



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
PROPOSED RETAINING WALLS AT HIGHWAY 85 AND FREDERICK STREET
HIGHWAY 7- NEW, KITCHENER TO GUELPH
G.W.P. 3005-20-00**

GEOCRES NO. 40P8-290

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Report

to

WSP

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TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTION.....	1
3.0	SITE INVESTIGATION AND FIELD TESTING.....	2
4.0	LABORATORY TESTING.....	5
5.0	DESCRIPTION OF SUBSURFACE CONDITIONS.....	5
5.1	SE Retaining Wall Site #33X-0497/W0 (Sta. 20+900 to 21+241 - Appendix A)...	5
5.1.1	Topsoil.....	6
5.1.2	Asphalt.....	6
5.1.3	Granular Fill.....	6
5.1.4	Sand.....	7
5.1.5	Silty Clay.....	8
5.1.6	Sandy Silt to Silty Sand.....	9
5.1.7	Groundwater Conditions.....	10
5.2	NE Retaining Wall Site #33X-0538/W0 (Sta. 21+276 to 21+455 – Appendix B).....	11
5.2.1	Asphalt.....	11
5.2.2	Granular Fill.....	11
5.2.3	Upper Sand.....	12
5.2.4	Silty Clay.....	13
5.2.5	Silt and Sand.....	15
5.2.6	Lower Sand.....	15
5.2.7	Groundwater Conditions.....	16
5.3	NW Retaining Wall Site #33X-0860/W0 (Sta. 10+202 to 10+295 – Appendix C).....	17
5.3.1	Asphalt.....	17
5.3.2	Granular Fill.....	17
5.3.3	Sand.....	18
5.3.4	Clayey Silt.....	18
5.3.5	Silty Clay.....	19
5.3.6	Silty Sand and Sandy Silt.....	20
5.3.7	Groundwater Conditions.....	20
5.4	SW Retaining Wall Site #33X-0861/W0 (Sta. 10+322 to 10+339 – Appendix D).....	21
5.4.1	Asphalt.....	21



5.4.2	Granular Fill.....	21
5.4.3	Sand.....	22
5.4.4	Upper Clayey Silt/ Silty Clay.....	22
5.4.5	Sandy Silt to Silty Sand.....	23
5.4.6	Lower Silty Clay.....	24
5.4.7	Silty Clay Till.....	25
5.4.8	Groundwater Conditions.....	25
6.0	CORROSIVITY AND SULPHATE TEST RESULTS.....	26
7.0	MISCELLANEOUS.....	26

APPENDICES

Appendix A	SE Retaining Wall Site #33X-0497/W0 – (Boreholes RW01-01 to RW01-07)
Appendix B	NE Retaining Wall Site #33X-0538/W0 – (Boreholes RW02-02 to RW02-04, RW01 to RW-04)
Appendix C	NW Retaining Wall Site #33X-0860/W0 – (Boreholes RW16-01 to RW16-03)
Appendix D	SW Retaining Wall Site #33X-0861/W0 – (Borehole BH20-01)
Appendix E	Corrosivity Results

Appendices A to D include:

- Record of Borehole Sheets
- Laboratory Test Results
- Drawing titled “Borehole Locations and Soil Strata”



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PART 1: FACTUAL INFORMATION

1.0 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at four (4) proposed standalone retaining walls (i.e. 33X-0497/W0, 33X-0538/W0, 33X0860/W0 and 33X-0861/W0) within the vicinity of the proposed Frederick Street bridge replacement along the existing Kitchener-Guelph Expressway (KWE - Highway 85) corridor in the Regional Municipality of Waterloo, Ontario.

The purpose of the investigations was to explore the subsurface conditions at the proposed retaining wall sites and, based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and written descriptions of the subsurface conditions. Models of the subsurface conditions under the proposed retaining walls 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:

- Foundation investigation and design report for Northeast Corner Retaining Wall, Frederick Street Underpass, Site No. 33-234, G.W.P. 3110-09-00, City of Kitchener, Ontario, prepared by Peto MacCallum Ltd., PML Ref. 10KF079C, Geocres No. 40P8-199, dated May 31,2012 (Reference 1).

2.0 SITE DESCRIPTION

The site is located in the City of Kitchener, approximately 350 m south of the Kitchener-Waterloo Expressway and Victoria Street interchange, where the Frederick Street crosses over the KWE. There is an underpass structure present at this site which carries Frederick Street over the northbound and southbound lanes (NBL and SBL) and existing ramps (E-S and S-E) of the KWE.



The existing cut slopes to the north and south of the bridge are retained by concrete wingwalls which extend from the ends of the bridge abutments.

The area outside of the KWE corridor is surrounded by industrial and commercial lands and is generally flat.

The designations and approximate locations of the proposed retaining walls are as follows:

Table 3.1 – Retaining Wall Details

Site No.	Location	Approx. Chainage (From)	Approx. Chainage (To)	Approx. Length (m)	Approx. Maximum Exposed Height (m)
33X-0497/W0	South of Frederick Street and east of the KWE	20+900	21+241	341	6.0
33X-0538/W0	North of Frederick Street and east of the KWE	21+276	21+455	179	7.2
33X-0860/W0	North of Frederick Street and west of the KWE	10+202	10+295	93	6.6
33x-0861/W0	South of Frederick Street and west of the KWE	10+322	10+339	17	5.4

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 kames or kame moraines, with outwash sands occupying the intervening hollows.

3.0 SITE INVESTIGATION AND FIELD TESTING

The current site investigation for the proposed walls was carried out between May 6, 2018 and August 19, 2020 at which time a total of fourteen (14) boreholes were advanced at the site. Four boreholes were previously drilled by Peto MacCallum Ltd. between April 8, 2011 and July 20, 2011.

A summary of the borehole locations, designations, borehole termination depths and termination elevations for each retaining wall is provided in Table 3.2. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets. Record of Borehole Sheets for each retaining wall are included in Appendices A to D.



Table 3.2 – Borehole Designations

Site No.	Approx. Chainage (From)	Approx. Chainage (To)	Boreholes	Borehole Termination Depth (m)	Borehole Termination Elevation (m)	Appendix
33X-0497/W0	20+900	21+241	RW01-01 to RW01-07	11.1 to 14.3	313.8 to 305.7	A
33X-0538/W0	21+276	21+455	RW02-02 to RW02-04, RW-1 to RW-4	6.4 to 17.4	316.5 to 301.7	B
33X-0860/W0	10+202	10+295	RW16-01 to RW16-03	11.3 to 12.5	310.0 to 307.4	C
33X-0861/W0	10+322	10+339	BH 20-01	38.3	289.2	D

The boreholes were drilled near the retaining wall alignments, with one borehole at each end and an approximate 50 m spacing in between boreholes with the exception of SW retaining wall (33X-0861/W0), where no borehole was drilled within its footprint. BH 20-01 drilled for the West Abutment of the proposed Frederick St. Bridge was the closest to the north end of this proposed SW retaining wall.

The approximate locations of the boreholes are shown on the drawings included in Appendices A through D.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations. All of the boreholes were drilled on MTO property and did not require Permission to Enter (PTE) to be obtained.

The boreholes were drilled using a track-mounted drill rig and the boreholes were advanced using 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) in the native soils.

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. Results of field drilling and sampling of the investigation are presented on the Record of Borehole sheets in Appendices A to D.

Groundwater conditions in the open boreholes were observed during the drilling operations. One (1) piezometer was installed in borehole RW01-04 and one piezometer was installed in BH 20-01



to permit for longer term monitoring of groundwater levels. The piezometer consisted of a 19 mm diameter PVC pipe with a 3.0 m slotted screen enclosed in filter sand. The locations and completion details of the piezometer is summarized in Table 3.3 along with the borehole completion details. The completion of the boreholes and the standpipe piezometers were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07). The boreholes were decommissioned following completion of drilling in accordance with O.Reg. 903 (as amended).

Table 3.3 – Borehole Completion Details

Site No.	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
33X-0497/W0	RW01-01	14.3/311.7	-	Borehole backfilled with grout to 4.3 m, bentonite holeplug to 0.2 m, then asphalt to surface.
	RW01-02	11.1/313.8	-	Borehole backfilled with grout to 3.7 m, bentonite holeplug to 0.1 m, then asphalt to surface.
	RW01-03	14.1/313.7	-	Borehole backfilled with bentonite holeplug to surface.
	RW01-04	14.0/312.8	13.7/313.1	Piezometer with 3.0 m slotted screen installed with sand filter from 14.0 m to 9.7 m, bentonite holeplug from 9.7 m to ground surface.
	RW01-05	14.3/307.1	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-06	14.3/306.2	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-07	14.3/305.7	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
33X-0538/W0	RW02-02	13.3/306.2	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-03	15.8/303.6	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-04	17.4/301.7	-	Borehole backfilled with bentonite holeplug to 0.6 m, sand to 0.2 m, then asphalt to surface.
33X-860/W0	RW16-01	11.3/310.0	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW16-02	11.3/309.1	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.



Site No.	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	RW16-03	12.5/307.4	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
33X-0861/W0	BH20-01	38.3/289.2	19.8/307.7	Piezometer with 3.0 m slotted screen installed with sand filter from 19.8 m to 15.8 m, bentonite holeplug to 13.7 m, and grout from 13.7 m to surface

4.0 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 included in Appendix A through D. The results of the previous investigation completed by Peto MacCallum are included in Appendix B.

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 the native soil from the retaining walls 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 E.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendices A to D and depicted on the “Borehole Locations and Soil Strata” drawings for each retaining wall alignments in these appendices. An overall description of the stratigraphy encountered in the current boreholes advanced at each retaining wall site 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.

5.1 SE Retaining Wall Site #33X-0497/W0 (Sta. 20+900 to 21+241 - Appendix A)

In general, the soil stratigraphy at this site consisted of surficial topsoil or asphalt overlying a granular fill layer, a layer of native sand, silty clay, and a layer of sandy silt to silty sand.



5.1.1 Topsoil

A layer of topsoil was encountered surficially in two boreholes drilled at this site, RW01-03 and RW01-04. It was generally dark brown in colour. The thickness of the topsoil layer ranged from 0.15 m to 0.2 m. The topsoil thickness may vary between the borehole locations and in other areas of the site.

5.1.2 Asphalt

Asphalt with a thickness of 100 mm was encountered at Boreholes RW01-01, RW01-02 and RW01-05. Asphalt with a thickness of 75 mm was encountered at Boreholes RW01-06 and RW01-07.

5.1.3 Granular Fill

Granular fill was encountered immediately below the asphalt at five boreholes at this site, Boreholes RW01-01, RW01-02 and RW01-05 to RW01-07. Granular fill was encountered immediately below the topsoil at Boreholes RW01-03 and RW01-04.

The granular fill consisted of sand to sand and gravel, generally brown in colour, with trace silt to silty and trace clay. Occasional organics were encountered in the granular fill in Borehole RW01-04. A layer of silt fill was also encountered below the sand fill in Boreholes RW01-02 and RW01-03, with trace to some sand and trace clay to clayey.

The thickness of the granular fill ranged from 0.6 m to 3.0 m, with the lower boundary of this layer encountered at depths of 0.7 m to 3.2 m (Elevation 324.6 to 319.4).

SPT N-values recorded in the granular fill ranged from 4 to 36 blows for 0.3 m penetration, indicating a loose to dense relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 27 percent.

Three samples of the granular fill underwent laboratory gradation analysis, and one sample of the clayey silt fill underwent Atterberg limits testing. 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 the Atterberg Limits tests are plotted on Figure A5. The results of this testing are summarized as follows:



Soil Particles	Granular Fill (%)
Gravel	0 to 32
Sand	0 to 46
Silt	22 to 76
Clay	5 to 27

Index Property	
Liquid Limit	20
Plastic Limit	13
Plasticity Index	7

The above results indicate that the clayey silt fill is of low plasticity with a group symbol of CL-ML.

5.1.4 Sand

A native sand layer was encountered below the granular fill in all boreholes at this site, Boreholes RW01-01 to RW01-07. The sand layer was encountered at depths ranging from 0.7 m to 3.2 m (Elevation 324.6 to 319.4).

The sand layer was brown in colour and contained some silt to silty, trace clay and trace gravel.

The thickness of the sand ranged from 0.6 m to 4.0 m, with the lower boundary of the sand layer encountered at depths ranging from 1.3 m to 7.2 m (Elevation 321.2 to 317.7).

SPT N-values recorded in the sand ranged from 5 to 37 blows for 0.3 m penetration, indicating a loose to dense relative density.

Moisture content of samples of the sand generally ranged from 4 percent to 23 percent.

Three samples of the sand 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 A2. The results of this testing are summarized as follows:



Soil Particles	Sand (%)
Gravel	0 to 3
Sand	76 to 81
Silt	16 to 19
Clay	2 to 5

5.1.5 Silty Clay

Silty clay was encountered below the sand layer in all boreholes, RW01-01 to RW01-07, at depths ranging from 1.3 m to 7.2 m (Elevation 321.2 to 317.7).

A 4.0 to 5.4 m thick silty sand to sandy silt layer was encountered within the silty clay in Boreholes RW01-05 and RW01-06.

The silty clay was grey and contained some trace to some sand and trace gravel.

The thickness of the silty clay layer where fully penetrated ranged from 1.3 m to 10.4 m, with the lower boundary of the silty clay encountered at depths ranging 5.6 m to 11.7 m (Elevation 319.3 to 308.3). Boreholes RW01-05 and RW01-06 were terminated in the silty clay layer at a depth of 14.3 m for both boreholes (Elevation 307.1 and 306.2).

SPT N-values recorded in the silty clay ranged from 7 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a firm to hard consistency (typically very stiff to hard).

The natural moisture content of samples of the silty clay ranged from 11 percent to 28 percent.

Six 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 the grain size distribution curves for these samples are plotted on Figure A3 of Appendix A. The results of the Atterberg Limits tests are plotted on Figure A6.

Soil Particles	Silty Clay (%)
Gravel	0 to 2
Sand	1 to 10
Silt	39 to 50
Clay	41 to 59



Index Property	
Liquid Limit	28 to 49
Plastic Limit	13 to 23
Plasticity Index	15 to 27

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

5.1.6 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand was encountered below the silty clay layer in Boreholes RW01-01 to RW01-04 at depths ranging from 5.6 m to 10.0 m (Elevation 319.3 to 316.8), and within the larger silty clay layer in Boreholes RW01-05 and RW01-06, at depths of 6.3 m and 7.2 m (Elevation 315.1 and 313.4), respectively.

Sandy silt to silty sand was also encountered below the silty clay layer in Borehole RW01-07 at a depth of 11.7 m (Elevation 308.3).

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

Boreholes RW01-01, to RW01-04 were terminated in the sandy silt to silty sand layer at depths ranging from 11.1 to 14.3 m (Elevation 313.8 to 311.7). Borehole RW01-07 was terminated in the sandy silt to silty sand at a depth of 14.3 m (Elevation 305.7).

The thickness of the sandy silt to silty sand encountered within the silty clay, in Boreholes RW01-05 and RW01-06 where the layer was fully penetrated, was 4.0 to 5.4 m, with the lower boundary of the sandy silt to silty sand encountered at depths from 11.2 to 11.7 m (Elevation 309.7 to 309.4).

SPT N-values recorded in the sandy silt to silty sand ranged from 30 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a dense to very dense relative density.

Moisture content of samples of the sandy silt to silty sand generally ranged from 10 percent to 22 percent.

Seven samples of the sandy silt to silty sand underwent laboratory gradation analysis, and one sample underwent Atterberg limits testing. The 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 A5 of Appendix A. The results of the Atterberg Limits tests are plotted on Figure A7. The results of this testing are summarized as follows:

Soil Particles	Sandy Silt to Silty Sand (%)
Gravel	0
Sand	22 to 72
Silt	26 to 68
Clay	1 to 19

Index Property	
Liquid Limit	17
Plastic Limit	12
Plasticity Index	5

The above results indicate one sample of the silty sand to sandy silt of low plasticity with a group symbol of CL-ML, indicating the possibility of silt or clay lenses within the silty sand to sandy silt.

5.1.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. One standpipe piezometer was installed at this site, in Borehole RW01-04, to monitor water levels after completion of drilling. The water levels measured in the piezometer 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	
RW01-01	Sept 24, 2019	2.2	323.8	Open borehole
RW01-02	Sept 24, 2019	3.2	321.7	Open borehole
RW01-03	June 05, 2018	5.0	322.8	Open borehole
RW01-04	June 25, 2018	4.9	321.9	Piezometer
RW01-05	Aug 12, 2019	4.1	317.3	Open borehole



Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW01-06	Aug 13, 2019	2.3	318.2	Open borehole
RW01-07	Aug 14, 2019	4.1	315.9	Open borehole

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.

Upon completion of drilling, Borehole RW01-05 caved-in at 7.9 m, and Borehole RW01-07 caved-in at 8.2 m.

5.2 NE Retaining Wall Site #33X-0538/W0 (Sta. 21+276 to 21+455 – Appendix B)

In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of silty clay, a layer of silt and sand, and a layer of sand. A layer of upper sand was encountered in Boreholes RW-03 and RW-04.

It should be noted that Borehole RW-03 and RW-04 were drilled behind the retaining wall and on the embankment, and not shown within the stratigraphy profiles.

5.2.1 Asphalt

Asphalt with thicknesses ranging from 112 mm to 200 mm was encountered surficially at Boreholes RW02-02 to RW02-04. Asphalt was also encountered surficially at Boreholes RW01 and RW-02.

5.2.2 Granular Fill

Granular fill consisting of sand was encountered immediately below the asphalt at Boreholes RW02-02 to RW02-04, RW01 and RW-02.

The granular fill below the asphalt consisted of sand generally brown in colour with gravel, trace silt to silty and trace clay.

The thickness of the granular fill ranged from 0.5 m to 1.4 m, with the lower boundary of this layer encountered at depths of 0.6 m to 1.4 m (Elevation 318.8 to 318.3).



Additionally, granular fill was encountered surficially in Boreholes RW-03 and RW-04 behind the retaining wall, in a previous investigation by others.

The granular fill in Boreholes RW-03 and RW-04 consisted of silty sand, silt, gravelly sand and contained clayey silt fill layers, generally brown in colour. The thickness of the fill layer was 2.3 m in both boreholes, with the lower boundary encountered at the depth of 2.3 m (Elevation 320.0 and 321.2).

SPT N-values recorded in the granular fill ranged from 3 to 27 blows for 0.3 m penetration, indicating a very loose to compact relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 18 percent.

Six samples of the granular fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figures RW-GS-1 to RW-GS-4 from previous investigations. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	3 to 23
Sand	20 to 68
Silt	11 to 54
Clay	4 to 18

It should be noted that cohesive clayey silt fill layers were observed within the granular fill in Boreholes RW-03 and RW-04.

5.2.3 Upper Sand

An upper native sand layer was encountered below the granular fill layer in Boreholes RW02-02 to RW02-04, at depths ranging from 0.6 m to 0.8 m (Elevation 318.8 to 318.5).

The sand was generally brown in colour, with some silt to silty, trace clay and trace gravel.

The thickness of the upper sand layer in Boreholes RW02-02 to RW02-04 ranged from 3.3 to 4.2 m, with the lower boundary encountered at a depth ranging from 4.1 to 5.0 m (Elevation 315.4 to 314.3).



Additionally, an upper native sand layer was encountered beneath the fill layer in Boreholes RW-03 and RW-04 behind the retaining wall, at the depth of 2.3 m (Elevation 320.0 and 321.2).

The sand was generally brown in colour, with trace to with gravel, trace to some silt and trace clay. The sand encountered in Borehole RW-04 below Elevation 319.7 was gravelly to with gravel.

The thickness of the upper sand layer in Boreholes RW-03 and RW-04 was 2.1 m and 3.6 m, with the lower boundary encountered at the depth of 4.4 m and 5.9 m (Elevation 317.9 and 317.6), respectively.

SPT N-values recorded in the upper sand generally ranged from 9 blows to 34 blows for 0.3 m penetration, indicating a generally compact to dense relative density with local loose layers.

Moisture content of samples of the upper sand generally ranged from 3 percent to 24 percent.

Ten samples of the upper sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B1 and Figure RW-GS-6. The results of this testing are summarized as follows:

Soil Particles	Upper Sand (%)
Gravel	0 to 38
Sand	43 to 94
Silt	3 to 31
Clay	0 to 6

It should be noted that soil descriptions in the “Borehole Locations and Soil Strata” drawing in Appendix B do not include information from Boreholes RW-03 and RW-04.

5.2.4 Silty Clay

Silty clay was encountered below the granular fill in Boreholes RW02-02 to 02-04, RW01 and RW-02 at depths ranging from 1.4 m to 5.9 m (Elevation 318.3 to 314.3).

The silty clay was generally brown to grey in colour and contained trace to with sand and trace gravel.



Borehole RW02-04 was terminated within the silty clay layer at a depth of 17.4 m (Elevation 301.7). Boreholes RW01 and RW-02 were both terminated within the silty clay layer at a depth of 9.8 m (Elevation 309.9).

The thickness of the silty clay layer was 3.8 m and 8.7 m in Boreholes RW02-02 and RW02-03, respectively, with the lower boundary of the silty clay encountered at depths of 7.9 and 13.7 m (Elevation 311.6 and 305.8).

Additionally, silty clay was encountered in Boreholes RW-03 and RW-04 below the upper sand layer at depths of 4.4 m and 5.9 m (Elevation 317.9 and 316.5), respectively. The silty clay was generally brown to grey in colour and contained trace sand, trace gravel and occasional cobbles.

Boreholes RW-03 and RW-04 were terminated in the silty clay at depths of 6.4 m and 7.0 m (Elevation 315.9 and 316.5), respectively.

SPT N-values recorded in the silty clay generally ranged from 6 blows for 0.3 m penetration to 70 blows for 0.15 m penetration, indicating a firm to hard consistency.

The natural moisture content of samples of the silty clay ranged from 9 percent to 41 percent.

Nine samples of the silty clay underwent laboratory gradation analysis and seven samples underwent Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix B and the grain size distribution curves for these samples are plotted on Figure B2 and Figure RW-GS-7 of Appendix B. The results of the Atterberg Limits tests are plotted on Figure B5 and Figure RW-PC-2.

Soil Particles	Silty Clay (%)
Gravel	0 to 7
Sand	0 to 37
Silt	30 to 50
Clay	24 to 69

Index Property	
Liquid Limit	35 to 46
Plastic Limit	17 to 23
Plasticity Index	18 to 27



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

5.2.5 Silt and Sand

A silt and sand layer was encountered below the silty clay in RW02-02. The silt and sand was grey in colour and contained trace clay and trace gravel.

Borehole RW02-02 was terminated within the silt and sand layer at a depth of 12.8 m (Elevation 306.8). A DCPT was performed from the base of the sampled borehole and was terminated at 13.3 m depth (Elevation 306.2) upon DCPT refusal.

SPT N-values recorded in the silt and sand ranged from 83 to 98 blows for 0.3 m penetration, indicating a very dense relative density.

Moisture content of samples of the silt and sand generally ranged from 19 percent to 20 percent.

One sample of the silt and sand underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B3 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Silt and Sand (%)
Gravel	0
Sand	43
Silt	56
Clay	1

5.2.6 Lower Sand

A lower sand layer was encountered below the silty clay in RW02-03. The sand was grey in colour and contained trace to some silt and trace clay.

Borehole RW02-03 was terminated within the lower sand layer at the depth of 15.8 m (Elevation 303.6).

SPT N-values recorded in the lower sand ranged from 43 to 75 blows for 0.3 m penetration, indicating a dense to very dense relative density.



Moisture content of samples of the lower sand ranged from 17 percent to 18 percent.

One sample of the sand underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B4 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Lower Sand (%)
Gravel	0
Sand	87
Silt	10
Clay	3

5.2.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed at this site for previous investigations by others, in Boreholes RW01 and RW-03. The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.2.

Table 5.2.– Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW02-02	Aug 22, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 4.6 m.
RW02-03	Sept 24, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 4.6 m
RW02-04	June 05, 2018	1.5	317.6	Open borehole
RW01 (*)	April 8, 2011	2.9	316.8	Piezometer
RW-02 (*)	April 8, 2011	7.3	312.4	Open borehole
RW-03 (*)	July 19, 2011	Dry	Dry	Piezometer
	Sept 23, 2011	3.3	319.0	
	Oct 8, 2011	3.3	319.0	



Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW-04 (*)	July 20, 2011	N/A	N/A	Water level in open borehole N/A. Cave-in observed at 5 m.

(*) *Peto MacCallum Ltd borehole (Reference 1)*

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.

Upon completion of drilling, Borehole RW02-02 caved-in at 4.6 m, Borehole RW02-03 caved-in at 4.6 m, Borehole RW02-04 caved-in at 8.7 m, Borehole RW-02 caved-in at 8.7 m and Borehole RW-04 caved-in at 5.0 m.

5.3 NW Retaining Wall Site #33X-0860/W0 (Sta. 10+202 to 10+295 – Appendix C)

In general the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand or clayey silt, a layer of silty clay and a lower layer of silty sand to sandy silt..

5.3.1 Asphalt

Asphalt with a thickness of 150 mm was encountered at all boreholes at this site, Boreholes RW16-01, RW16-02 and RW16-03.

5.3.2 Granular Fill

Granular fill consisting of sand and gravel was encountered immediately beneath the asphalt layers for boreholes RW16-02 and RW16-03, and sandy silt fill for Borehole RW16-01.

The granular fill consisted of sand and gravel or sandy silt with gravel and was generally brown in colour.

The thickness of the granular fill ranged from 0.5 m to 0.6 m, with the lower boundary of this layer encountered at depths of 0.7 m to 0.8 m (Elevation 320.5 to 319.3).

Moisture content of samples of the granular fill generally ranged from 1 percent to 3 percent.



5.3.3 Sand

Native sand was encountered immediately beneath the asphalt layer in Boreholes RW16-01 and RW16-02.

The sand was brown in colour and contained some silt to silty, trace to some clay, trace gravel, with occasional cobbles.

The thickness of the sand layer was 1.5 m and 0.7 m, with the lower boundary of the sand encountered at a depth of 2.3 m and 1.4 m, at Boreholes RW16-01 and RW16-02, respectively (Elevation 319.0 and 319.0).

SPT N-values within the sand varied from 8 to 26 blows for 0.3 m penetration, indicating loose to compact relative density.

Measured moisture contents within the sand were 14% to 18%.

The result of grain size distribution analysis carried out on one sample of the native sand is presented on the Record of Borehole Sheets included in Appendix C and on Figure C1 of Appendix C. The result of the grain size distribution analysis is summarized below:

Soil Particle	Sand (%)
Gravel	2
Sand	78
Silt	16
Clay	4

5.3.4 Clayey Silt

A layer of clayey silt was encountered immediately below the granular fill at 0.7 m depth (Elevation 319.3) in Borehole RW16-03.

The clayey silt was grey in colour and contained some sand and gravel.

The thickness of the clayey silt was 0.7 m, with the lower boundary of the layer encountered at a depth of 1.4 m (Elevation 318.5).

The SPT N-value recorded in the clayey silt was 39 blows for 0.3 m penetration, indicating a hard consistency.



The moisture content of the sample of the clayey silt was 21 percent.

5.3.5 Silty Clay

A layer of silty clay was encountered below the upper sand layer in Boreholes RW16-01 and RW16-02, and below the clayey silt in Borehole RW16-03, at 2.3 m, 1.4 m and 1.4 m depth, respectively (Elevation 319.0, 319.0 and 318.5).

The silty clay was brown to grey in colour and contained trace to some sand, trace gravel and trace shale.

Borehole RW16-02 was terminated in the silty clay layer at a depth of 11.3 m (Elevation 309.1).

The thickness of the silty clay was 6.5 m and 7.3 m at Boreholes RW16-01 and RW16-03, respectively, with the lower boundary of the layer encountered at depths of 8.8 m and 8.7 m (Elevation 312.5 and 311.3).

SPT N-values recorded in the silty clay ranged from 15 to 58 blows for 0.3 m penetration, indicating a very stiff to hard consistency.

Moisture content of samples of the silty clay generally ranged from 10 percent to 33 percent.

Four 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 C and the grain size distribution curves for these samples are plotted on Figure C2 of Appendix C. The results of the Atterberg Limits tests are plotted on Figure C4.

Soil Particles	Silty Clay (%)
Gravel	0
Sand	1 to 5
Silt	32 to 53
Clay	42 to 67

Index Property	
Liquid Limit	36 to 46
Plastic Limit	18 to 21
Plasticity Index	17 to 26



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

Audible grinding of the auger during drilling in Borehole RW16-03 was noted between depths of 3.6 m and 9.1 m (Elevation 316.3 and 310.8), indicating the possibility of occasional cobbles within the silty clay layer and in the underlying sandy silty layer.

5.3.6 Silty Sand and Sandy Silt

A silty sand to sandy silt layer was encountered immediately below the silty clay in Boreholes RW16-01 and RW16-03, at depths of 8.8 m and 8.7 m, respectively (Elevation 312.5 and 311.3).

The silty sand to sandy silt was grey in colour and contained trace clay.

Boreholes RW16-01 and RW16-03 were both terminated in the silty sand to sandy silt layer at a depth of 11.3 m (Elevation 310.0 and 308.7).

SPT N-values within the silty sand to sandy silt varied from 18 to 45 blows for 0.3 m penetration, indicating compact to dense relative density.

Measured moisture contents within the silty sand to sandy silt were 12 percent to 20 percent.

The result of grain size distribution analysis carried out on one sample of the silty sand to sandy silt is presented on the Record of Borehole Sheets included in Appendix C and on C3 of Appendix C. The result of the grain size distribution analysis is summarized below:

Soil Particle	Silty Sand to Sandy Silt (%)
Gravel	0
Sand	24
Silt	70
Clay	6

5.3.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. No standpipe piezometers were installed at this site. The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.3.



Table 5.3 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW16-01	Aug 19, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 0.2 m.
RW16-02	Aug 19, 2019	3.7	316.7	Open borehole
RW16-03	Aug 15, 2019	8.8	311.1	Open borehole

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.

Upon completion of drilling, Boreholes RW16-01 caved-in at 0.2 m, RW16-02 caved-in at 10.4 m and RW16-03 caved-in at 9.1 m.

5.4 SW Retaining Wall Site #33X-0861/W0 (Sta. 10+322 to 10+339 – Appendix D)

No borehole was drilled within the footprint of this retaining wall. The subsurface conditions are interpreted based on an adjacent borehole (BH20-01) advanced behind the proposed west abutment of Frederick St Underpass and it is only for preliminary design purposes. Additional boreholes need to be completed at each end of the retaining wall by the Design-Build Contractor to confirm subsurface conditions and detail design assumptions. In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand over silty clay/ clayey silt layer. The cohesive layer is in turn overlying a lower silty sand to sandy silt layer over a lower silty clay deposit underlain by silty clay till

5.4.1 Asphalt

Asphalt with a thickness of 200 mm was encountered at this site in BH20-01.

5.4.2 Granular Fill

Granular fill consisting of sand and gravel to sand was encountered immediately beneath the asphalt layer in BH20-01. The granular fill was generally brown in colour.



The thickness of the granular fill was 3.9, with the lower boundary of this layer encountered at Elevation 323.4 m.

Moisture content of samples of the granular fill generally ranged from 3% to 5%.

SPT N-values within the granular fill varied from 3 to 28 blows for 0.3 m penetration, indicating a compact to very loose relative density.

The result of grain size distribution analysis carried out on one sample of the granular fill is presented on the Record of Borehole Sheets included in Appendix D and on Figure D1 of Appendix D. The result of the grain size distribution analysis is summarized below:

Soil Particle	Granular Fill (%)
Gravel	0
Sand	89
Silt	11
Clay	

5.4.3 Sand

Native sand was encountered immediately beneath the granular fill in BH20-01. The sand was brown in colour and contained a trace of silt.

The thickness of the sand layer was 3.1 m, with the lower boundary of the layer encountered at a depth of 7.2 m (Elevation 320.3).

SPT N-values within the sand varied from 17 to 27 blows for 0.3 m penetration, indicating a compact relative density.

Measured moisture contents within the sand ranged from 14% to 20%.

5.4.4 Upper Clayey Silt/ Silty Clay

A layer of clayey silt/ silty clay was encountered immediately below the sand layer at 7.2 m depth (Elevation 320.3) in BH 20-01.

The clayey silt/ silty clay layer was brown to grey in colour and contained traces of sand and gravel.



The thickness of the clayey silt and silty clay layers were 1.5 m and 4.6 m respectively, with the lower boundary of the silty clay layer encountered at a depth of 13.3 m (Elevation 314.2 m).

The SPT N-value recorded in the clayey silt/ silty clay layer varied between 9 and 31 blows for 0.3 m penetration, indicating a stiff to hard consistency.

The moisture contents of the samples of the clayey silt/ silty clay layer were 18% to 40%.

Three samples of the silty clay/ clayey silt 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 D and the grain size distribution curves for these samples are plotted on Figure D2 of Appendix D. The results of the Atterberg Limits tests are plotted on Figure D6.

Soil Particles	Clayey Silt/ Silty Clay (%)
Gravel	0 to 1
Sand	0 to 7
Silt	30 to 78
Clay	14 to 70

Index Property	
Liquid Limit	49
Plastic Limit	20
Plasticity Index	29

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

5.4.5 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand containing trace clay was encountered underlying the upper clayey silt / silty clay deposit in BH 20-01. The thickness of the sandy silt to silty sand deposit was 6.1 m and the base of the deposit was encountered at depth of 19.4 m below ground surface (Elevation 308.1).



SPT 'N' values measured in the sandy silt to silty sand ranged from 45 to 88 blows per 0.3 m of penetration, indicating a dense to very dense relative density (typically very dense). The natural moisture contents measured on samples of the sandy silt to silty sand ranged from 12% to 31 %.

The result of a grain size analysis testing conducted on one sample of the sandy silt to silty sand is provided on the Record of Borehole Sheets in Appendix D and shown on Figure D3 in Appendix D. A summary of the test result is provided below:

Soil Particles	(%)
Gravel	0
Sand	28
Silt	66
Clay	6

5.4.6 Lower Silty Clay

A relatively thick deposit of grey silty clay containing a trace of sand was encountered underlying the sandy silt to silty sandy deposit in BH 20-01. This lower silty clay deposit was 14.4 m thick and the base of the layer was located at a depth of 33.8 m (Elevation of 293.7 m).

SPT 'N' values measured within the lower silty clay ranged from 23 to 39 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. The natural moisture contents measured on samples of the lower silty clay ranged from 16 % to 25 %.

Grain size analysis was carried out on one sample of the lower silty clay as part of the current investigation. The result of grain size analysis is provided on the Record of Borehole Sheets in Appendix D and illustrated in Figure D4 in Appendix D. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	4
Silt	36
Clay	60

The results of an Atterberg Limits test conducted on a sample of the lower silty clay are shown in Figure D7 in Appendix D and summarized below.



Liquid Limit	42
Plastic Limit	18
Plasticity Index	24

The results indicate that the silty clay is of intermediate plasticity with a group symbol of CI.

5.4.7 Silty Clay Till

Silty clay till, sandy with trace gravel, was encountered underlying the lower silty clay layer in BH20-01. The surface of the till was encountered at a depth of 33.8 m (Elevation 293.7 m). BH20-01 was terminated in this till deposit at a depth of 38.3 m (Elevation 289.2 m).

SPT 'N' values measured within the till ranged from 76 blows per 0.250 m of penetration to 105 blows per 0.175 m of penetration, indicating a hard consistency. The natural moisture contents measured on samples of the till ranged from 9 % to 10 %.

The result of a grain size analysis conducted on a sample of the till is provided on the Record of Borehole Sheets in Appendix D and illustrated in Figure D5 in Appendix D. The results are summarized as follows:

Soil Particles	(%)
Gravel	3
Sand	31
Silt	51
Clay	15

5.4.8 Groundwater Conditions

A monitoring well was installed in BH20-01 to permit monitoring of the water level. Water level measured in the piezometer on August 24, 2020 was at a depth of 5.5 m (Elevation 322.0 m).

In general, the groundwater level is expected to be located slightly below the adjacent highway grade (i.e. at or below Elev. 320 m).

The above value is a short-term reading, and seasonal fluctuation of the groundwater level is to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.



6.0 CORROSIVITY AND SULPHATE TEST RESULTS

Samples of the sand from Boreholes RW01-02, SS4 (depth of 2.3 m) and RW16-01, SS2 (depth of 0.8 m), and the sand fill from Boreholes RW02-04, SS3 (depth of 1.5 m) and BH20-01, SS4 (depth of 3.4m) were 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 E.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Test Results			
		RW01-02 SS4 2.3 m	RW02-04 SS3 1.5 m	RW16-01 SS2 0.8 m	BH20-01 SS 4 3.4 m
		(Soil Sample)			
Corrosivity Index	none	9	5	4	8
Soil Redox Potential	mV	309	218	309	287
Sulphide	%	< 0.02	< 0.02	< 0.02	<0.04
Moisture Content	%	17.2	17.5	13.8	5.0
pH	pH Units	8.79	8.97	8.95	9.66
Chloride	µg/g	190	100	140	210
Sulphate	µg/g	13	5.8	12	8.3
Conductivity	uS/cm	543	356	117	547
Resistivity (calculated)	ohms.cm	1840	2810	8550	1830

7.0 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 for the boreholes were obtained with GPS equipment by Thurber, and the elevations 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. and Mr. Geoff Lay, P.Eng. Interpretation of the data and preparation of the report was carried out by Mr. Hooman Robin Motamedi, P.Eng., and Mr. Geoff Lay, 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.



Hooman Robin Motamedi, P.Eng.
Geotechnical Engineer



Jason Lee, P.Eng.
Principal/Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact



APPENDIX A
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations, and Soil Strata
Drawing
SE Retaining Wall - Site # 33X-0497/W0

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

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

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

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

RECORD OF BOREHOLE No RW01-01 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 375.5 E 226 297.0 ORIGINATED BY ES
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.455902 LONGITUDE -80.469603 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
10.0	Silty SAND , trace gravel Dense to Very Dense Grey Moist	[Stratigraphic Column]	10	SS	71												
	silt layer at 12.0m (600mm)																
313.4			11	SS	70												
12.6	Silty SAND , trace clay Very Dense Grey Wet																
311.7		12	SS	74												0 72 26 2	
14.3	END OF BOREHOLE AT 14.3m. WATER LEVEL AT 2.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 4.3m, BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.																

ONT/MT452_MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

RECORD OF BOREHOLE No RW01-02 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 419.6 E 226 272.7 ORIGINATED BY ES
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.456484 LONGITUDE -80.470036 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
							20 40 60 80 100				20 40 60				
324.9	GROUND SURFACE														
0.0	ASPHALT: (100mm)														
0.1	SAND, some to trace gravel Loose Brown Moist (FILL)		1	GS											
	Clayey silt layer at 1.1m (400mm)		2	SS	6		324								
323.4	SILT, some sand, trace clay Dense Brown Moist (FILL)		3	SS	36		323							0 19 76 5	
322.7	SAND, some silt, trace gravel Compact to Loose Brown Moist to Wet		4	SS	15		322								Switch to tricone
			5	SS	9		321								
320.7	Silty CLAY, some sand, trace gravel Hard Grey Moist		6	SS	31		320								
319.3	Sandy SILT, trace clay Very Dense Grey Moist		7	SS	57		319								
			8	SS	95		317								
			9	SS	106		316							0 27 65 8	
							315								

ONT/MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW01-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 419.6 E 226 272.7 ORIGINATED BY ES
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.456484 LONGITUDE -80.470036 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
314.7	Continued From Previous Page																
10.2	Silty SAND, trace gravel Very Dense Grey Wet																
313.8			10	SS	105		314										
11.1	END OF BOREHOLE AT 11.1m. WATER LEVEL AT 3.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 3.7m, HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.																

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

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

RECORD OF BOREHOLE No RW01-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 475.3 E 226 263.8 ORIGINATED BY AF
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.06.05 - 2018.06.05 LATITUDE 43.457067 LONGITUDE -80.470499 CHECKED BY NB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)					
						20	40	60	80	100	20	40	60			
10.0	Continued From Previous Page SILT , some sand to sandy, some clay Dense to Very Dense Grey Moist															
			9	SS	47											
			10	SS	100/ 0.250										0 19 62 19	
			11	SS	100/ 0.200											
313.7 14.1	END OF BOREHOLE AT 14.1m. WATER LEVEL AT 5.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

ONT/MT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

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

RECORD OF BOREHOLE No RW01-04 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 519.0 E 226 257.8 ORIGINATED BY JB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2018.05.06 - 2018.05.06 LATITUDE 43.457461 LONGITUDE -80.470575 CHECKED BY NB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
326.8	GROUND SURFACE													
0.0	TOPSOIL(200mm)													
0.2	SAND, some silt to silty, trace to some gravel, occasional organics Loose to Compact Brown Moist (FILL)		1	SS	4									
			2	SS	6									
324.5	SAND, some silt to silty, trace clay Compact Brown Moist		3	SS	20									
2.3			4	SS	21								0 79 19 2	
			5	SS	24									
			6	SS	7									
321.2	Silty CLAY, trace sand, trace gravel Very Stiff to Hard Grey Wet		7	SS	17									
5.6			8	SS	39								0 5 47 48	
316.8														

ONT\MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW01-04 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 519.0 E 226 257.8 ORIGINATED BY JB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2018.05.06 - 2018.05.06 LATITUDE 43.457461 LONGITUDE -80.470575 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
10.0	Continued From Previous Page Sandy SILT, some clay, trace gravel Very Dense Grey Moist		9	SS	64		316									
			10	SS	90		315									
			11	SS	100/		314									
312.8							313									
14.0	END OF BOREHOLE AT 14.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.06.25 4.9 321.9				0.150											0 22 59 19

ONT/MT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

RECORD OF BOREHOLE No RW01-05 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 571.9 E 226 227.3 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.12 - 2019.08.13 LATITUDE 43.457951 LONGITUDE -80.470715 CHECKED BY NB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						20	40	60	80	100	20	40	60	GR SA SI CL
321.4	GROUND SURFACE													
0.0	ASPHALT: (100mm)													
0.1	SAND and GRAVEL Brown Dry (FILL)	1	GS											
320.7														
0.7														
	Silty SAND, trace gravel Compact Brown Moist	2	SS	16										
	Silty SAND, trace gravel Compact Brown Moist	3	SS	16										
319.2	Silty CLAY, trace sand Stiff to Hard Grey Moist	4	SS	11										
	Silty CLAY, trace sand Stiff to Hard Grey Moist	5	SS	23										0 3 39 58
	Silty SAND to Sandy SILT, trace clay Dense to Very Dense Grey Moist	6	SS	36										
315.1	Silty SAND to Sandy SILT, trace clay Dense to Very Dense Grey Moist	7	SS	42										
	Silty SAND to Sandy SILT, trace clay Dense to Very Dense Grey Moist	8	SS	67										
	Silty SAND to Sandy SILT, trace clay Dense to Very Dense Grey Moist	9	SS	32										
311.4														

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW01-05 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 571.9 E 226 227.3 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.12 - 2019.08.13 LATITUDE 43.457951 LONGITUDE -80.470715 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
10.0	Silty SAND, trace clay Dense Grey Moist		10	SS	45		311							0 71 28 1	
309.7							310								
11.7	Silty CLAY, trace sand Hard Grey Moist			11	SS	32		309							
307.1			12	SS	42		308						0 2 39 59		
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 7.9m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.														

ONT/MT/4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

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

RECORD OF BOREHOLE No RW01-06 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 618.5 E 226 222.2 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.13 - 2019.08.13 LATITUDE 43.458395 LONGITUDE -80.470785 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100						
320.5	GROUND SURFACE															
0.0	ASPHALT: (75mm)															
0.1			1	GS												
319.9	SAND and GRAVEL, trace silt, trace clay Brown Dry (FILL)															
0.7			2	SS	15											
	SAND, some silt, trace clay, trace gravel Loose to Dense Brown Moist to Wet															
			3	SS	5										3 76 16 5	
			4	SS	34											
317.7																
2.8	Silty CLAY, trace sand Very Stiff to Hard Grey Moist															
			5	SS	34											
			6	SS	30											
			7	SS	29											
313.4																
7.2	Sandy SILT to SILT and SAND, trace to some clay, trace gravel Compact to Dense Grey Moist to Wet															
			8	SS	30										0 38 49 13	
			9	SS	32											

ONT\MT452_MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW01-06 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 618.5 E 226 222.2 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.13 - 2019.08.13 LATITUDE 43.458395 LONGITUDE -80.470785 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
309.4	Continued From Previous Page		10	SS	30		310								
11.2	Silty CLAY , trace to some sand Hard Grey Moist						309								
			11	SS	33		308							0 10 45 45	
			12	SS	33		307								
306.2	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 4.4m AND WATER LEVEL AT 2.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.														

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

RECORD OF BOREHOLE No RW01-07 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 661.7 E 226 221.5 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.14 - 2019.08.14 LATITUDE 43.458833 LONGITUDE -80.471043 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
320.0	GROUND SURFACE														
0.0	ASPHALT: (75mm)														
0.1	SAND and GRAVEL , some silt, trace clay Brown Dry (FILL)		1	GS										32 46 22 (SI+CL)	
319.4															
0.7															
318.8	Silty SAND , trace gravel Dense Brown Moist		2	SS	32										
1.3															
	Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist		3	SS	32										
			4	SS	32										
			5	SS	35										
			6	SS	34									2 7 50 41	
			7	SS	28										
			8	SS	24										
			9	SS	23										

ONTMT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

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

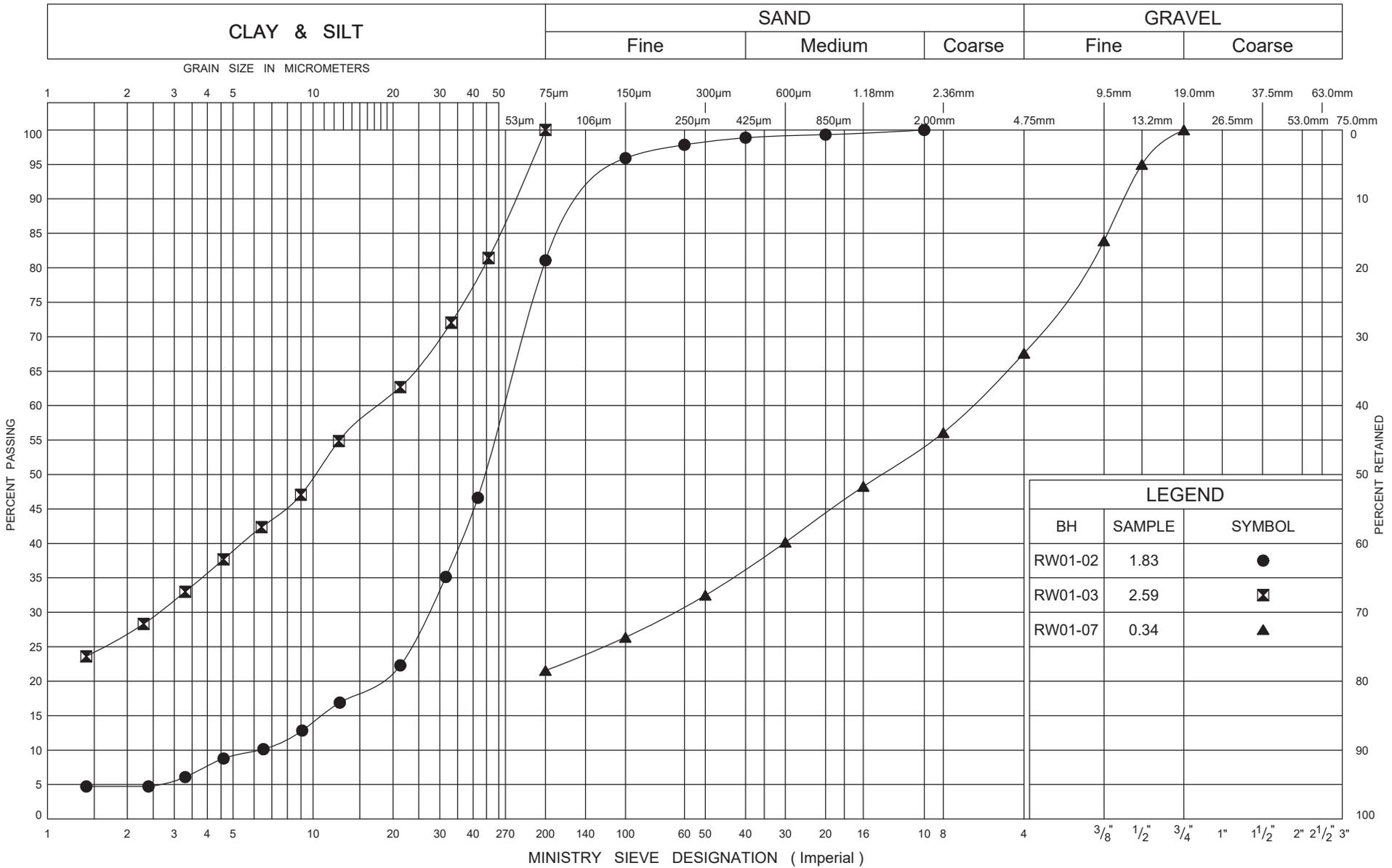
RECORD OF BOREHOLE No RW01-07 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 661.7 E 226 221.5 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.14 - 2019.08.14 LATITUDE 43.458833 LONGITUDE -80.471043 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
308.3	Continued From Previous Page Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist		10	SS	19									
11.7	Sandy SILT , trace clay Dense to Very Dense Grey Moist		11	SS	31									
305.7			12	SS	55									0 25 68 7
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 8.2m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT TO SURFACE.													

ONT/MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

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



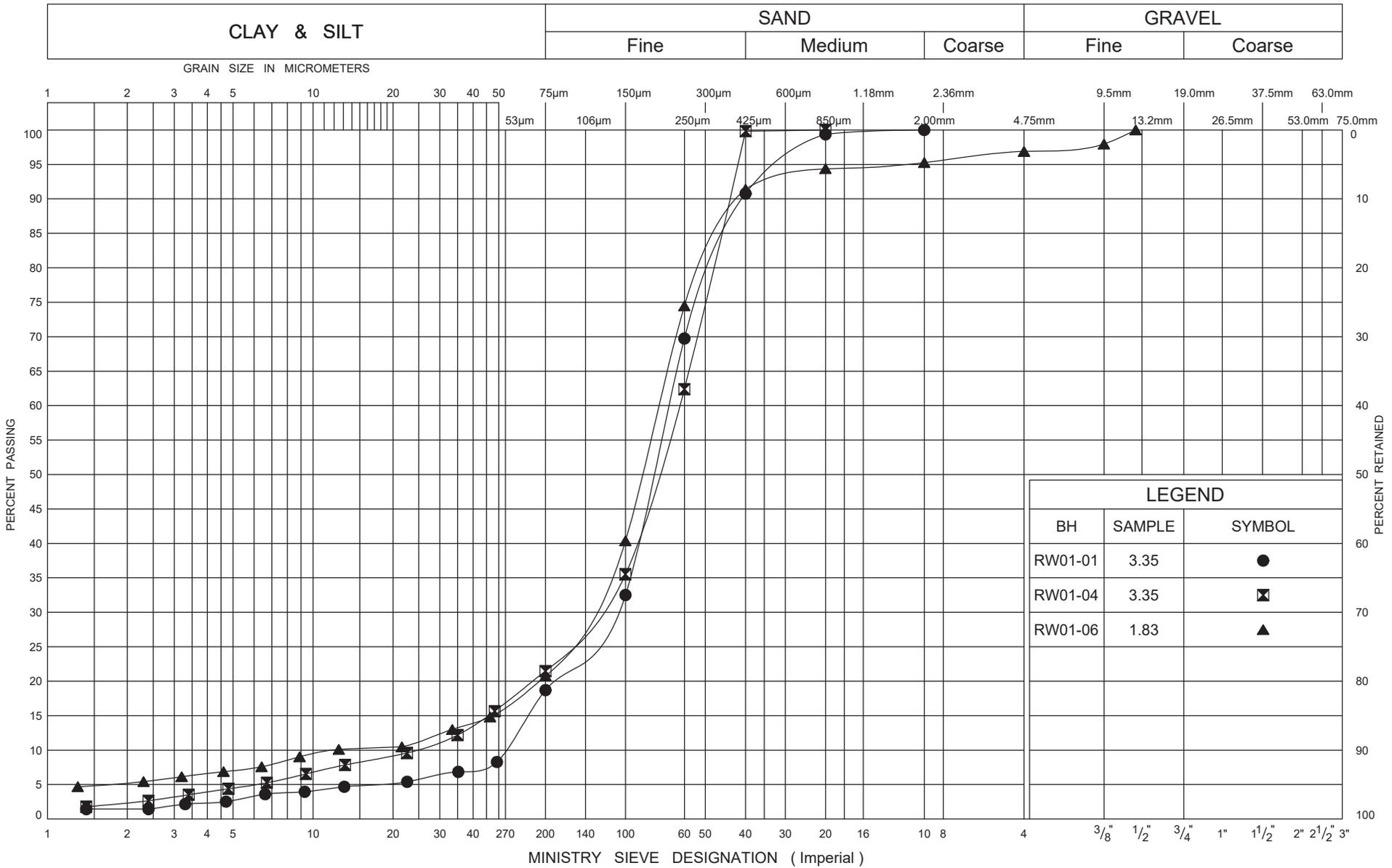
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Granular FILL

FIG No A1
 W P 408-88-00
 Retaining Wall 1

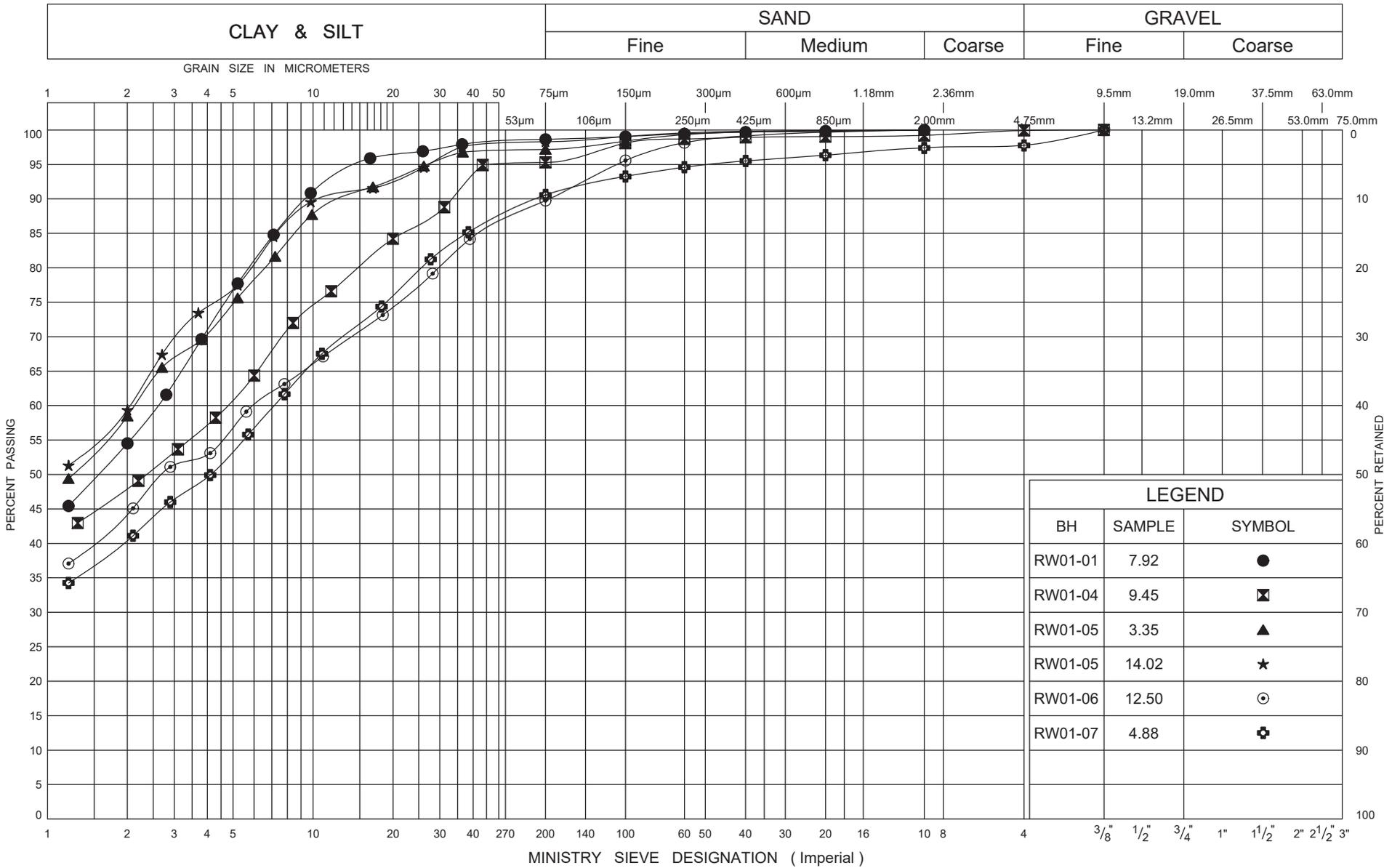


ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION
SAND

FIG No A2
 W P 408-88-00
 Retaining Wall 1



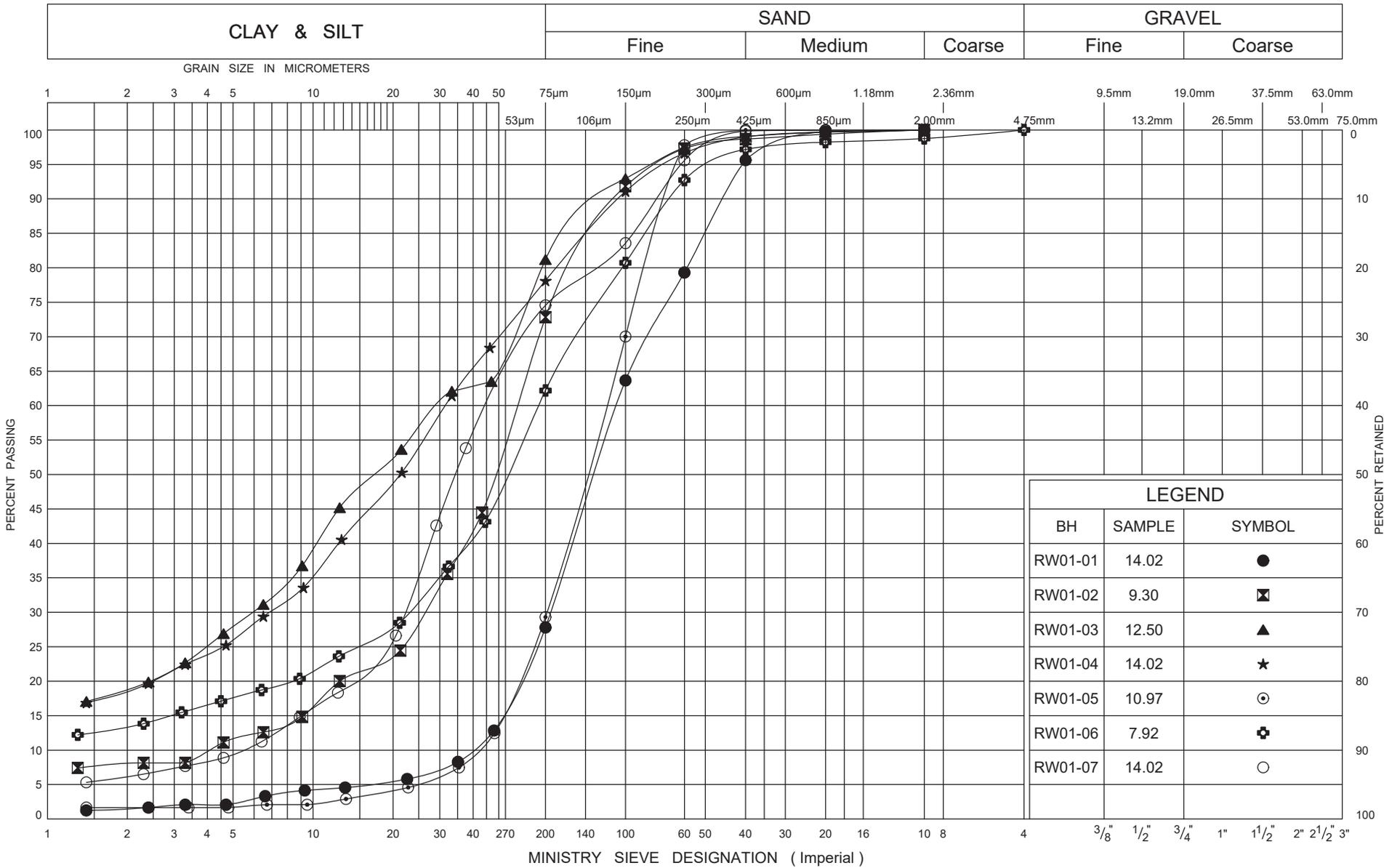
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Silty CLAY

FIG No A3
 W P 408-88-00
 Retaining Wall 1



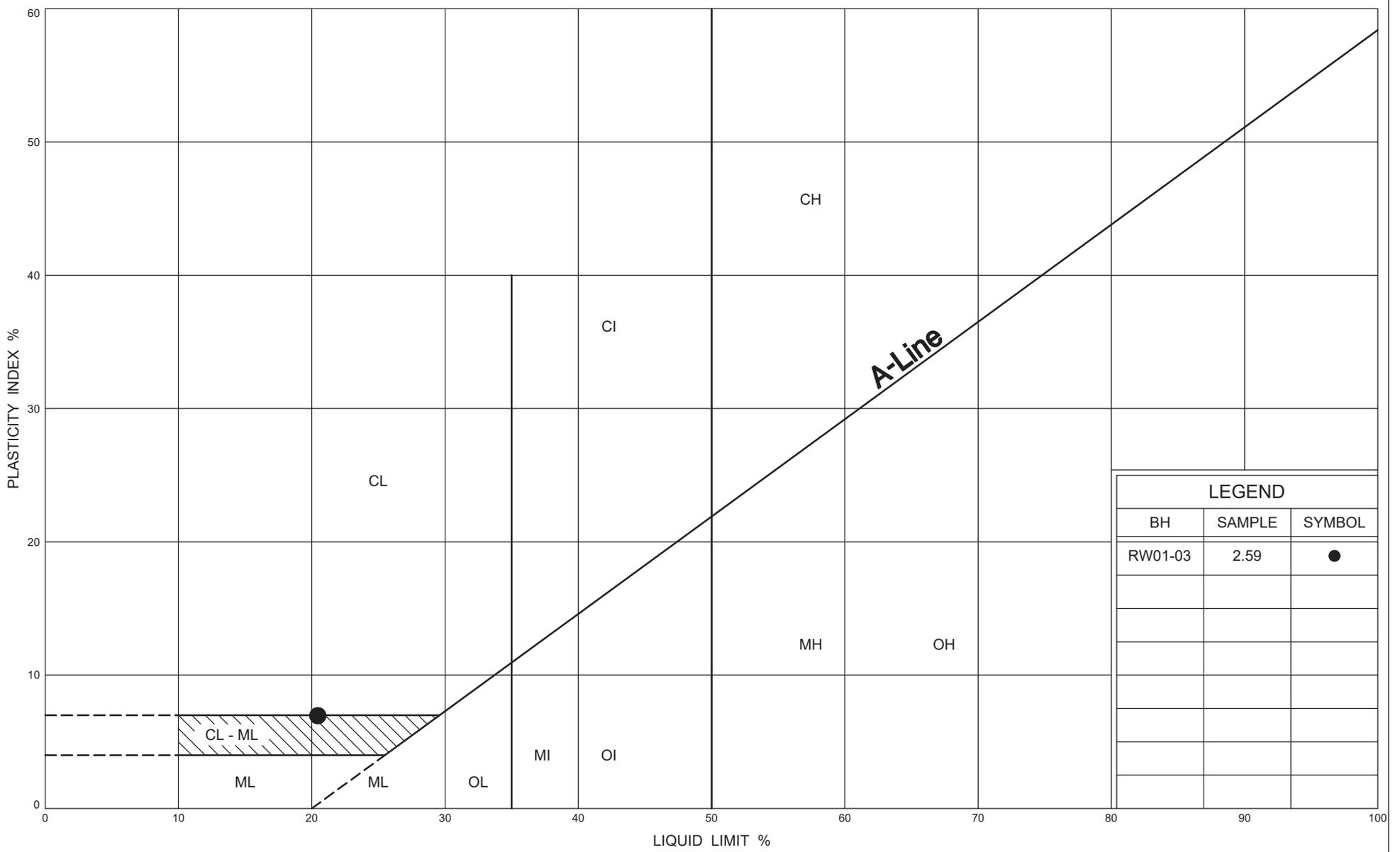
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Sandy SILT / Silty SAND

FIG No A4
 W P 408-88-00
 Retaining Wall 1



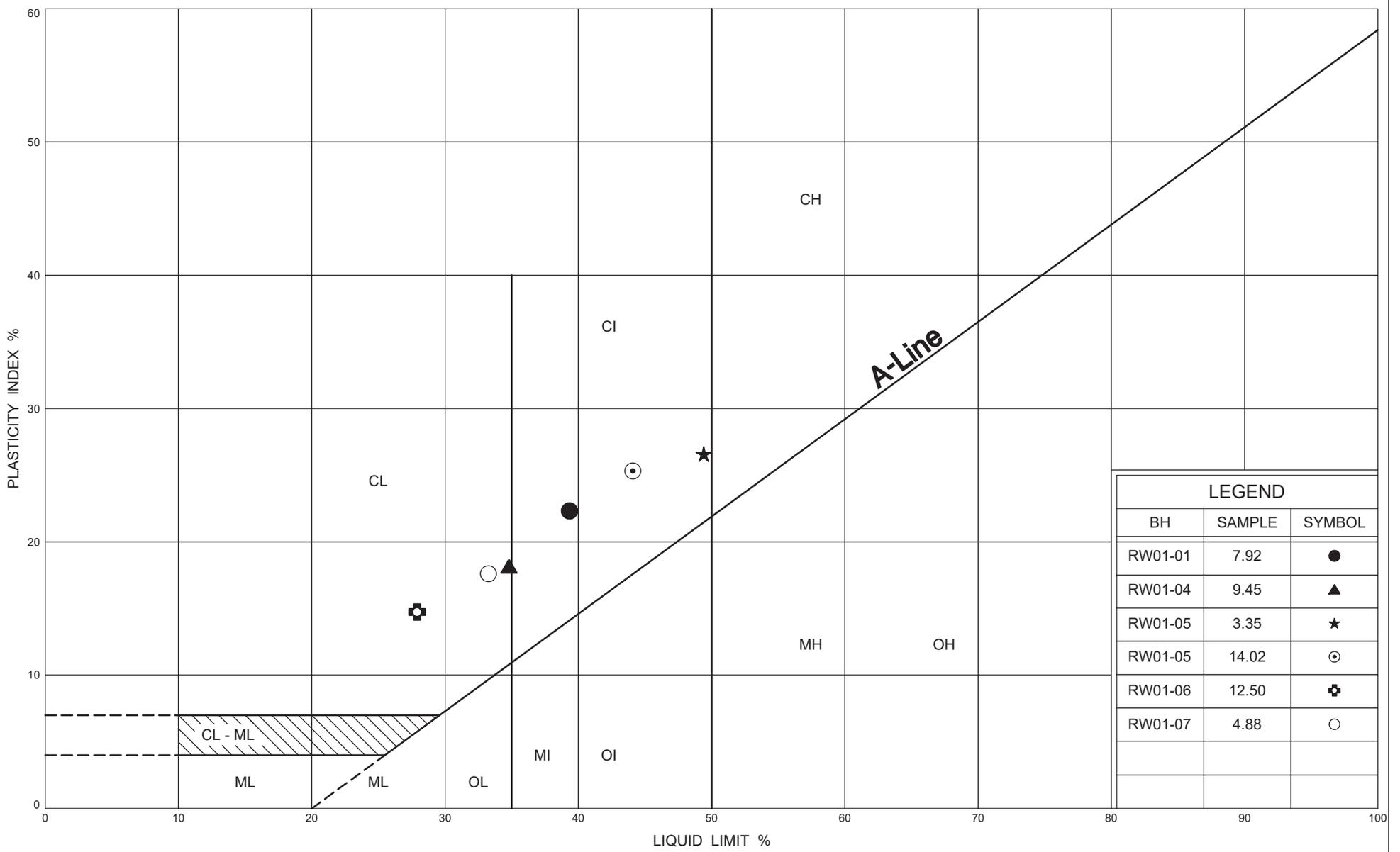
LEGEND		
BH	SAMPLE	SYMBOL
RW01-03	2.59	●

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



PLASTICITY CHART
Granular (Silt) FILL

FIG No A5
W P 408-88-00
Retaining Wall 1



LEGEND		
BH	SAMPLE	SYMBOL
RW01-01	7.92	●
RW01-04	9.45	▲
RW01-05	3.35	★
RW01-05	14.02	⊙
RW01-06	12.50	⊕
RW01-07	4.88	○

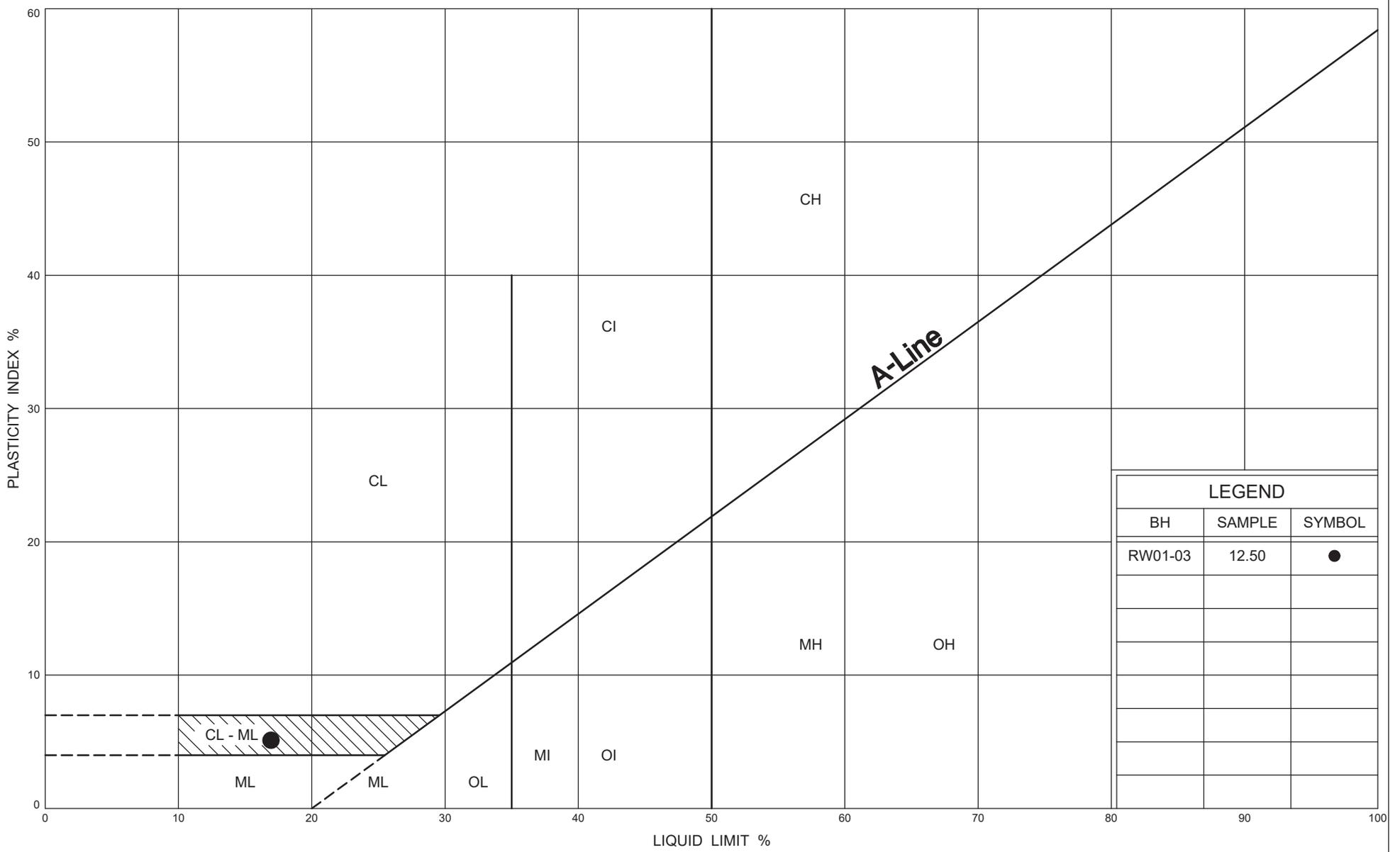
ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



PLASTICITY CHART

Silty CLAY

FIG No A6
 W P 408-88-00
 Retaining Wall 1



LEGEND		
BH	SAMPLE	SYMBOL
RW01-03	12.50	●

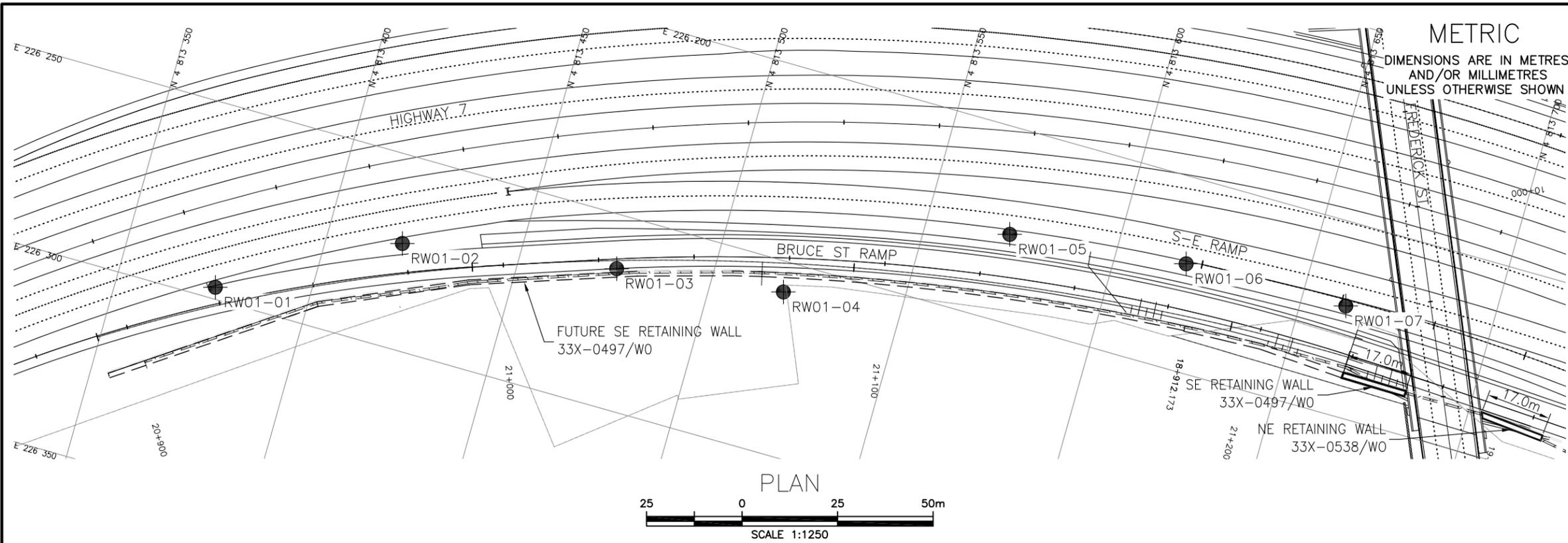
ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



PLASTICITY CHART
Sandy SILT / Silty SAND

FIG No A7
W P 408-88-00
Retaining Wall 1

MINISTRY OF TRANSPORTATION, ONTARIO



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

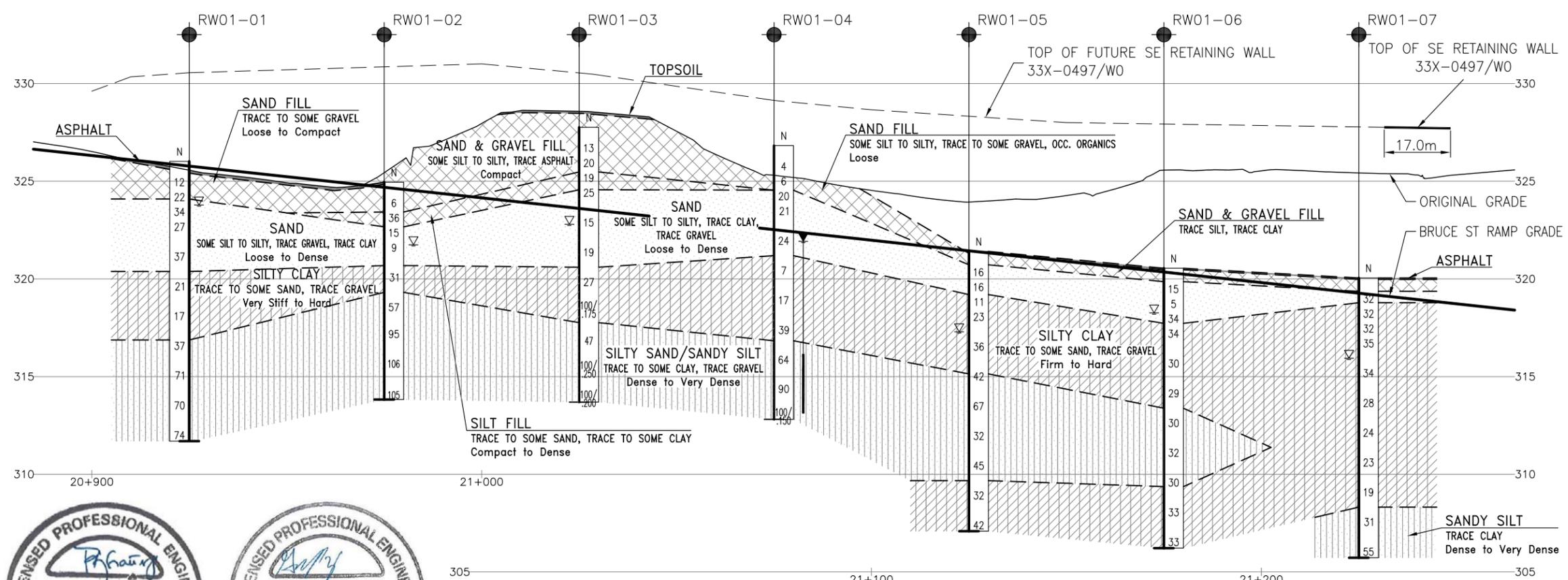
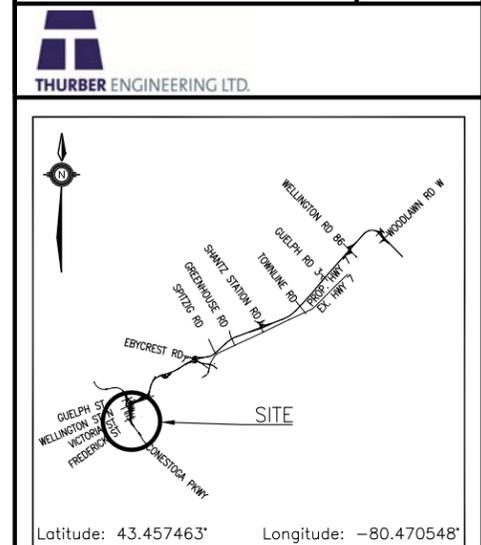
CONT No
GWP No 3005-20-00

HIGHWAY 7
FREDERICK ST.-S/E-BECKER ST.
SE RETAINING WALL 33X-0497/WO
BOREHOLE LOCATIONS AND SOIL STRATA

WSP

THURBER ENGINEERING LTD.

SHEET



NO	ELEVATION	NORTHING	EASTING
RW01-01	326.0	4 813 375.5	226 297.0
RW01-02	324.9	4 813 419.6	226 272.7
RW01-03	327.8	4 813 475.3	226 263.8
RW01-04	326.8	4 813 519.0	226 257.8
RW01-05	321.4	4 813 571.9	226 227.3
RW01-06	320.5	4 813 618.5	226 222.2
RW01-07	320.0	4 813 661.7	226 221.5

-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. 40P8-290

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE	LOAD	DATE	JUN 2021
DRAWN	MFA	CHK	NB	SITE	STRUCT	DWG	1

LICENSED PROFESSIONAL ENGINEER

P. K. Chatterji

P. K. CHATTERJI

06/08/2021

PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER

G. R. Lay

G. R. LAY

100194778

06/08/2021

PROVINCE OF ONTARIO

FILENAME: H:\Working\1000\11375\11375-BHP-RW01.dwg
PLOTDATE: 6/8/2021 9:34 PM



APPENDIX B
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil
Strata Drawing
NE Retaining Wall - Site # 33X-0538/W0



Record of Borehole Sheets, Laboratory Test Results and Borehole Locations
and Soil Strata Drawing for Current Investigation
(RW02-02 to RW02-04)

RECORD OF BOREHOLE No RW02-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 757.0 E 226 227.0 ORIGINATED BY JP
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.22 - 2019.08.22 LATITUDE 43.459602 LONGITUDE -80.470929 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%) 20 40 60								
306.8	SILT and SAND, trace clay Very Dense Grey Wet		10	SS	83									
307			11	SS	98								0 43 56 1	
306.2	End of sampling and start DCPT													
13.3	END OF BOREHOLE AT 13.3m UPON DCPT REFUSAL. BOREHOLE CAVED TO 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.													

ONT\MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/13/19

RECORD OF BOREHOLE No RW02-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 807.5 E 226 232.5 ORIGINATED BY JP
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.21 - 2019.08.21 LATITUDE 43.460057 LONGITUDE -80.470870 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
10.0	Continued From Previous Page Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist Sandy silt layer at 11.0m (500mm)		10	SS	28		309								
							308								
			11	SS	68		307								
							306								
305.8							305								
13.7	SAND , trace to some silt, trace clay Dense to Very Dense Grey Wet		12	SS	75		304								
			13	SS	43									0	87 10 3
303.6															
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE CAVED TO 4.6m AND WATER LEVEL NOT AVAILABLE UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT TO SURFACE.														

ONT/MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/13/19

RECORD OF BOREHOLE No RW02-04 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 856.9 E 226 242.2 ORIGINATED BY ES
 DIST _____ HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2019.09.23 - 2019.09.23 LATITUDE 43.460514 LONGITUDE -80.470774 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
319.1	GROUND SURFACE														
0.0	ASPHALT:(112mm)						319								
0.1	SAND, with gravel Brown Moist (FILL)		1	GS											
318.5	SAND, trace silt and clay, trace gravel Compact to Dense Brown Wet		2	SS	26		318								
0.6			3	SS	32		317								
			4	SS	21		316							1 94 5 (SI+CL)	
			5	SS	34		315								
							314								
314.3	Silty CLAY, some sand to sandy, trace gravel Very Stiff Grey Moist		6	SS	17		313								
4.8			7	SS	16		312							0 21 45 34	
			8	SS	26		311								
			9	SS	17		310								

ONTMT452_MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/13/19

Continued Next Page

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

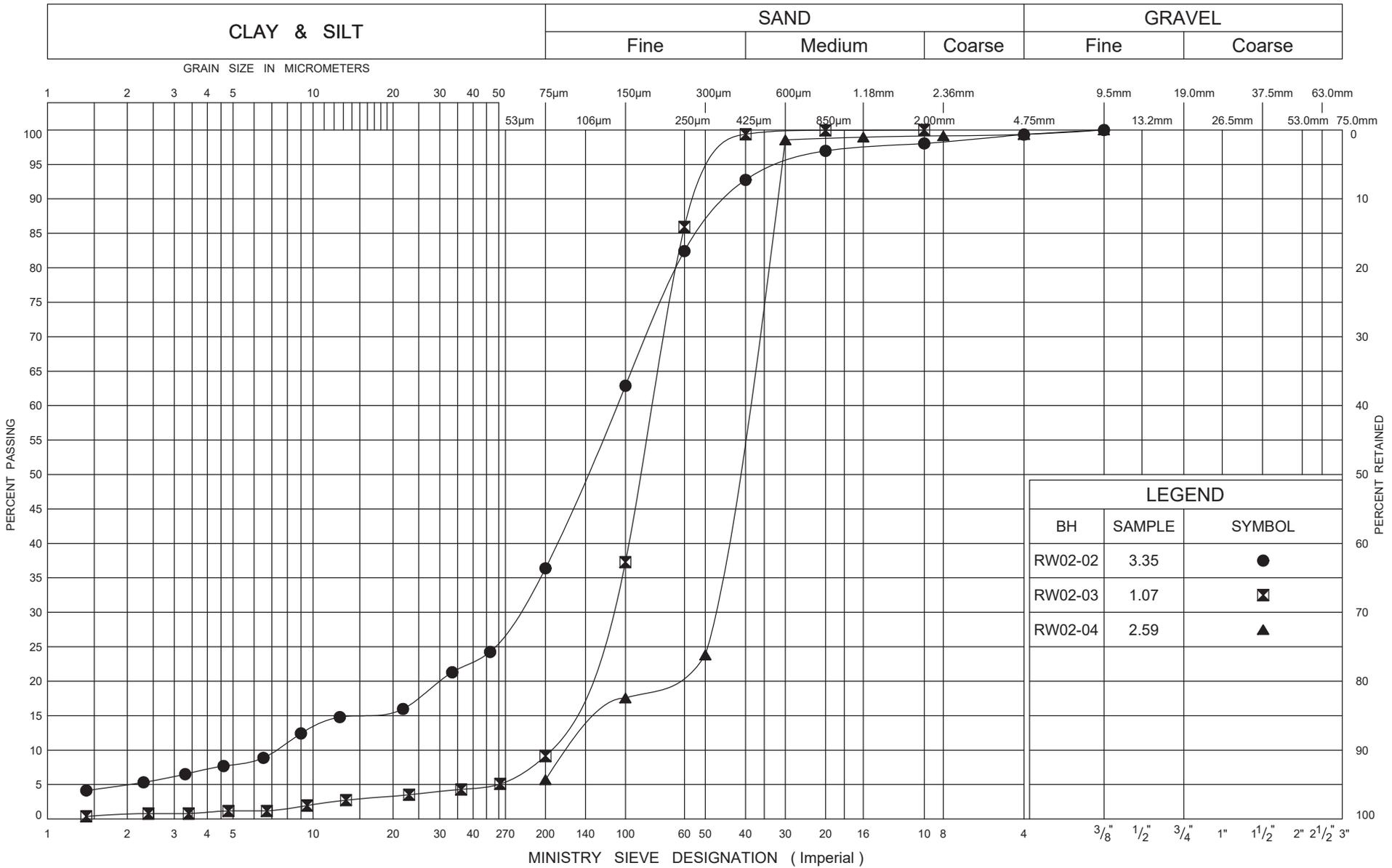
RECORD OF BOREHOLE No RW02-04 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 856.9 E 226 242.2 ORIGINATED BY ES
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2019.09.23 - 2019.09.23 LATITUDE 43.460514 LONGITUDE -80.470774 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
306.9	Continued From Previous Page Silty CLAY , some sand to sandy, trace gravel Very Stiff Grey Moist Hard		10	SS	37		309								
12.2	Silty CLAY , trace sand Stiff Grey Wet		11	SS	9		307							0 1 30 69	
			12	SS	12		306								
			13	SS	12		305								
			14	SS	37		302							0 2 39 59	
17.4	END OF BOREHOLE AT 17.4m. WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.6m, SAND TO 0.2m, THEN ASPHALT TO SURFACE.						303								

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/13/19

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



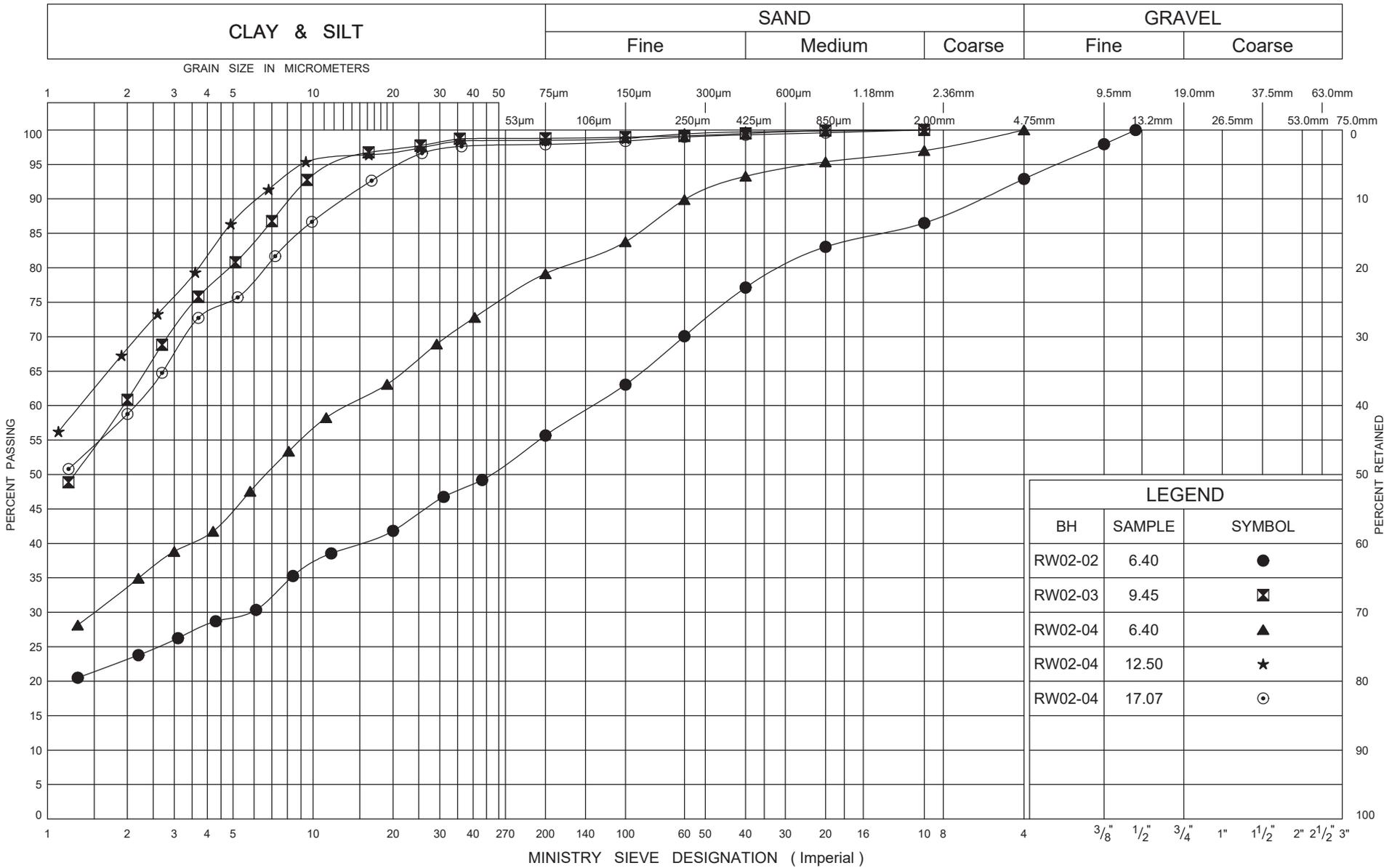
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Upper SAND

FIG No B1
 W P 408-88-00
 Retaining Wall 2



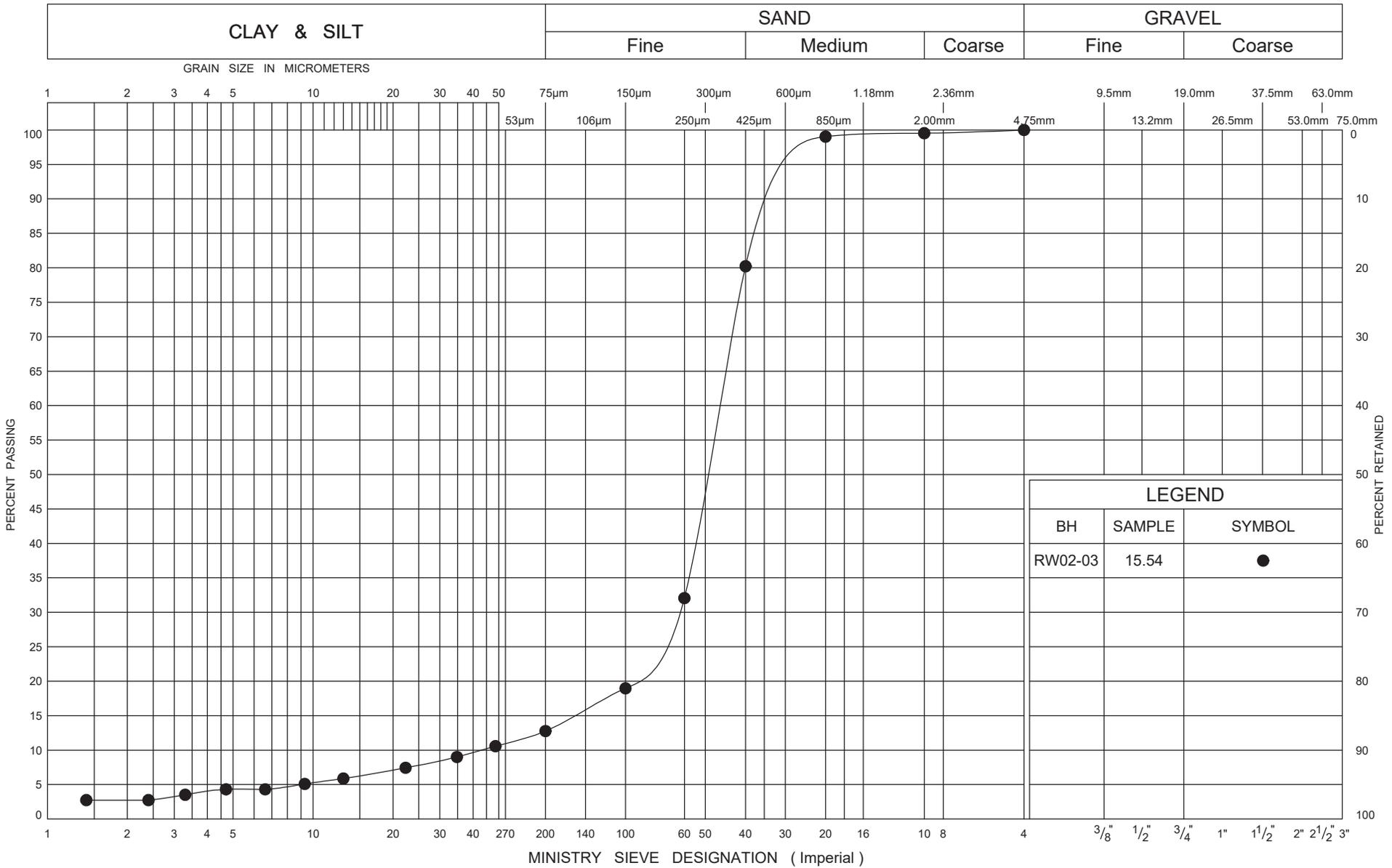
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Silty CLAY

FIG No B2
 W P 408-88-00
 Retaining Wall 2



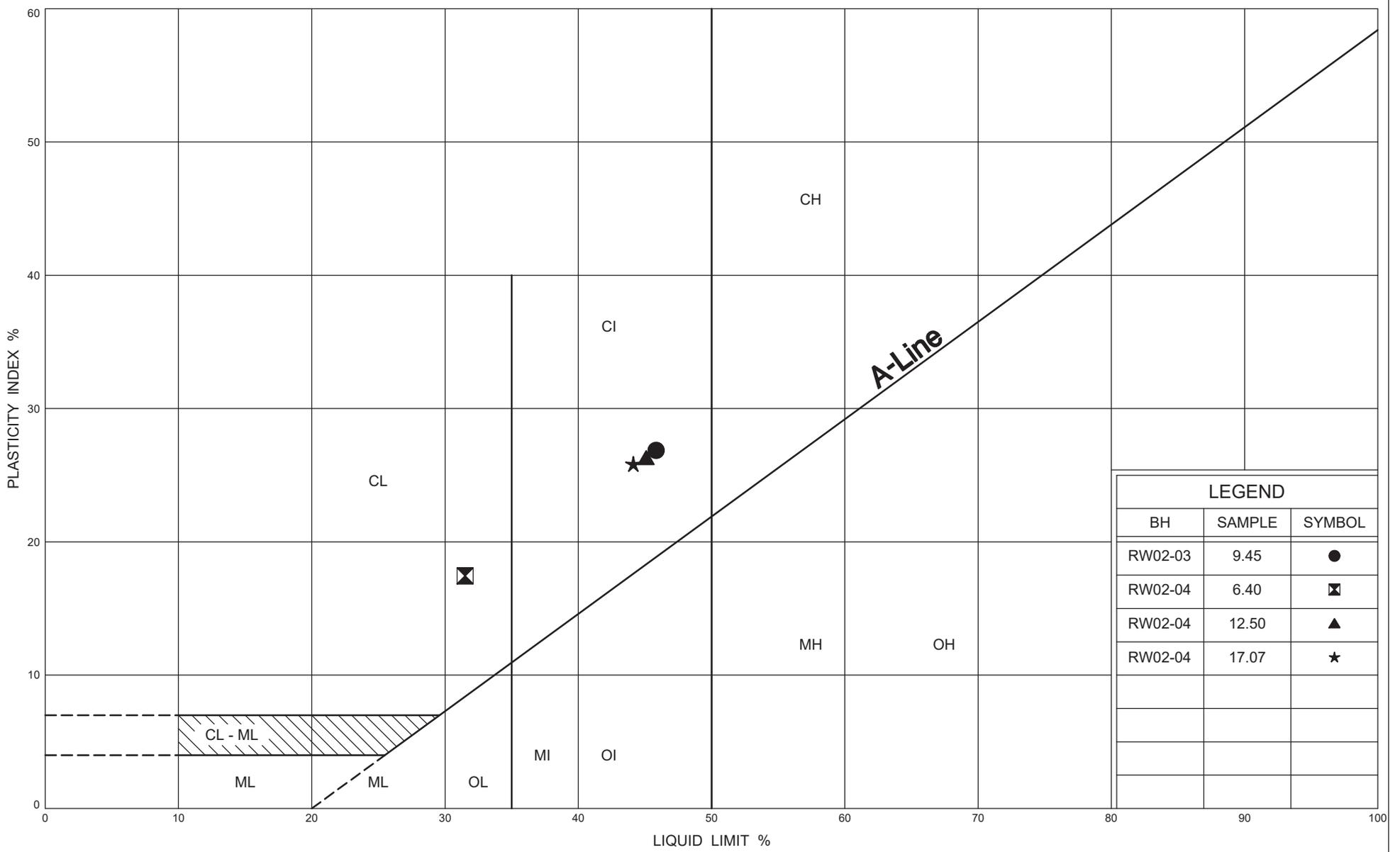
ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION

Lower SAND

FIG No B4
 W P 408-88-00
 Retaining Wall 2



LEGEND		
BH	SAMPLE	SYMBOL
RW02-03	9.45	●
RW02-04	6.40	⊠
RW02-04	12.50	▲
RW02-04	17.07	★

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



PLASTICITY CHART
Silty CLAY

FIG No B5
W P 408-88-00
Retaining Wall 2



Record of Borehole Sheets and Laboratory Test Results for Previous
Investigation (Geocres No. 40P8-199 - Reference 1)

(RW-01 to RW-04)

Foundation investigation and design report for Northeast Corner Retaining Wall, Frederick Street Underpass, Site No. 33-234, G.W.P. 3110-09-00, City of Kitchener, Ontario, prepared by Peto MacCallum Ltd., PML Ref. 10KF079C, Geocres No. 4098-199, dated May 31, 2012

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILTY)

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS / 0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm² IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
u	l	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	l	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	l	COMPRESSION INDEX
C_s	l	SWELLING INDEX
C_α	l	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	l	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{VD}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	l	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	n	l, %	POROSITY	e_{max}	l, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	w	l, %	WATER CONTENT	e_{min}	l, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m ³	DENSITY OF WATER	s_r	%	DEGREE OF SATURATION	I_D	l	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kN/m ³	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	l	UNIFORMITY COEFFICIENT
ρ_d	kg/m ³	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_L	l	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m ³ /s	RATE OF DISCHARGE
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_C	l	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	l	HYDRAULIC GRADIENT
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	APT		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	kN/m ²	SEEPAGE FORCE
e	l, %	VOID RATIO						

RECORD OF BOREHOLE No RW-1

1 of 1

METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 701.9 N; 226 222.6 E **ORIGINATED BY** R.B.
DIST London **HWY** 7/ 85 **BOREHOLE TYPE** C.F.H.S.A. and Dynamic Cone Penetration Test **COMPILED BY** N.S.B.
DATUM Geodetic **DATE** April 08, 2011 **CHECKED BY** B.R.G.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
319.7	Ground Surface															
0.0	Asphalt over sand some silt, some gravel Very loose Brown Wet (FILL)		1	AS	-											
318.3			2	SS	3											
1.4	Silty clay, trace sand Very stiff Brown Moist sand layers to 4.9m Hard to Greyish very stiff brown		3	SS	17						225				(**)	
			4	SS	34						225					
			5	SS	25						225					
			6	SS	28						225					
	Hard		7	SS	37						225					
			8	SS	31						225					
			9	SS	33						225					
			10	SS	39						225					
309.9	End of borehole															
9.8	* Borehole dry (**) Base of footing -El.318.2 Note: Borehole cave-in at 8.5m C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers <u>Water Level Readings:</u> Date Depth Elev. Apr. 08, '11 2.9 316.8 <u>Piezometer Legend:</u> Bentonite seal Filter sand 19mm dia. PVC screen Bentonite grout															

RECORD OF BOREHOLE No RW-2

1 of 1

METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 710.4 N; 226 223.0 E **ORIGINATED BY** R.B.
DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers **COMPILED BY** N.S.B.
DATUM Geodetic **DATE** April 08, 2011 **CHECKED BY** B.R.G.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	20	40	60	80					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				GR SA SI CL
319.7	Ground Surface														
0.0	Asphalt over sand and crushed gravel, trace silt		1	AS	-										
	Compact Brown Moist (FILL)		2	SS	11										
318.3															
1.4	Silty clay, trace gravel sand layers		3	SS	9						225				(**)
	Stiff Dark brown Moist sand layers to 3.7m		4	SS	31						225				1 4 43 52
	Hard Greyish brown		5	SS	23						225				0 2 45 53
			6	SS	44						225				
			7	SS	43						225				0 0 32 68
			8	SS	35						225				
			9	SS	29						225				
309.9	End of borehole														
9.8															

* 2011 04 08

Water level measured after drilling

(**) Base of footing -El.318.2

Note: Borehole cave-in at 8.7m

RECORD OF BOREHOLE No RW-3

1 of 1

METRIC

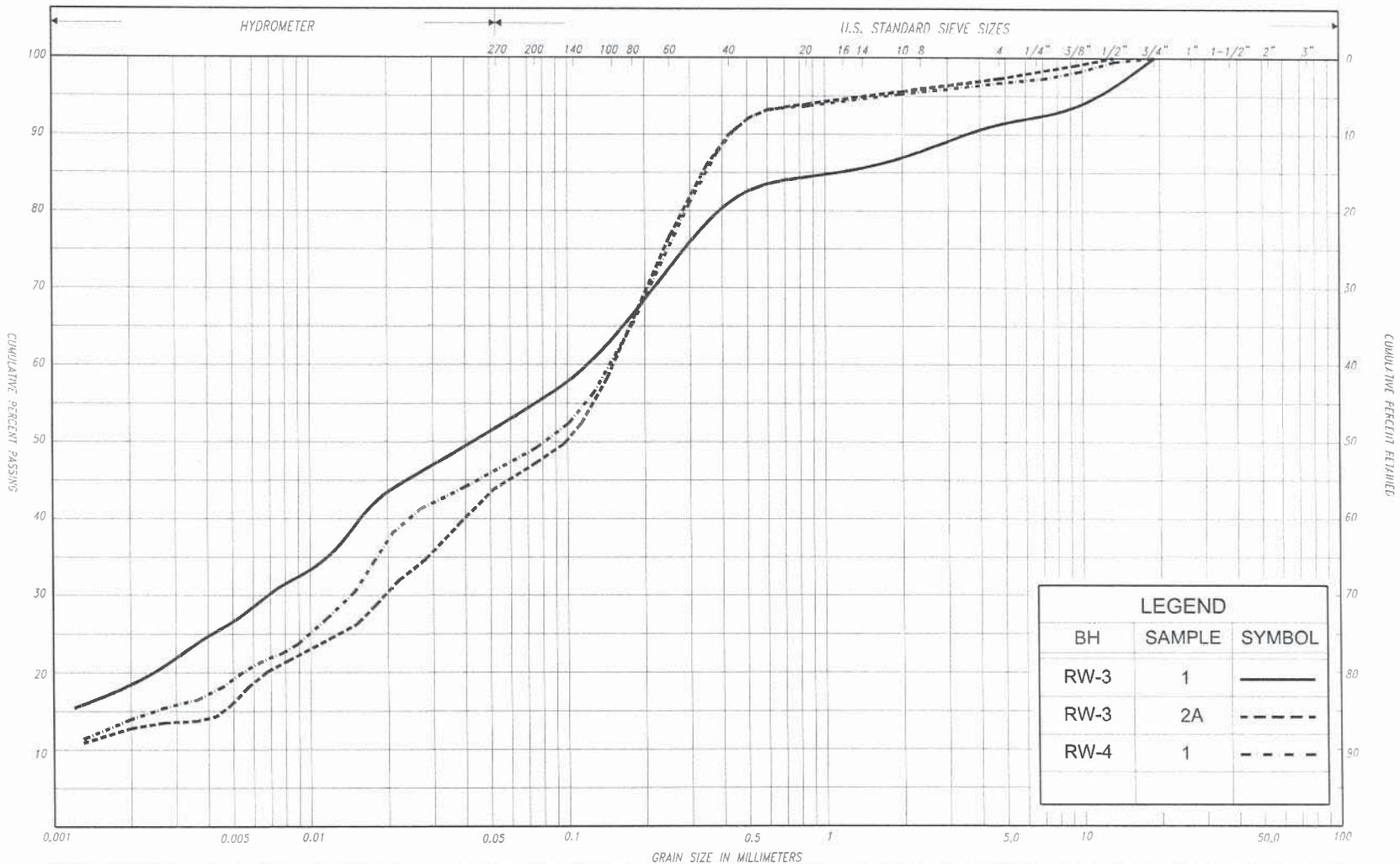
G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 719.3 N; 226 229.5 E **ORIGINATED BY** F.P.
DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Dynamic Ram Sounder **COMPILED BY** N.S.B.
DATUM Geodetic **DATE** July 19, 2011 **CHECKED BY** B.R.G.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
322.3	Ground Surface																	
0.0	Silty sand some clay, trace gravel organic inclusions		1	SS	14													8 37 37 18
	Compact Grey Moist (FILL)		2	SS	27													3 50 34 13
	clayey silt layers																	4 26 45 25
	gravelly sand																	23 39 27 11
320.0	Compact Brown Damp clayey silt layers		3	SS	20													4 25 42 29
2.3	Sand trace to some gravel trace clay		4	SS	21													15 76 6 3
	Compact Brown Moist to wet		5	SS	18													10 76 10 4
			6	SS	14													(1#) 73 12 4
317.9	Silty clay trace sand, trace gravel silty sand and gravelly sand layers, cobbles		7	SS	36													3 23 50 24
	Hard Grey Moist		8	SS	67													
315.9	End of borehole		9	SS	70/15cm													
6.4	Sample 9: Sampler bouncing																	
	* 2011 07 19																	
	▽ Water level observed during drilling																	
	(**) Base of footing -El.318.2																	
	<u>Water Level Readings:</u>																	
	Date Depth Elev.																	
	July 19, '11 (m) Dry ----																	
	Sept. 23, '11 3.3 319.0																	
	Oct. 08, '11 3.3 319.0																	
	<u>Piezometer Legend:</u>																	
	Bentonite seal																	
	Filter sand																	
	30mm dia. PVC screen																	
	Filter bed																	



TABLE A-1
LIST OF ATTERBERG LIMITS RESULTS

SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	DEPTH / ELEVATION (m)	MOISTURE CONTENT (W %)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
Clayey Silt Fill	RW-3	3B	2.1 / 320.2	-	22	12	10
Silty Clay	RW-2	3	1.9 / 317.8	19	36	18	18
	RW-2	5	3.3 / 316.3	19	35	17	18
	RW-2	7	6.3 / 313.4	21	45	23	22



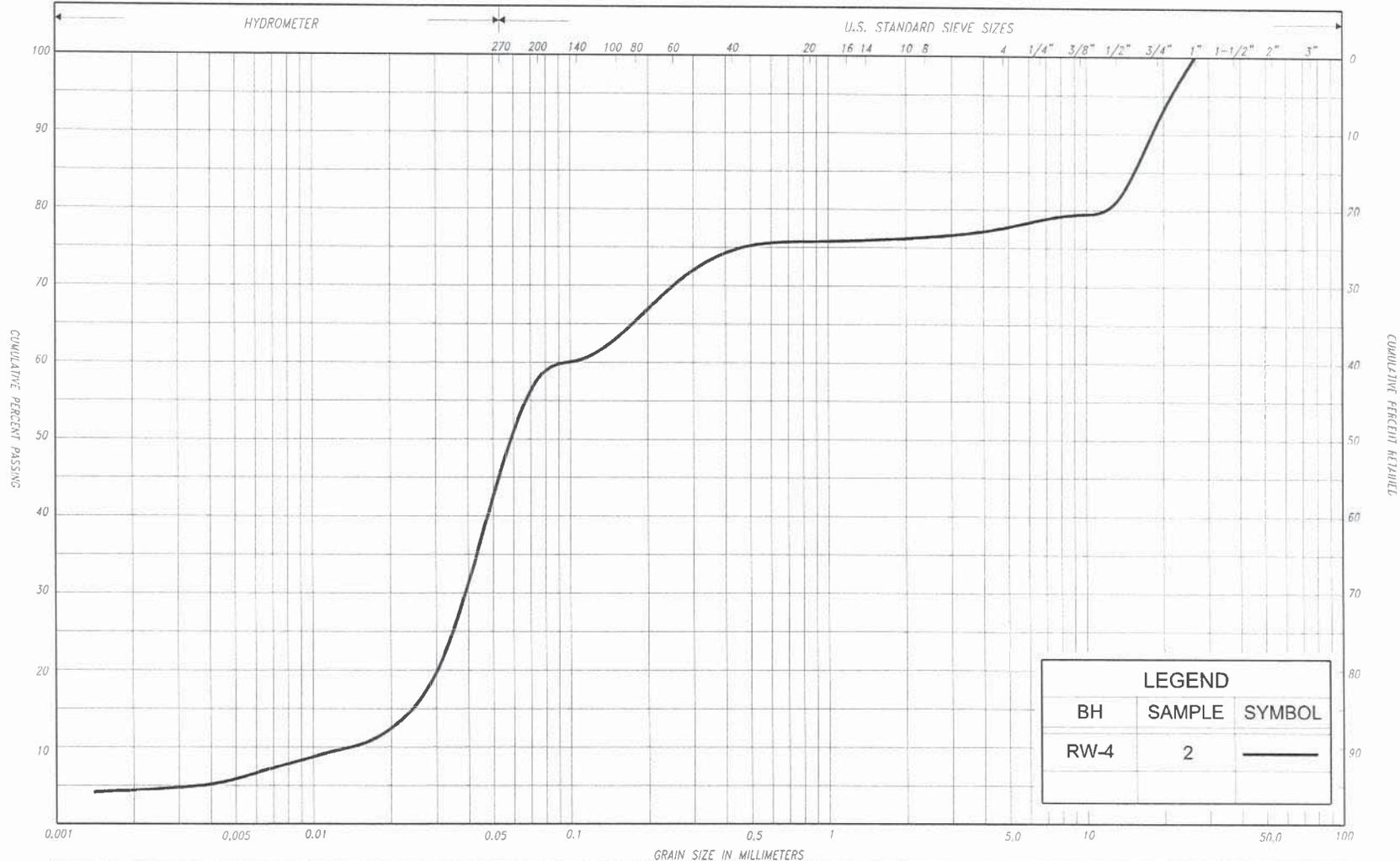
LEGEND		
BH	SAMPLE	SYMBOL
RW-3	1	—
RW-3	2A	- - -
RW-4	1	- · - ·

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COR. R.F.S.	UNIFIED
CLAY	FINE SILT		MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL				CORRI.F.S.	M.I.T.	
CLAY		SILT			V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL					U.S. BUREAU

GRAIN SIZE DISTRIBUTION
 SILTY SAND, some clay, trace gravel
 (FILL)

FIG No. RW-GS-1
 HWY: 7 / 85
 G.W.P. No. 3110-09-00





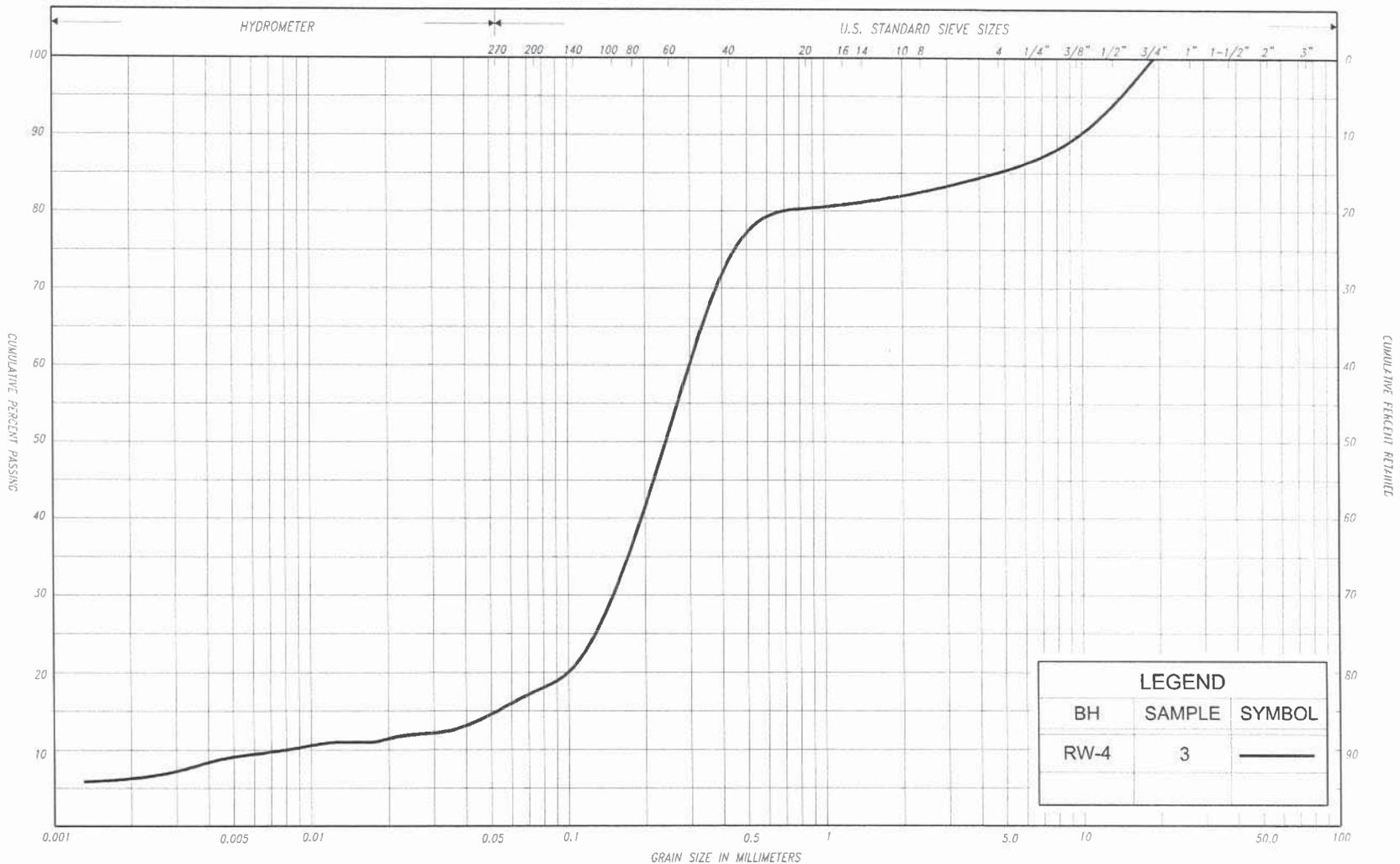
LEGEND		
BH	SAMPLE	SYMBOL
RW-4	2	—

SILT & CLAY			FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			COR. BLES	UNIFIED
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			CORBLES			M.I.T.			
CLAY	SILT			V. FINE	FINE	MED.	COARSE	GRAVEL			CORBLES			U.S. BUREAU		

GRAIN SIZE DISTRIBUTION
 SILT, some sand, some gravel, trace clay
 (FILL)

FIG No. RW-GS-2
 HWY: 7 / 85
 G.W.P. No. 3110-09-00





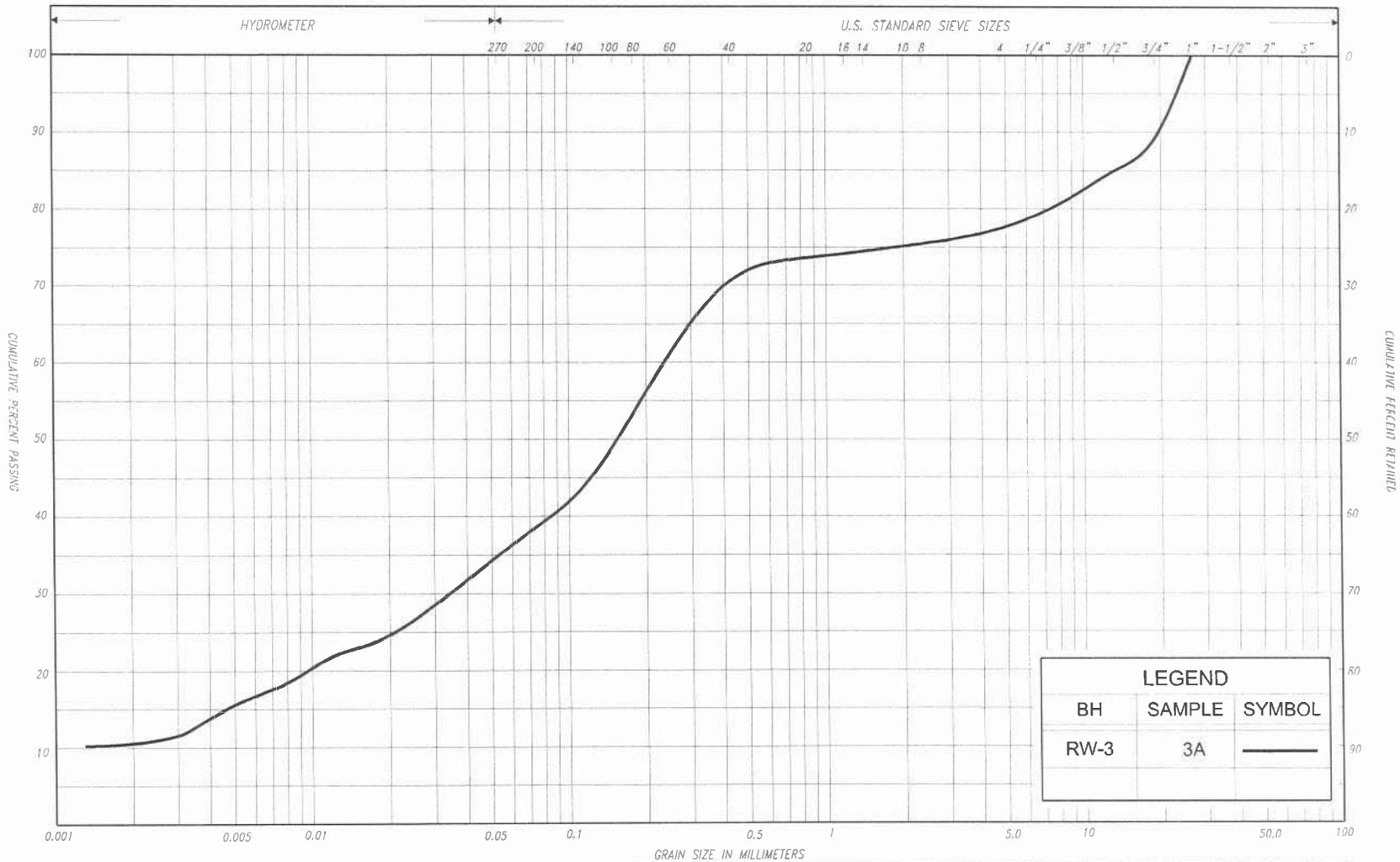
LEGEND		
BH	SAMPLE	SYMBOL
RW-4	3	—

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COR. BLES	UNIFIED		
CLAY	FINE SILT		MEDIUM SILT		COARSE SILT		FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL		CORRI FS	M.I.T.
CLAY		SILT			V. FINE SAND		FINE SAND		MED. SAND		COARSE SAND		GRAVEL			U.S. BUREAU

GRAIN SIZE DISTRIBUTION
SAND, some silt, some gravel, trace clay
(FILL)

FIG No. RW-GS-3
 HWY: 7 / 85
 G.W.P. No. 3110-09-00





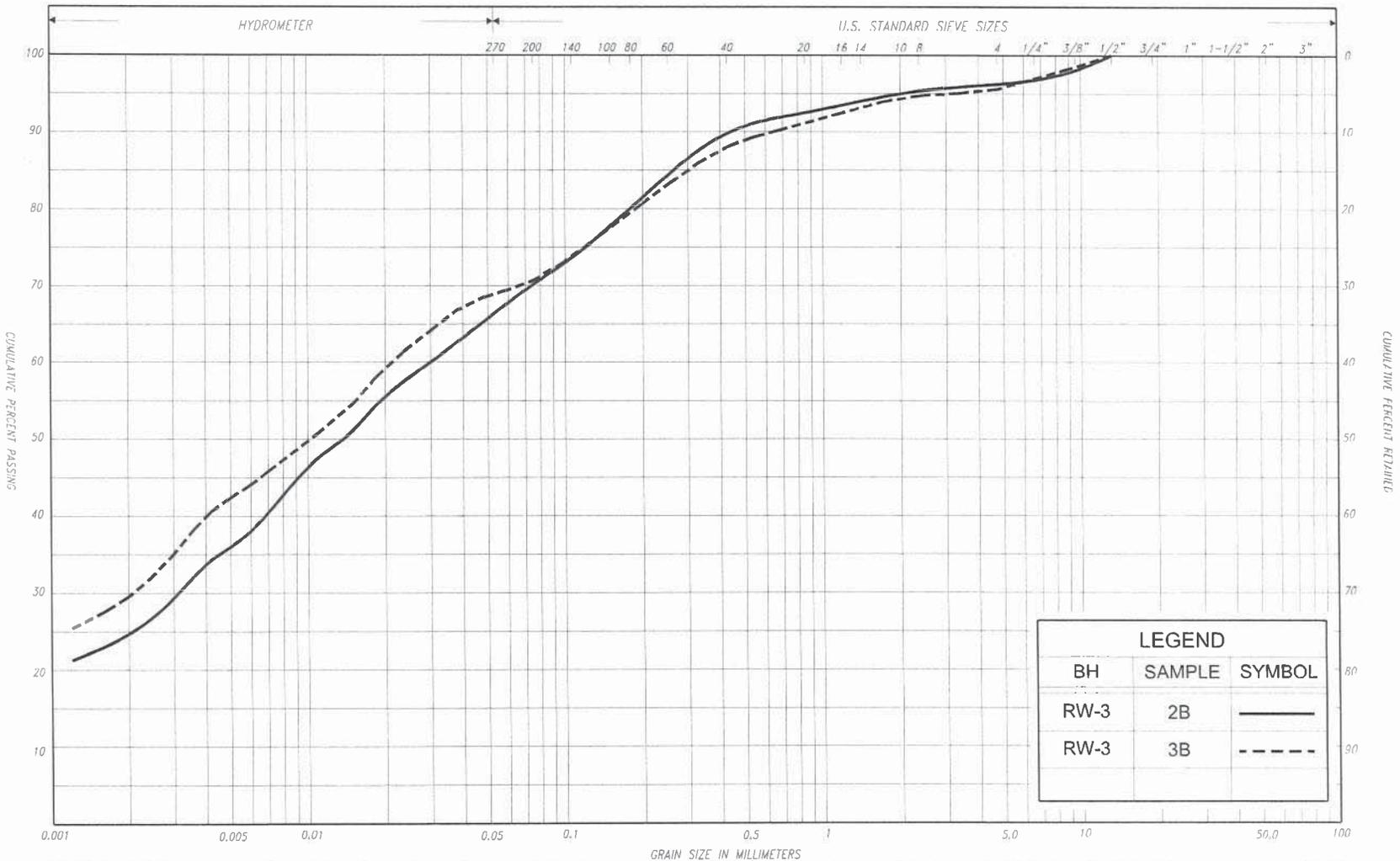
LEGEND		
BH	SAMPLE	SYMBOL
RW-3	3A	—

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COBBLES	UNIFIED
CLAY	FINE SILT		COARSE SILT	FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL		COBBLES	M.I.T.	
CLAY	SILT			SAND		SAND		SAND		GRAVEL			U.S. AIRFAU	



GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, with silt, some clay
(FILL)

FIG No. RW-GS-4
 HWY: 7 / 85
 G.W.P. No. 3110-09-00



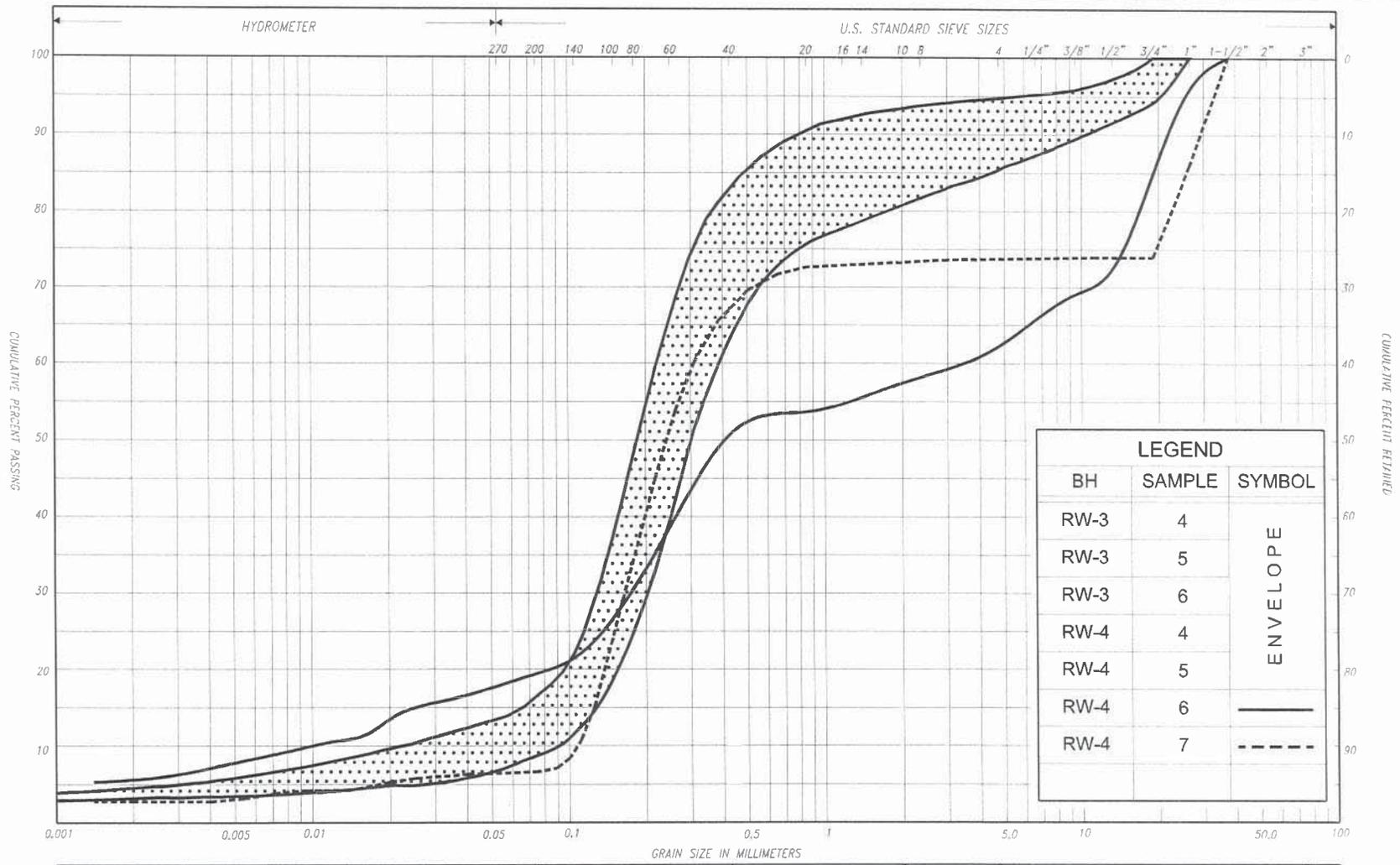
LEGEND		
BH	SAMPLE	SYMBOL
RW-3	2B	—
RW-3	3B	- - -

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COB BLES	UNIFIED
CLAY	FINE SILT		COARSE SILT	FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL		COB BLES	M.I.T.	
CLAY		SILT		Y. FINE SAND	FINE SAND	MED. SAND	COARSE SAND		GRAVEL				U.S. BUREAU	

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, with sand, trace gravel (CI)
(FILL)

FIG No. RW-GS-5
 HWY: 7 / 85
 G.W.P. No. 3110-09-00





LEGEND		
BH	SAMPLE	SYMBOL
RW-3	4	ENVELOPE
RW-3	5	
RW-3	6	
RW-4	4	
RW-4	5	
RW-4	6	
RW-4	7	

SILT & CLAY				FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			CORRIELES	UNIFIED
CLAY	FINE SILT		MEDIUM SILT		COARSE SILT		FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL			CORRIELES	M.I.T.
CLAY		SILT			V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND		GRAVEL							U.S. BUREAU

GRAIN SIZE DISTRIBUTION

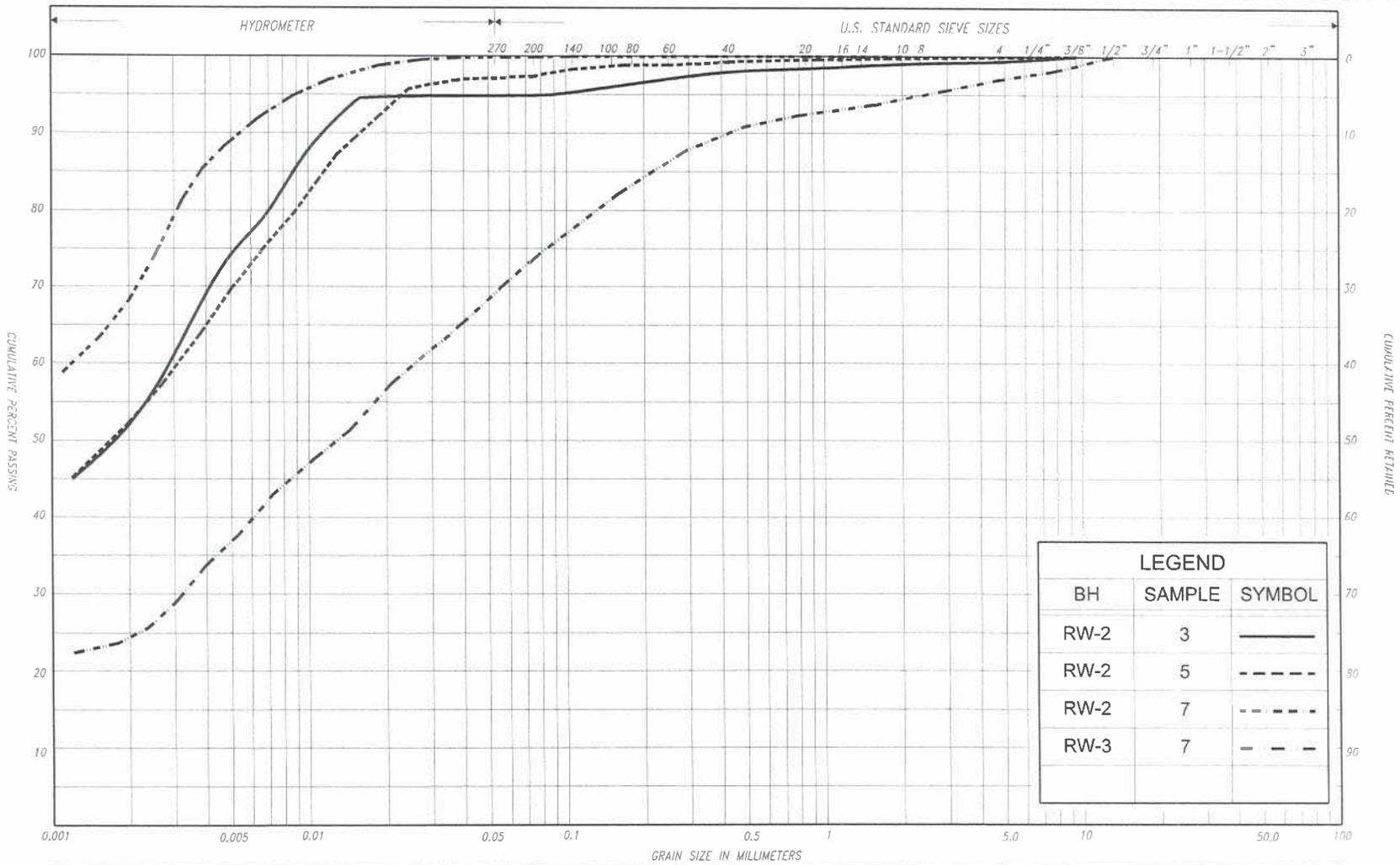
SAND, trace gravel to gravelly, trace to some silt, trace clay

FIG No. RW-GS-6

HWY: 7 / 85

G.W.P. No. 3110-09-00





LEGEND		
BH	SAMPLE	SYMBOL
RW-2	3	—
RW-2	5	- - - - -
RW-2	7	- - - - -
RW-3	7	- - - - -

SILT & CLAY				FINE SAND			MEDIUM SAND		COARSE SAND		GRAVEL		COB BLFS	UNIFIED
CLAY	FINE SILT		COARSE SILT	FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL		COARLES	M.I.T.	
CLAY		SILT		V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND		GRAVEL				U.S. BUREAU	

GRAIN SIZE DISTRIBUTION

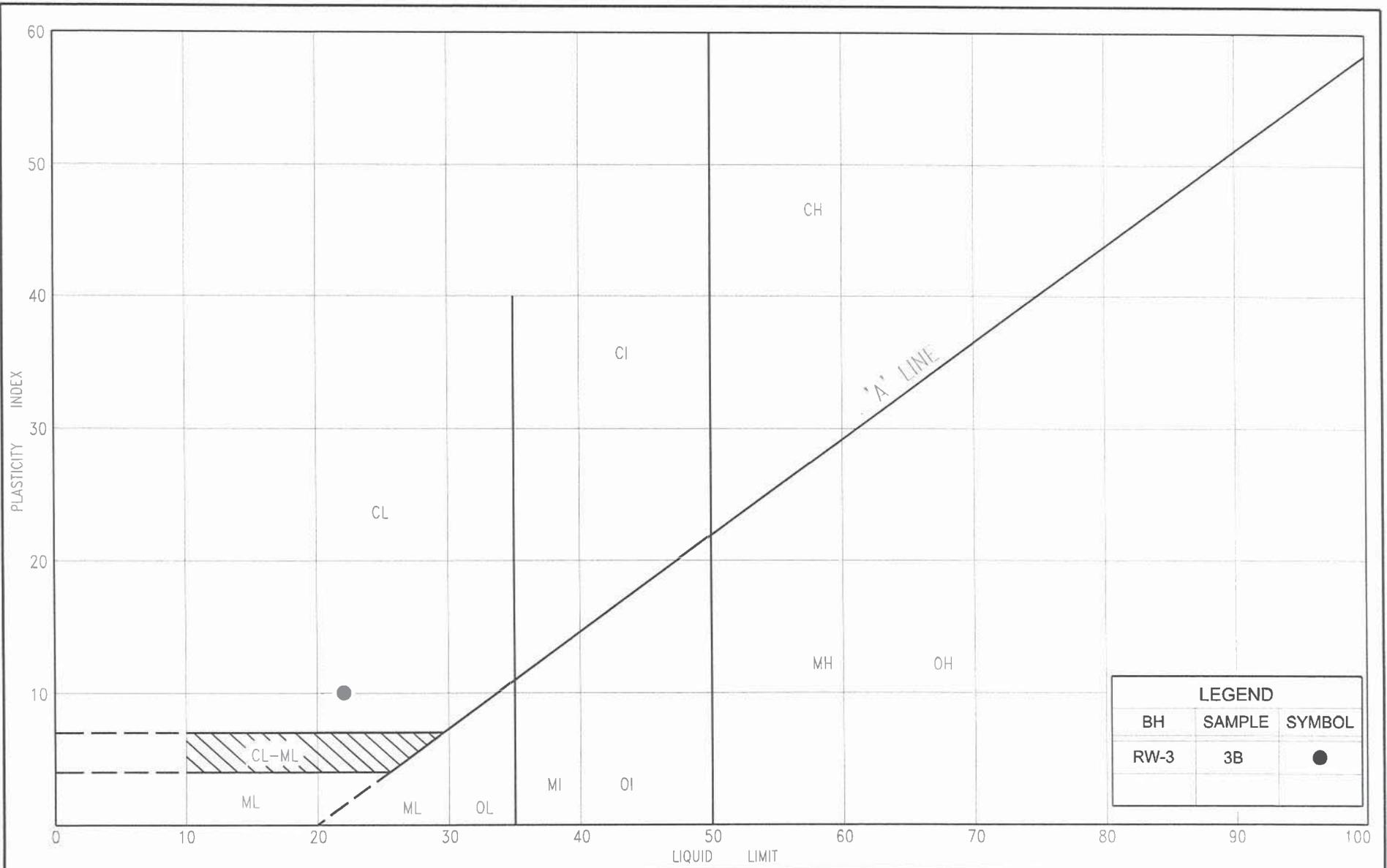
SILTY CLAY, trace to with sand, trace gravel (CI)

FIG No. RW-GS-7

HWY: 7 / 85

G.W.P. No. 3110-09-00





PLASTICITY CHART

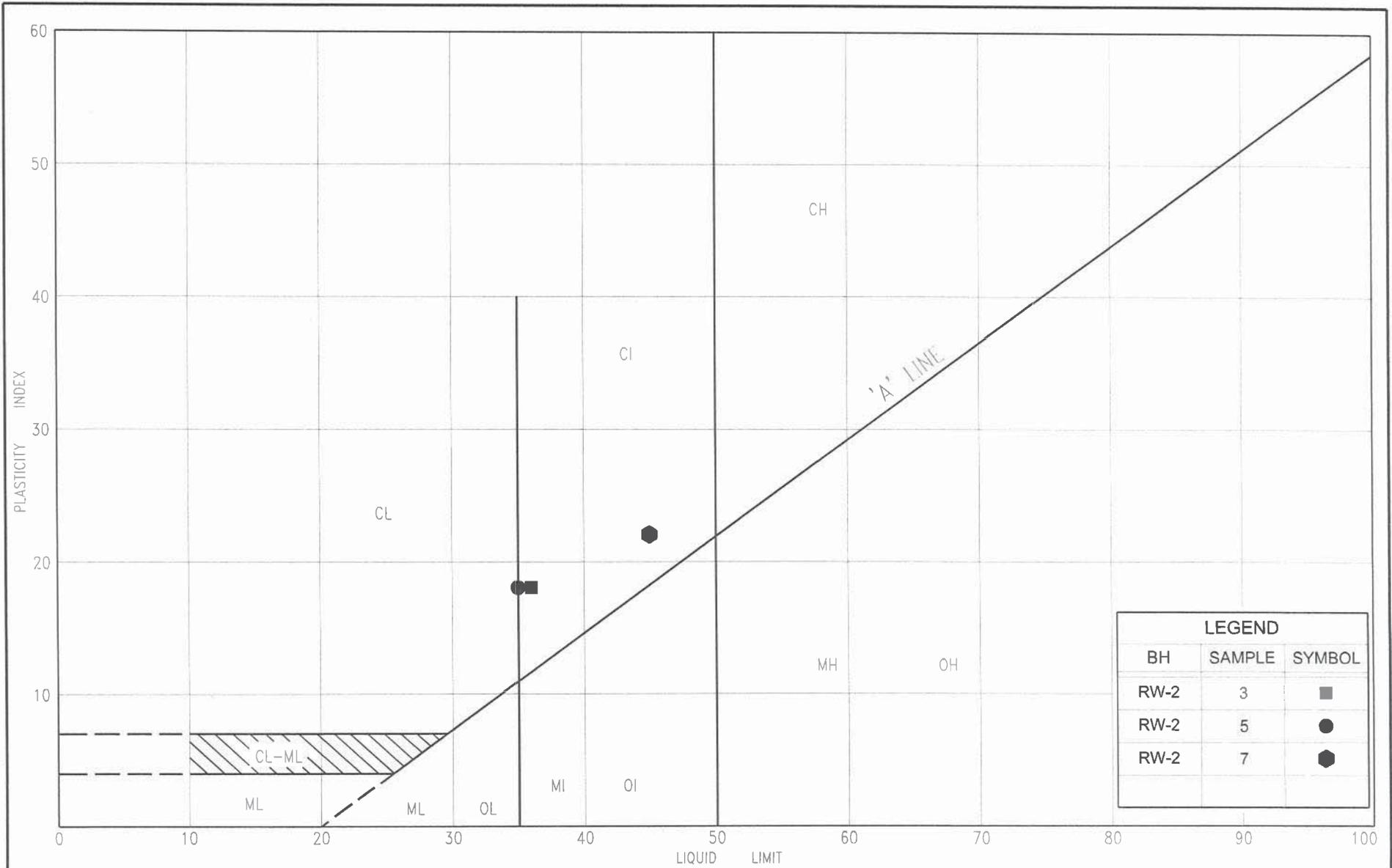
CLAYEY SILT, with sand, trace gravel (CL)
(FILL)

FIG No. RW-PC-1

HWY: 7 / 85

G.W.P. No. 3110-09-00





PLASTICITY CHART

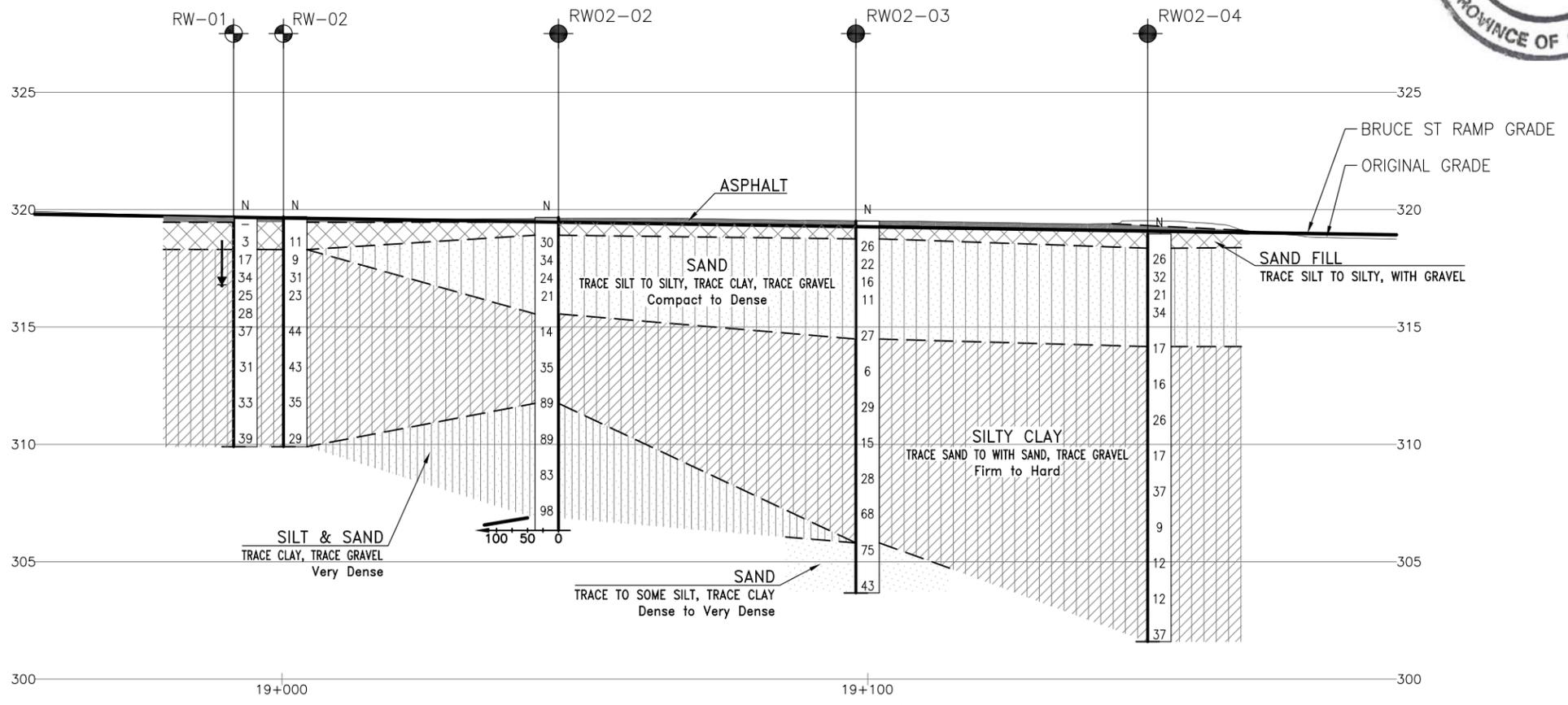
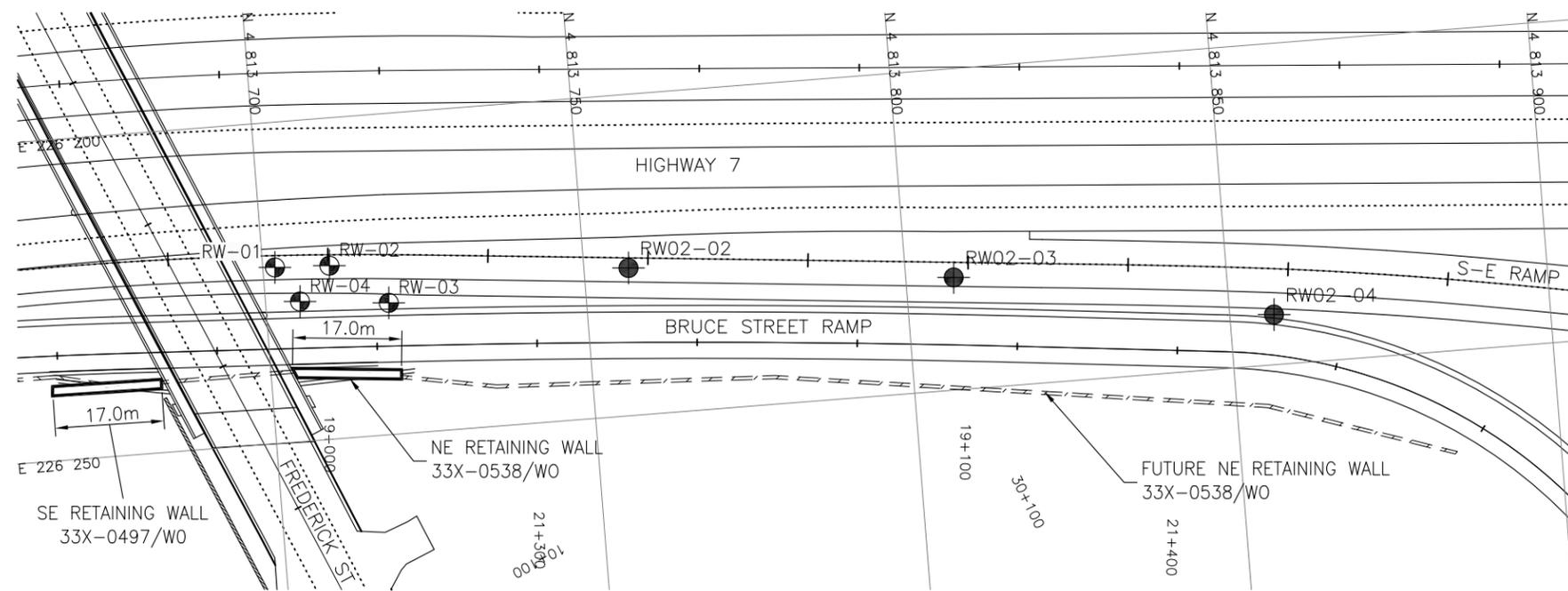
SILTY CLAY, trace to with sand, trace gravel (CI)

FIG No. RW-PC-2

HWY: 7 / 85

G.W.P. No. 3110-09-00





PROFILE ALONG BRUCE STREET RAMP
 FREDERICK STREET-N/E-ANN STREET
 H 1:1000
 V 1:250

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



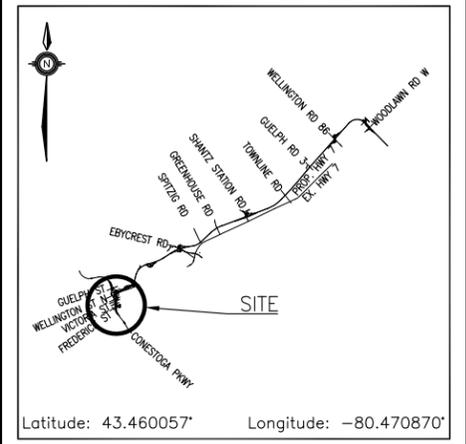
CONT No
 GWP No 3005-20-00

HIGHWAY 7
 FREDERICK ST.-N/E-ANN ST.
 NE RETAINING WALL 33X-0538/WO
 BOREHOLE LOCATIONS AND SOIL STRATA

WSP

THURBER ENGINEERING LTD.

SHEET



KEYPLAN

LEGEND

- Borehole (Current Investigation)
- Borehole (by Others)
- 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
RW02-02	319.6	4 813 757.0	226 227.0
RW02-03	319.5	4 813 807.5	226 232.5
RW02-04	319.1	4 813 856.9	226 242.2
RW-01	319.7	4 813 710.9	226 222.6
RW-02	319.7	4 813 710.4	226 233.0
RW-03	322.3	4 813 719.2	226 229.5
RW-04	323.5	4 813 705.4	226 228.2

- 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. 40P8-290

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	PKC	CODE	LOAD	DATE
NB	MFA				JUN 2021

DRAWN	CHK	NB	SITE	STRUCT	DWG
MFA					1



APPENDIX C
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata
Drawing
NW Retaining Wall - Site # 33X-0860/W0

RECORD OF BOREHOLE No RW16-01 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 677.3 E 226 163.6 ORIGINATED BY JP
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.19 - 2019.08.19 LATITUDE 43.458863 LONGITUDE -80.471748 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
321.3	GROUND SURFACE														
0.0	ASPHALT: (150mm)														
0.2	Sandy SILT, with gravel Brown Dry (FILL)		1	GS			321								
320.5	SAND, some silt to silty, trace clay, trace gravel Compact Brown Wet		2	SS	25		320								
0.8			3	SS	26		320							2 78 16 4	
			4	SS	25		319								
319.0	Silty CLAY, trace sand, trace gravel Very Stiff Grey Moist		5	SS	22		318								
2.3			6	SS	21		317								
			7	SS	28		315							0 1 32 67	
			8	SS	58		313								
312.5	Hard						314								
							312								
8.8	Sandy SILT, trace clay Dense Grey Wet		9	SS	42		312								

ONTMT452_MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW16-01 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 677.3 E 226 163.6 ORIGINATED BY JP
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.19 - 2019.08.19 LATITUDE 43.458863 LONGITUDE -80.471748 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page															
310.0			10	SS	45		311								0 24 70 6	
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED TO 0.2m AND WATER LEVEL NOT OBSERVED. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.															

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

RECORD OF BOREHOLE No RW16-02 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 716.6 E 226 163.9 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.15 - 2019.08.19 LATITUDE 43.459222 LONGITUDE -80.471733 CHECKED BY NB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
					20 40 60 80 100			20 40 60			kn/m ³	GR SA SI CL		
320.4	GROUND SURFACE													
0.0	ASPHALT: (150mm)													
0.2	SAND and GRAVEL, granular Brown Dry	1	GS											
319.7	(FILL)													
0.7	Silty SAND, some clay, occasional cobbles Loose	2	SS	8										
319.0	Brown Moist													
1.4	Silty CLAY, trace sand, trace shale Very Stiff to Hard Brown Dry to Moist	3	SS	25										
		4	SS	35									0 5 53 42	
	Grey	5	SS	39										
		6	SS	38										
		7	SS	21										
		8	SS	32										
		9	SS	41									0 1 45 54	
310.4														

ONT\MT452_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

Continued Next Page

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

RECORD OF BOREHOLE No RW16-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 716.6 E 226 163.9 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.15 - 2019.08.19 LATITUDE 43.459222 LONGITUDE -80.471733 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
							20	40	60	80	100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
							20	40	60	80	100	20	40	60		
10.0	Continued From Previous Page Silty CLAY , trace sand, trace shale Very Stiff to Hard Brown Dry to Moist		10	SS	21		310									
309.1																
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED TO 10.4m AND WATER LEVEL AT 3.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.															

ONTMT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

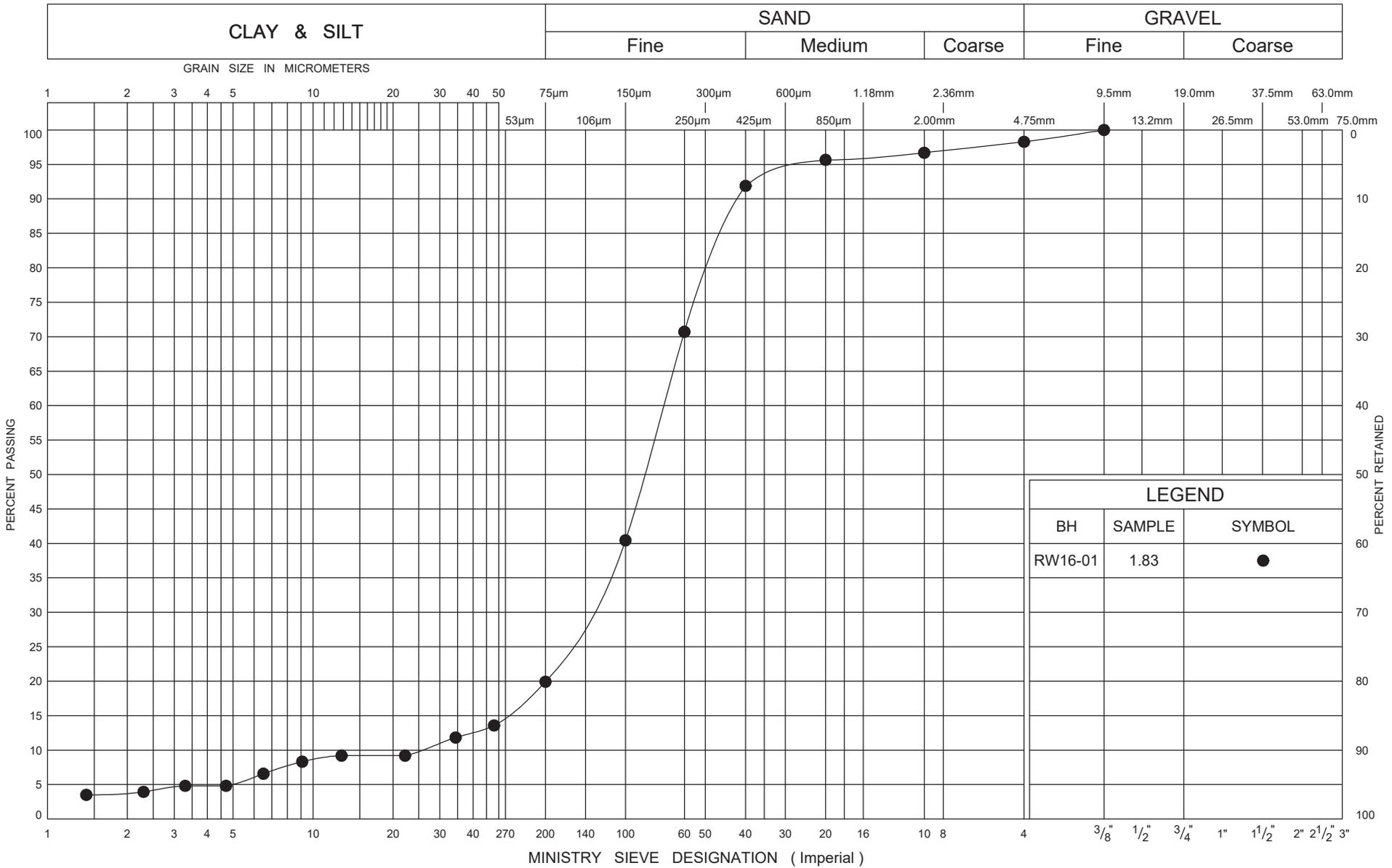
+³, ×³: Numbers refer to Sensitivity 20
15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW16-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 755.4 E 226 164.5 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.15 - 2019.08.15 LATITUDE 43.459582 LONGITUDE -80.471709 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
	Continued From Previous Page														
308.7	Sandy SILT to Silty SAND Compact Grey Wet		10	SS	27									Auger grinding	
11.3	End of sampling DCPT from 11.3m to 12.5m														
307.4															
12.5	END OF BOREHOLE AT 12.5m. BOREHOLE CAVED TO 9.1m AND WATER LEVEL AT 8.8m UPON DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.														

ONT/MT4S2_MTO-11375.GPJ_2017TEMPLATE(MTO).GDT_12/10/19

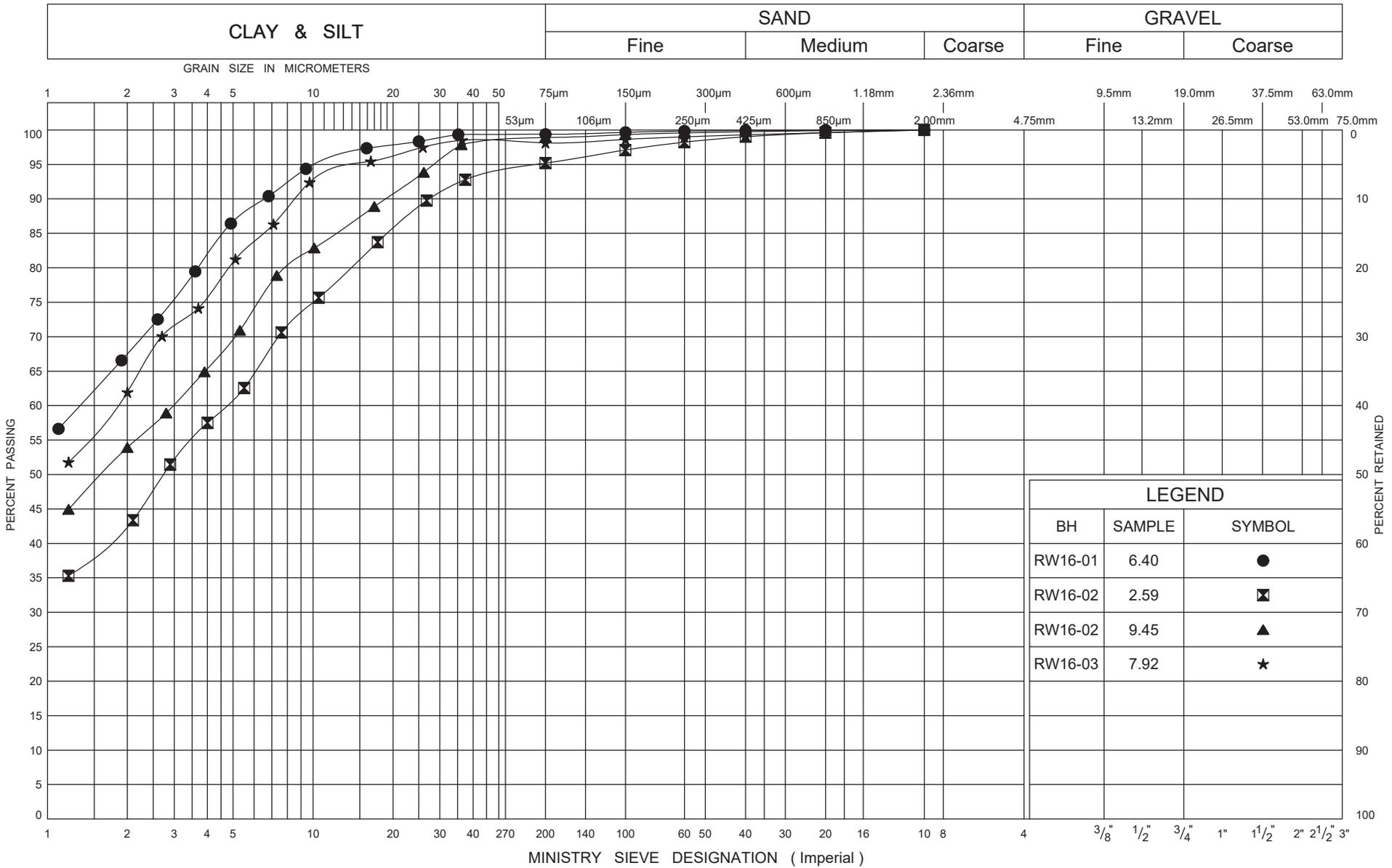


ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



GRAIN SIZE DISTRIBUTION SAND

FIG No E1
W P 408-88-00
Retaining Wall 16



LEGEND		
BH	SAMPLE	SYMBOL
RW16-01	6.40	●
RW16-02	2.59	⊠
RW16-02	9.45	▲
RW16-03	7.92	★

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



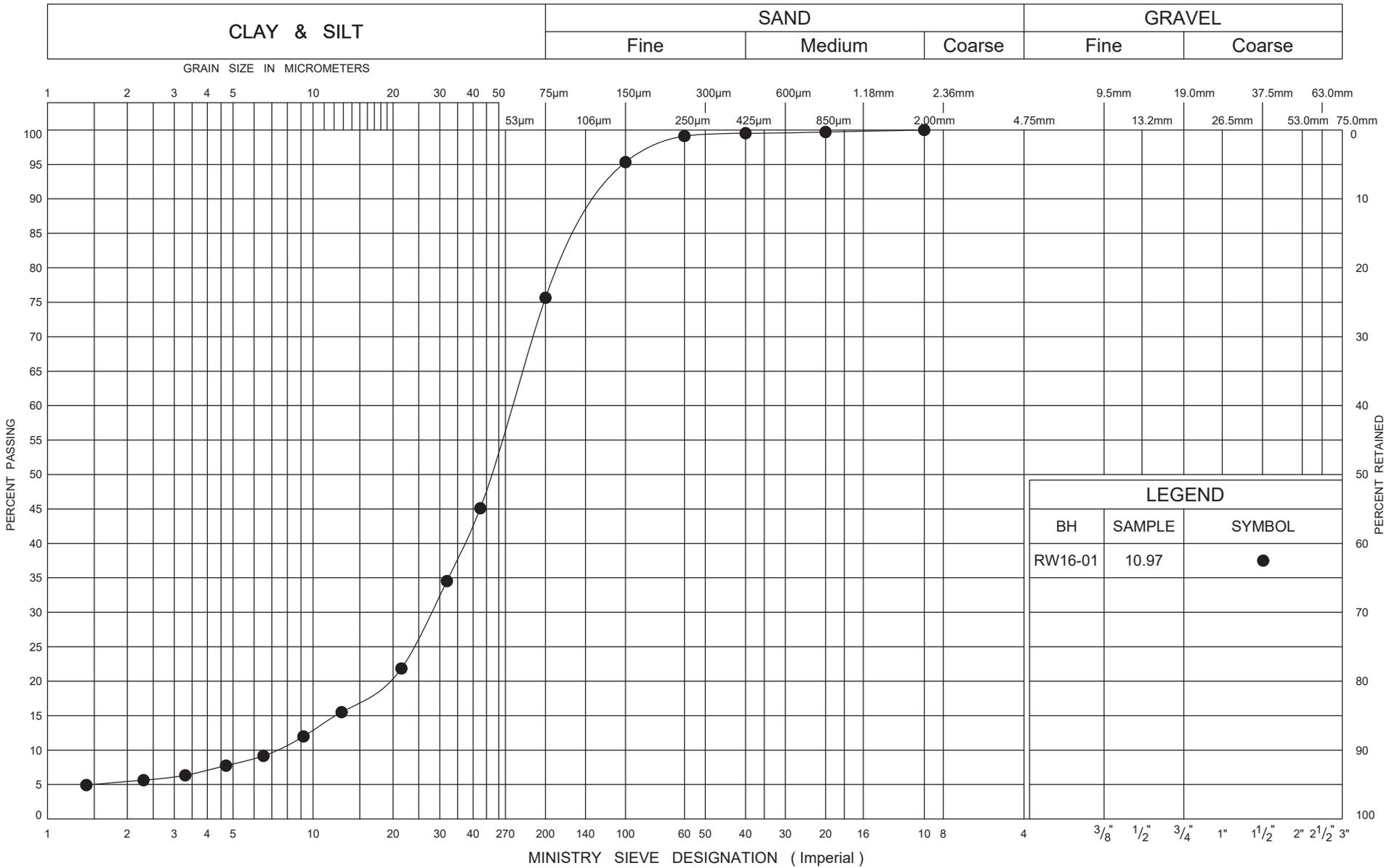
GRAIN SIZE DISTRIBUTION

Silty CLAY

FIG No E2

W P 408-88-00

Retaining Wall 16



ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

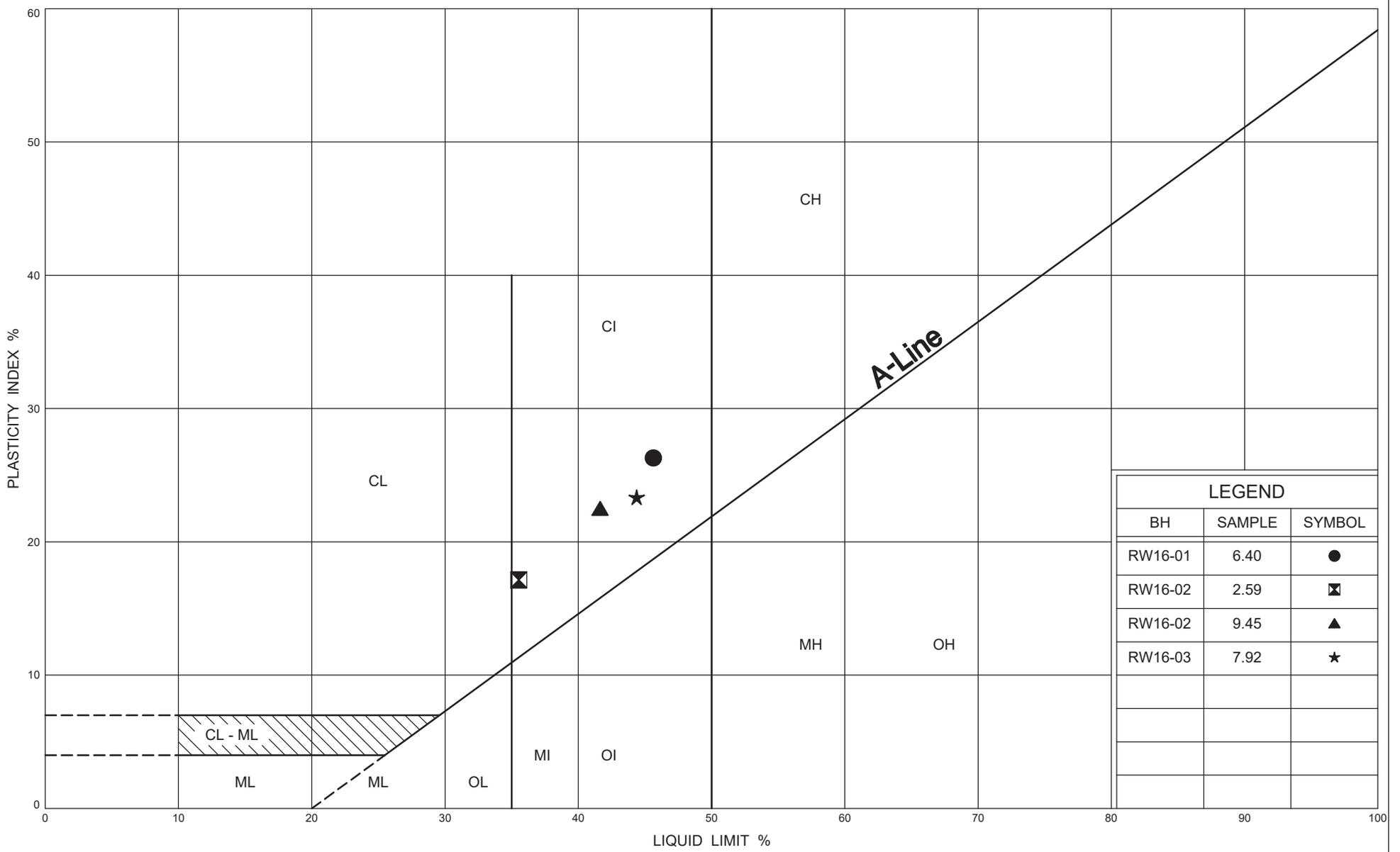


GRAIN SIZE DISTRIBUTION
Silty SAND to Sandy SILT

FIG No E3

W P 408-88-00

Retaining Wall 16



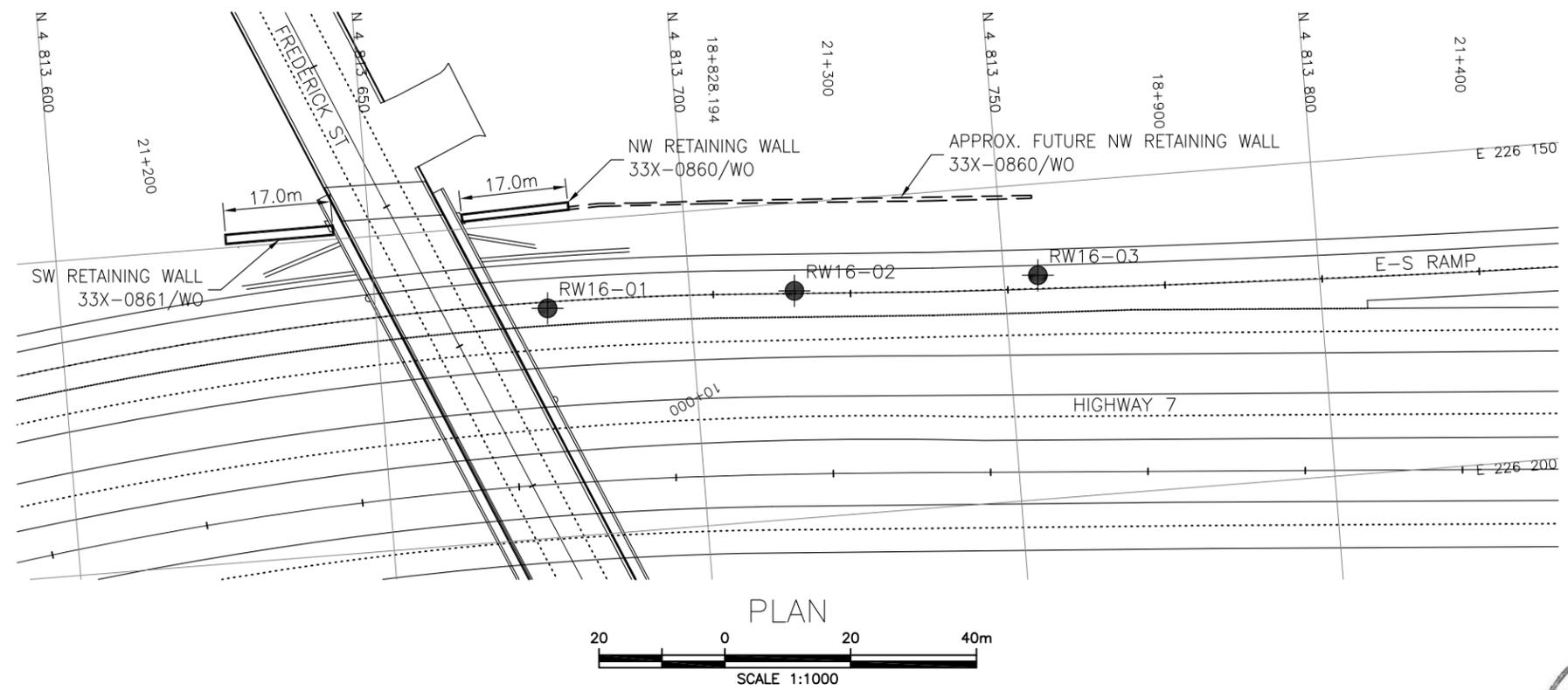
LEGEND		
BH	SAMPLE	SYMBOL
RW16-01	6.40	●
RW16-02	2.59	⊠
RW16-02	9.45	▲
RW16-03	7.92	★

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

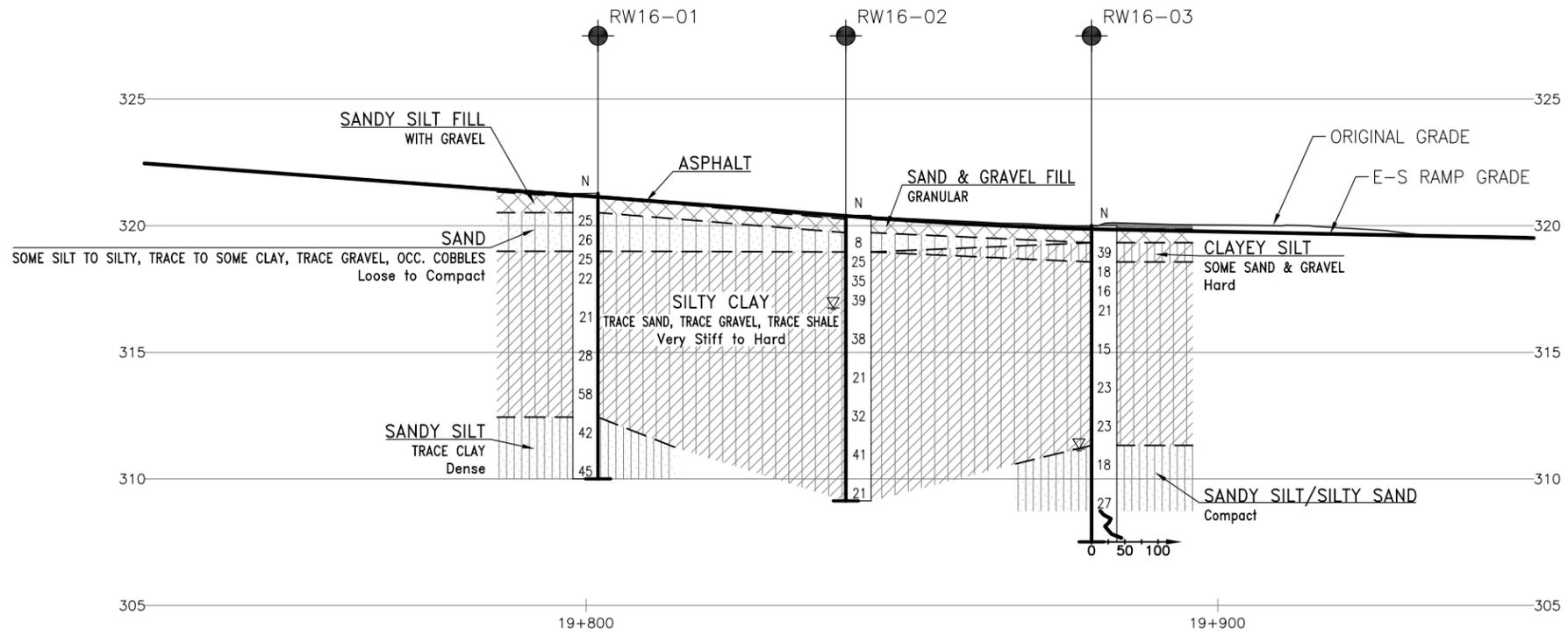


PLASTICITY CHART
Silty CLAY

FIG No E4
W P 408-88-00
Retaining Wall 16



PLAN
SCALE 1:1000

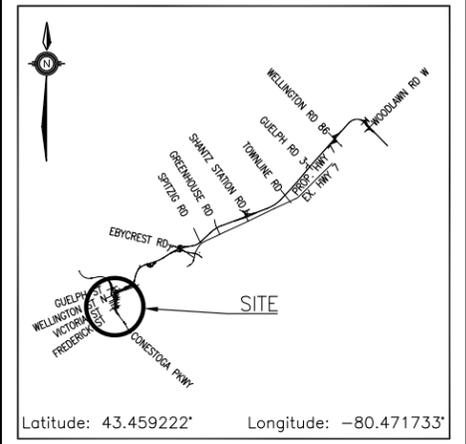


PROFILE ALONG HWY 85 SB/E-S RAMP
H 1:1000
V 1:250

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

CONT No
GWP No 3005-20-00

HIGHWAY 7
HWY 85 SB/E-S RAMP
NW RETAINING WALL 33X-0860/WO
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

- Borehole (Current Investigation)
- ⊕ Borehole (by Others)
- 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
RW16-01	321.3	4 813 677.3	226 163.6
RW16-02	320.4	4 813 716.6	226 163.9
RW16-03	319.9	4 813 755.4	226 164.5

-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. 40P8-290



REVISIONS	DATE	BY	DESCRIPTION

DESIGN NB	CHK PKC	CODE	LOAD	DATE	JUN 2021
DRAWN	MFA	CHK NB	SITE	STRUCT	DWG 1



APPENDIX D
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata
Drawing
SW Retaining Wall - Site # 33X-0861/W0

RECORD OF BOREHOLE No BH20-01

1 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
327.5	GROUND SURFACE														
0.0	ASPHALT: (200mm)														
0.2	SAND and GRAVEL Brown Dry (FILL)														
326.7															
0.8	SAND, some silt, some gravel Compact Brown Dry (FILL)		1	SS	28										
			2	SS	12										
325.3															
2.2	SAND, trace silt Very Loose to Loose Brown Dry (FILL)		3	SS	3										
			4	SS	8										0 89 11 (SI+CL)
323.4															
4.1	SAND, trace silt Compact Brown Wet		5	SS	27										
			6	SS	17										
320.3															
7.2	Clayey SILT, trace sand, trace gravel Stiff Brown Wet		7	SS	9										1 7 78 14
318.8															
8.7	Silty CLAY, trace sand Very Stiff to Hard Grey Wet		8	SS	31										

ONTMT452 MTO-11375(GINTDATA)\GPJ 2017TEMPLATE(MTO)_GDT 2/9/21

Continued Next Page

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

RECORD OF BOREHOLE No BH20-01

2 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60					
Continued From Previous Page														
314.2		9	SS	24										0 0 30 70
13.3	Silty SAND to Sandy SILT, trace clay Very Dense to Dense Grey Wet	11	SS	72										
		12	SS	85										
		13	SS	88										0 28 66 6
		14	SS	45										
308.1														
19.4	Silty CLAY, trace sand Hard Grey Wet													

ONTMT452 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO)_GDT 2/9/21

Continued Next Page

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

RECORD OF BOREHOLE No BH20-01

3 OF 4

METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
Continued From Previous Page															
			15	SS	39										
			16	SS	37										
			17	SS	32										
			18	SS	30										0 4 36 60

Continued Next Page

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

ONTMT452 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO)_GDT 2/9/21

RECORD OF BOREHOLE No BH20-01

4 OF 4

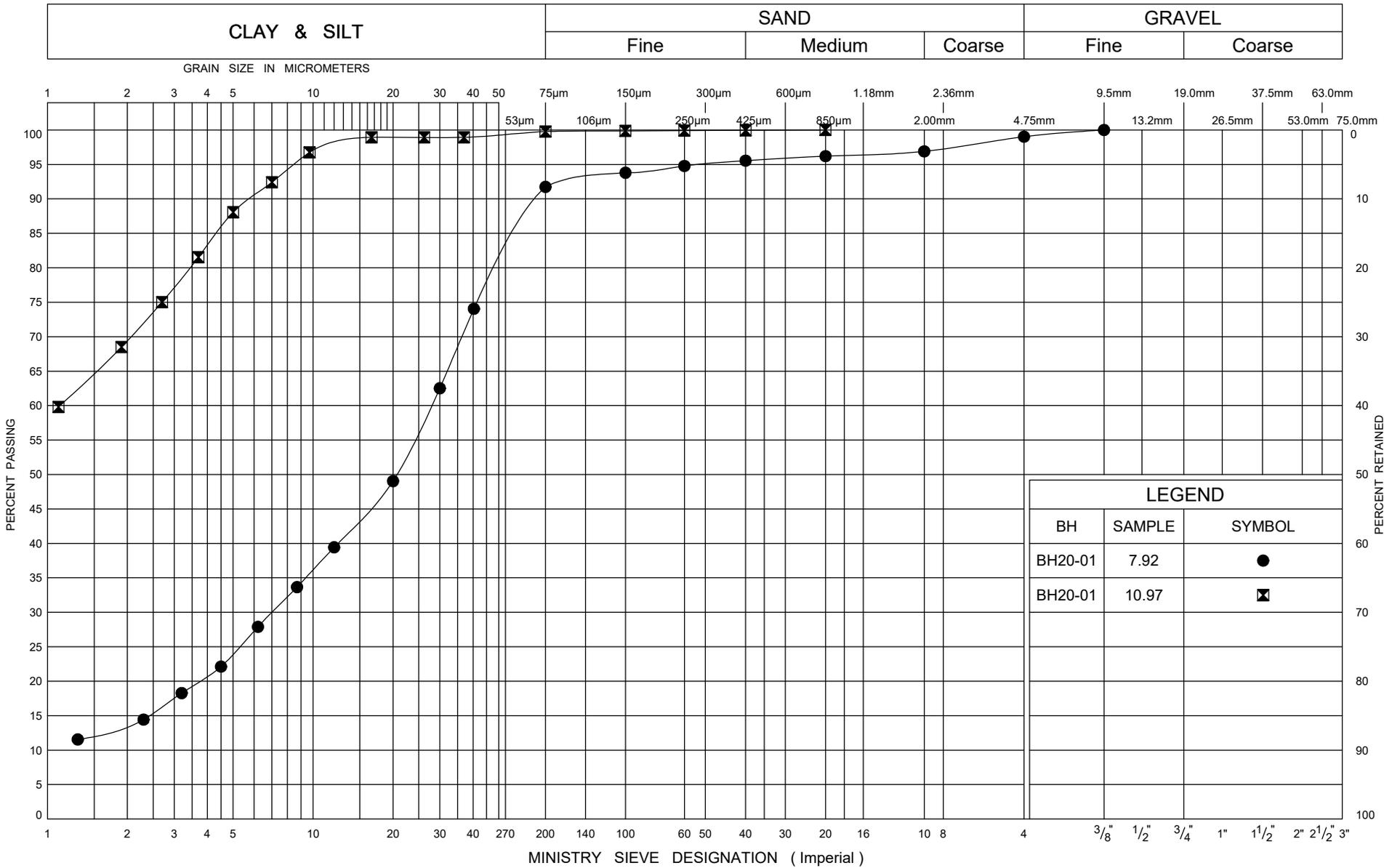
METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
Continued From Previous Page															
293.7	Very Stiff	[Hatched Pattern]	19	SS	23										
33.8	Silty CLAY , sandy, trace gravel Hard Grey Wet (TILL)	[Dotted Pattern]	20	SS	100/ 0.275										
			21	SS	76/ 0.250										3 31 51 15
289.2			22	SS	105/ 0.175										
38.3	END OF BOREHOLE AT 38.3m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2020.08.24 5.5 322.0														

ONTMT452 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 2/9/21

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



LEGEND		
BH	SAMPLE	SYMBOL
BH20-01	7.92	●
BH20-01	10.97	⊠

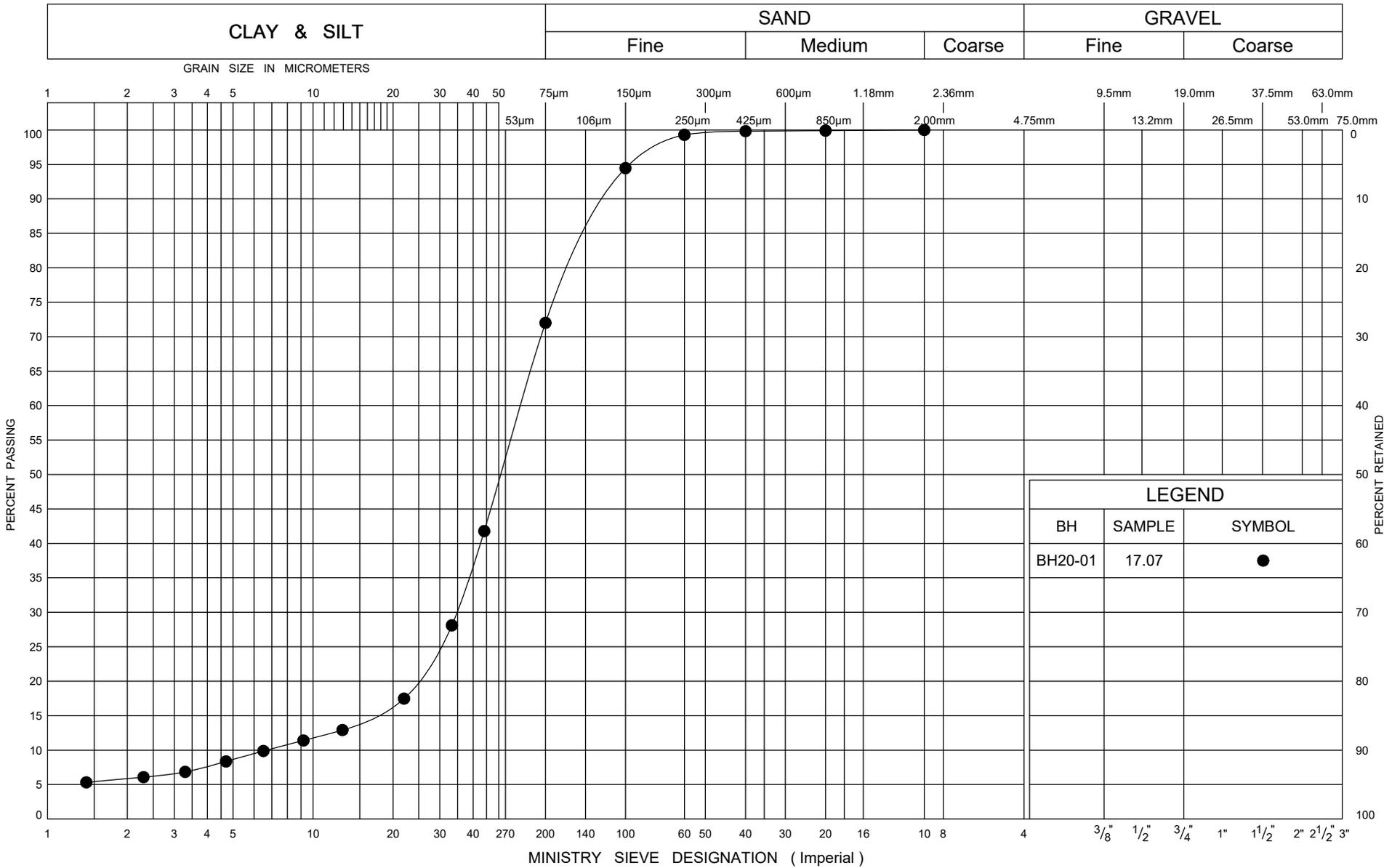
ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ_ONTARIO MOT.GDT 6/3/21



GRAIN SIZE DISTRIBUTION

Upper Clayey SILT

FIG No D2
 W P 408-88-00
 SW Retaining Wall



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ_ONTARIO MOT.GDT 6/3/21

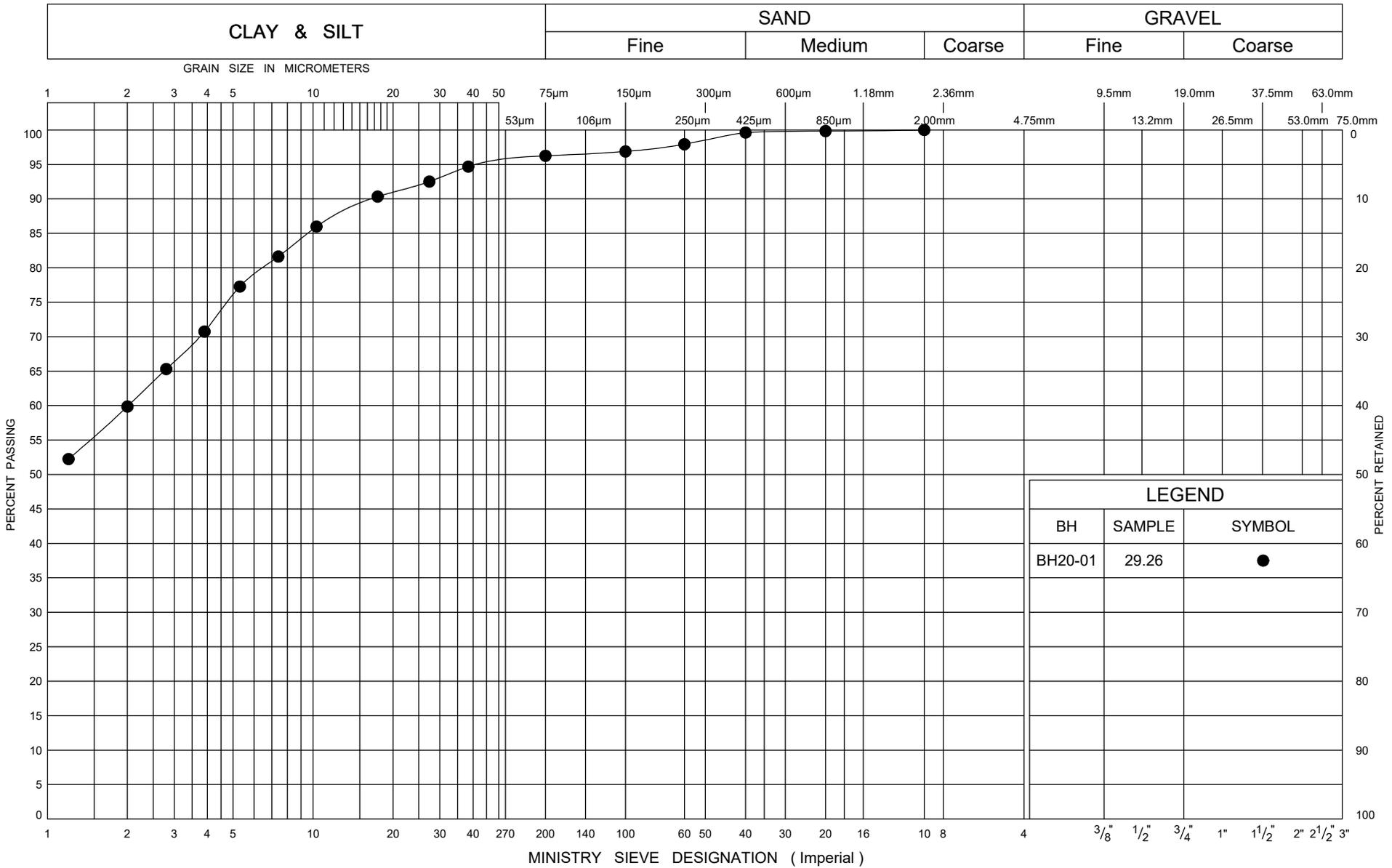


GRAIN SIZE DISTRIBUTION
Silty SAND to Sandy SILT

FIG No D3

W P 408-88-00

SW Retaining Wall



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ_ONTARIO MOT.GDT 6/3/21



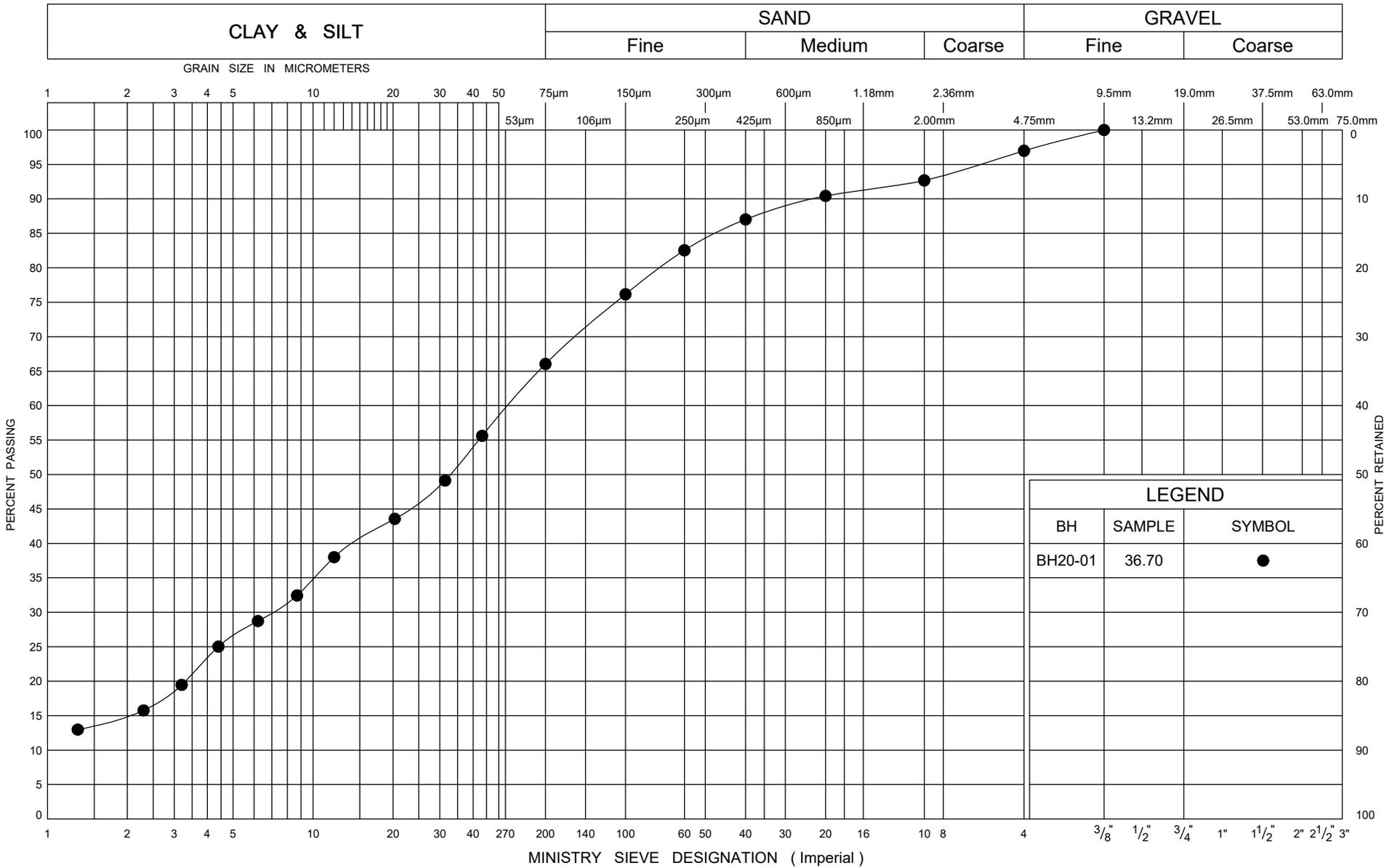
GRAIN SIZE DISTRIBUTION

Lower Silty CLAY

FIG No D4

W P 408-88-00

SW Retaining Wall



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA)\GPJ_ONTARIO MOT.GDT 6/3/21



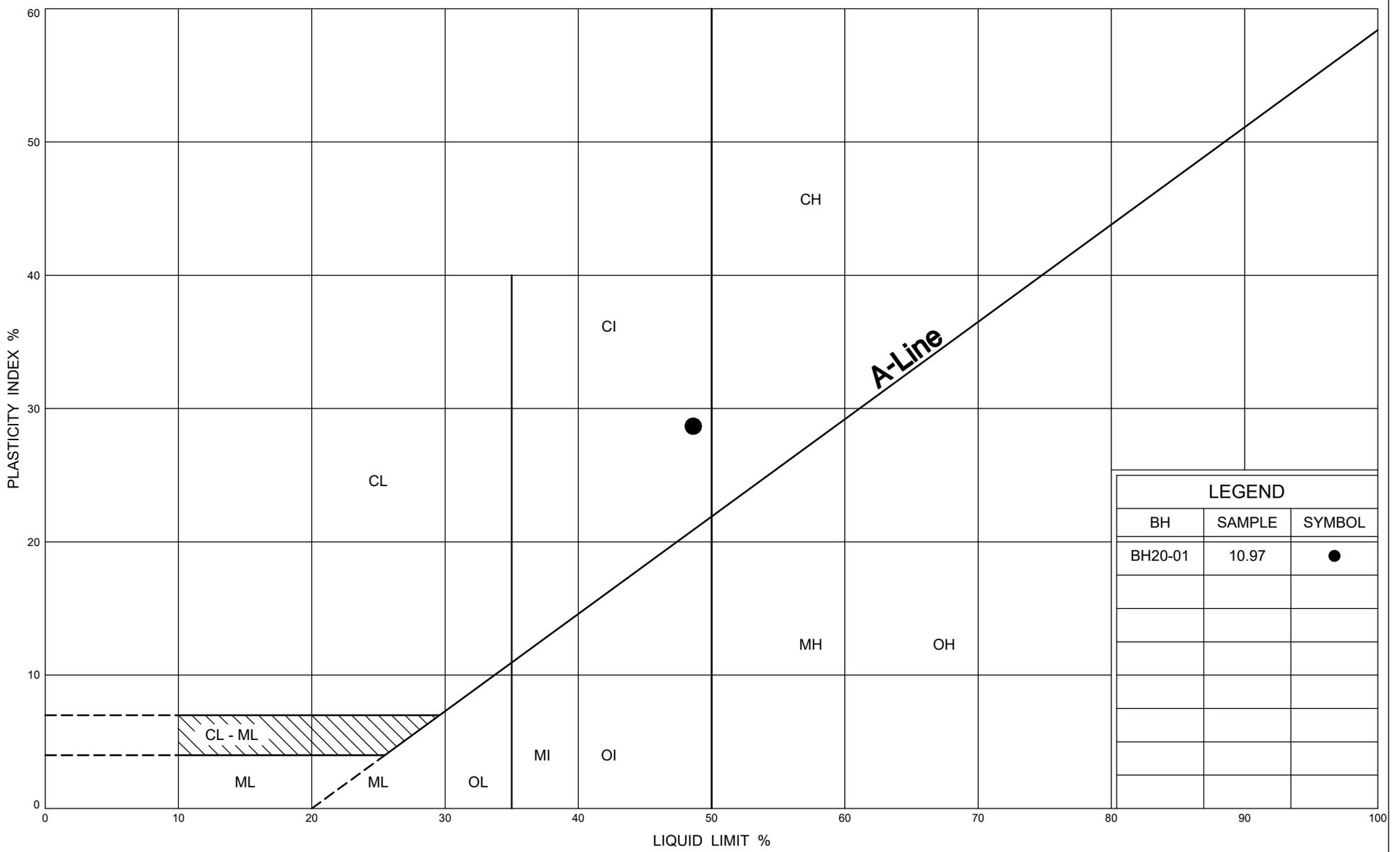
GRAIN SIZE DISTRIBUTION

Silty CLAY TILL

FIG No D5

W P 408-88-00

SW Retaining Wall



ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21



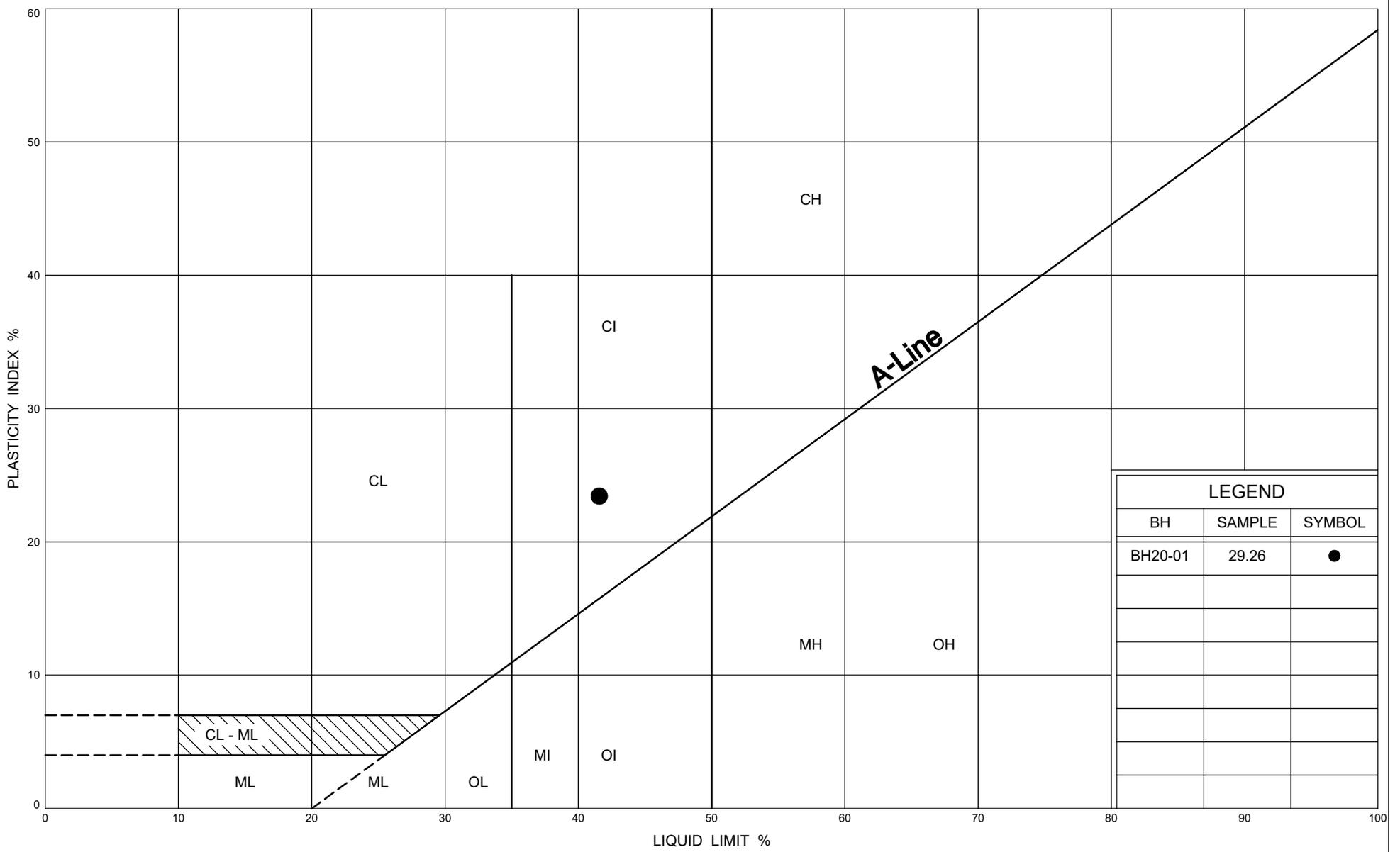
PLASTICITY CHART

Upper Clayey SILT

FIG No D6

W P 408-88-00

SW Retaining Wall



LEGEND		
BH	SAMPLE	SYMBOL
BH20-01	29.26	●

ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21



PLASTICITY CHART
Lower Silty CLAY

FIG No D7
W P 408-88-00
SW Retaining Wall



APPENDIX E
Corrosivity Results



FINAL REPORT

CA14058-MAY18 R1

11375

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

LABORATORY DETAILS

Client	Thurber Engineering Ltd.	Project Specialist	Deanna Edwards, B.Sc, C.Chem
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7.	Laboratory	SGS Canada Inc.
Contact	Rocio Palomeque	Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	905-829-8666 x 263	Telephone	705-652-2000
Facsimile		Facsimile	705-652-6365
Email	rreyna@thurber.ca	Email	deanna.edwards@sgs.com
Project	11375	SGS Reference	CA14058-MAY18
Order Number		Received	05/02/2018
Samples	Soil (7)	Approved	05/09/2018
		Report Number	CA14058-MAY18 R1
		Date Reported	05/09/2018

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
 Cooling Agent Present: No
 Custody Seal Present: No

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

Deanna Edwards, B.Sc, C.Chem



TABLE OF CONTENTS

First Page.....	1
Index.....	2
Results.....	3-4
QC Summary.....	5-6
Legend.....	7
Annexes.....	8-9



FINAL REPORT

CA14058-MAY18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9	10	11
Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018

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

Corrosivity Index

Corrosivity Index	none	1	4	3	4	4	4	3	4
Soil Redox Potential	mV	-	230	182	274	164	133	232	215
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	no unit	0.05	8.67	9.11	9.04	9.19	8.50	9.11	9.25
Resistivity (calculated)	ohms.cm	-9999	4610	17100	6670	13200	5250	13400	10100

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9	10	11
Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018

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

General Chemistry

Conductivity	uS/cm	2	217	59	150	76	190	75	99
--------------	-------	---	-----	----	-----	----	-----	----	----

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9	10	11
Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018

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

Metals and Inorganics

Moisture Content	%	0.1	9.3	4.4	11.3	8.3	13.4	4.1	8.8
Sulphate	µg/g	0.4	15	1.1	13	5.5	11	4.0	8.7



FINAL REPORT

CA14058-MAY18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9	10	11
Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018

Parameter	Units	RL	Result						
Other (ORP)									
Chloride	µg/g	0.4	70	3.2	53	12	46	19	30

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	DIO0131-MAY18	µg/g	0.4	<0.4	6	20	95	80	120	106	75	125
Sulphate	DIO0131-MAY18	µg/g	0.4	<0.4	42	20	98	80	120	98	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	ECS0004-MAY18	%	0.02	<0.02	8	20	99	80	120			

pH

Method: SM 4500 | Internal ref.: ME-CA-IENVIEWL-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	EWL0048-MAY18	no unit	0.05	NA	1		100			NA		

QC SUMMARY

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. 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.

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-- End of Analytical Report --

Project Number: 11375

ONTARIO REGULATION 153/04

SGS Sample ID: ON14058-May 18

Date / Time Sampled: Apr 11, 12, 18, 19, 20, 23

Client Sample ID: See CoC

ALL

Sample Submission General Sample Integrity Violations

- Temperature >10 C upon receipt if not sampled same day
- No evidence of cooling trend initiated if sampled same day
- Chain of Custody not submitted
- Chain of Custody incomplete
- Chain of Custody not signed / dated
- Chain of Custody not a current version
- Bottles / Samples listed on CoC but not received
- Bottles / Samples received but not listed on the CoC
- Sample container received empty

Sample Specific Sample Integrity Violations

- | | | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Sample received past hold time | <input type="checkbox"/> |
| Incorrect preservation (including no preservation where required) | <input type="checkbox"/> |
| Headspace present in VOC vial (aqueous) | <input type="checkbox"/> |
| Sample(s) received frozen | <input type="checkbox"/> |
| Bottle(s) broken or damaged in transport | <input type="checkbox"/> |
| Discrepancy between sample label and chain of custody | <input type="checkbox"/> |
| Analysis requirements absent / unclear | <input type="checkbox"/> |
| Missing or incorrect sample label(s) | <input type="checkbox"/> |
| Inappropriate sample container used | <input type="checkbox"/> |
| Insufficient number of bottles received | <input type="checkbox"/> |
| Limited sample volume | <input type="checkbox"/> |
| Insufficient sample volume | <input type="checkbox"/> |
| Sample contains multiple phases | <input type="checkbox"/> |

Sediment Log

- Groundwater samples contain visible sediment / particulate
- Groundwater contains greater than 1cm of sediment / particulate matter in bottle

Additional Comments/Remarks:

No issues upon receipt



Initials:

BW



FINAL REPORT

CA14209-NOV19 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 (3)**

LABORATORY DETAILS

Project Specialist **Brad Moore Hon. B.Sc**

Laboratory **SGS Canada Inc.**

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

Telephone **705-652-2143**

Facsimile **705-652-6365**

Email **brad.moore@sgs.com**

SGS Reference **CA14209-NOV19**

Received **11/07/2019**

Approved **11/13/2019**

Report Number **CA14209-NOV19 R1**

Date Reported **11/13/2019**

COMMENTS

Temperature of Sample upon Receipt: 18 degrees C
Cooling Agent Present: Yes
Custody Seal Present: No

Chain of Custody Number: 009973

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

Brad Moore Hon. B.Sc



TABLE OF CONTENTS

First Page.....	1
Index.....	2
Results.....	3-4
QC Summary.....	5-7
Legend.....	8
Annexes.....	9



FINAL REPORT

CA14209-NOV19 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
Sample Name	RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix	Soil	Soil	Soil
Sample Date	23/09/2019	20/08/2019	24/09/2019

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

Corrosivity Index

Corrosivity Index	none	1	5	4	9
Soil Redox Potential	mV	-	218	309	309
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02
pH	pH Units	0.05	8.97	8.95	8.79
Resistivity (calculated)	ohms.cm	-9999	2810	8550	1840

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7
Sample Name	RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix	Soil	Soil	Soil
Sample Date	23/09/2019	20/08/2019	24/09/2019

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

General Chemistry

Conductivity	uS/cm	2	356	117	543
--------------	-------	---	-----	-----	-----

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7
Sample Name	RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix	Soil	Soil	Soil
Sample Date	23/09/2019	20/08/2019	24/09/2019

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

Metals and Inorganics

Moisture Content	%	0.1	17.5	13.8	17.2
Sulphate	µg/g	0.4	5.8	12	13



FINAL REPORT

CA14209-NOV19 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
Sample Name	RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix	Soil	Soil	Soil
Sample Date	23/09/2019	20/08/2019	24/09/2019

Parameter	Units	RL	Result	Result	Result
Other (ORP)					
Chloride	µg/g	0.4	100	140	190

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	DIO0141-NOV19	µg/g	0.4	<0.4	6	20	100	80	120	114	75	125
Sulphate	DIO0141-NOV19	µg/g	0.4	<0.4	2	20	97	80	120	91	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	ECS0018-NOV19	%	0.02	<0.02	5	20	112	80	120			

QC SUMMARY

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-ENVIEWL-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	EWL0137-NOV19	uS/cm	2	< 2	3	10	101	90	110	NA		
Conductivity	EWL0179-NOV19	uS/cm	2	< 0.002	0	10	99	90	110	NA		

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	EWL0137-NOV19	pH Units	0.05	NA	0		100			NA		
pH	EWL0179-NOV19	pH Units	0.05	NA	0		100			NA		

QC SUMMARY

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. 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.

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-- End of Analytical Report --



Request for Laboratory Services and CHAIN OF CUSTODY

Laboratory Information Section - Lab use only

Received By: Amrned Al-Moudallawi
Received Date (mm/dd/yyyy): 11/01/19 (mm/dd/yy)
Received Time: 4:15

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

Cooling Agent Present: Yes No
Temperature Upon Receipt (°C): 18.18

Non added
FCF
18.18
LAB LIMS #: CA 14209-NDV19

REPORT INFORMATION

Company: Thurber Engineering Ltd
Contact: Nancy Berg
Address: 103-2010 Winston Park Dr
Oakville ON L6H 5Z7
Phone: 647-633-8417
Email: nberge@thurber.ca

INVOICE INFORMATION

(same as Report Information)
Company: _____
Contact: _____
Address: _____
Phone: _____
Email: _____

PROJECT INFORMATION

Quotation #: _____ P.O. #: _____
Project #: 11375 Site Location/ID: Hwy 7 New, Kitchener
TURNAROUND TIME (TAT) REQUIRED
 Regular TAT (5-7days)
RUSH TAT (Additional Charges May Apply): 1 Day 2 Days 3 Days 4 Days
PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION
Specify Due Date: _____ Rush Confirmation ID: _____

REGULATIONS

Regulation 153/04:
 Table 1 RPI/1 Soil Texture: _____
 Table 2 I/C/C Coarse
 Table 3 A/O Medium
 Table _____ Fine
Other Regulations:
 Reg 347/558 (3 Day min TAT) PWOO MMER
 CCME Other: _____
Sewer By-Law:
 Sanitary Storm
Municipality: _____

NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY
ANALYSIS REQUESTED

COMMENTS:

SAMPLE IDENTIFICATION

1	2	3	4	5	6	7	8	9	10	11	12
RW02-04	RW16-04	RW01-02									
SS#3	SS#2	SS#1									
Sept. 23/19	Aug 28/19	Sept 24/19									
1	1	1									
Soil	Soil	Soil									

RECORD OF SITE CONDITION (RSC)

YES NO

DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX

Observations/Comments/Special Instructions

Sampled By (NAME): Nancy Berg Signature: [Signature] Date: 11/05/19 (mm/dd/yy)
Relinquished by (NAME): _____ Signature: _____ Date: _____ (mm/dd/yy)



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



TABLE OF CONTENTS

First Page.....	1
Index.....	2
Results.....	3-4
QC Summary.....	5-6
Legend.....	7
Annexes.....	8



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.

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-- End of Analytical Report --



FINAL REPORT

CA14882-AUG20 R1

1375 Frederick St.

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

LABORATORY DETAILS

Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Laboratory	SGS Canada Inc.
Contact	Geoff Lay	Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	905-829-8666	Telephone	2165
Facsimile		Facsimile	705-652-6365
Email	glay@thurber.ca	Email	jill.campbell@sgs.com
Project	1375 Frederick St.	SGS Reference	CA14882-AUG20
Order Number		Received	08/28/2020
Samples	Soil (2)	Approved	09/03/2020
		Report Number	CA14882-AUG20 R1
		Date Reported	09/03/2020

COMMENTS

Temperature of Sample upon Receipt:7 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody Number:NA

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

Jill Campbell, B.Sc.,GISAS



TABLE OF CONTENTS

First Page.....	1-2
Index.....	3
Results.....	4-5
QC Summary.....	6-7
Legend.....	8
Annexes.....	9



FINAL REPORT

CA14882-AUG20 R1

Client: Thurber Engineering Ltd.

Project: 1375 Frederick St.

Project Manager: Geoff Lay

Samplers: Brett Thomas

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL	Result	Result
Corrosivity Index				
Corrosivity Index	none	1	8	13
Soil Redox Potential	mV	-	287	285
Sulphide	%	0.04	< 0.04	< 0.04
pH	pH Units	0.05	9.66	9.37
Resistivity (calculated)	ohms.cm	-9999	1830	892

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL	Result	Result
General Chemistry				
Conductivity	uS/cm	2	547	1120

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL	Result	Result
Metals and Inorganics				
Moisture Content	%	0.1	3.8	4.4
Sulphate	µg/g	0.4	8.3	21



FINAL REPORT

CA14882-AUG20 R1

Client: Thurber Engineering Ltd.

Project: 1375 Frederick St.

Project Manager: Geoff Lay

Samplers: Brett Thomas

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL	Result	Result
Other (ORP)				
Chloride	µg/g	0.4	210	750

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	DIO0461-AUG20	µg/g	0.4	<0.4	2	20	96	80	120	103	75	125
Sulphate	DIO0461-AUG20	µg/g	0.4	<0.4	8	20	98	80	120	95	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	ECS0001-SEP20	%	0.04	< 0.04	ND	20	100	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	EWL0414-AUG20	uS/cm	2	< 0.002	1	20	99	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	EWL0414-AUG20	pH Units	0.05	NA	1		100			NA		

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LEGEND

FOOTNOTES

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