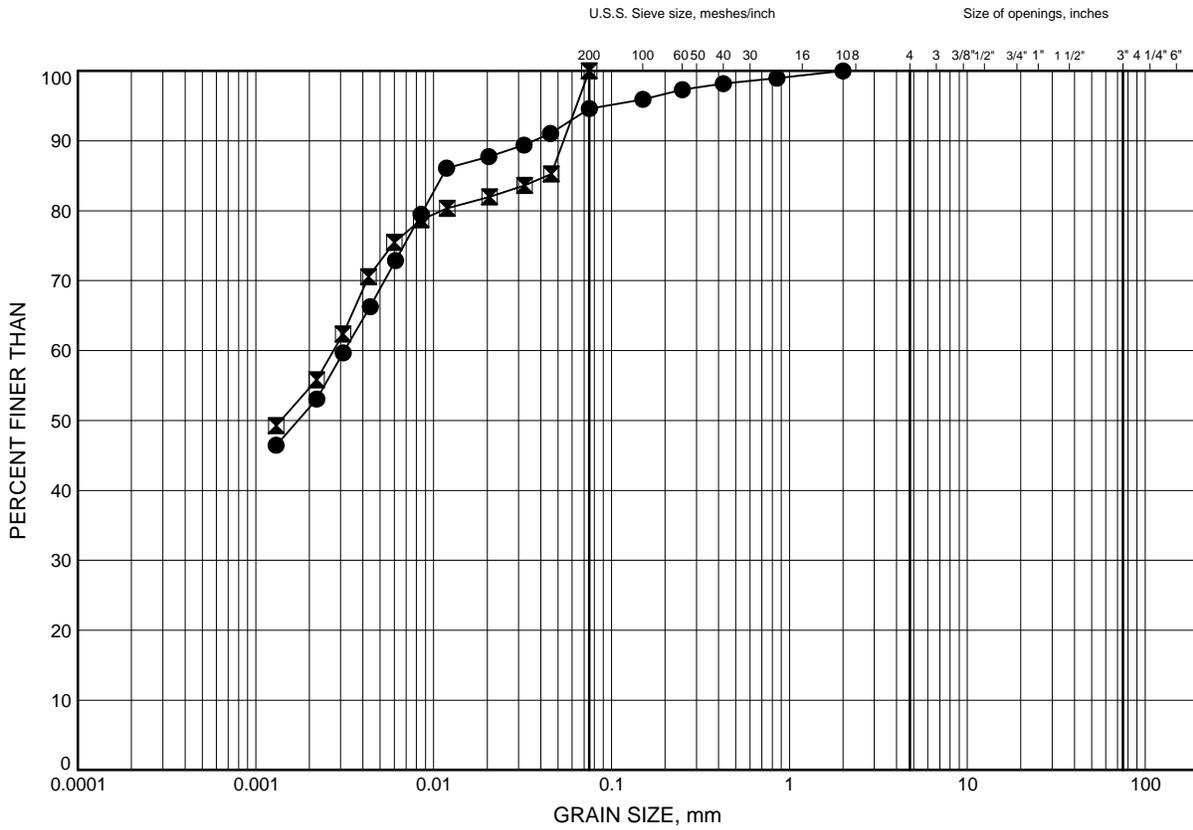


Prep'd .. AN ..
Chkd. .. AMP ..

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

GRAIN SIZE DISTRIBUTION - THURBER 1224.GPJ 10/27/15

Date October 2015
 GWP# 3079-09-00

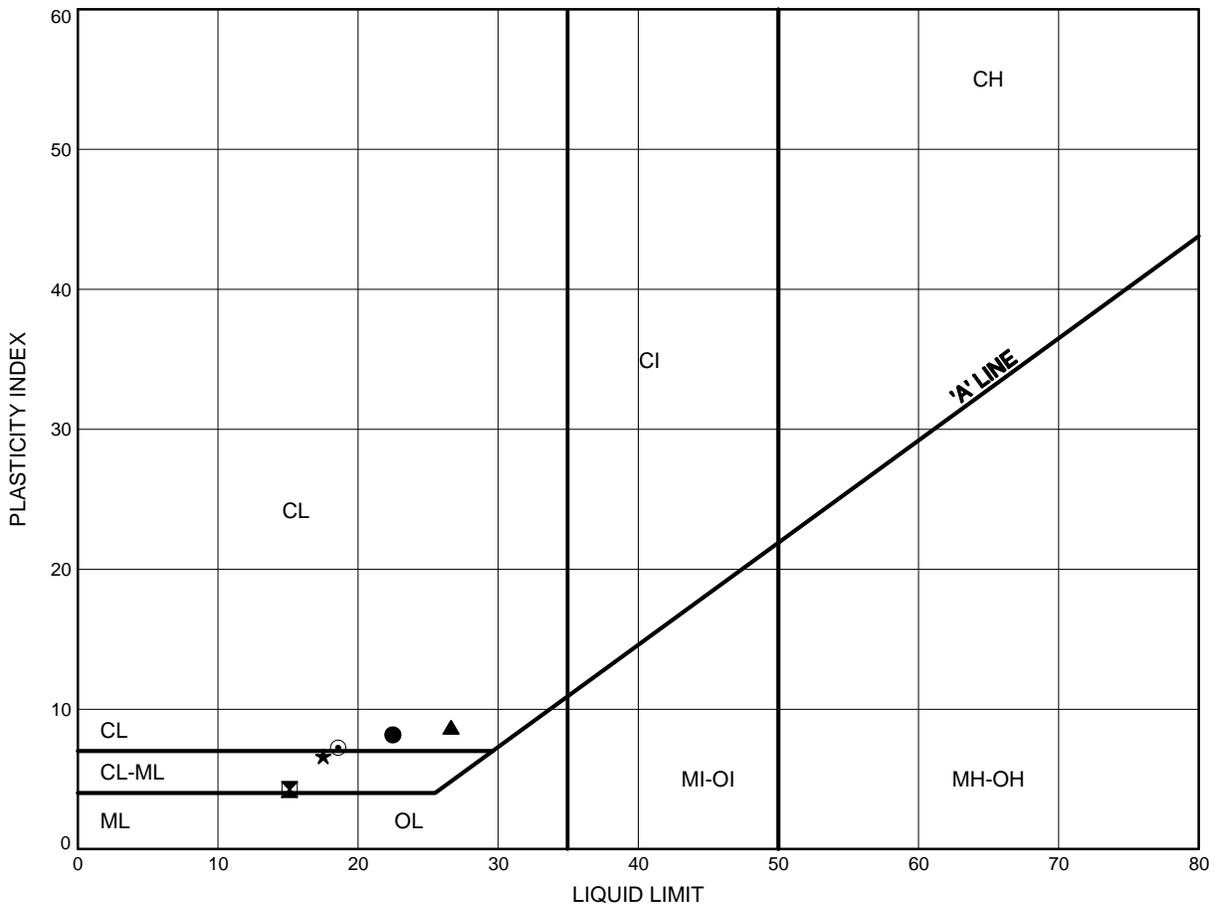


Prep'd AN
 Chkd. AMP

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

THURBALT 1224.GPJ 10/27/15

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

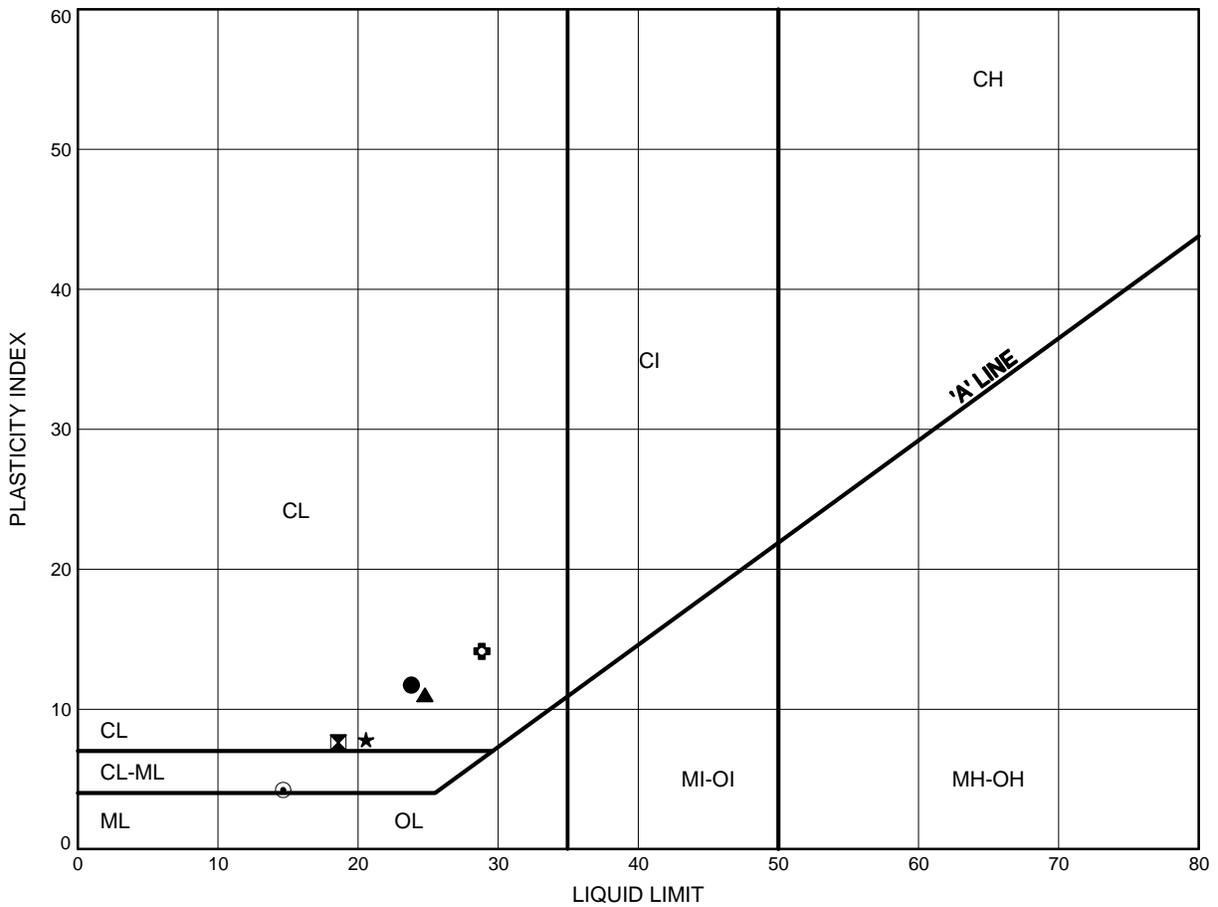


Prep'd .. AN ..
 Chkd. .. AMP ..

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

THURBALT 1224.GPJ 10/27/15

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

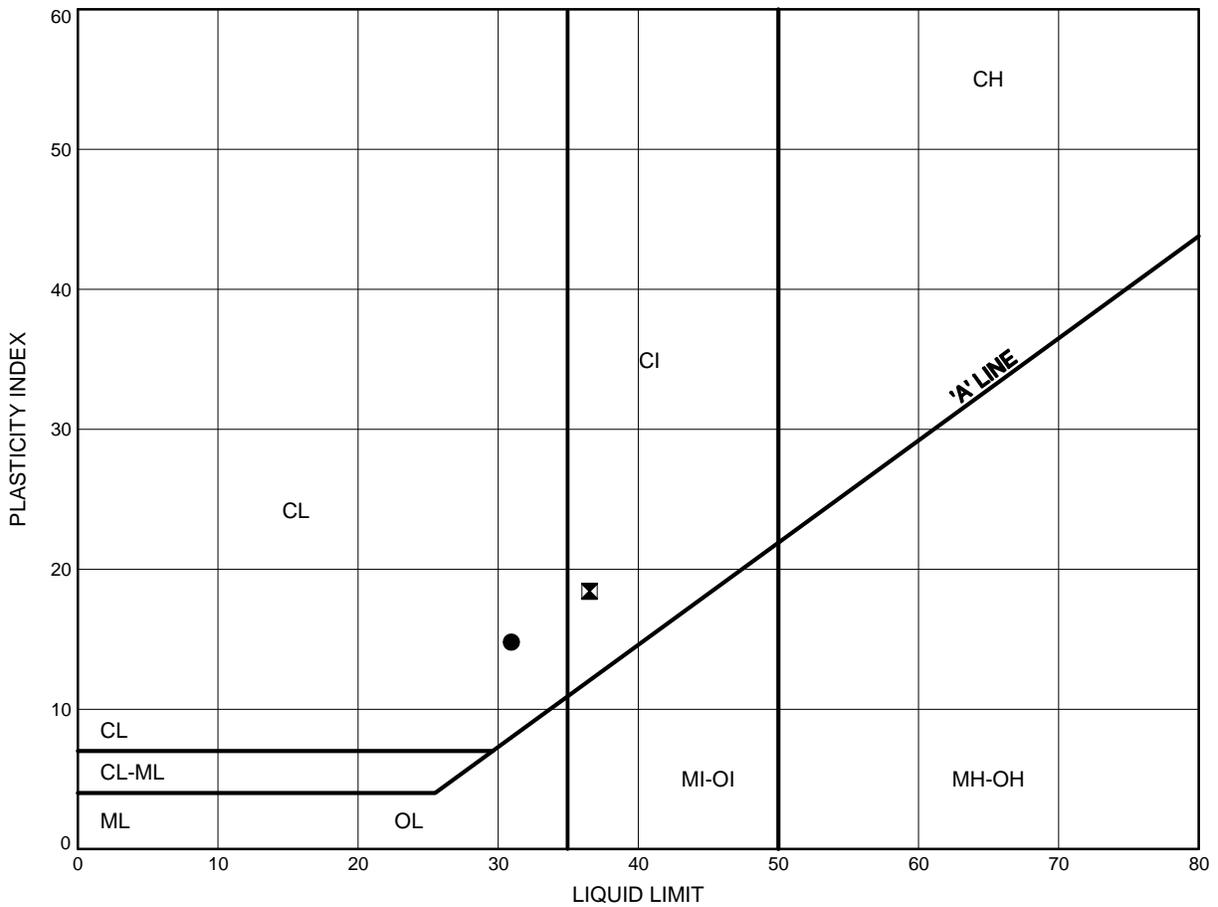


Prep'd .. AN ..
 Chkd. .. AMP ..

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

THURBALT 1224.GPJ 10/27/15

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



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

Appendix C
Analytical Test Results



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

ATTENTION TO: Stephen Peters

SAMPLING SITE:

SAMPLED BY:

pH, Sulphate (Soil)

DATE RECEIVED: 2014-12-05

DATE REPORTED: 2014-12-15

Parameter	Unit	SAMPLE DESCRIPTION:		14-04 SS11	14-02 SS1	NW-02 SS11	NW-04 SS1
		G / S	RDL	(40' -42')	(6' -2')	(40' -42')	(0' -2')
				Soil	Soil	Soil	Soil
				12/4/2014	12/4/2014	12/4/2014	12/4/2014
				6157014	6157025	6157026	6157027
pH, 2:1 CaCl2 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 CaCl ₂ 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 ₂ 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.

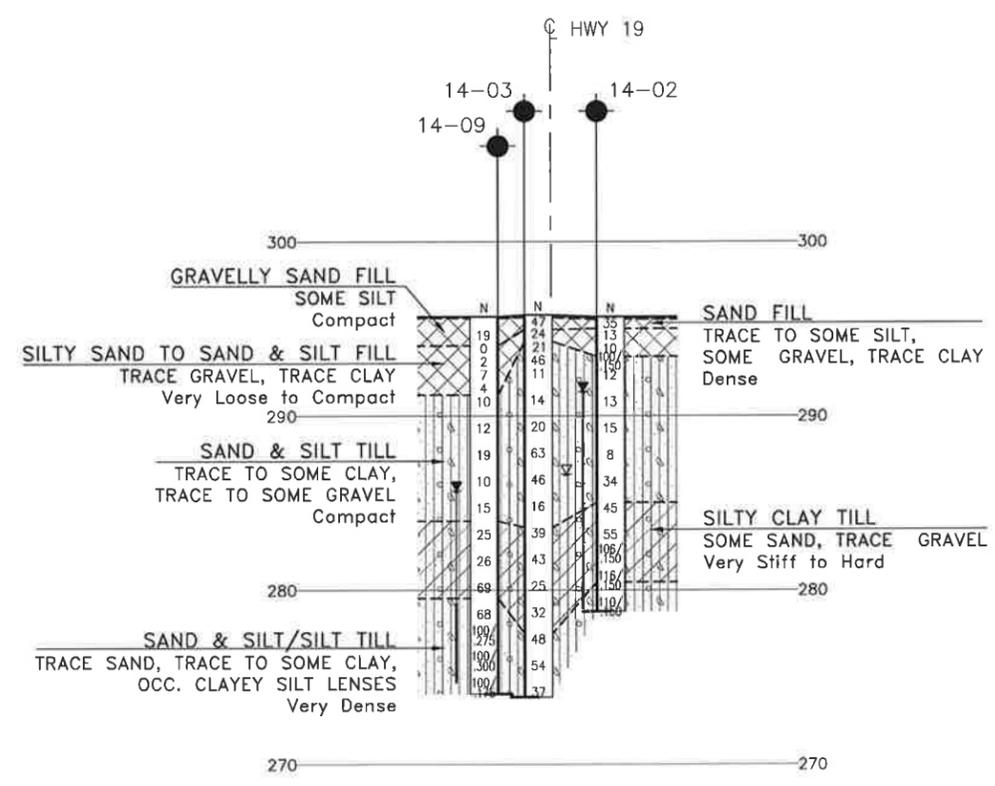


Photograph 6 – Looking towards north bridge abutment

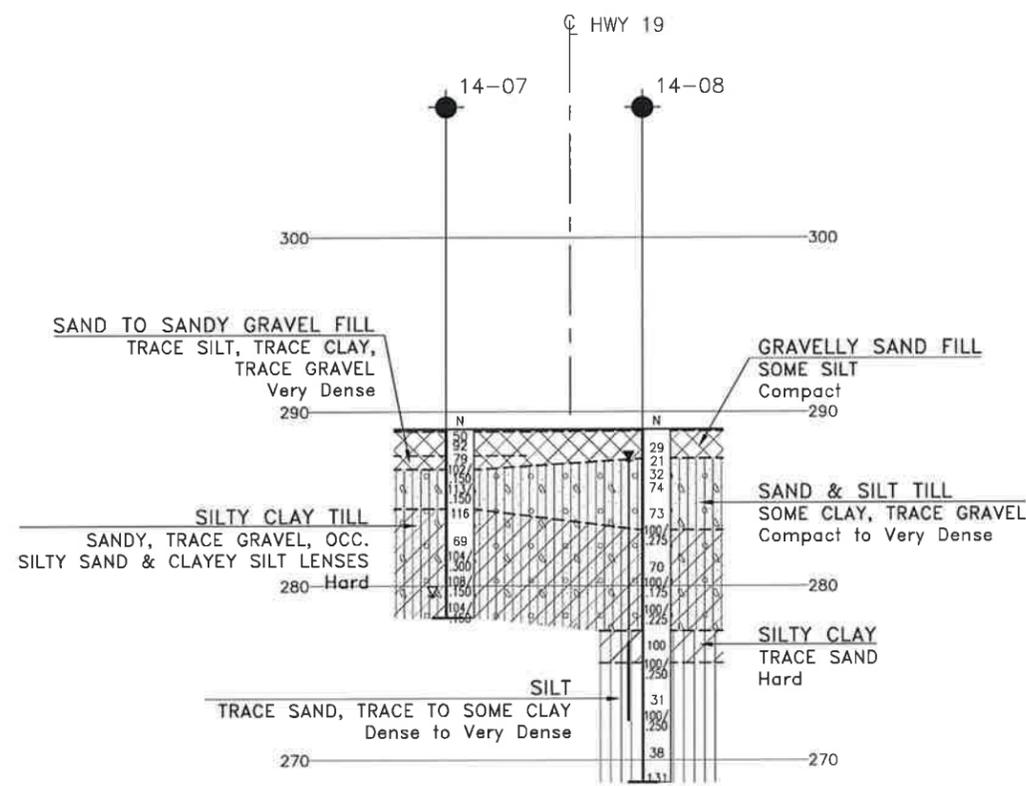
Appendix E

Borehole Location and Soil Strata Drawing

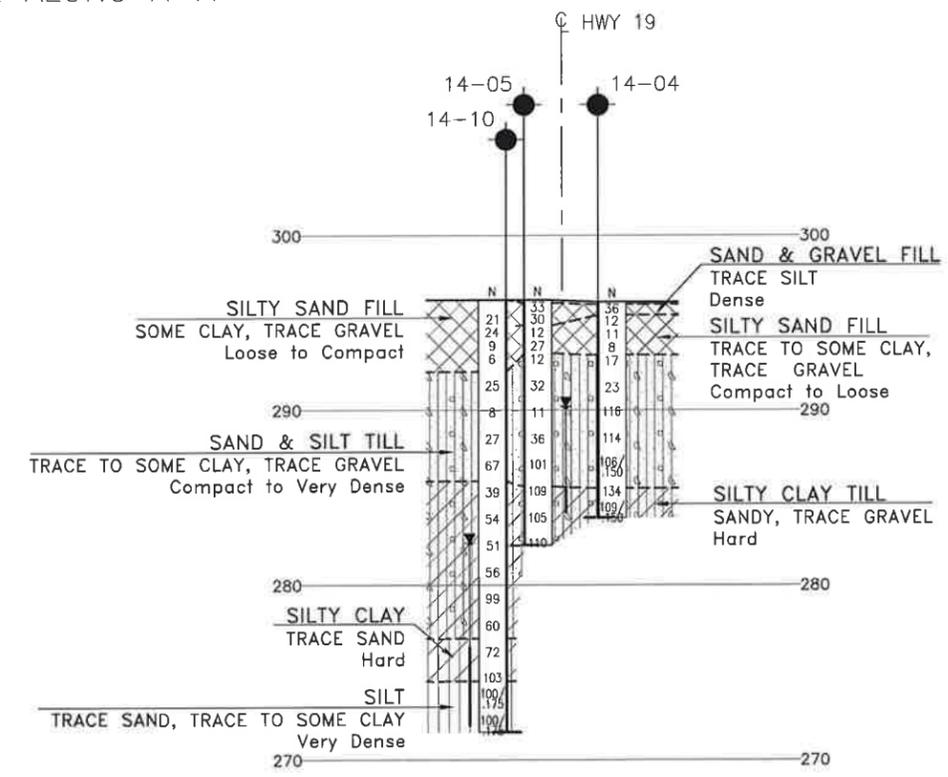
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 DATE PLOTTED: 12/09/2015 10:20:57 AM
 BY: DRAFTING02



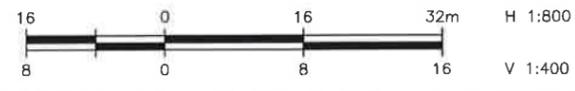
PROFILE ALONG A-A



PROFILE ALONG B-B



PROFILE ALONG C-C



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

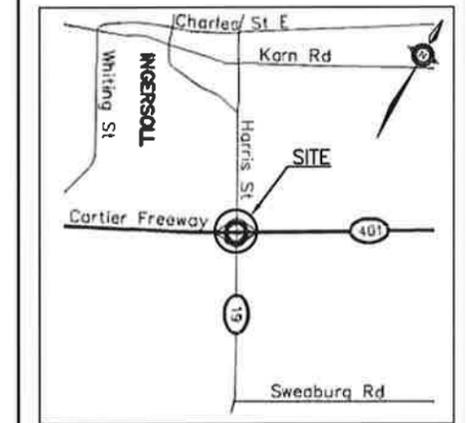
CONT No
GWP No 3079-09-00

HIGHWAY 401
HIGHWAY 19 UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
128



METRIC



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

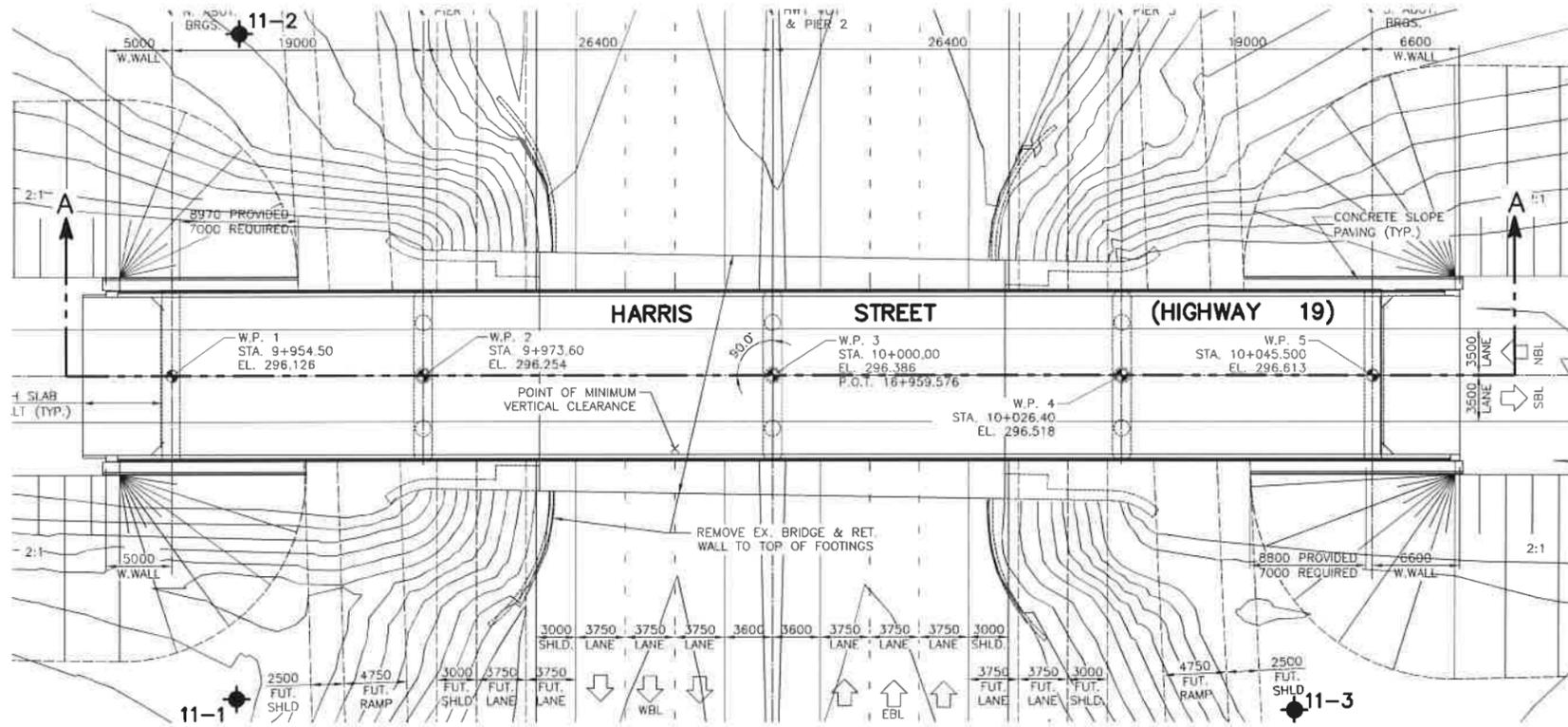


REVISIONS	DATE	BY	DESCRIPTION

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**



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.

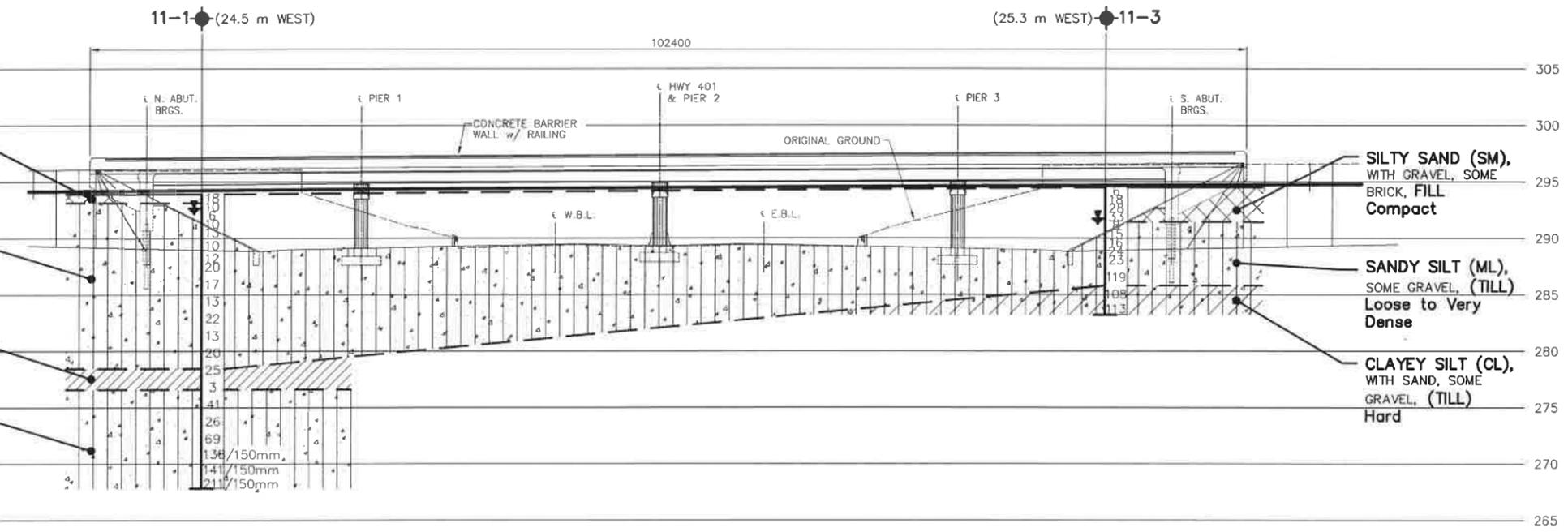
REVISIONS

DATE	BY	DESCRIPTION

GEOCREs No 40P2-74

HWY No	SG	CHECKED	DATE	SITE	DIST
401			2012-07-12	23-210	

DRAWN KDM CHECKED APPROVED DWG 1



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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, Spitspoon 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 w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
293.9	Tall Grass												
293.7	Silty sand, some roots, brown, FILL		1	SS	18								
0.2	Silty gravel, FILL Compact Brown												
293.1	Silty sand (SM) to sandy silt (ML), some gravel, TILL		2	SS	10								
0.8	Loose to compact Brown to grey		3	SS	6								11 50 (39)
			4	SS	10								Water Flow From Sampler
			5	SS	13								Water Flow From Sampler
			6	SS	10								
	- wet		7	SS	10								11 41 (48)
	- Clayey silt @ 5.6 m		8	SS	12								
			9	SS	20								
			10	SS	17								Water Flow From Sampler
	- moist to wet		11	SS	13								7 39 (54)
													Water Flow From Sampler
283.9													

ONTARIO.MTO STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO.MOT.GDT 13/2/14

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✕ × 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No BH 11-1

2 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, Splitspoon 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 W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
10.0	(continued) Silty sand (SM) to sandy silt (ML), some gravel, TILL Loose to compact Brown to grey		12	SS	22	283							Water Flow From Sampler
			13	SS	13	282							Water Flow From Sampler
			14	SS	20	280						14 33 (53)	
278.5	SILTY CLAY (CL) Soft to very stiff Grey		15	SS	25	278						0 3 54 43	
276.6	Silty sand (SM) to sandy silt (ML), some gravel, TILL Compact to very dense Greyish brown		16	SS	3	277							Water Flow From Sampler
273.9			17	SS	41	275						5 61 (34)	Water Flow From Sampler

ONTARIO MTO STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO MOT.GDT 13/2/4

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



RECORD OF BOREHOLE No BH 11-1

3 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, Splitspoon 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 w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						20 40 60 80 100	20 40 60 80 100						
20.0	(continued) Silty sand (SM) to sandy silt (ML), some gravel, TILL Compact to very dense Greyish brown		18	SS	26								
	- occasional cobbles below 22 m		19	SS	69								
	- Clayey silt @ 22.9 m		20	SS	138/ 150mm								
			21	SS	141/ 150mm								20 27 (53)
267.8	End of Borehole		22	SS	211/ 150mm								
26.1	Standpipe Installed to 11.4 m												

ONTARIO MTO STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ_ONTARIO MTO.GDT 13/2/4

✕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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40					
291.7	Tall Grass												
290.8	TOPSOIL												
0.2	Silty sand (SM) to sandy silt (ML), some gravel, TILL Loose to dense Brown	1	SS	9									
		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	SAND (SP), compact, brown												
6.1													
285.4	Silty sand (SM) to sandy silt (ML), some gravel, TILL Very dense Grey - with cobbles and boulders - sand infilling augers @ 7.3 m - cobbles and boulders	9	SS	18									Water Flow From Sampler
6.3													
		10	SS	88									
283.0	Clayey silt (CL) with sand, some gravel, TILL Hard Grey - with cobbles and boulders												
8.7													
		11	SS	103									
281.7													

ONTARIO MTO STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO MOT.GDT 13/2/4

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✖³ ✖³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No BH 11-2

2 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
10.0	(continued) Clayey silt (CL) with sand, some gravel, TILL Hard Grey - with cobbles and boulders		12	SS	100		281						11 17 43 29
278.9			13	SS	100		280						
12.8	End of Borehole Standpipe Installed to 11.0 m						279						

ONTARIO MTO STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO MOT.GDT 13/2/4

✕, ✕³: Numbers refer to Sensitivity ○ 3% 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
294.5	Tall Grass		1	SS	6								
291.1	Silty sand, some roots, brown, FILL Silty sand (SM) with gravel, FILL Compact Brown to grey		2	SS	18								
			3	SS	28								
	- pieces of red brick		4	SS	33								20 60 (20)
291.5	3.1		5	SS	8								
	Sandy silt (ML), some gravel, TILL Loose to very dense Brown to greyish brown to grey		6	SS	15								7 40 (53)
			7	SS	16								
			8	SS	24								
			9	SS	23								13 35 (52)
	- very dense below 7.0 m - occasional cobbles and boulders		10	SS	119								
285.8	8.7		11	SS	108								
	Clayey silt (CL) with sand, some gravel, TILL Hard Grey - cobbles and boulders												
284.5													

ONTARIO MTD STANTEC 165000775-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO MOT.GDT 13/2/4

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× × × : 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 NATURAL MOISTURE CONTENT LIQUID LIMIT	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											

ONTARIO MTD STANTEC 165000776-B - HIGHWAY 401 INGERSOLL.GPJ ONTARIO.MOT.GDT 13/2/4

\times 3, \times 3: Numbers refer to Sensitivity \circ 3% STRAIN AT FAILURE