



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
METROLINX RAILWAY BRIDGE FROM WELLINGTON STREET NORTH TO EDNA  
STREET CONNECTION AND E-S RAMP  
HIGHWAY 7-NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**GEOCREs No. 40P8-278**

**Latitude 43.457463 ° , Longitude -80.470548 °**

**Report**

to

**WSP**

Date: June 17, 2020  
File: 11375



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**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the site of the proposed E-S Ramp and Wellington to Edna Street Connection Road underpass bridge that will pass under the Metrolinx tracks as part of the Highway 7-New Project in the Regional Municipality of Waterloo, Ontario.

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, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. Models of the subsurface conditions under the potential foundation footprint were developed from the data obtained in the course of the current and previous investigations.

Thurber was retained by WSP to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 3014-E-0013.

Reference has been made to information on subsurface conditions contained in a previous foundation report prepared for this site during the preliminary design phase. The title of the report is:

- Preliminary, Foundation Investigation and Design Report, E-S Ramp and Connection Road under CNR Tracks, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00,

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Geocres No. 40P8-166, Report to Ministry of Transportation Ontario Southwestern Region, File: 15-64-17, dated November 10, 2009. (Reference 1).

- Foundation investigation report for C.N.R. Subway, Kitchener-Waterloo Expressway, District #4 (Hamilton), Geocres No. 40P8-45, W.J. 66-F-37, W.P. 636-64, dated July 4, 1966. (Reference 2).

Records of boreholes from the previous reports (Boreholes 08-041 and 08-042) are attached in Appendix B for reference.

## **2. SITE DESCRIPTION**

The site lies on the west side of Kitchener-Waterloo Expressway (KWE), approximately 250 m to the south of Wellington Street and 110 m north of Victoria Street. At this location, the proposed E-S Ramp and Wellington to Edna Connection Road will pass under the existing twin east-west Metrolinx tracks. Approximately 50 m west of the existing Metrolinx bridge over KWE, the double tracks emerge from a Metrolinx yard with a number of tracks as well as a spur line. The Metrolinx yard extends some 980 m west, to Lancaster Street East. The site lies within an area of industrial and commercial lands and is generally flat. Photographs of the site are included in Appendix E.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

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

A detailed site investigation was carried out from July 3, 2018 to August 29, 2019. Eight boreholes, numbered CN16-01 to CN16-08, were drilled near the west and east abutments of the proposed structure. A summary of the borehole locations, designations, borehole termination depths and termination elevations for each borehole is provided in Table 3.1. The boreholes were drilled to depths from 15.8 to 38.3 m (Elevation 310.0 to 282.0). The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets. It should be noted that no borehole was drilled to investigate the railway embankment due to access constraints as well as restrictions imposed by Metrolinx.

The Record of Borehole sheets for the current investigation boreholes are included in Appendix A, and the Record of Borehole sheets for the previous investigation boreholes are included in

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Appendix B. The approximate locations of the current and previous boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations. The boreholes were drilled using a track-mounted drill rig and advanced with a combination of hollow stem augers and mud rotary drilling. Samples were obtained at selected depth intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber’s technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber’s laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed during the drilling operations. Three piezometers were installed at Boreholes CN16-01, CN16-04 and CN16-07 to permit for longer term monitoring of the groundwater levels. The piezometers consisted of 25 mm or 50 mm diameter PVC pipe with a slotted screen enclosed in filter sand. The piezometers are planned to be decommissioned in the summer of 2020. The completion of the boreholes were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07).

**Table 3.1 – Borehole Completion Details**

Foundation Unit	Borehole	Ground Surface Elevation	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
East Abutment	CN16-01	325.5	15.8/309.7	15.2/310.3	Piezometer with 3.0 m slotted screen installed with sand filter from 15.2 m to 11.6 m, bentonite holeplug from 11.6 m to 9.1 m, grout from 9.1 m to 0.3 m and bentonite holeplug from 0.3 m to ground surface.
	CN16-03	321.3	38.3/283.1	No Installation	Borehole backfilled with grout holeplug.



Foundation Unit	Borehole	Ground Surface Elevation	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	CN16-05	325.5	38.3/287.3	No Installation	Borehole backfilled with cement and grout, and bentonite holeplug to surface.
	CN16-07	320.8	15.8/305.0	15.2/305.6	Piezometer with 3.0 m slotted screen installed with sand filter from 15.2 m to 11.6 m, bentonite holeplug from 11.6 m to 10.7 m and grout from 10.7 m to ground surface.
	08-042	322.8	20.1/302.7	19.2/303.6	Piezometer with 1.5 m slotted screen installed with sand filter to 17.4 m, holeplug from 17.4 m to 16.8 m, grout from 16.8 m to 0.6 m, then holeplug to surface.
West Abutment	CN16-02	326.1	37.0/289.1	No Installation	Borehole backfilled with cement and grout, and bentonite holeplug to surface.
	CN16-04	323.3	41.3/282.0	41.1/282.2	Piezometer with 3.0 m slotted screen installed with sand filter from 41.1 m to 37.2 m, bentonite pellets from 37.2 m to 36.3 m, grout from 36.3 m to 1.5 m and bentonite holeplug from 1.5 m to ground surface.
	CN16-06	325.9	15.8/310.0	No Installation	Borehole backfilled with cement and grout, and bentonite holeplug to surface.
	CN16-08	322.0	15.8/306.2	No Installation	Borehole backfilled with cement and grout, and bentonite holeplug to surface.
	08-041	326.3	37.2/289.1	No Installation	Grout to 0.6 m then bentonite holeplug to ground surface.



#### **4. LABORATORY TESTING**

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets and figures in Appendix A for the current investigation, and Appendix B for the previous investigation.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of silty sand fill was collected and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters. The results of the analytical testing are summarized in this report and presented in Appendix C.

#### **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and Appendix B and on the “Borehole Locations and Soil Strata” drawings included in Appendix D.

An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the soil stratigraphy at this site consisted of surficial topsoil overlying a cohesionless fill layer, a layer of upper sand, silty clay till, silty clay, a lower sand layer and sandy silt till.

##### **5.1 Topsoil**

A layer of topsoil was encountered surficially in nine boreholes drilled at this site, CN16-02 to CN16-08, 08-041 and 08-042. It was generally dark brown in colour. The thickness of the topsoil layer ranged from 40 mm to 300 mm. The topsoil thickness may vary between the borehole locations and in other areas of the site.



## 5.2 Fill

Fill was encountered surficially in Borehole CN16-01 and immediately below the topsoil in the other boreholes at this site, Boreholes CN16-02 to CN16-08, 08-041 and 08-042.

The fill generally consisted of silty sand and contained trace gravel to gravelly, trace to some clay, and was generally brown in colour. Zones of sandy silt fill and sand fill were also encountered in Boreholes CN16-06 and 08-041.

A layer of clayey silt fill was also encountered below the sand fill in Borehole 08-041 and contained some sand to sandy and trace gravel. The clayey silt fill was generally brown in colour.

Occasional organics were encountered in the fill in Boreholes CN16-01, CN16-02, CN16-07, CN16-08 and 08-042, and occasional decayed wood fragments were encountered in Borehole CN16-07. Occasional cobbles were encountered in the fill in Boreholes CN16-01, CN16-02, CN16-06 and CN16-07. Auger grinding was noted in the fill in Borehole CN16-01.

The thickness of the fill ranged from 1.2 m to 4.0 m, with the lower boundary of this layer encountered at depths ranging from 1.4 m to 4.1 m (Elevation 324.9 to 317.8).

SPT N-values recorded in the cohesionless fill generally ranged from 6 blows for 0.3 m penetration to 100 blows for 0.25 m penetration, indicating a loose to very dense relative density.

Moisture content of samples of the cohesionless fill generally ranged from 4 percent to 18 percent.

Select samples of the cohesionless fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure A1 of Appendix A. The results of this testing are summarized as follows:

Soil Particles	Fill (%)
Gravel	1 to 24
Sand	38 to 60
Silt	25 to 44
Clay	4 to 14



### 5.3 Organics

A layer of buried organics was encountered below the silty sand fill layer in Borehole CN16-05, at a depth of 3.5 m (Elevation 322.0).

The thickness of the organics layer was 0.6 m, with the lower boundary of this layer encountered at a depth of 4.1 m (Elevation 321.4).

The organics layer was generally black in colour and contained occasional roots and rootlets.

The moisture content from a sample of the organics layer was measured to be 15 percent.

The organics thickness may vary beyond the borehole location and in other areas of the site.

### 5.4 Upper Sand

An upper sand layer was encountered below the fill in all the boreholes at this site, except for CN16-05, where the sand was encountered below the buried organics layer.

The upper sand layer was encountered at depths ranging from 1.4 m to 4.1 m (Elevation 324.9 to 317.8).

The upper sand layer was brown to grey in colour and contained trace gravel to gravelly, trace to some silt and trace clay. Occasional organics were encountered in the sand layer in Borehole CN16-02, and occasional cobbles were encountered in Boreholes CN16-02 and CN16-06.

The thickness of the upper sand layer ranged from 1.1 m to 10.4 m, with the lower boundary of the sand layer encountered at depths ranging from 4.1 m to 11.8 m (Elevation 318.5 to 314.5).

SPT N-values recorded in the upper sand ranged from 4 blows for 0.3 m penetration to 100 blows for 0.175 m penetration, indicating a loose to very dense relative density.

Moisture content of samples of the upper sand generally ranged from 3 percent to 28 percent.

Select samples of the upper sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix A and B and the grain size distribution curves for these samples are plotted on Figure A2 and A3 and Figure B1. The results of this testing are summarized as follows:



Soil Particles	Upper Sand (%)
Gravel	0 to 27
Sand	64 to 97
Silt and Clay	2 to 22

### 5.5 Silty Sand to Sandy Silt

A silty sand pocket was encountered below the silty clay till in Borehole CN16-06 at a depth of 13.3 m (Elevation 312.6). The silty sand pocket contained some clay and trace gravel, with a thickness of 2.4 m and a lower boundary at 15.7 m (Elevation 310.2).

A sandy silt pocket was also encountered within the silty clay in Borehole CN16-03 at a depth of 14.8 m (Elevation 306.5). The sandy silt pocket contained some clay, with a thickness of 0.9 m and a lower boundary at 15.7 m (Elevation 305.6).

SPT N-Values recorded in the silty sand and sandy silt ranged from 39 blows to 90 blows for 0.3 m penetration, indicating a dense to very dense relative density.

Moisture content of samples of the silty sand to sandy silt generally ranged from 16 percent to 19 percent.

One sample of silty sand underwent laboratory gradation analysis, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are plotted on Figure A4.

Soil Particles	Silty Sand (%)
Gravel	6
Sand	59
Silt	20
Clay	15

### 5.6 Silty Clay Till

A layer of silty clay till was encountered below the upper sand layer in all boreholes at this site, at depths ranging from 4.1 m to 11.8 m (Elevation 318.5 to 314.5).

The silty clay till was generally grey in colour and contained some sand to sandy and trace gravel.



The thickness of the silty clay till ranged from 3.0 m to 8.2 m, with the lower boundary encountered at depths ranging from 10.0 m to 20.0 m (Elevation 313.8 to 306.3).

SPT N-values recorded in the silty clay till ranged from 15 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a very stiff to hard consistency.

Moisture content of samples of the silty clay till generally ranged from 8 percent to 26 percent.

Select samples of the silty clay till underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and Appendix B and the grain size distribution curves for these samples are plotted on Figure A5 and Figure B2. The results of the Atterberg Limits tests are plotted on Figure A11 and B5.

Soil Particles	Silty Clay Till (%)
Gravel	1 to 3
Sand	16 to 30
Silt	47 to 55
Clay	19 to 35

Index Property	
Liquid Limit	22 to 28
Plastic Limit	13 to 16
Plasticity Index	9 to 13

The above results indicate that the silty clay till is of low plasticity with a group symbol of CL.

It should be noted that glacial tills are known to contain cobbles and boulders.

## 5.7 Sandy Gravel

A pocket of sandy gravel was encountered below the silty clay till in Borehole CN16-05 at a depth of 14.8 m (Elevation 310.7). The sandy gravel was generally grey in colour and contained trace silt and clay and occasional cobbles.

The thickness of the sandy gravel pocket was 1.5 m, with the lower boundary encountered at a depth of 16.3 m (Elevation 309.2).



The SPT-N value recorded in the sandy gravel was 55 blows for 0.3 m penetration, indicating a very dense relative density.

The moisture content of the sample of the sandy gravel was 12 percent.

One sample of the sandy gravel underwent laboratory gradation analysis, the results which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are plotted on Figure A6.

Soil Particles	Sandy Gravel (%)
Gravel	51
Sand	30
Silt and Clay	19

## 5.8 Silty Clay

A thick layer of silty clay was encountered below the silty clay till layer in Boreholes CN16-01 to CN16-04, CN16-07, CN16-08, 08-041 and 08-042. Silty clay was also encountered below the sandy gravel pocket in CN16-05 and the silty sand pocket in CN16-06.

The silty clay layer was encountered at depths ranging from 10.0 m to 20.0 m (Elevation 313.8 to 306.3).

The silty clay was generally grey in colour and contained trace sand to sandy and trace gravel. Occasional cobbles were encountered in Borehole CN16-05.

Boreholes CN16-01, CN16-02, CN16-06 to CN16-08 and 08-042 were terminated in the silty clay layer at depths ranging from 15.8 m to 37.0 m (Elevation 310.0 to 289.1).

In Boreholes CN16-03 to CN16-05 and 08-041, the thickness of the silty clay ranged from 14.4 m to 27.4 m, with the lower boundary encountered at depths ranging from 33.7 m to 40.7 m (Elevation 291.9 to 282.6).

SPT N-values recorded in the silty clay ranged from 19 blows for 0.3 m penetration to 100 blows for 0.1 m penetration, indicating a very stiff to hard consistency.

Moisture content of samples of the silty clay generally ranged from 12 percent to 39 percent.

Select samples of the silty clay underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the



Record of Borehole sheets in Appendix A and Appendix B and the grain size distribution curves for these samples are plotted on Figure A7 and A8 and Figure B3. The results of the Atterberg Limits tests are plotted on Figure A12, A13 and B6.

Soil Particles	Silty Clay (%)
Gravel	0 to 3
Sand	0 to 36
Silt	24 to 57
Clay	16 to 66

Index Property	
Liquid Limit	22 to 48
Plastic Limit	12 to 21
Plasticity Index	10 to 27

The above results indicate that the silty clay is of low to intermediate plasticity with a group symbol of CL – CI.

## 5.9 Lower Sand

A lower sand pocket was encountered within the silty clay in Borehole CN16-02 at a depth of 34.4 m (Elevation 291.6).

The lower sand was generally grey in colour and contained some silt and trace clay.

The thickness of the lower sand pocket was 1.7 m, with the lower boundary encountered at a depth of 36.1 m (Elevation 290.0).

The SPT-N value recorded in the lower sand was 100 blows for 0.3 m penetration, indicating a very dense relative density.

The moisture content of the sample of the lower sand was 21 percent.

One sample of the lower sand underwent laboratory gradation analysis, the results which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and the grain size distribution curve for this sample is plotted on Figure A9.



Soil Particles	Lower Sand (%)
Gravel	0
Sand	77
Silt	16
Clay	7

### 5.10 Sandy Silt Till

A sandy silt till layer was encountered below the silty clay in Boreholes CN16-03 to CN16-05 and 08-041, at depths ranging from 33.7 m to 40.7 m (Elevation 291.9 to 282.6).

The silt till was generally grey in colour, and contained some sand to sandy, trace to some gravel, trace to some clay, with occasional cobbles encountered in Borehole CN16-05.

Boreholes CN16-03 to CN16-05 and 08-041 were terminated in the silt till at depths from 37.2 to 41.3 m (Elevation 289.1 to 282.0).

All SPT N-values recorded in the silt till were above 100 blows for 0.3 m penetration, indicating a very dense relative density.

Moisture content of samples of the silt till generally ranged from 13 percent to 26 percent.

Two samples of the silt till underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix A and B and the grain size distribution curves for these samples are plotted on Figure A10 and B4. The results of this testing are summarized as follows:

Soil Particles	Silt Till (%)
Gravel	0 to 6
Sand	19 to 28
Silt	50 to 75
Clay	6 to 16

It should be noted that glacial tills are known to contain cobbles and boulders.



## 5.11 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Three standpipe piezometers were installed at this site, in Borehole CN16-01, CN16-04 and CN16-07, to monitor water levels after completion of drilling. One piezometer was installed in the previous investigation, in Borehole 08-042. The water levels measured in the piezometers are summarized in Table 5.1, along with the measurements in the open boreholes upon completion of drilling.

**Table 5.1 – Water Level Measurements**

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
CN16-01	Aug 31, 2018	8.3	317.2	Piezometer
	Aug 08, 2019	8.1	317.4	
	Aug 29, 2019	8.3	317.2	
CN16-02	July 04, 2019	-	-	Water level upon completion not available due to mud rotary drilling method.
CN16-03	Aug 26, 2019	-	-	Water level upon completion not available due to mud rotary drilling method.
CN16-04	Aug 29, 2019	16.8	306.6	Piezometer
CN16-05	July 08, 2019	-	-	Water level upon completion not available due to mud rotary drilling method.
CN16-06	July 08, 2019	-	-	Water level upon completion not available due to mud rotary drilling method.
CN16-07	Aug 31, 2019	5.8	315.0	Piezometer
CN16-08	Aug 29, 2019	-	-	Water level upon completion not available due to mud rotary drilling method.
08-041	Aug 11, 2008	-	-	Water level upon completion not available.



Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
08-042	Aug 20, 2008	7.9	314.9	Piezometer

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

## 6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the silty sand fill from Borehole CN16-04 (depth of 2.6 m) was submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix C.

**Table 6.1 – Analytical Test Results**

Parameter	Units (Soil)	Test Results
		CN16-04 (SS4 at 2.6 m)
		(Soil Sample)
Soil Redox Potential	mV	312
Sulphide	%	< 0.02
pH	pH Units	8.29
Chloride	µg/g	7.8
Sulphate	µg/g	12
Conductivity	uS/cm	317



Parameter	Units (Soil)	Test Results
		CN16-04 (SS4 at 2.6 m)
		(Soil Sample)
Resistivity (calculated)	ohms.cm	3200

## 7. MISCELLANEOUS

Landshark Drilling of Brantford, Ontario supplied a rubber track mounted B-57 drill rig and conducted the drilling, sampling and in-situ testing operations for the investigation.

The coordinates and elevations for the boreholes were provided by WSP.

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

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory in Oakville. Analytical laboratory testing was carried out by SGS Canada Inc.

Overall supervision of the field program for the investigation was conducted by Dr. Nancy Berg, P.Eng. Interpretation of the data and preparation of the report was carried out by Ms. Judy Mei, EIT, and Dr. Nancy Berg, P.Eng.

Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.



Thurber Engineering Ltd.

A handwritten signature in black ink, appearing to read 'Judy Mei', written over a horizontal line.

Judy Mei, EIT

Geotechnical EIT



Jason Lee, P.Eng.

Principal/Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.,

Review Principal, Designated MTO Contact

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## **Appendix A**

### **Record of Borehole Sheets and Laboratory Test Results**

#### **Present Investigation**

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

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

UNIFIED SOILS CLASSIFICATION

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

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.				CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.				SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.				SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.				COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.				Bedrock (general)
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<b><u>TERMS</u></b>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

**RECORD OF BOREHOLE No CN16-01 1 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 134.5 E 226 136.6 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.13 - 2018.07.13 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
						20 40 60 80 100	20 40 60 80 100	20 40 60 80 100						
325.5	GROUND SURFACE													
0.0	Silty SAND, some clay, trace gravel, occasional organics, occasional cobbles Dense to Very Dense Brown Moist (FILL)	[Cross-hatched pattern]	1	SS	31									
			2	SS	64									Auger grinding
	Loose		3	SS	6									Auger grinding 3 56 27 14
			4	SS	30									
322.5														
3.0	SAND, some silt, trace clay Loose to Compact Brown Moist	[Dotted pattern]	5	SS	51									
			6	SS	11									Switch to tricone
			7	SS	4									
	Very Dense		8	SS	80									0 84 16 (SI+CL)
316.8														
8.7	Silty CLAY, some sand, trace gravel Hard Grey Moist (TILL)	[Diagonal lines]	9	SS	37									

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

**RECORD OF BOREHOLE No CN16-01 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 134.5 E 226 136.6 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.13 - 2018.07.13 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
						20	40	60	80	100	20	40	60	GR SA SI CL
Continued From Previous Page														
313.8	Silty CLAY, some sand Very Stiff Grey Moist (TILL)		10	SS	24									
11.7	Silty CLAY, trace sand Very Stiff to Hard Grey Moist		11	SS	19									
			12	SS	26									
309.7			13	SS	32									0 3 34 63
15.8	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.08.31 8.3 317.2 2019.08.08 8.1 317.4 2019.08.29 8.3 317.2													

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## RECORD OF BOREHOLE No CN16-02 1 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 122.9 E 226 124.1 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.03 - 2019.07.04 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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			WATER CONTENT (%)				
						20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		
326.1	GROUND SURFACE														
0.0	<b>TOPSOIL:</b> (100mm)														
0.1	Silty <b>SAND</b> , gravelly, trace clay, occasional cobbles, occasional organics Compact Brown Moist (FILL)		1	SS	14						○				24 38 30 8
			2	SS	13						○				
			3	SS	12						○				
	Dense		4	SS	42						○				
323.1															
3.0	<b>SAND</b> , some gravel to gravelly, trace silt and clay, occasional cobbles, occasional organics Compact to Dense Brown Dry to Moist		5	SS	19						○				Switch to tricone
	Wet		6	SS	32						○				27 64 9 (SI+CL)
	Very Dense		7	SS	52						○				
			8	SS	44						○				
317.4															
8.7	<b>SAND</b> , trace gravel, trace silt and clay Dense Brown Wet		9	SS	39						○				1 97 2 (SI+CL)

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



**RECORD OF BOREHOLE No CN16-02 3 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 122.9 E 226 124.1 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.03 - 2019.07.04 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page														
	Silty <b>CLAY</b> , trace sand, trace gravel Hard Grey Moist		16	SS	53		306							Tricone grinding	
			17	SS	100/ 0.250		303								
			18	SS	100/ 0.300		302							Tricone grinding	
			19	SS	100/ 0.300		300								
			20	SS	74		298								
							297								

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

**RECORD OF BOREHOLE No CN16-02 4 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 122.9 E 226 124.1 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.03 - 2019.07.04 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			20 40 60 80 100 20 40 60				GR SA SI CL		
Continued From Previous Page															
291.6	Silty <b>CLAY</b> Hard Grey Moist		21	SS	56									0 0 38 62	
	100mm thick silt layer at 33.8m		22	SS	100/ 0.225										
291.6															
34.4	<b>SAND</b> , some silt, trace clay Very Dense Grey Moist		23	SS	100/ 0.275									0 77 16 7	
290.0															
36.1	Silty <b>CLAY</b> , sandy, trace gravel Hard Grey Moist		24	SS	100/ 0.275										
289.1															
37.0	END OF BOREHOLE AT 37.0m. CAVED-IN DEPTH AND WATER LEVEL NOT AVAILABLE DUE TO USE OF MUD ROTARY DRILLING. BOREHOLE BACKFILLED WITH GROUT AND CEMENT, THEN BENTONITE HOLEPLUG TO SURFACE.														

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## RECORD OF BOREHOLE No CN16-03 1 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 090.7 E 226 146.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.25 - 2019.08.26 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)								
321.3	GROUND SURFACE													
0.0 0.1	<b>TOPSOIL:</b> (75mm) Silty <b>SAND</b> , trace clay, trace gravel Loose to Compact Brown Moist (FILL)		1	SS	15									
			2	SS	13								1 59 34 6	
			3	SS	7									
319.1														
2.2	<b>SAND</b> , trace to some silt, trace clay, trace, gravel Compact to Dense Brown Dry to Moist		4	SS	35									
			5	SS	47								Switch to tricone 1 87 12 (SI+CL)	
			6	SS	64									
	Very Dense Wet													
315.7														
5.6	Silty <b>CLAY</b> , some sand to sandy Hard Grey Moist (TILL)		7	SS	32									
			8	SS	33									
			9	SS	37								2 18 55 25	

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

**RECORD OF BOREHOLE No CN16-03 2 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 090.7 E 226 146.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.25 - 2019.08.26 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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			20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W		
	Continued From Previous Page											
309.6			10	SS	56							
11.7	Silty <b>CLAY</b> , trace sand Hard Grey Moist		11	SS	33							
306.5			12	SS	33							
14.8	Sandy <b>SILT</b> , some clay Very Dense Grey Moist		13	SS	90							
305.6			14	SS	72							Tricone grinding
15.7	Silty <b>CLAY</b> , trace sand Hard Grey Moist		15	SS	90							0 1 38 61

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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 CN16-03 3 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 090.7 E 226 146.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.25 - 2019.08.26 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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													
	Silty <b>CLAY</b> , trace sand Hard Grey Moist		16	SS	72									
						301								
						300								
						299								
			17	SS	51									
						298								
						297								
						296								
			18	SS	62									
						295								
						294								
						293								
			19	SS	51									
						292								

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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 CN16-03 4 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 090.7 E 226 146.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.25 - 2019.08.26 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 $\gamma$ 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	SS	97	291								
						290								
						289								
						288								
287.6						287								Tricone grinding
33.7	Sandy <b>SILT</b> , some clay, trace gravel Very Dense Grey Moist (TILL)		21	SS	100/ 0.150	286								
						285								
			22	SS	100/ 0.125	284								6 28 50 16 Tricone grinding
283.1														
38.3	END OF BOREHOLE AT 38.3m. CAVED-IN DEPTH AND WATER LEVEL NOT AVAILABLE DUE TO USE OF MUD ROTARY DRILLING. BOREHOLE BACKFILLED WITH GROUT HOLEPLUG.													

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## RECORD OF BOREHOLE No CN16-04 1 OF 5 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.0 E 226 130.4 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.23 - 2019.08.24 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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		WATER CONTENT (%)		PLASTIC LIMIT	NATURAL MOISTURE CONTENT		
							20 40 60 80 100	20 40 60	W <sub>p</sub> W W <sub>L</sub>						
323.3	GROUND SURFACE														
0.0	<b>TOPSOIL:</b> (50mm)														
	Silty <b>SAND</b> , some gravel, trace clay Loose to Compact Brown Dry to Moist (FILL)		1	SS	15										
			2	SS	8										
			3	SS	6									18 52 25 5	
			4	SS	7										
320.3															
3.0	<b>SAND</b> , trace to some gravel, trace silt, trace clay Dense Brown Moist		5	SS	14									Switch to tricone	
			6	SS	32									6 79 15 (SI+CL)	
			7	SS	37									17 73 10 (SI+CL)	
	75mm thick gravel layer at 6.4m														
316.2															
7.2	Silty <b>CLAY</b> , some sand, trace gravel Very Stiff to Hard Brown Moist (TILL)		8	SS	23										
			9	SS	35										

ONTMT4S2 MTO-11375(GINTDATA)GPJ 2017TEMPLATE(MTO).GDT 6/8/20

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

**RECORD OF BOREHOLE No CN16-04 2 OF 5 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.0 E 226 130.4 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.23 - 2019.08.24 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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													
	Silty <b>CLAY</b> , some sand, trace gravel Hard Grey Moist (TILL)		10	SS	35									
			11	SS	48									
310.1			12	SS	40								0 2 43 55	
13.3	Silty <b>CLAY</b> , trace sand Hard Grey Moist		13	SS	37									
			14	SS	48									
			15	SS	39									

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

**RECORD OF BOREHOLE No CN16-04 3 OF 5 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.0 E 226 130.4 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.23 - 2019.08.24 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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													
	Silty <b>CLAY</b> , trace sand Hard Grey Moist		16	SS	76									
						303								
						302								
						301								
			17	SS	98									
						300								
						299								
						298								
						297							0 2 42 56	
						296								
						295								
			19	SS	49									
						294								

ONTM14S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

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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 CN16-04 4 OF 5 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.0 E 226 130.4 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.23 - 2019.08.24 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
	Continued From Previous Page						20 40 60 80 100							
	Silty <b>CLAY</b> , some sand to sandy, trace gravel Hard Grey Moist													
			20	SS	75									
														Tricone grinding
	Silt seams		21	SS	62									
														Tricone grinding
			22	SS	100/ 0.125									
			23	SS	100/									0 19 51 30

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

Continued Next Page

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No CN16-04 5 OF 5 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.0 E 226 130.4 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.23 - 2019.08.24 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 $\gamma$ 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				0.250		20	40	60	80	100					
282.6						283										
40.7	Sandy SILT, trace gravel Very Dense Brown		24	SS	100/											
282.0	Moist (TILL)				0.125											
41.3	END OF BOREHOLE AT 41.3m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS DATE          DEPTH(m)    ELEV.(m) 2019.08.29      16.8            306.6															

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

## RECORD OF BOREHOLE No CN16-05 1 OF 4 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 129.0 E 226 137.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.04 - 2019.07.08 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
						20 40 60 80 100	20 40 60							
325.5	GROUND SURFACE													
0.0	<b>TOPSOIL:</b> (125mm)													
0.1	Silty <b>SAND</b> , some clay, trace gravel Loose to Compact Brown Moist (FILL)		1	SS	16									
			2	SS	13									
			3	SS	7								3 54 31 12	
	Very Dense		4	SS	53								Switch to tricone	
322.0			5	SS	50									
3.5	<b>ORGANICS</b> occasional roots and rootlets Black Moist													
321.4														
4.1	<b>SAND</b> , trace silt, trace clay, trace gravel Very Dense Brown Moist		6	SS	34									
			7	SS	100/ 0.275									
			8	SS	100/ 0.250								0 85 15 (SI+CL)	
			9	SS	92									
316.0	Wet													
9.5	Silty <b>CLAY</b> , sandy, trace gravel Hard Grey													

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

Continued Next Page

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



**RECORD OF BOREHOLE No CN16-05 3 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 129.0 E 226 137.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.04 - 2019.07.08 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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					
	Continued From Previous Page														
	Silty <b>CLAY</b> , trace sand Hard Grey Moist		16	SS	43										
							305								
							304								
							303								
			17	SS	88		302							0 2 42 56	
							301								
							300								
			18	SS	80		299								
							298								
							297								
			19	SS	93		296								

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

Continued Next Page

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

**RECORD OF BOREHOLE No CN16-05 4 OF 4 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 129.0 E 226 137.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.04 - 2019.07.08 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page													
	Silty <b>CLAY</b> , trace sand, trace gravel, occasional cobbles Hard Grey Moist					295								
						294								
		20	SS	80		293								
						292								
						291								
	0.3m thick sandy silt layer at 34.6m	21	SS	100/ 0.125		290								
						289								
		22	SS	100/ 0.150		288							3 15 24 58 Tricone grinding	
287.9														
37.6	Sandy <b>SILT</b> , gravelly, some clay, occasional cobbles Very Dense Grey Moist (TILL)													
287.3		23	SS	100/ 0.150										
38.3	END OF BOREHOLE AT 38.3m. CAVED-IN DEPTH AND WATER LEVEL NOT AVAILABLE DUE TO USE OF MUD ROTARY DRILLING. BOREHOLE BACKFILLED WITH CEMENT AND GROUT, THEN BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20



**RECORD OF BOREHOLE No CN16-06 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 136.3 E 226 121.6 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.07.08 - 2019.07.08 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 $\gamma$ 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															
315.8 10.1	Silty <b>CLAY</b> , some sand, trace gravel Hard Grey Moist (TILL)  0.5m thick silty sand layer at 10.9m		10	SS	100/ 0.225	315									
			11	SS	65	313									
312.6 13.3			Silty <b>SAND</b> , some clay, trace gravel with silty clay seams Dense to Very Dense Grey Moist	12	SS	63	312								6 59 20 15
310.2 310.0 15.8	Silty <b>CLAY</b> , some to trace sand, trace gravel Hard Grey Moist  END OF BOREHOLE AT 15.8m. CAVED-IN DEPTH AND WATER LEVEL NOT AVAILABLE DUE TO USE OF MUD ROTARY DRILLING. BOREHOLE BACKFILLED WITH CEMENT AND GROUT, THEN BENTONITE HOLEPLUG TO SURFACE.	13		SS	39	311									

ONTM14S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20



**RECORD OF BOREHOLE No CN16-07 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 089.7 E 226 153.3 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.29 - 2019.08.29 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
310.6	Continued From Previous Page													
10.2	Silty <b>CLAY</b> , some sandy to sandy, trace gravel Hard Grey Wet		10	SS	31									
			11	SS	39									
			12	SS	31									
			13	SS	43									0 22 50 28
305.0	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.													
15.8	WATER LEVEL READINGS DATE            DEPTH(m)    ELEV.(m) 2019.08.31        5.8            315.0													

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

## RECORD OF BOREHOLE No CN16-08 1 OF 2 METRIC

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 087.3 E 226 137.0 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.29 - 2019.08.29 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)								
322.0	GROUND SURFACE													
0.0	<b>TOPSOIL:</b> (125mm)													
0.1	Silty <b>SAND</b> , trace gravel, occasional organics Loose Brown Moist (FILL)	X	1	SS	13									
		X	2	SS	9									
		X	3	SS	7									
319.8	<b>SAND</b> , some silt, trace clay, trace gravel Loose to Compact Brown Moist	O	4	SS	7								4 74 22 (SI+CL)	
		O	5	SS	17								Switch to tricone	
317.9	Silty <b>CLAY</b> , some sand, trace gravel Very Stiff to Hard Grey Moist (TILL)	O	6	SS	16									
		O	7	SS	29									
		O	8	SS	31								1 16 49 34	
		O	9	SS	40									

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

Continued Next Page

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

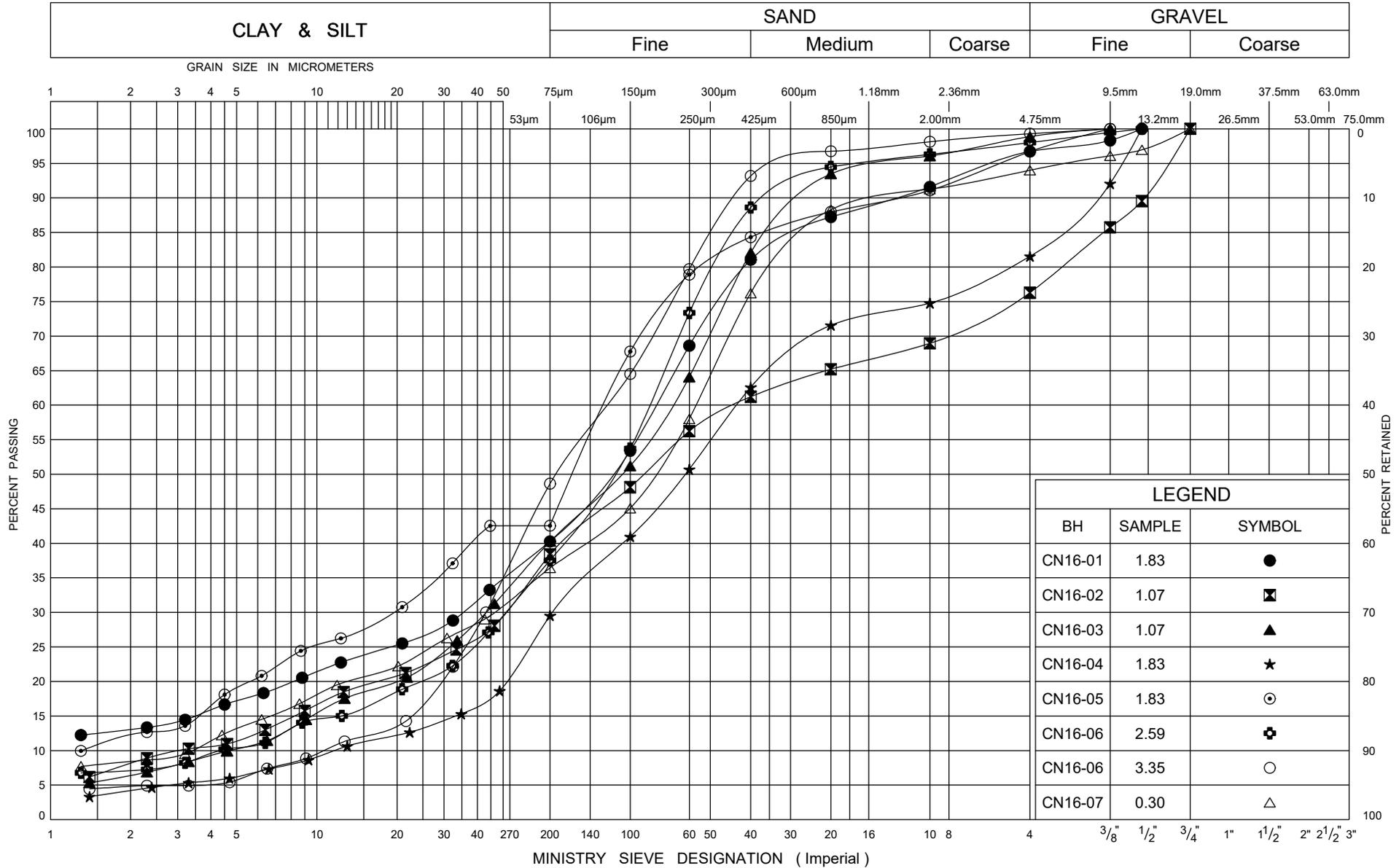
**RECORD OF BOREHOLE No CN16-08 2 OF 2 METRIC**

GWP# 408-88-00 LOCATION MTM NAD 83 Zone 10: N 4 814 087.3 E 226 137.0 ORIGINATED BY BL  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY BH  
 DATUM Geodetic DATE 2019.08.29 - 2019.08.29 LATITUDE \_\_\_\_\_ LONGITUDE \_\_\_\_\_ CHECKED BY JPL

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						
310.3	Continued From Previous Page Silty <b>CLAY</b> , some sand, trace gravel Hard Grey Moist (TILL)		10	SS	34									
11.7	Silty <b>CLAY</b> , trace sand Hard Grey Moist		11	SS	46								0 6 45 49	
306.2			12	SS	44									
15.8	END OF BOREHOLE AT 15.8m. CAVED-IN DEPTH AND WATER LEVEL NOT AVAILABLE DUE TO USE OF MUD ROTARY DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 3.0m, THEN HOLEPLUG TO SURFACE.		13	SS	62									

ONTM14S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 6/8/20

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPI\_ONTARIO MOT.GDT 1/16/20

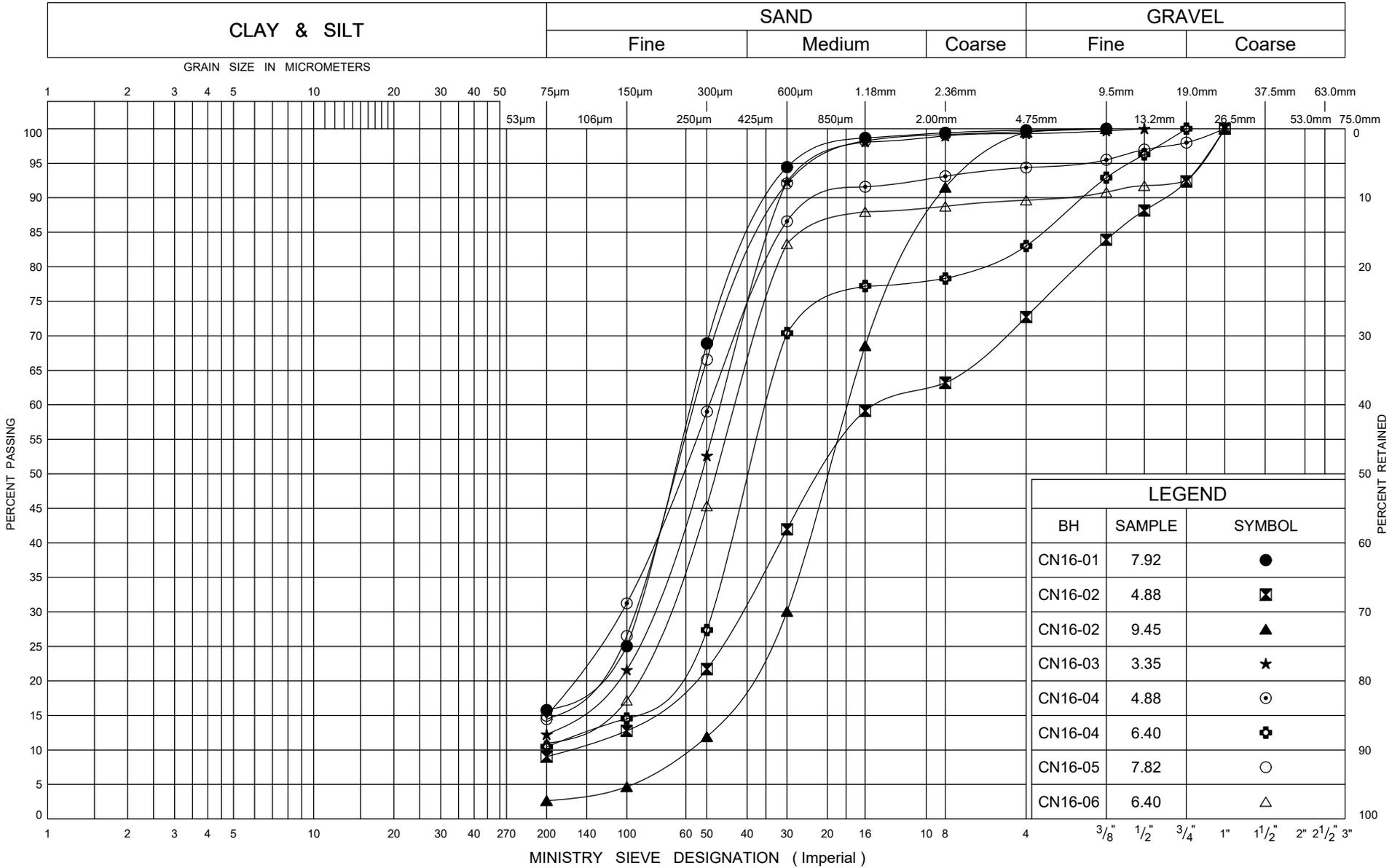


## GRAIN SIZE DISTRIBUTION

### Cohesionless FILL

FIG No A1  
W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPI\_ONTARIO MOT.GDT 1/16/20

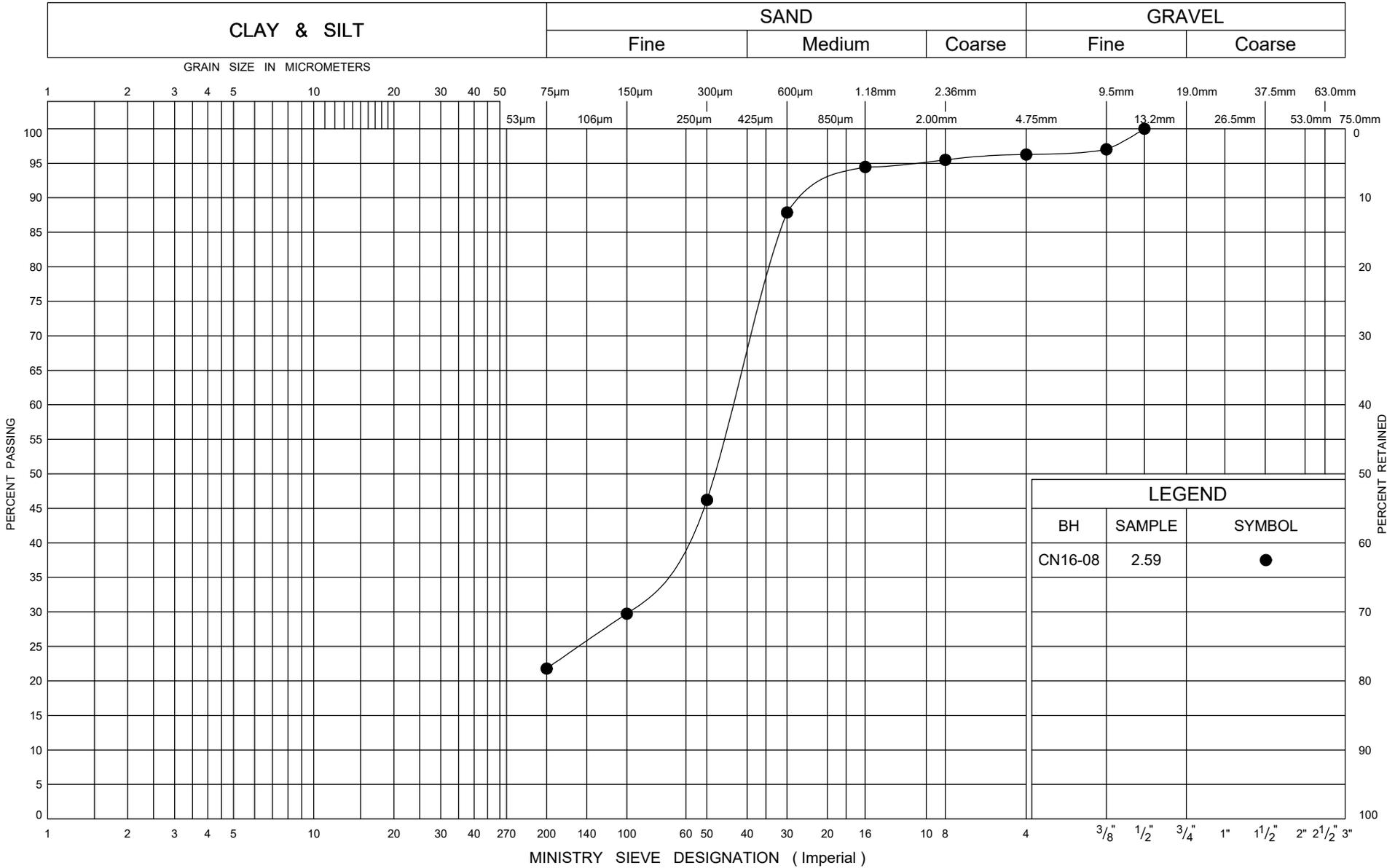


## GRAIN SIZE DISTRIBUTION

### Upper SAND

FIG No A2  
W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT\_5/14/20

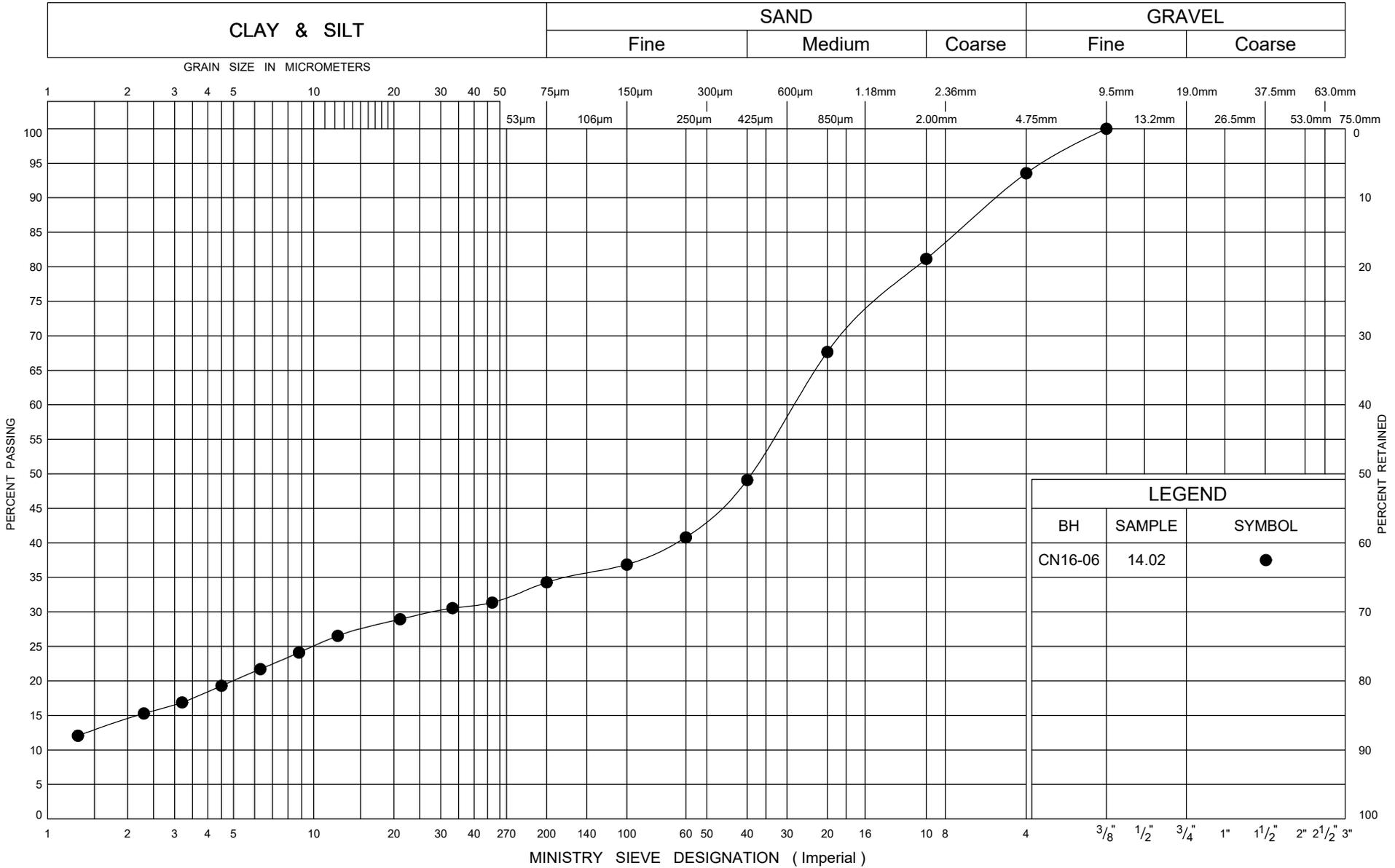


## GRAIN SIZE DISTRIBUTION

### Upper SAND

FIG No A3  
W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



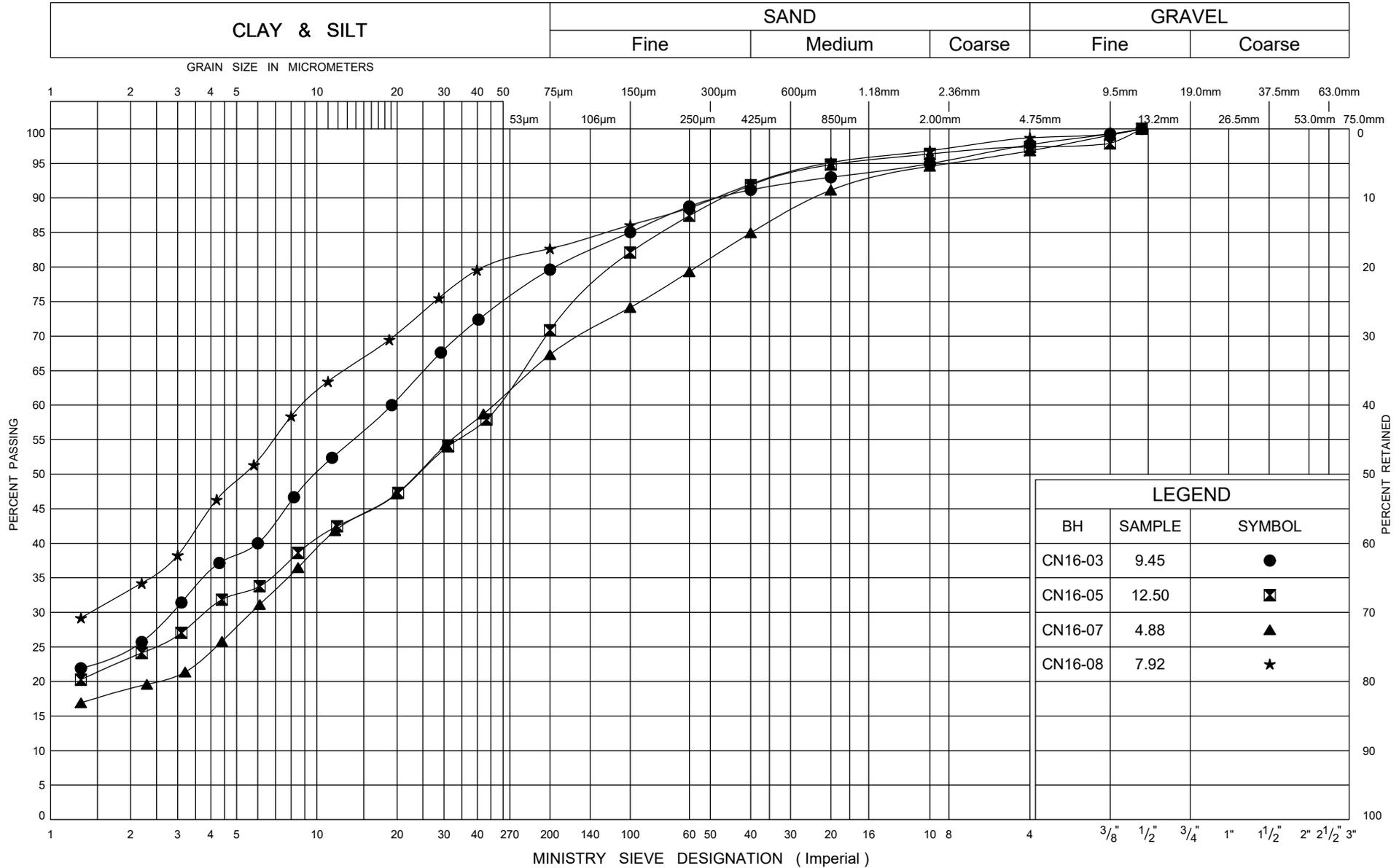
ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 5/14/20



**GRAIN SIZE DISTRIBUTION**  
Silty SAND

FIG No A4  
W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPI\_ONTARIO MOT\_GDT 1/16/20



## GRAIN SIZE DISTRIBUTION

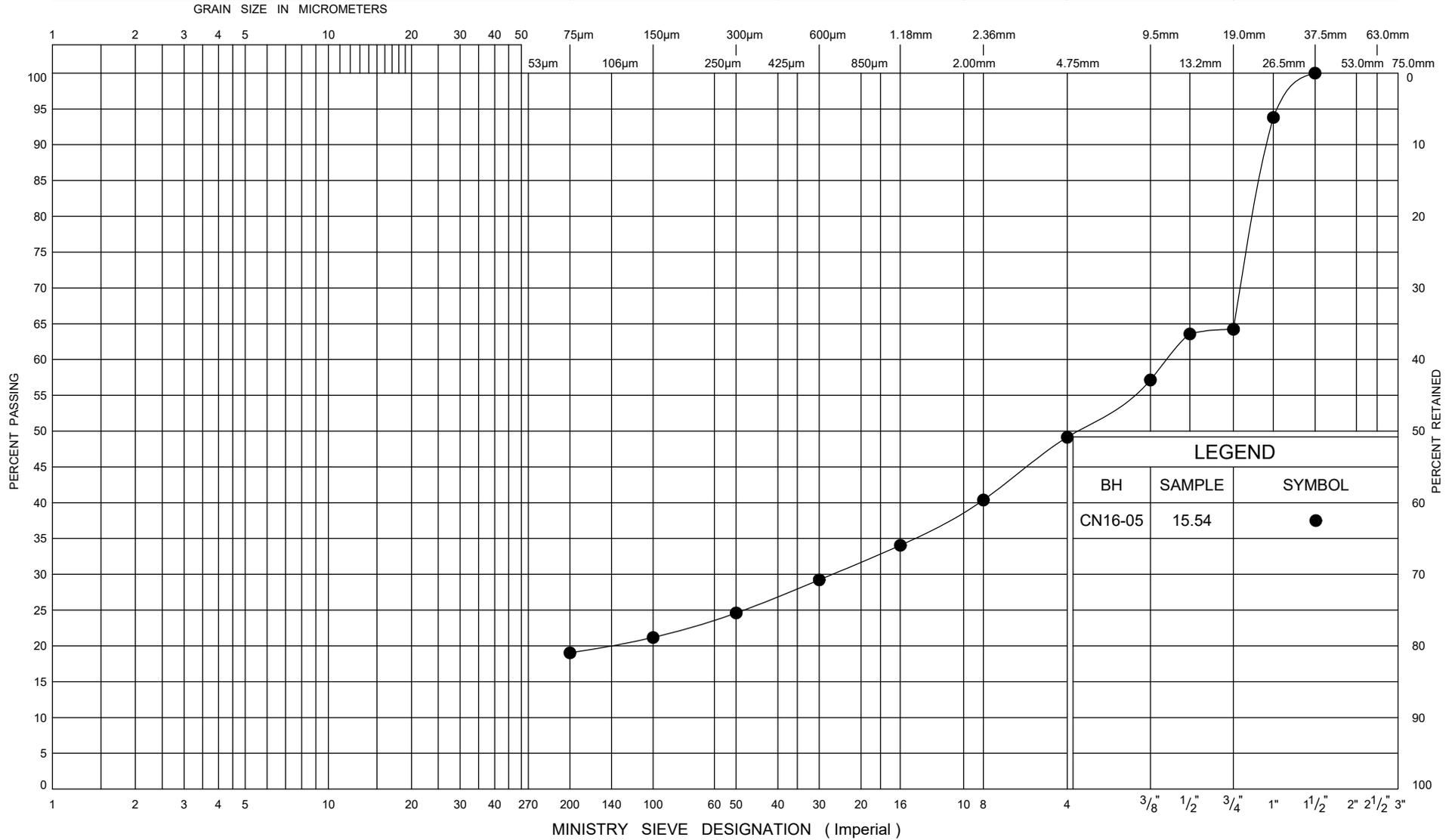
### Silty CLAY TILL

FIG No A5

W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPI\_ONTARIO MOT.GDT 1/16/20



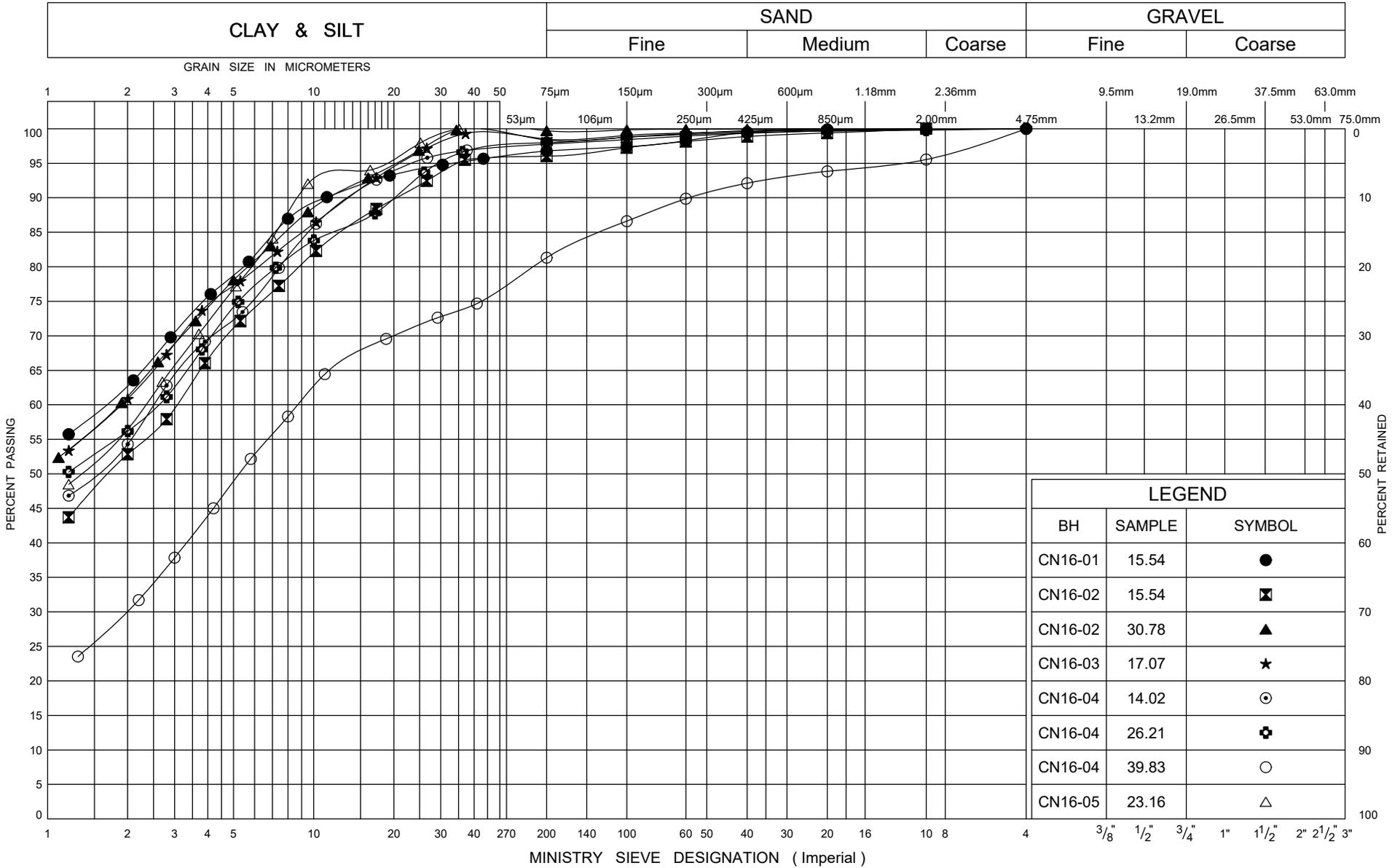
## GRAIN SIZE DISTRIBUTION

### Sandy GRAVEL

FIG No A6

W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/16/20



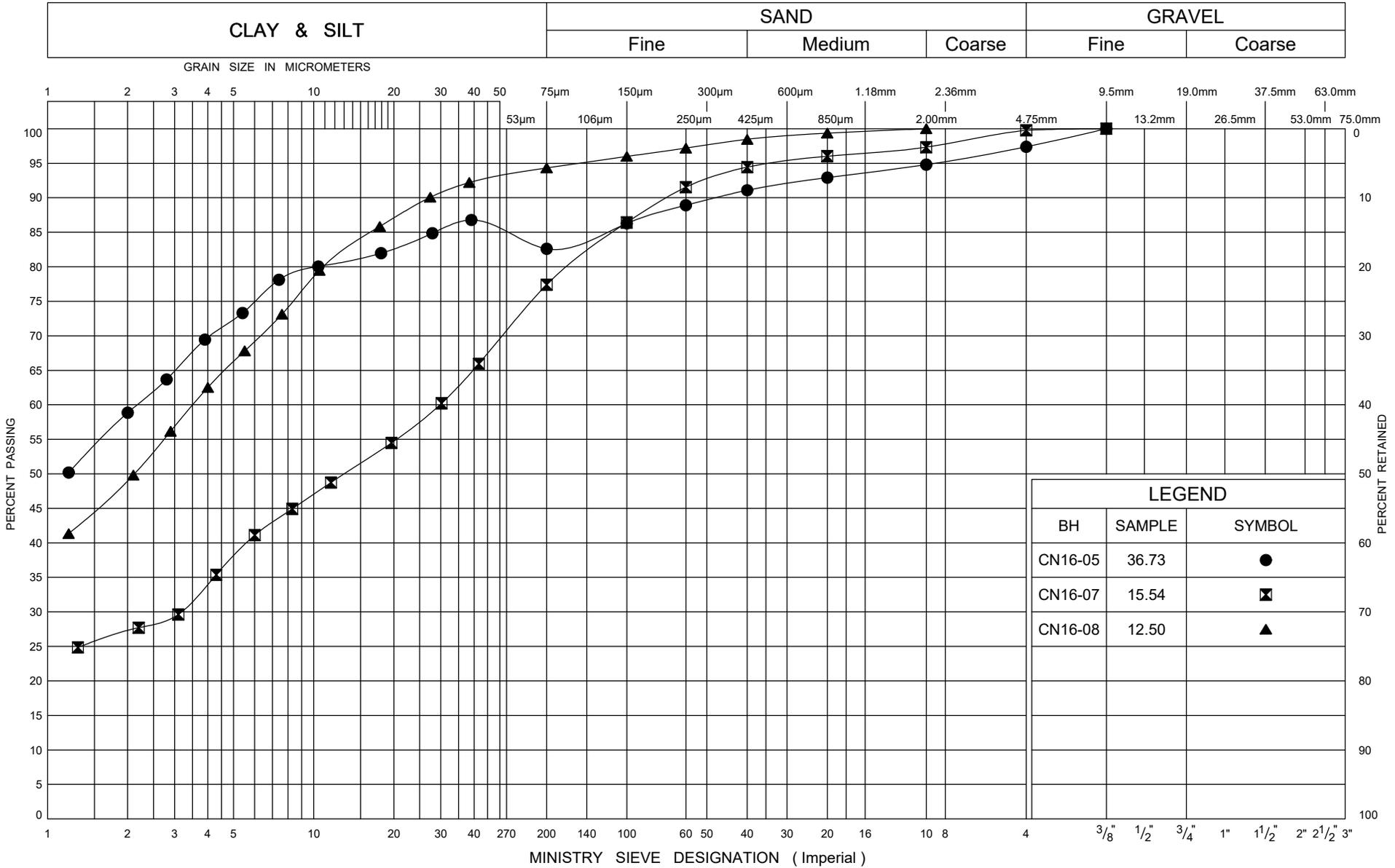
## GRAIN SIZE DISTRIBUTION

### Silty CLAY

FIG No A7

W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
CN16-05	36.73	●
CN16-07	15.54	⊠
CN16-08	12.50	▲

ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPJ\_ONTARIO MOT.GDT 1/16/20

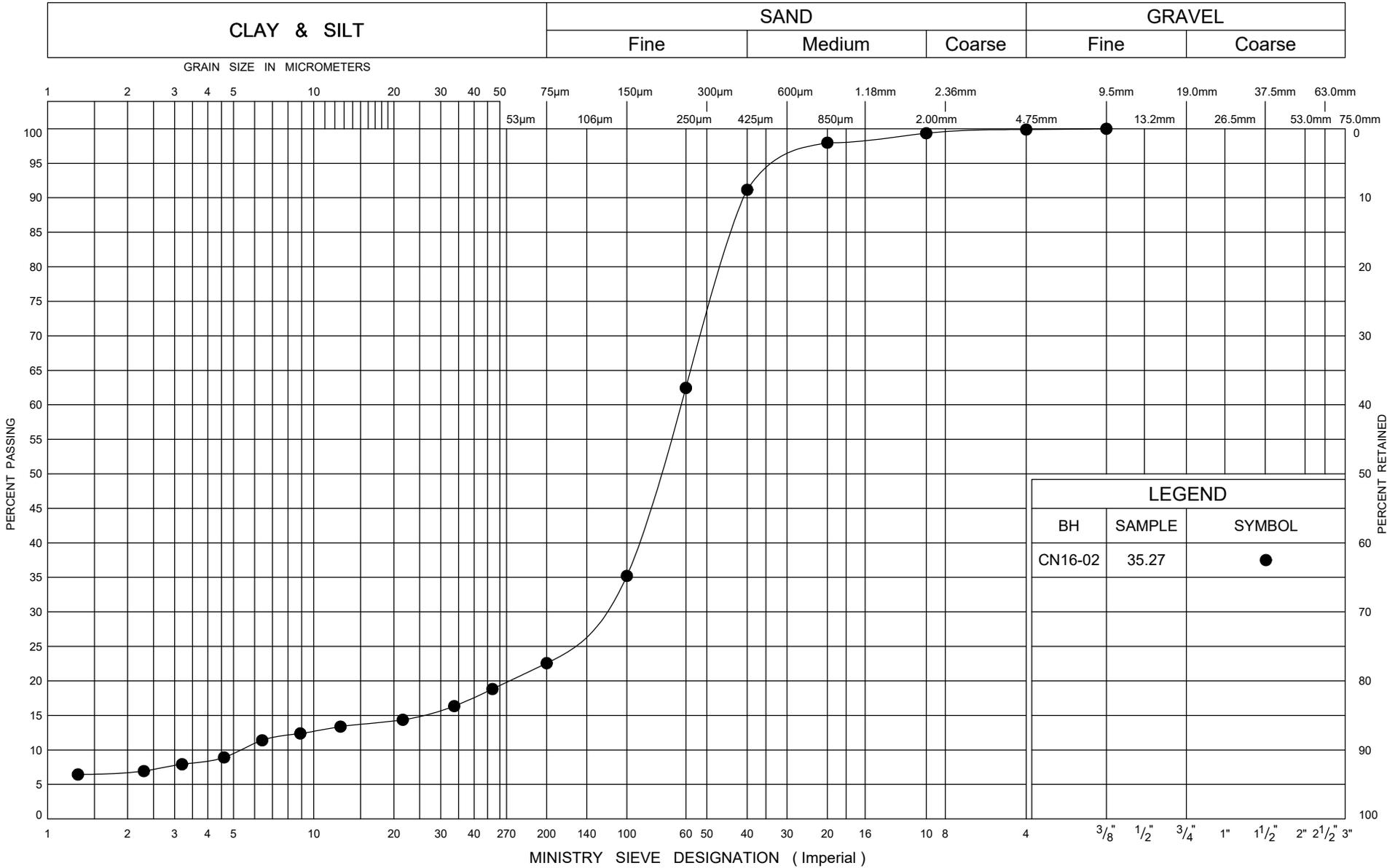


## GRAIN SIZE DISTRIBUTION

### Silty CLAY

FIG No A8  
W P 408-88-00

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375(GINTDATA)\GPI\_ONTARIO.MOT.GDT 1/16/20

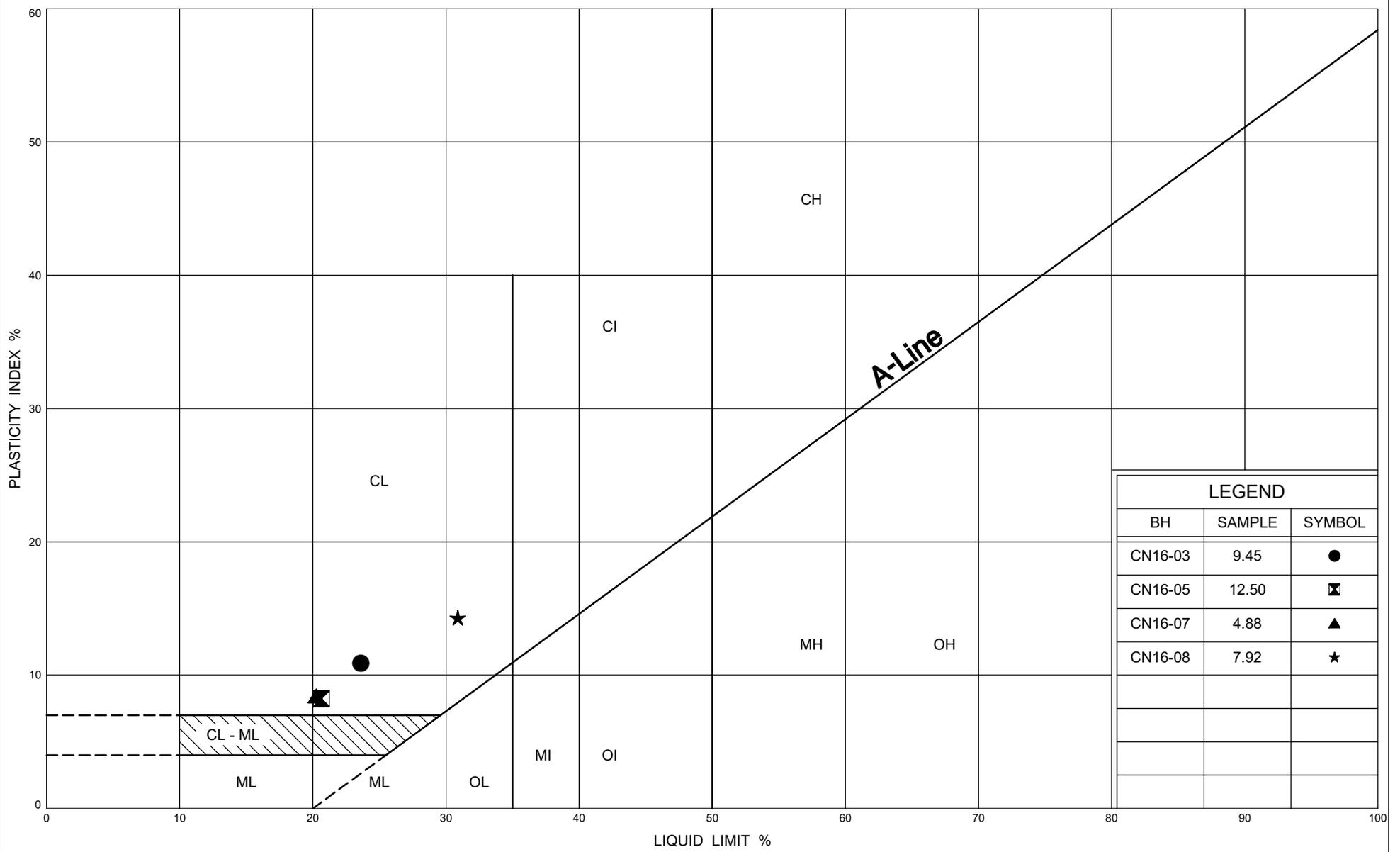


## GRAIN SIZE DISTRIBUTION

### Lower SAND

FIG No A9  
W P 408-88-00





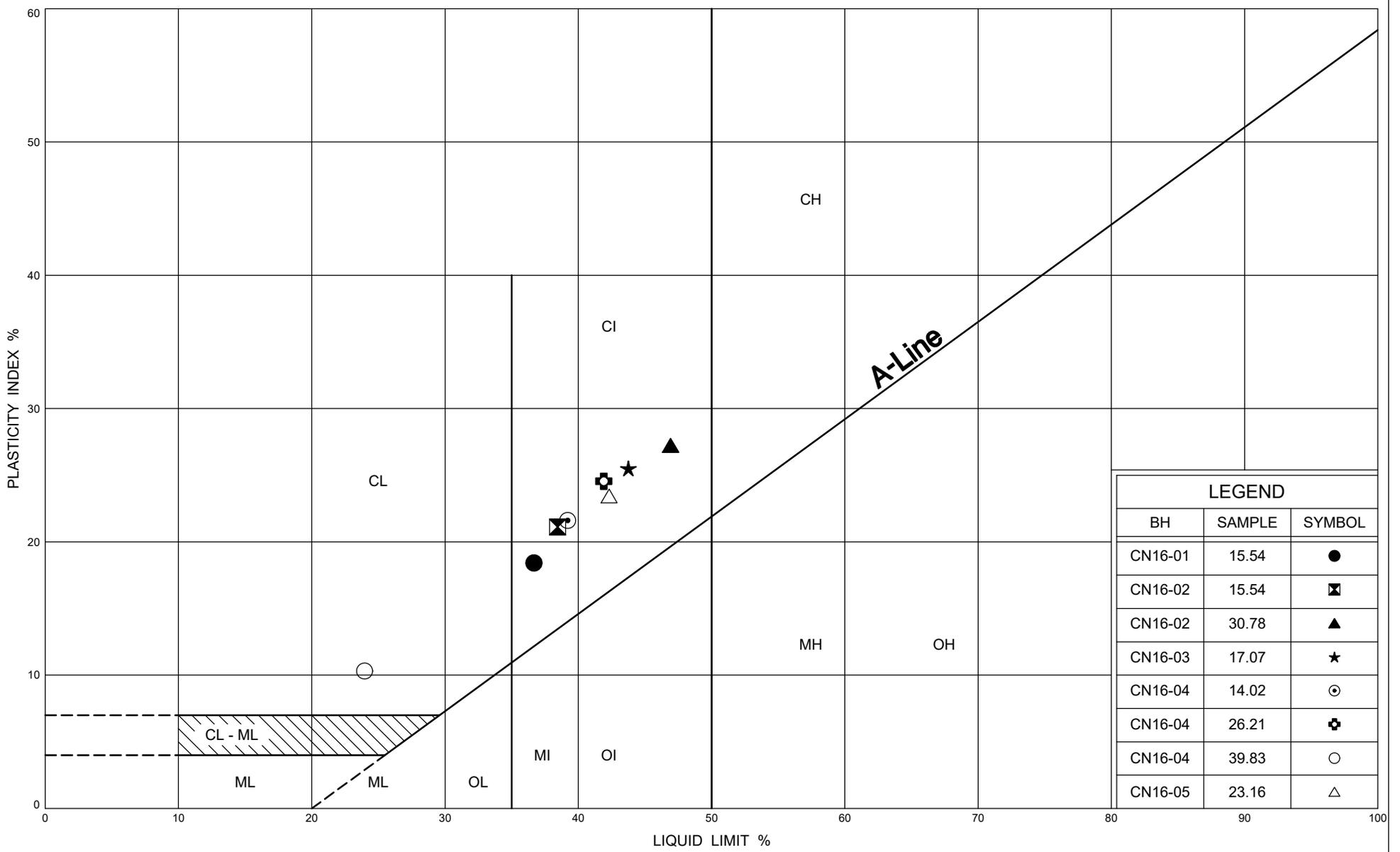
LEGEND		
BH	SAMPLE	SYMBOL
CN16-03	9.45	●
CN16-05	12.50	⊠
CN16-07	4.88	▲
CN16-08	7.92	★

ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ\_ONTARIO MOT.GDT\_1/16/20



**PLASTICITY CHART**  
Silty CLAY TILL

FIG No A11  
W P 408-88-00



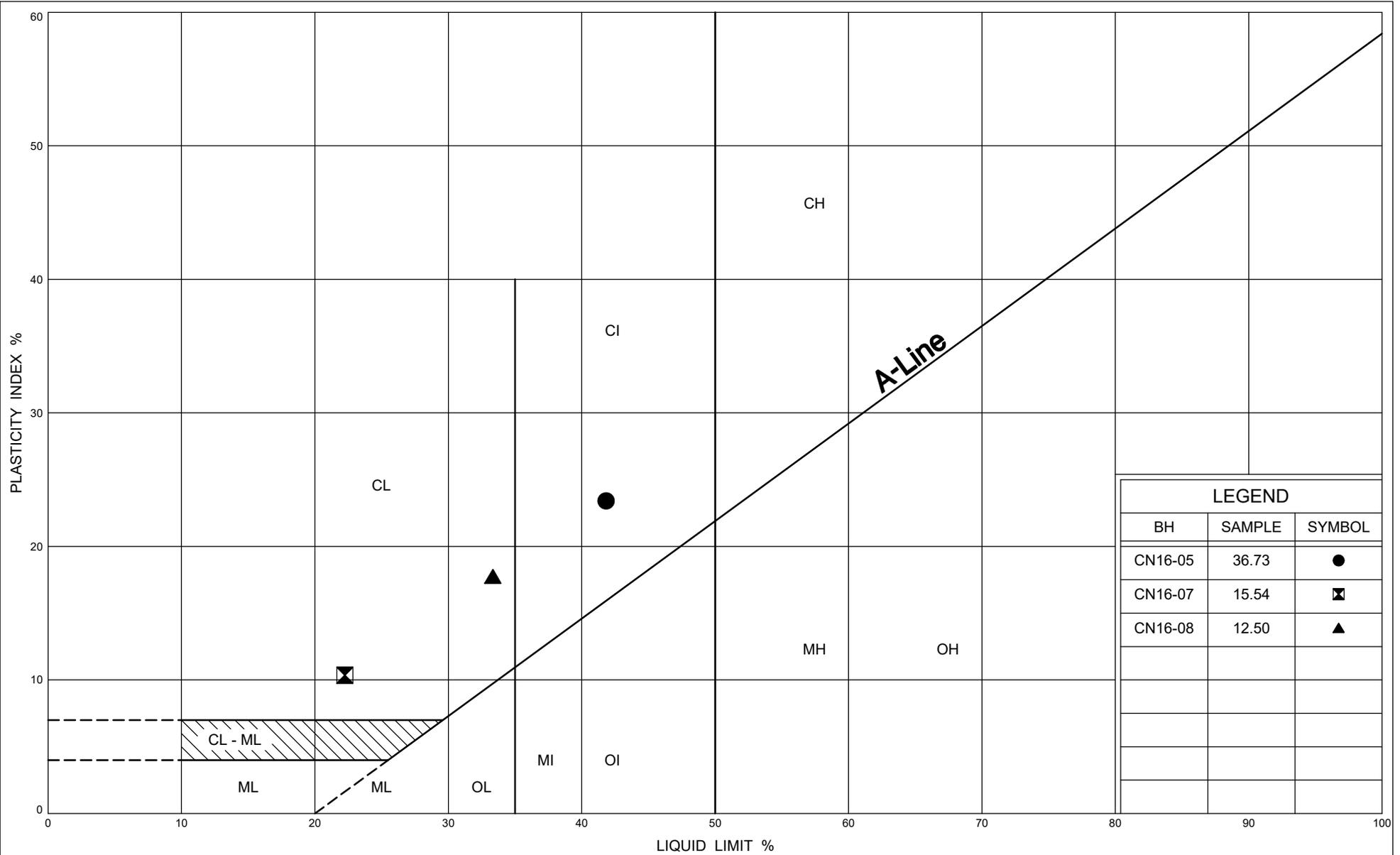
LEGEND		
BH	SAMPLE	SYMBOL
CN16-01	15.54	●
CN16-02	15.54	⊠
CN16-02	30.78	▲
CN16-03	17.07	★
CN16-04	14.02	⊙
CN16-04	26.21	⊕
CN16-04	39.83	○
CN16-05	23.16	△

ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ\_ONTARIO MOT.GDT 1/16/20



**PLASTICITY CHART**  
Silty CLAY

FIG No A12  
W P 408-88-00



LEGEND		
BH	SAMPLE	SYMBOL
CN16-05	36.73	●
CN16-07	15.54	⊠
CN16-08	12.50	▲



PLASTICITY CHART  
Silty CLAY

FIG No A13  
W P 408-88-00



## **Appendix B**

### **Record of Borehole Sheets and Laboratory Test Results**

#### **Previous investigation**

# 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

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

$\nabla$  Water Level  
 $C_{pen}$  Shear Strength Determination by Pocket Penetrometer

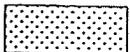
(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

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

UNIFIED SOILS CLASSIFICATION

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

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
Fresh (FR)	No visible signs of weathering.		CLAYSTONE		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		SILTSTONE		
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SANDSTONE		
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		COAL		
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		Bedrock (general)		
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.				
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
<b>Bedding</b>	<b>Bedding Plane Spacing</b>	<b>Rock Strength</b>	<b>Approximate Uniaxial Compressive Strength</b>	<b>Field Estimation of Hardness*</b>	
			(MPa)      (psi)		
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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
<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.				
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.				
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

### RECORD OF BOREHOLE No 08-041

1 OF 4

**METRIC**

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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						
						20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	kN/m <sup>3</sup>	GR SA SI CL
326.3														
0.0														
0.1	TOPSOIL: (40mm), occasional rootlets and roots	[diagonal lines]												
325.7	SAND, some gravel Brown Moist (FILL)	[diagonal lines]												
0.6	Clayey SILT, some sand to sandy, trace gravel Very Stiff Brown (FILL)	[diagonal lines]	1	SS	26				○					
324.9	SAND, trace to some silt, trace gravel Compact to Dense Brown Moist	[diagonal lines]	2	SS	36				○					
1.4	occasional topsoil, black	[diagonal lines]	3	SS	32				○					
		[diagonal lines]	4	SS	28				○					2 86 12 (SI+CL)
		[diagonal lines]	5	SS	13				○					
		[diagonal lines]	6	SS	100/ 225				○					
	Very Dense Grey	[diagonal lines]	7	SS	100/ 200				○					2 89 10 (SI+CL)
		[diagonal lines]	8	SS	76				○					

ONTMT4S 6417R.GPJ 10/31/08

Continued Next Page

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

RECORD OF BOREHOLE No 08-041

2 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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						
314.5	Continued From Previous Page SAND, trace to some silt, trace gravel Very Dense Grey Moist		9	SS	63								2 86 12 (SI+CL)	
11.8	Silty CLAY, some sand to sandy, trace gravel Hard Grey (TILL)		10	SS	54								1 16 48 35	
			11	SS	33									
			12	SS	31									
			13	SS	33									
	silty sand seams		14	SS	31									
306.3														

ONTMT4S 6417R.GPJ 10/24/08

Continued Next Page

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

RECORD OF BOREHOLE No 08-041

3 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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 (%)			
						20	40	60	80	100	20	40	60	GR	SA	SI	CL	
20.0	Continued From Previous Page Silty CLAY, trace to some sand Hard Grey		15	SS	23													0 6 30 64
			16	SS	73													
			17	SS	108													0 6 41 53
			18	SS	101/ 275													
			19	SS	58													
			20	SS	76													0 2 32 66

ONTMT4S 6417R.GPJ 10/24/08

Continued Next Page

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

RECORD OF BOREHOLE No 08-041

4 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK  
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
Continued From Previous Page						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		GR SA SI CL
291.9	Silty CLAY Hard Grey		21	SS	55										
	silt seams		22	SS	74										
			23	SS	100/ .150										
34.4	SILT, some sand, trace clay Very Dense Grey Moist (TILL)		24	SS	100/ .175										
289.1			25	SS	100/ .150										0 19 75 6
37.2	END OF BOREHOLE AT 37.2m BOREHOLE BACK FILLED WITH GROUT TO 0.61m HOLEPLUG TO SURFACE														

ONTMT4S 6417R.GPJ 11/12/09

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



### RECORD OF BOREHOLE No 08-042

2 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 134.35 E 226 152.53 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
 DATUM Geodetic DATE 2008.08.14 - 2008.08.14 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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 (%)		
10.0	Continued From Previous Page Silty CLAY, trace gravel, trace sand Hard Grey											
			10	SS	39							
			11	SS	36							0 1 36 63
			12	SS	61							
	sandy		13	SS	100/ .225							1 36 38 25
			14	SS	100/ .150							1 27 57 16
			15	SS	118/ .100							0 1 41 58

ONTMT4S 6417R.GPJ 10/28/08

Continued Next Page

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

### RECORD OF BOREHOLE No 08-042

3 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 134.35 E 226 152.53 ORIGINATED BY SA  
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA  
 DATUM Geodetic DATE 2008.08.14 - 2008.08.14 CHECKED BY RPR

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
Continued From Previous Page						20	40	60	80	100						GR SA SI CL	
302.7			16	SS	100												
20.1	END OF BOREHOLE AT 20.1m. WATER LEVEL OBSERVED AT 4.5m DURING DRILLING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m) 2008.08.20      7.9      314.9				.150												

ONTMT4S 6417R.GPJ 10/24/08

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

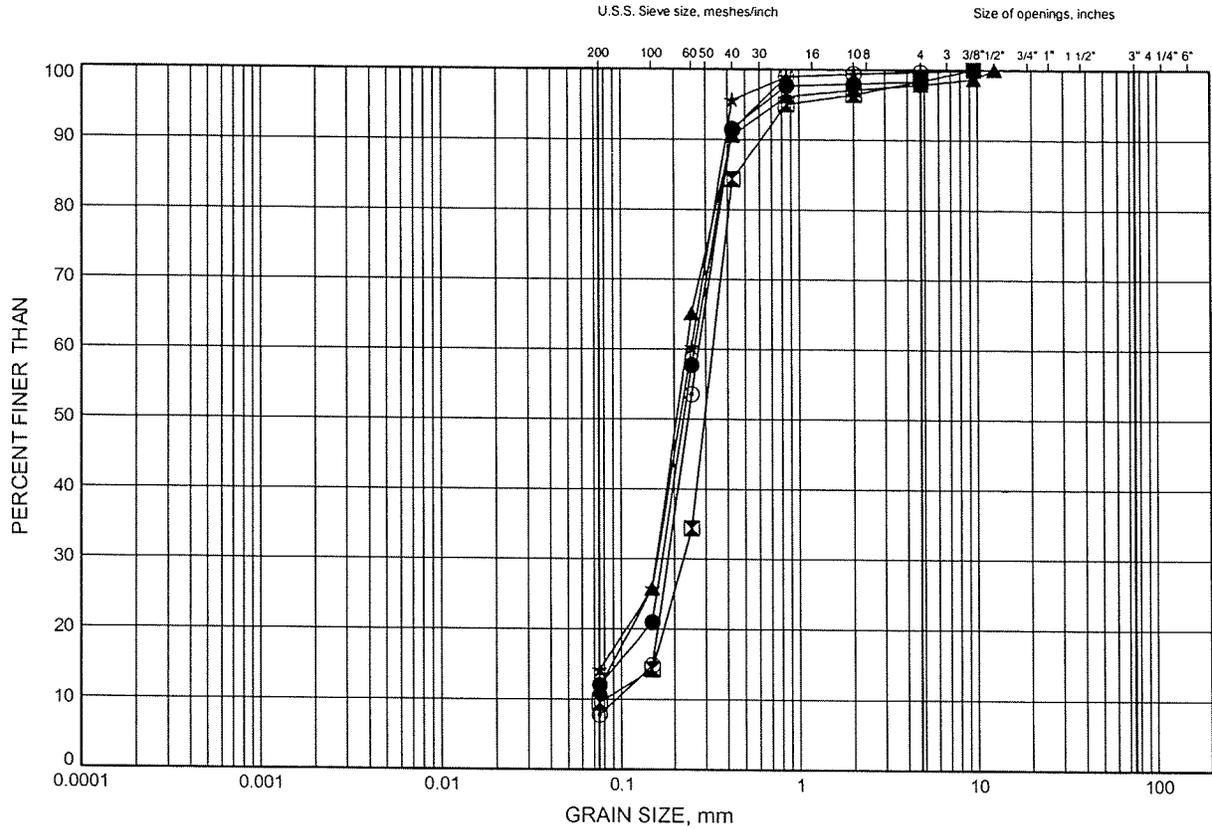
**Appendix B**

**Laboratory Test Results**

# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	3.35	322.95
⊠	08-041	7.80	318.50
▲	08-041	10.96	315.34
★	08-042	1.83	320.95
⊙	08-042	3.35	319.43

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 10/28/08

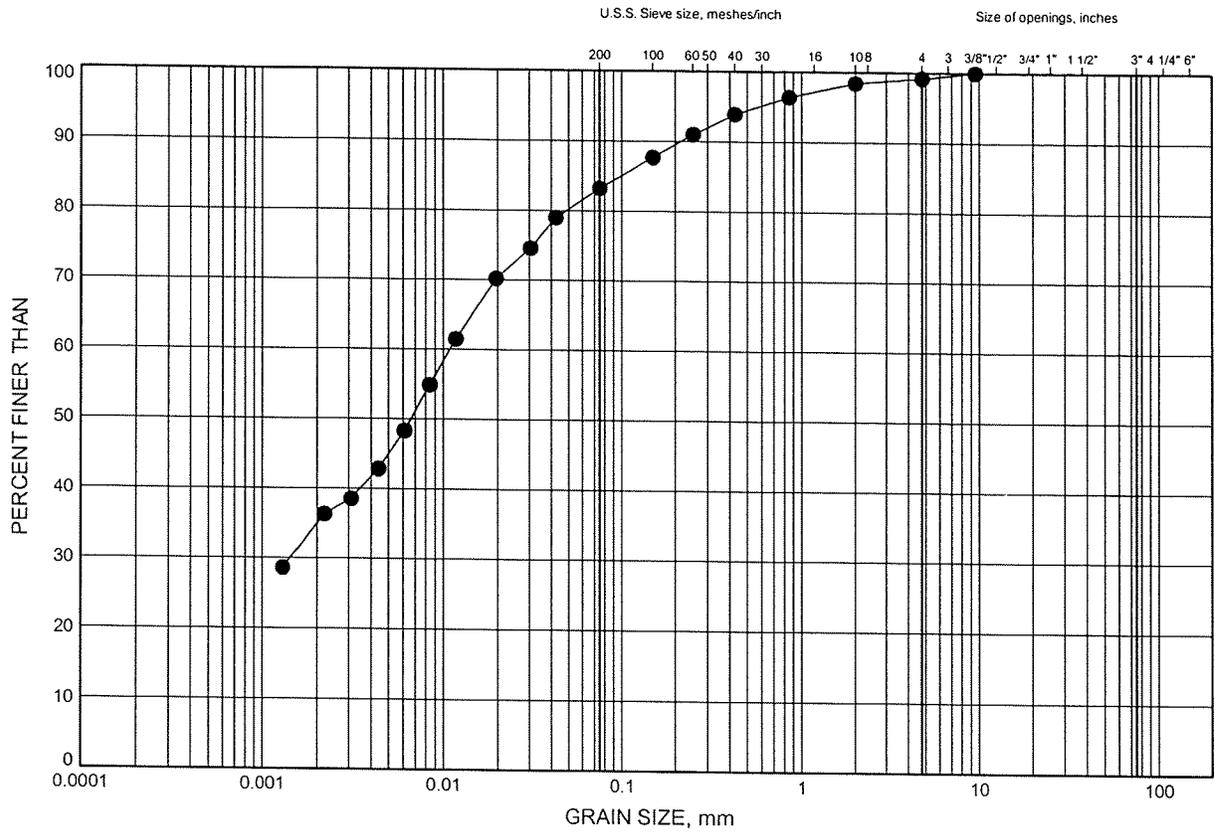
W.P.# .408-88-00.....  
 Prepared By .AN.....  
 Checked By .RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2

## Silty Clay Till



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	14.02	312.28

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 10/28/08

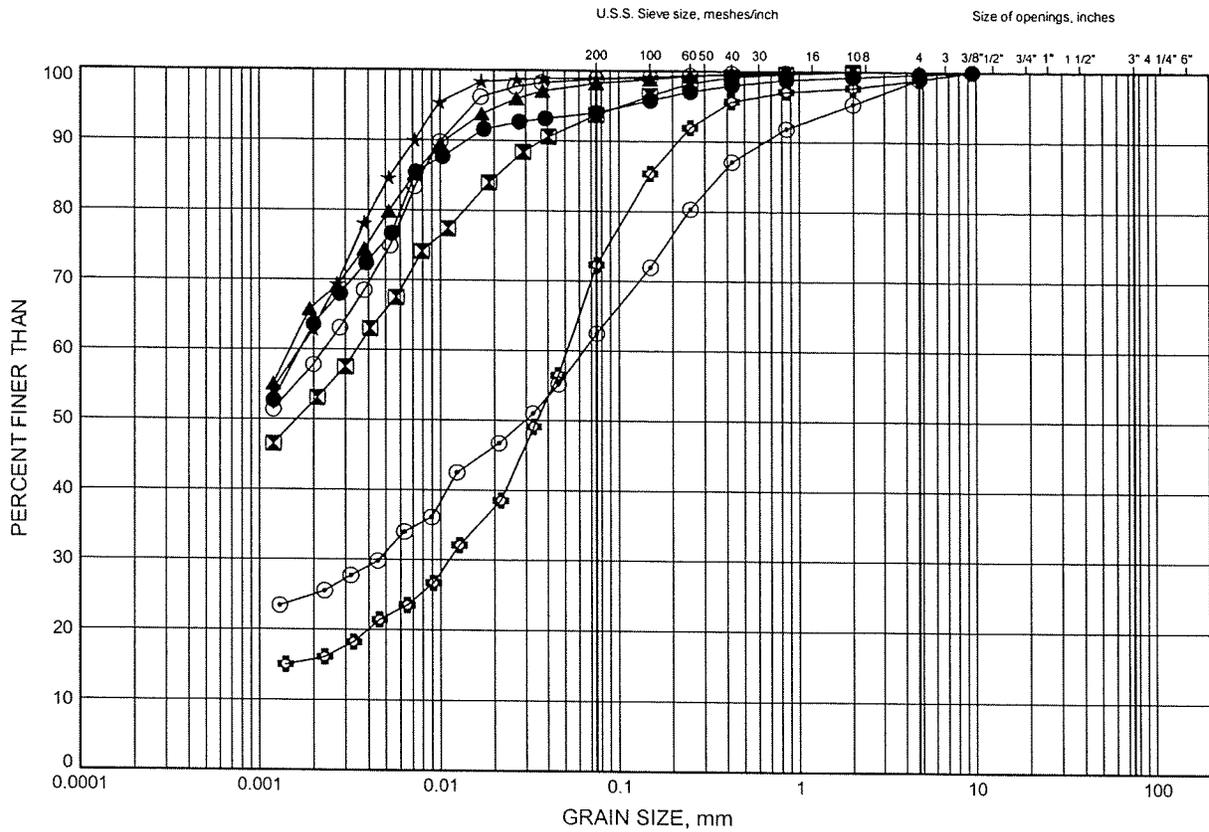
W.P.# .408-88-00.....  
 Prepared By .AN.....  
 Checked By .RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

## Silty Clay



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	20.12	306.18
⊠	08-041	24.46	301.84
▲	08-041	29.26	297.04
☆	08-042	12.50	310.29
⊙	08-042	15.29	307.49
⊗	08-042	16.92	305.87

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 10/28/08

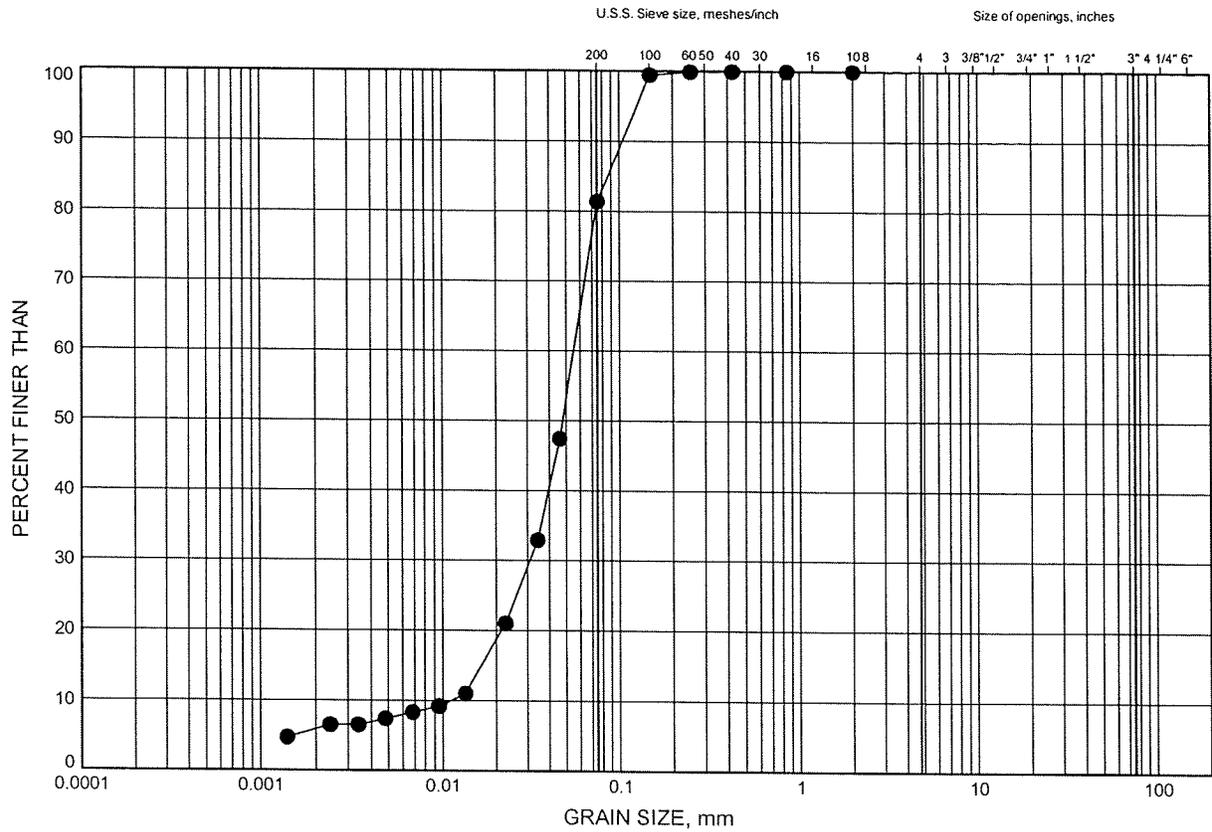
W.P.# .408-88-00.....  
 Prepared By .AN.....  
 Checked By .RPR.....



# Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4

## Silt Till



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	36.73	289.57

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 10/28/08

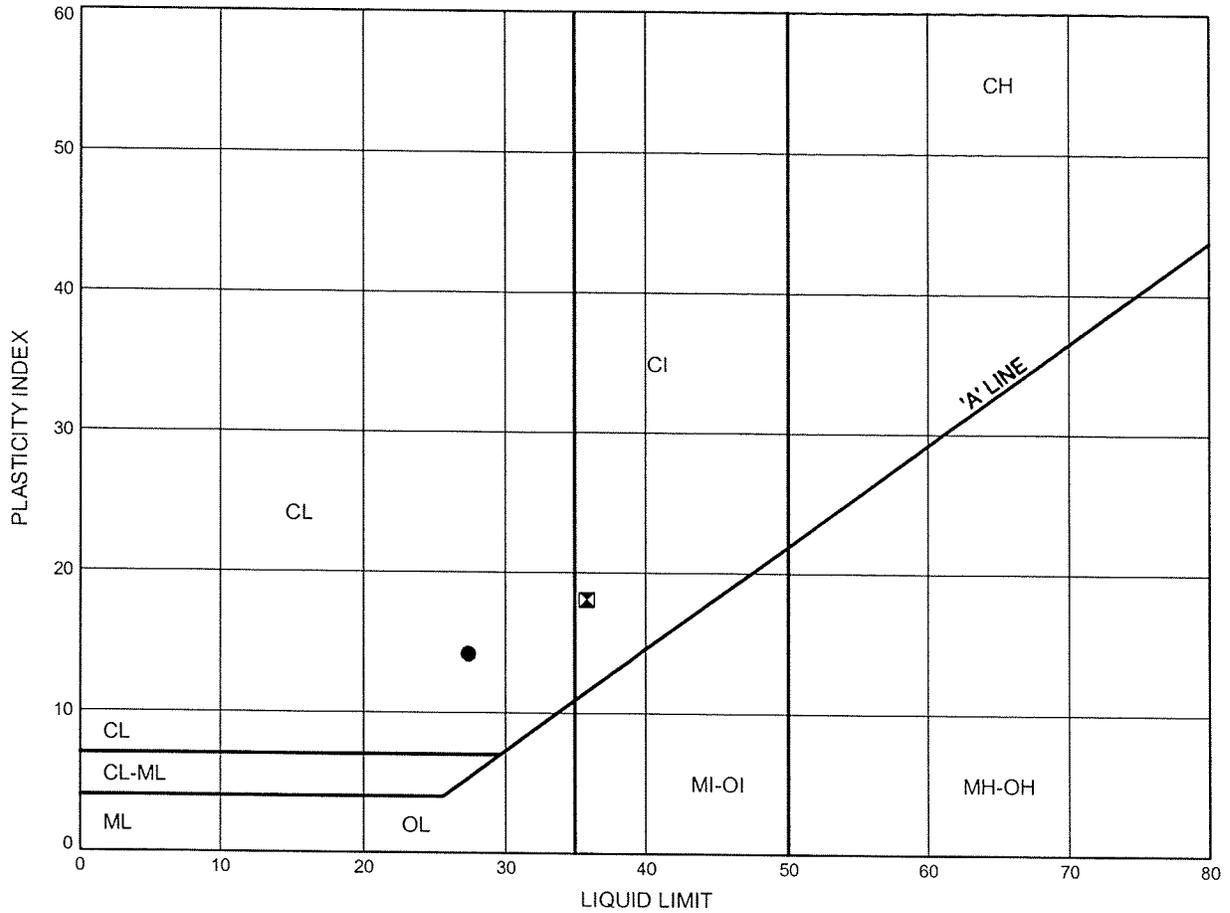
W.P.# 408-88-00  
 Prepared By AN  
 Checked By RPR



# Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B5

## Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-041	14.02	312.28
⊠	08-042	9.45	313.33

THURBALT 6417R.GPJ 10/28/08

Date October 2008  
Project 408-88-00

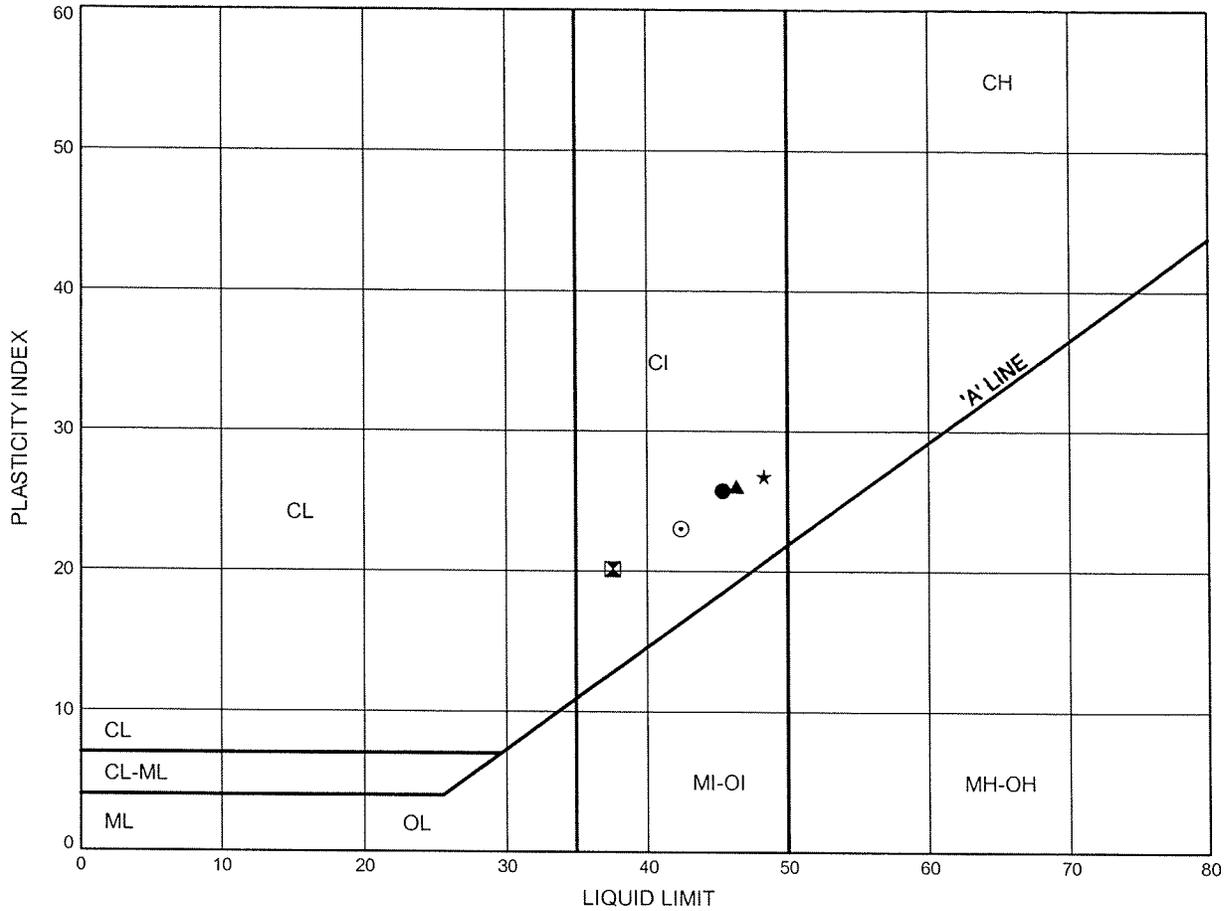


Prep'd AN  
Chkd. RPR

Highway 7 - New  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6

Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-041	20.12	306.18
⊠	08-041	24.61	301.69
▲	08-041	29.26	297.04
★	08-042	12.50	310.29
⊙	08-042	18.59	304.19

THURBALT 6417R.GPJ 10/29/06

Date October 2008  
 Project 408-88-00



Prep'd AN  
 Chkd. RPR



## Appendix C

### Analytical Laboratory Test Results (Present Investigation)



## FINAL REPORT

CA14437-AUG19 R1

11375 Hwy 7 New, Kitchener

Prepared for

**Thurber Engineering Ltd.**

## First Page

### CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **103, 2010 Winston Park Drive  
Oakville, ON  
L6H 5R7, Canada**

Contact **Nancy Berg**

Telephone **905-829-8666 x 228**

Facsimile

Email **nberg@thurber.ca**

Project **11375 Hwy 7 New, Kitchener**

Order Number

Samples **Soil (5)**

### LABORATORY DETAILS

Project Specialist **Rob Irwin B.Sc., C.Chem**

Laboratory **SGS Canada Inc.**

Address **185 Concession St., Lakefield ON, K0L 2H0**

Telephone **705-652-2361**

Facsimile **705-652-6365**

Email **rob.irwin@sgs.com**

SGS Reference **CA14437-AUG19**

Received **08/13/2019**

Approved **08/19/2019**

Report Number **CA14437-AUG19 R1**

Date Reported **08/19/2019**

### COMMENTS

Temperature of Sample upon Receipt: 4 degrees C  
Cooling Agent Present: yes  
Custody Seal Present: no

Chain of Custody Number: 009972

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

### SIGNATORIES

Rob Irwin B.Sc., C.Chem



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# FINAL REPORT

CA14437-AUG19 R1

Client: Thurber Engineering Ltd.

Project: 11375 Hwy 7 New, Kitchener

Project Manager: Nancy Berg

Samplers: Nancy Berg

## PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------

### Corrosivity Index

Corrosivity Index	none	1	4	1	5	11	14
Soil Redox Potential	mV	-	306	312	255	263	227
Sulphide	%	0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02
pH	pH Units	0.05	8.56	8.29	7.88	8.18	8.66
Resistivity (calculated)	ohms.cm	-9999	5100	3200	2500	780	1400

## PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------

### General Chemistry

Conductivity	uS/cm	2	195	317	400	1280	736
--------------	-------	---	-----	-----	-----	------	-----

## PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------

### Metals and Inorganics

Moisture Content	%	0.1	20.1	6.1	24.6	13.1	6.5
Sulphate	µg/g	0.4	25	12	100	31	13



# FINAL REPORT

CA14437-AUG19 R1

**Client:** Thurber Engineering Ltd.

**Project:** 11375 Hwy 7 New, Kitchener

**Project Manager:** Nancy Berg

**Samplers:** Nancy Berg

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9
Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019

Parameter	Units	RL	Result	Result	Result	Result	Result
Other (ORP)							
Chloride	µg/g	0.4	25	7.8	60	760	430

## QC SUMMARY

### Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0262-AUG19	µg/g	0.4	<0.4	9	20	93	80	120	98	75	125
Sulphate	DIO0262-AUG19	µg/g	0.4	<0.4	13	20	94	80	120	96	75	125

### Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0029-AUG19	%	0.02	<0.02	ND	20	110	80	120			

### Conductivity

Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0246-AUG19	uS/cm	2	< 0.002	0	10	100	90	110	NA		

## QC SUMMARY

### pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0246-AUG19	pH Units	0.05	NA	0		100			NA		

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

**LEGEND**

---

**FOOTNOTES**

**NSS** Insufficient sample for analysis.  
**RL** Reporting Limit.  
    ↑ Reporting limit raised.  
    ↓ Reporting limit lowered.  
**NA** The sample was not analysed for this analyte  
**ND** Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full. This report supersedes all previous versions.

-- End of Analytical Report --

## Request for Laboratory Services and CHAIN OF CUSTODY

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment  
 - London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8080 Fax: 519-672-0361

### Laboratory Information Section - Lab use only

Received By: Oleg Mozhin  
 Received Date (mm/dd/yy): 8/15/19 (mm/dd/yy)  
 Received Time: 11:05

Received By (signature): [Signature]  
 Custody Seal Present:  NO  
 Custody Seal Intact:  NO

Cooling Agent Present:  Ice  
 Temperature Upon Receipt (°C): 9.90/9.0

LAB LIMS #: 0A14437-AUG19

REPORT INFORMATION		INVOICE INFORMATION		PROJECT INFORMATION	
Company: <u>Thurber Engineering Ltd</u> Contact: <u>Nancy Berg</u> Address: <u>103 - 2010 Winston Peak Dr</u> <u>Oakville On L6H 5A7</u> Phone: <u>647-633-8417</u> Email: <u>nberg@thurber.ca</u> Email: _____		<input type="checkbox"/> (same as Report Information) Company: _____ Contact: _____ Address: _____ Phone: _____ Email: _____		Quotation #: _____ P.O. #: _____ Project #: <u>11375</u> Site Location/ID: <u>How 7 New, Kitchens</u> <b>TURNAROUND TIME (TAT) REQUIRED</b> TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day <input checked="" type="checkbox"/> Regular TAT (5-7days) <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3 Days <input type="checkbox"/> 4 Days <b>RUSH TAT (Additional Charges May Apply):</b> <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3 Days <input type="checkbox"/> 4 Days <b>PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION</b> Specify Due Date: _____ Rush Confirmation ID: _____	
<b>REGULATIONS</b> <b>Regulation 153/04:</b> <input type="checkbox"/> R/P/I <input type="checkbox"/> Soil Texture: <input type="checkbox"/> Coarse <input type="checkbox"/> Medium <input type="checkbox"/> Fine <input type="checkbox"/> Table 1 <input type="checkbox"/> I/C/C <input type="checkbox"/> A/O <input type="checkbox"/> Table 2 <input type="checkbox"/> PWQO <input type="checkbox"/> MMER <input type="checkbox"/> Other: <input type="checkbox"/> Table 3 <input type="checkbox"/> C/CME <input type="checkbox"/> MISA <input type="checkbox"/> Table _____ <input type="checkbox"/> MSA <b>Other Regulations:</b> <input type="checkbox"/> Reg 347/558 (3 Day min TAT) <b>Sewer By-Law:</b> <input type="checkbox"/> Sanitary <input type="checkbox"/> Storm <input type="checkbox"/> Municipality: _____					
<b>RECORD OF SITE CONDITION (RSC)</b> <input type="checkbox"/> YES <input type="checkbox"/> NO					
SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	COMMENTS:
1 CN16-10 555	July 19/19		1	soil	
2 CN16-04 554	July 23/19		1	soil	
3 CN16-15 554	July 18/19		1	soil	
4 RW24-02 554	Aug 6/19		1	soil	
5 NE16-09 554	Aug 7/19		1	soil	
6					
7					
8					
9					
10					
11					
12					
Observations/Comments/Special Instructions					
Sampled By (NAME): <u>Nancy Berg</u> Signature: <u>[Signature]</u> Date: <u>08/15/19</u> (mm/dd/yy)				Pink Copy - Client	
Relinquished by (NAME): <u>Nancy Berg</u> Signature: <u>[Signature]</u> Date: <u>08/15/19</u> (mm/dd/yy)				Yellow & White Copy - SGS	



## Appendix D

### Borehole Locations and Soil Strata Drawing

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

CONT No  
GWP No 408-88-00



METROLINX RAILWAY BRIDGE  
FROM WELLINGTON ST N TO EDNA ST  
CONNECTION AND E-S RAMP  
BOREHOLE LOCATIONS PLAN

SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

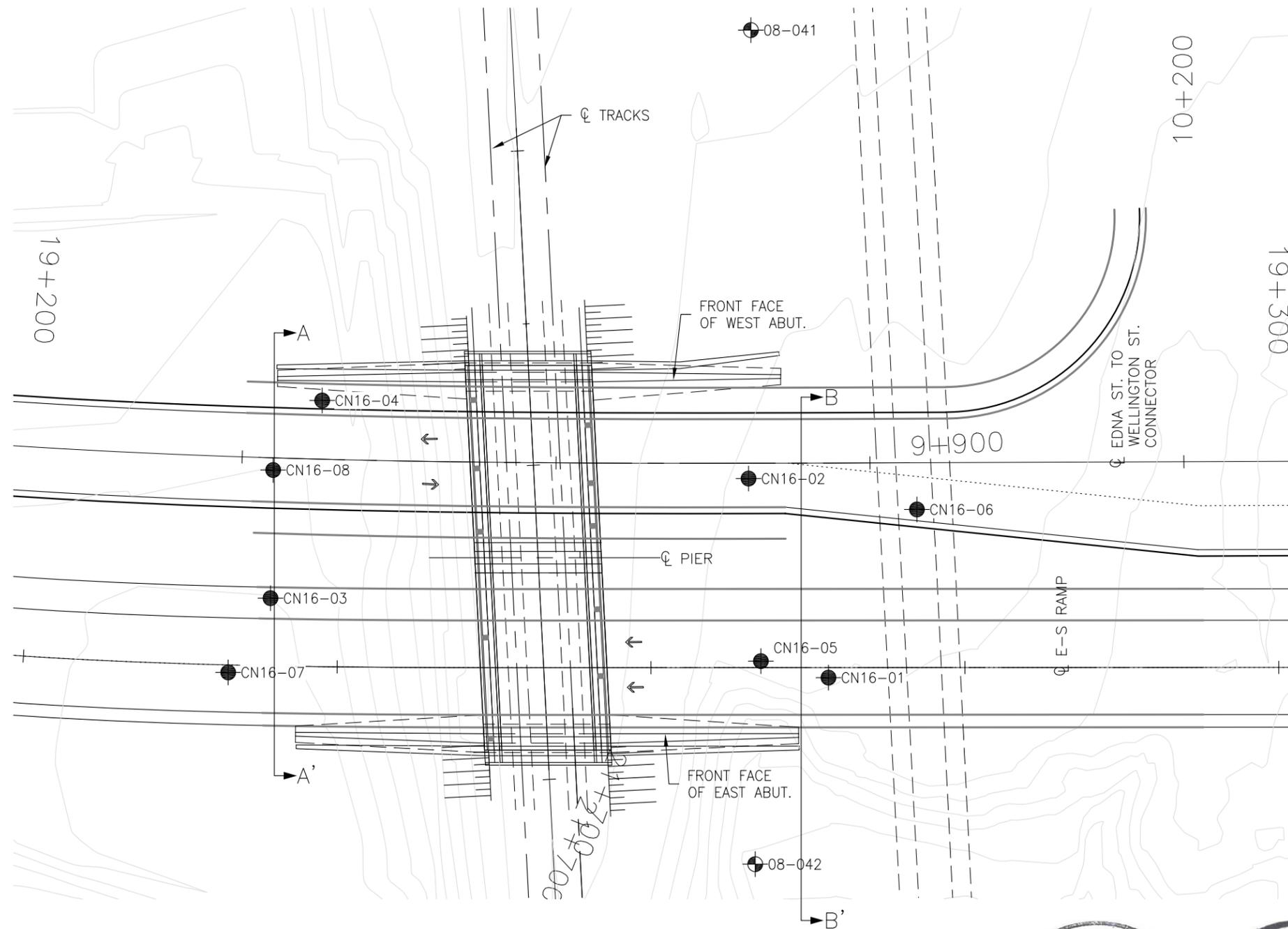
- Borehole (Current Investigation)
- ⊕ Borehole (Previous Investigation By Thurber)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ∇ Water Level
- ⊕ Head Artesian Water
- ⊕ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
08-041	326.3	4 814 110.3	226 090.8
08-042	322.8	4 814 134.4	226 152.5
CN16-01	325.5	4 814 134.5	226 136.6
CN16-02	326.1	4 814 122.9	226 124.1
CN16-03	321.3	4 814 090.7	226 146.6
CN16-04	323.3	4 814 089.0	226 130.4
CN16-05	325.5	4 814 129.0	226 137.3
CN16-06	325.9	4 814 136.3	226 121.6
CN16-07	320.8	4 814 089.7	226 153.3
CN16-08	322.0	4 814 087.3	226 137.0

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P8-278

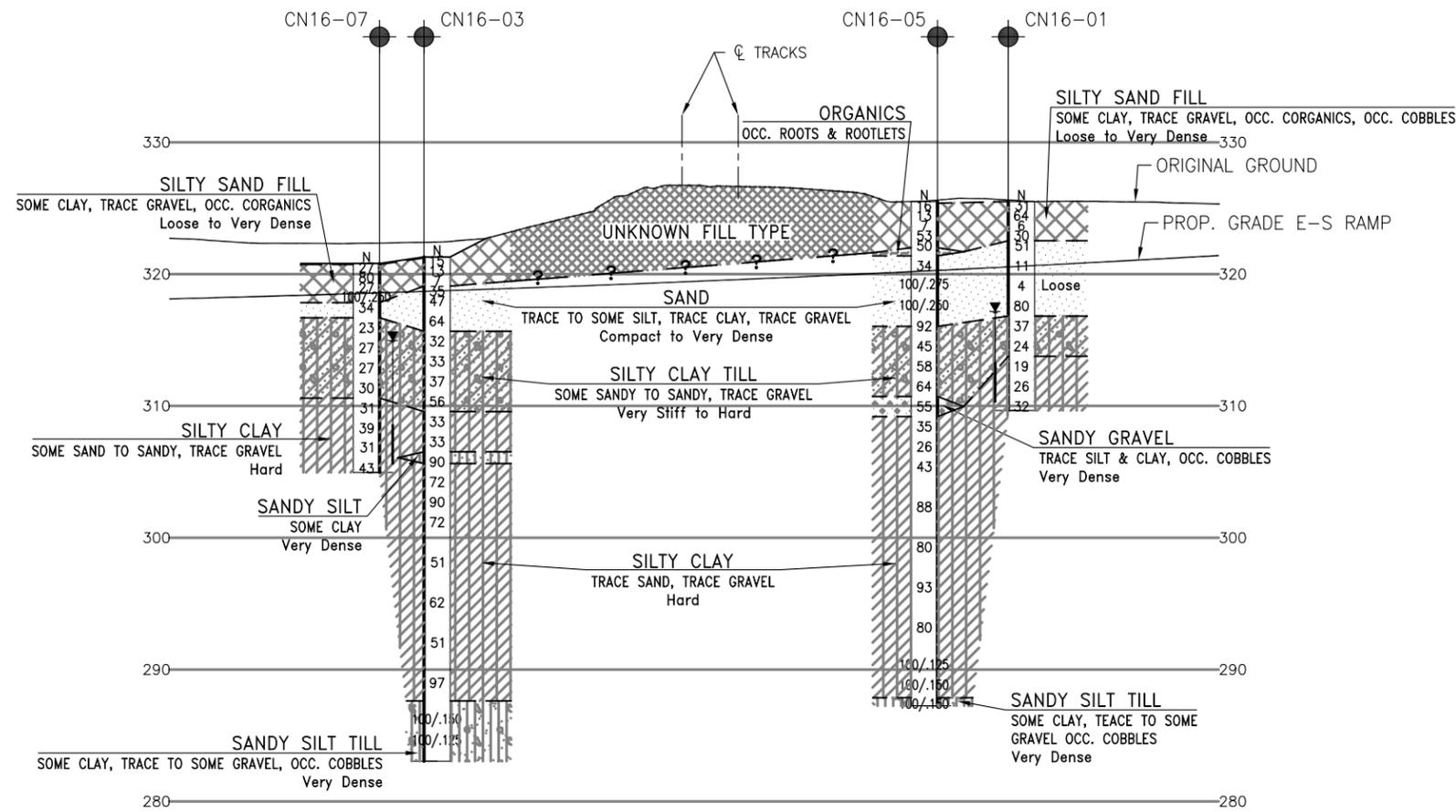


PLAN

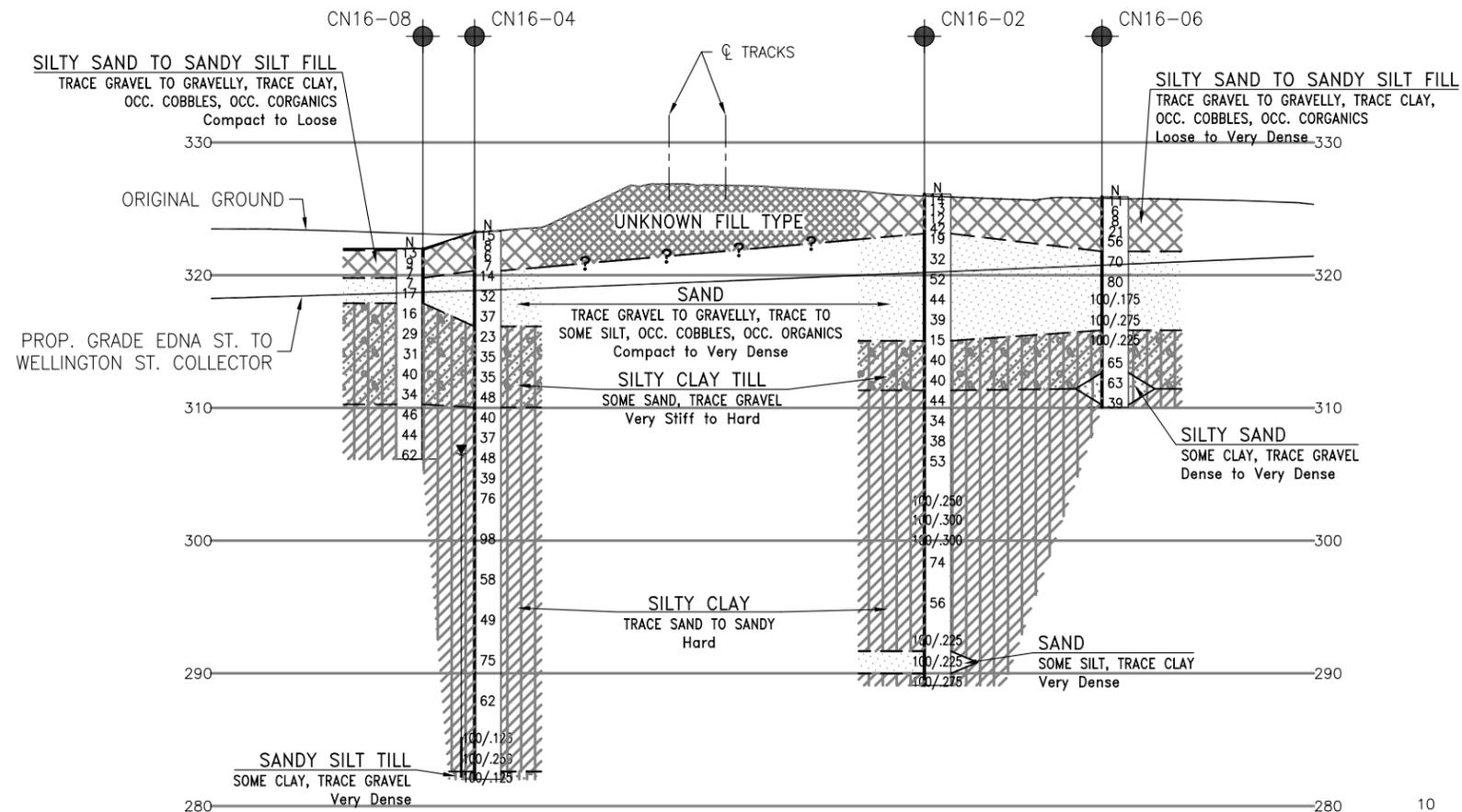


REVISIONS	DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE	LOAD	DATE	JUN 2020
DRAWN	AN	CHK	NB	SITE	STRUCT	DWG	1



PROFILE ALONG EAST ABUTMENT



PROFILE ALONG WEST ABUTMENT

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

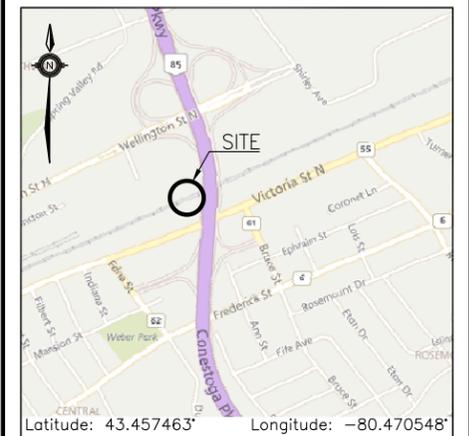
CONT No  
GWP No 408-88-00

METROLINX RAILWAY BRIDGE  
FROM WELLINGTON ST N TO EDNA ST  
CONNECTION AND E-S RAMP  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



THURBER ENGINEERING LTD.



Latitude: 43.457463° Longitude: -80.470548°

KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
08-041	326.3	4 814 110.3	226 090.8
08-042	322.8	4 814 134.4	226 152.5
CN16-01	325.5	4 814 134.5	226 136.6
CN16-02	326.1	4 814 122.9	226 124.1
CN16-03	321.3	4 814 090.7	226 146.6
CN16-04	323.3	4 814 089.0	226 130.4
CN16-05	325.5	4 814 129.0	226 137.3
CN16-06	325.9	4 814 136.3	226 121.6
CN16-07	320.8	4 814 089.7	226 153.3
CN16-08	322.0	4 814 087.3	226 137.0

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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GEORES No. 40P8-278



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	PKC	CODE	LOAD	DATE	JUN 2020
DRAWN	AN	CHK	NB	SITE	STRUCT	DWG 2

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

CONT No  
GWP No 408-88-00

METROLINX RAILWAY BRIDGE  
FROM WELLINGTON ST N TO EDNA ST  
CONNECTION AND E-S RAMP  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

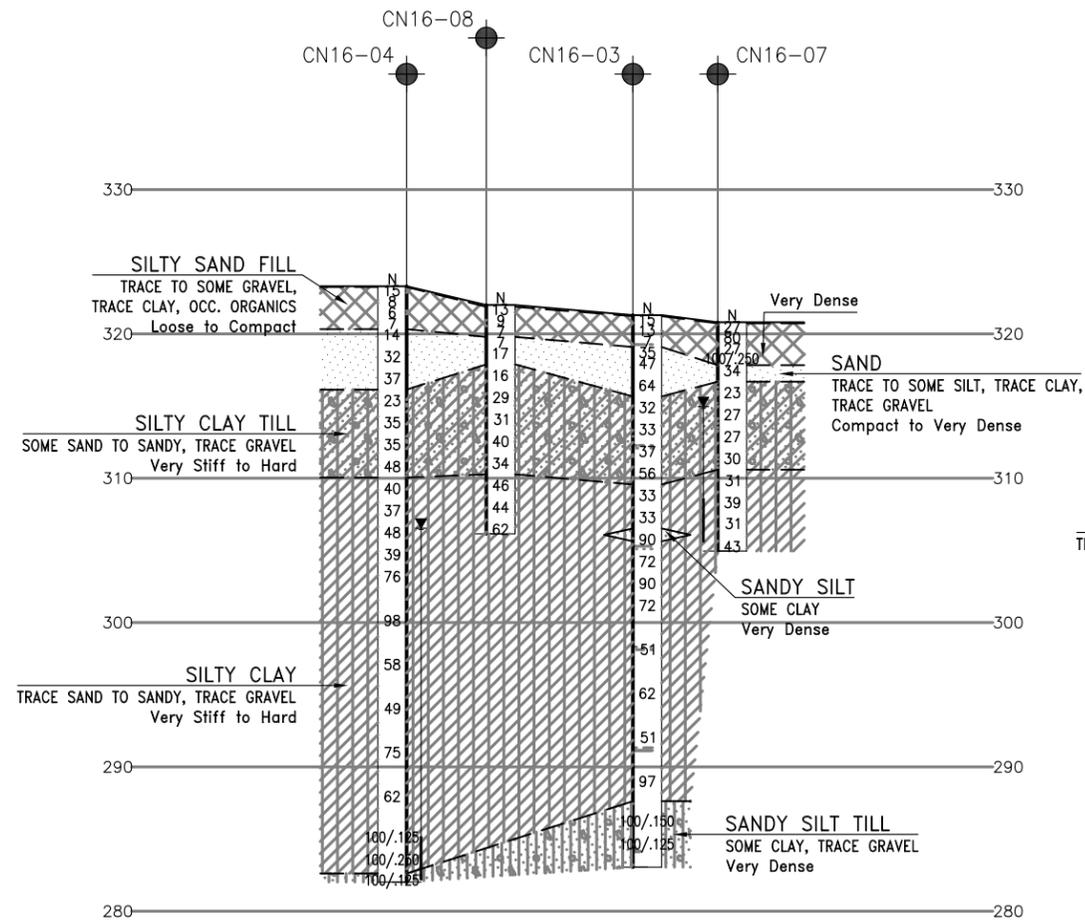
- Borehole (Current Investigation)
- Borehole (Previous Investigation By Thurber)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
08-041	326.3	4 814 110.3	226 090.8
08-042	322.8	4 814 134.4	226 152.5
CN16-01	325.5	4 814 134.5	226 136.6
CN16-02	326.1	4 814 122.9	226 124.1
CN16-03	321.3	4 814 090.7	226 146.6
CN16-04	323.3	4 814 089.0	226 130.4
CN16-05	325.5	4 814 129.0	226 137.3
CN16-06	325.9	4 814 136.3	226 121.6
CN16-07	320.8	4 814 089.7	226 153.3
CN16-08	322.0	4 814 087.3	226 137.0

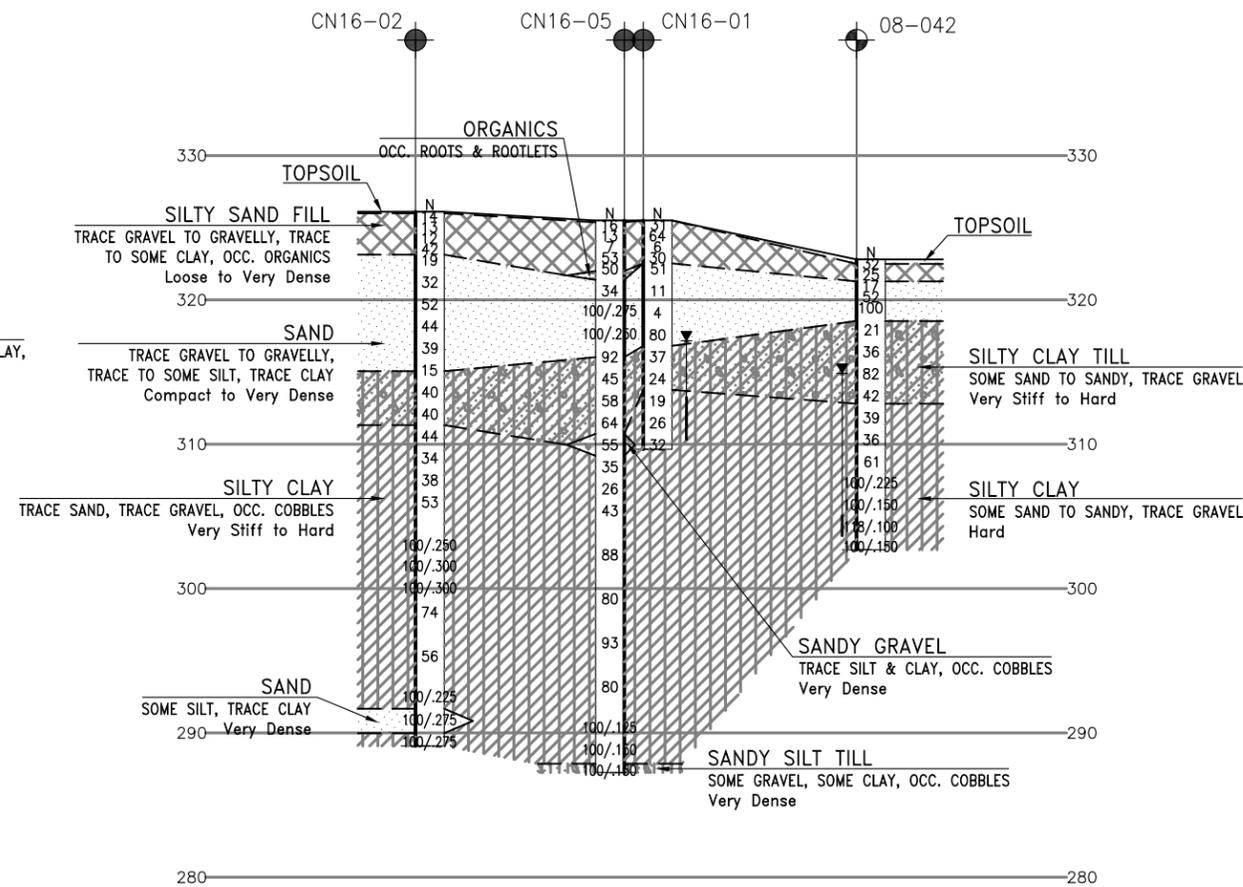
-NOTES-

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

GEOCRES No. 40P8-278



SECTION ALONG A-A'



SECTION ALONG B-B'



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE	LOAD	DATE	JUN 2020
DRAWN	AN	CHK	NB	SITE	STRUCT	DWG	3