



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED RETAINING WALLS
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

Geocres Number: 40P9-58

Report

To

WSP

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- Record of Borehole Sheets
- Laboratory Test Results
- Slope Stability Output
- 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 seven (7) proposed standalone retaining wall sites along the proposed Highway 7-New mainline alignment and the existing Kitchener-Guelph Expressway (KWE - Highway 85) corridor in the City of Kitchener, 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.

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).

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

2.0 SITE DESCRIPTION

The retaining wall sites addressed in this report are located within the existing Highway 7/Highway 85 interchange from north of Guelph Street to South of Frederick Street. A total of



seven (7) retaining walls were identified within this section of the proposed Highway 7-New mainline.

The area is surrounded by industrial and commercial lands and is generally flat.

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

Retaining Wall No.	Location	Approx. Chainage (From)	Approx. Chainage (To)	Approx. Length (m)	Maximum Height (m)
RW01	Frederick St - S/E - Becker Street Retaining Wall	20+910	21+250	340.0	6.0
RW02	Frederick St - N/E - Ann Street Retaining Wall	21+270	21+455	185.00	7.2
RW10	E-S Ramp Hwy 85 Overpass - N/E	19+830	20+075	245.0	4.5
RW12	S-E Ramp-Wellington St Overpass - S/E	19+867	20+150	283.0	7.6
RW16	Highway 85 SB/E-S Ramp - North of Frederick Street	18+800	18+880	80.0	5.5
RW24	E-N Ramp over Guelph Street - North Abutment	19+412	19+500	88.0	3.5
RW28	Dumfries Avenue	21+030	21+120	90.0	2.8

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

A detailed site investigation was carried out for the seven proposed retaining walls. Thirty one boreholes were drilled by Thurber Engineering between October 20, 2016 and September 24, 2019. Four boreholes were 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 3.1. 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 G.

Table 3.1 – Borehole Designations

Retaining Wall	Approx. Chainage (From)	Approx. Chainage (To)	Borehole	Borehole Termination Depth (m)	Borehole Termination Elevation (m)	Appendix
RW01	20+910	21+250	RW01-01 to RW01-07	11.1 m to 14.3 m	313.8 to 305.7	A
RW02	21+270	21+455	RW02-02 to RW02-04, (RW1 to RW4) ¹	9.8 m to 17.4 m	309.9 to 301.7	B
RW10	19+830	20+075	RW09-02, RW10-02 to RW10-06	9.6 m to 13.5 m	313.2 to 305.1	C
RW12	19+867	20+150	RW12-01 to RW12-06	15.6 m to 20.1 m	322.8 m to 325.3 m	D
RW16	18+800	18+880	RW16-01 to RW16-03	11.3 m to 12.5 m	310.0 to 307.4	E
RW24	19+412	19+500	RW24-01 to RW24-03	11.3 m to 12.8 m	307.4 to 305.3	F
RW28	21+030	21+120	RW28-01 to RW28-03	9.8 m to 11.3 m	325.3 to 323.6	G

¹ Boreholes RW1 to RW4 were drilled in a previous investigation conducted by Peto MacCallum, as detailed in Reference 1.

Three to seven boreholes were drilled at each retaining wall site. The boreholes were drilled along the retaining wall alignments, with one borehole at each end and an approximate 50 m spacing in between boreholes.

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

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 with a combination of hollow stem augers and mud rotary drilling. Samples were obtained at



selected depth intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) 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 G.

Groundwater conditions in the open boreholes were observed during the drilling operations. Five piezometers were installed at boreholes RW01-04, RW10-03, RW12-03, RW12-04 and RW12-05 to permit for longer term monitoring of groundwater levels. The piezometers consisted of 25 mm diameter PVC pipe with a slotted screen enclosed in filter sand. The locations and completion details of the piezometers are summarized in Table 3.2 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).

Table 3.2 – Borehole Completion Details

Retaining Wall	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
RW01	RW01-01	14.3	-	Borehole backfilled with grout to 4.3 m, bentonite holeplug to 0.2 m, then asphalt to surface.
	RW01-02	11.1	-	Borehole backfilled with grout to 3.7 m, bentonite holeplug to 0.1 m, then asphalt to surface.
	RW01-03	14.1	-	Borehole backfilled with bentonite holeplug to surface.
	RW01-04	14.0	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	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-06	14.3	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-07	14.3	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.



Retaining Wall	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
RW02	RW02-02	13.3	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-03	15.8	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-04	17.4	-	Borehole backfilled with bentonite holeplug to 0.6 m, sand to 0.2 m, then asphalt to surface.
RW10	RW09-02	9.6	-	Borehole backfilled with bentonite holeplug and grout to surface.
	RW10-02	9.4	-	Borehole backfilled with bentonite holeplug to 0.3 m and cuttings to surface.
	RW10-03	9.8	9.1/319.3	Piezometer with 3.0 m slotted screen installed with sand filter from 9.1 m to 5.5 m, bentonite holeplug from 5.5 m to 0.3 m, then well gravel to ground surface.
	RW10-04	9.5	-	Borehole backfilled with bentonite holeplug to 0.15 m and cuttings to surface.
	RW10-05	8.1	-	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
	RW10-06	13.5	-	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
RW12	RW12-01	15.8	-	Borehole backfilled with bentonite holeplug to 0.3 m and auger cuttings to surface.
	RW12-02	15.8	-	Borehole backfilled with bentonite holeplug to surface.
	RW12-03	15.8	13.7/311.6	Piezometer with 3.0 m slotted screen installed with sand filter from 14.3 m to 10.1 m, then bentonite holeplug from 10.1 m to ground surface.
	RW12-04	15.8	4.5/320.6	Piezometer with 1.5 m slotted screen installed with sand filter from 4.8 m to 2.7 m, bentonite holeplug from 2.7 m to 0.9 m, then cuttings to ground surface.
	RW12-05	15.6	15.2/308.2	Piezometer with 3.0 m slotted screen installed with sand filter from 15.2 m to 11.6 m, bentonite holeplug from 11.6 m to 0.3 m, then well gravel to ground surface.
	RW12-06	20.1	-	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
RW16	RW16-01	11.3	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.



Retaining Wall	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	RW16-02	11.3	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW16-03	12.5	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
RW24	RW24-01	12.8	-	Borehole backfilled with bentonite holeplug and auger cuttings, then asphalt to surface.
	RW24-02	12.8	-	Borehole backfilled with bentonite holeplug and auger cuttings and asphalt to surface.
	RW24-03	11.3	-	Borehole backfilled with bentonite holeplug and auger cuttings and asphalt to surface.
RW28	RW28-01	9.8	-	Borehole backfilled with bentonite holeplug and auger cuttings and asphalt to surface.
	RW28-02	9.8	-	Borehole backfilled with bentonite holeplug and auger cuttings and asphalt to surface.
	RW28-03	11.3	-	Borehole backfilled with bentonite holeplug and auger cuttings and asphalt 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 G.

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 H.

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 G and depicted on the “Borehole Locations and Soil Strata” drawings for each retaining wall alignments in these appendices. An overall description of the



stratigraphy 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 Retaining Wall RW01 - Frederick St - S/E - Becker Street (Station 20+910 to 21+250 - 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 to clayey 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 5.3 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 brown to 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 5.1.1, along with the measurements in the open boreholes upon completion of drilling.

Table 5.1.1 – 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
RW01-06	Aug 13, 2019	2.3	318.3	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 Retaining Wall RW02 - Frederick St - N/E - Ann Street (Station 21+270 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. Due to the difference in elevations and location, the encountered soil depths and elevations will be discussed separately to Boreholes RW02-02 to 02-04, RW-01 and RW-02.



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 RW-01 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, RW-01 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 0.6 m to 1.4 m, with the lower boundary of this layer encountered at depths of 0.8 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 320.2 and 321.1).

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 16 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 320.2 and 321.1).

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 317.6 and 317.9), 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, RW-01 and RW-02 at depths ranging from 1.4 m to 5.0 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 RW-01 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 1.5 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 5.6 and 13.7 m (Elevation 313.9 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 sand till 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).

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 16 percent to 19 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 RW-01 and RW-03. The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.2.1.

Table 5.2.1 – 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
RW-01	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	
RW-04	July 20, 2011	N/A	N/A	Water level in open borehole N/A. Cave-in observed at 5 m.

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 Retaining Wall RW10 - E-S Ramp Hwy 85 Overpass - N/E (Station 19+830 to 20+075 – Appendix C)

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

5.3.1 Topsoil

A layer of topsoil was encountered surficially in three boreholes drilled at this site, RW10-04, RW10-05 and RW10-06. It was generally dark brown in colour.

The thickness of the topsoil layer ranged from 0.2 m to 0.5 m. The topsoil thickness may vary between the borehole locations and in other areas of the site.

Moisture content of samples of the topsoil generally ranged from 25 percent to 50 percent.

5.3.2 Granular Fill

Granular fill consisting of sand to sand and gravel was encountered surficially at three boreholes at this site, Boreholes RW10-02 and RW10-03. Granular fill was encountered immediately below the topsoil at Borehole RW10-04.

The granular fill consisted of sand generally brown in colour, with trace silt to silty, trace to some clay and trace to no gravel, or consisted of sand and gravel.

The thickness of the granular fill ranged from 2.7 m to 3.2 m, with the lower boundary of this layer encountered at depths of 3.0 m to 3.7 m (Elevation 325.3 to 323.9).

SPT N-values recorded in the granular fill ranged from 2 to 20 blows for 0.3 m penetration, indicating a loose to compact relative density.

Moisture content of samples of the granular fill generally ranged from 6 percent to 14 percent.

Three samples of the granular fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C1 of Appendix C. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	0 to 13
Sand	64 to 87
Silt	10 to 25
Clay	3 to 11

5.3.3 Upper Sand

An upper native sand layer was encountered at ground surface in RW09-02, below the granular fill in RW10-02, RW10-03 and RW-04 and immediately below the topsoil in Borehole RW10-05.

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

The thickness of the upper sand layer ranged from 1.7 m to 3.4 m with the lower boundary of the sand layer encountered at depths ranging from 2.2 to 7.1 (Elevation 322.5 to 320.4).

SPT N-values recorded in the upper sand layer ranged from 6 to 32 blows for 0.3 m penetration, indicating a loose to compact relative density.

Moisture content of samples of the upper sand layer generally ranged from 1 percent to 14 percent.

Three samples of the sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C2 of Appendix C. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	0 to 4
Sand	79 to 89
Silt and Clay	7 to 19

5.3.4 Silty Clay

Silty clay was encountered below the granular fill in Boreholes RW09-02, RW10-02 and RW10-04, at depths ranging from 2.4 m to 7.1 m (Elevation 322.1 to 320.4).

Silty clay was also encountered below the upper native sand layer at 7.0 m depth (Elevation 321.4) in Borehole RW10-03, and 2.2 m depth (Elevation 322.5) in Borehole RW10-05, and immediately below the topsoil in Borehole RW10-06.

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

Boreholes RW10-02, RW10-03 and RW10-04 were terminated within the silty clay at a depth of 9.4 m, 9.8 m and 9.5 m, respectively (Elevation 319.6, 318.6 and 317.3).

The thickness of the silty clay layer was 2.3 m, 3.4 m and 2.9 m for Boreholes RW09-02, RW10-05 and RW10-06, respectively, with the lower boundary of the silty clay encountered at depths of 9.4 m, 5.6 m and 3.4 m (Elevation 318.7, 319.1 and 315.2).

SPT N-values recorded in the silty clay ranged from 12 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a stiff to hard consistency.

The natural moisture content of samples of the silty clay ranged from 6 percent to 23 percent.

Six samples of the silty clay underwent laboratory gradation analysis and five 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 C and the grain size distribution curves for these samples are plotted on Figure C3 of Appendix C. The results of the Atterberg Limits tests are plotted on Figure C6.

Soil Particles	Silty Clay (%)
Gravel	0
Sand	0 to 38
Silt	39 to 49
Clay	19 to 53

Index Property	
Liquid Limit	29 to 37
Plastic Limit	14 to 16
Plasticity Index	15 to 21

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

5.3.5 Sand and Silt

Sand and silt was encountered below the silty clay at the depth of 4.1 m (Elevation 318.7) in Borehole RW09-02 and 5.6 m (Elevation 319.1) in Borehole RW10-05.

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

Borehole RW09-02 was terminated in the sand and silt at the depth of 9.6 m (Elevation 313.2) and Borehole RW10-05 was terminated in the sand and silt at the depth of 8.1 m (Elevation 316.6).

SPT N-values recorded in the sand and silt ranged from 41 to 109 blows for 0.3 m penetration, indicating a dense to very dense relative density.

Moisture content of samples of the sand and silt generally ranged from 2 percent to 19 percent.

Two samples of the sand and silt underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C4 of Appendix C. The results of this testing are summarized as follows:

Soil Particles	Sand and Silt (%)
Gravel	0
Sand	49 to 52
Silt	38 to 41
Clay	10

5.3.6 Lower Sand to Silty Sand

A lower sand to silty sand layer was encountered below the silty clay in RW10-06 at the depth of 3.4 m (Elevation 315.2).

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

Borehole RW10-06 was terminated in the lower sand to silty sand layer at the depth of 13.5 m (Elevation 305.1).

SPT N-values recorded in the sand to silty sand ranged from 5 to 72 blows for 0.3 m penetration, indicating a loose to very dense relative density.

Moisture content of samples of the sand to silty sand generally ranged from 14 percent to 20 percent.

Two samples of the sand to silty sand underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix C and the grain size distribution curves for these samples are plotted on Figure C5 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Lower Sand to Sandy Silt (%)
Gravel	0
Sand	71 to 87
Silt	13 to 25
Clay	0 to 4

5.3.7 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 RW10-03, to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.3.1, along with the measurements in the open boreholes upon completion of drilling.

Table 5.3.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW09-02	April 11, 2018	7.1	315.7	Open borehole
RW10-02	April 19, 2018	Dry	-	Open borehole
RW10-03	April 27, 2018	6.2	322.2	Piezometer
	May 16, 2018	6.1	322.3	
	May 31, 2018	6.0	322.4	
	June 25, 2018	5.7	322.6	
RW10-04	April 18, 2019	4.9	322.0	Open borehole
RW10-05	Oct 26, 2016	Dry	-	Open borehole
RW10-06	Oct 24, 2016	4.6	314.0	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 RW10-04 caved-in at 4.6 m and Borehole RW10-04 caved-in at 5.3 m.

5.4 Retaining Wall RW12 - S-E Ramp-Wellington St Overpass - S/E (Station 19+867 to 20+150 – Appendix D)

In general the soil stratigraphy at this site consisted of granular fill overlying a layer of upper native sand, an upper layer of silty clay or silty clay till, a lower sand or silt layer, and a lower layer of silty clay.



5.4.1 Topsoil

A layer of topsoil was encountered surficially at one borehole drilled at this site, RW12-03. It was generally dark brown in colour. The thickness of the topsoil layer 0.3 m. The topsoil thickness may vary between the borehole locations and in other areas of the site.

The moisture content of samples of the topsoil was 15 percent.

5.4.2 Granular Fill

Granular fill was encountered surficially at five boreholes at this site, Boreholes RW-12-01, RW12-02, RW12-04, RW12-05 and RW12-06. Granular fill was encountered immediately below the topsoil layer in Borehole RW12-03.

The granular fill was brown to grey in colour and consisted of sand, with trace silt to silty, trace to some gravel and trace clay, or sand and silt. Occasional organics were observed at Boreholes RW12-01 and RW12-04.

The thickness of the granular fill ranged from 0.7 m to 3.0 m, with the lower boundary of this layer encountered at depths of 0.7 m to 3.0 m (Elevation 320.5 to 323.7).

SPT N-values recorded in the granular fill ranged from 3 to 38 blows for 0.3 m penetration, indicating a very loose to dense relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 26 percent.

Four samples of the granular fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figure D1 of Appendix D. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	0 to 15
Sand	35 to 86
Silt	5 to 60
Clay	0 to 8

5.4.3 Upper Sand

An upper native sand layer was encountered immediately below the granular fill in five boreholes at this site, Boreholes RW12-01 to RW12-05, at depths ranging from 1.4 m to 3.0 m (Elevation 323.7 m to 321.3 m).

The upper native sand layer was brown to grey in colour and contained trace silt, trace clay and trace gravel.

The thickness of the upper sand ranged from 0.6 m to 1.9 m, with the lower boundary of the sand layer encountered at depths ranging from 2.0 m to 4.1 m (Elevation 323.1 to 320.5).

SPT N-values recorded in the upper sand ranged from 4 to 26 blows for 0.3 m penetration, indicating a loose to compact relative density.

Moisture content of samples of the upper sand generally ranged from 15 percent to 39 percent.

One sample of the upper sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figure D2 of Appendix D. The results of this testing are summarized as follows:

Soil Particles	Upper Sand (%)
Gravel	0
Sand	93
Silt	7
Clay	0

5.4.4 Silty Clay Till

A silty clay till layer was encounter below the upper native sand layer at a depth of 4.1 m in Boreholes RW12-01, RW12-02 and RW12-03 (Elevation 320.4, 321.0, 321.2).

The silty clay till was brown to grey and contained some to with sand, trace gravel and occasional cobbles.

The thickness of the silty clay till layer ranged from 1.5 m to 4.6 m in Boreholes RW12-01 to RW12-03, with the lower boundary of the silty clay till encountered at depths ranging from 5.6 m to 8.7 m (Elevation 315.9 to 319.6).

SPT N-values recorded in the silty clay till ranged from 19 to 34 blows for 0.3 m penetration, indicating a very stiff to hard consistency.

The natural moisture content of samples of the silty clay till ranged from 8 percent to 30 percent.

Two samples of the silty clay till underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix D and the grain size distribution curve for this sample is plotted on Figure D3 of Appendix D. The results of the Atterberg Limits tests are plotted on Figure D7.

Soil Particles	Silty Clay Till (%)
Gravel	3 to 7
Sand	19 to 24
Silt	39 to 50
Clay	23 to 35

Index Property	
Liquid Limit	24 to 27
Plastic Limit	14 to 15
Plasticity Index	10 to 12

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

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

5.4.5 Upper Silty Clay

An upper silty clay layer was encountered immediately below the granular fill in Borehole RW12-06 at a depth of 0.7 m (Elevation 320.5 m) and below the upper sand layer in Boreholes RW12-04 and RW12-05 at a depth of 2.0 m and 2.9 m, respectively (Elevation 323.1 and 320.5).

Silty clay was also encountered below the silty clay till layer at Borehole RW12-03 at a depth of 5.6 m (Elevation 319.6), and below the lower sand layer at Boreholes RW12-01 and RW12-02 at depths of 12.3 m and 12.2 m (Elevation 312.2 and 312.9), respectively.



The upper silty clay was brown to grey and contained trace to with sand.

Boreholes RW12-01 and RW12-02 were terminated in the silty clay layer at the depth of 15.8 m for both boreholes (Elevation 308.7 and 309.2).

In Boreholes RW12-03, RW12-04 and RW12-06, the thickness of the silty clay layer was 5.4 m, 5.2 m and 9.8 m, with the lower boundary of the silty clay encountered at a depth of 11.0 m, 7.2 m and 10.5 m (Elevation 314.3, 317.9 and 310.7), respectively.

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

The natural moisture content of samples of the upper silty clay ranged from 12 percent to 43 percent.

Eight samples of the upper 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 D and the grain size distribution curve for this sample is plotted on Figure D4 of Appendix D. The results of the Atterberg Limits tests are plotted on Figure D8.

Soil Particles	Upper Silty Clay (%)
Gravel	0 to 3
Sand	0 to 39
Silt	35 to 57
Clay	19 to 61

Index Property	
Liquid Limit	17 to 42
Plastic Limit	9 to 18
Plasticity Index	8 to 24

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

5.4.6 Lower Sand to Sand and Silt

A lower sand to sand and silt layer was encountered below the silty clay till at Boreholes RW12-01 and RW12-02 at a depth of 8.7 m and 7.2 m, respectively (Elevation 315.9

and 317.9). A lower sand to sand and silt layer was also encountered below the silty clay at Boreholes RW12-03 to RW12-06, at depths ranging from 7.2 m to 11.0 m (Elevation 315.1 to 310.7).

The lower sand to sand and silt layer was generally brown to grey in colour, and contained trace gravel and trace clay, with occasional cobbles.

The thickness of the lower sand to sand and silt layer ranged from 1.3 m to 4.8 m, with the lower boundary of the sand encountered at depths ranging from 10.0 m to 15.2 m (Elevation 315.1 to 308.6).

And additional sand layer was encountered in Borehole RW12-06 below the lower silty clay, at a depth of 17.8 m (Elevation 303.4). Borehole RW12-06 was terminated in this second sand layer at a depth of 20.1 m (Elevation 301.1).

SPT N-values recorded in the lower sand ranged from 11 to 130 blows for 0.3 m penetration, indicating a compact to very dense relative density.

Moisture content of samples of the lower sand generally ranged from 9 percent to 25 percent.

Six samples of the lower sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix D and the grain size distribution curves for these samples are plotted on Figure D5 of Appendix D. The results of this testing are summarized as follows:

Soil Particles	Lower Sand (%)
Gravel	0 to 7
Sand	40 to 94
Silt	6 to 53
Clay	0 to 9

5.4.7 Lower Silty Clay

A lower silty clay layer was encountered below the lower sand to sand and silt layer in Boreholes RW12-03 to RW12-06, at depths ranging from 11.7 m to 15.2 m (Elevation 313.3 to 308.6).

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



Boreholes RW12-03, RW12-04 and RW12-05 were terminated in the lower silty clay layer at a depth of 15.8, 15.8 m and 15.6 m (Elevation 309.4, 309.2 and 307.8), respectively.

In Borehole RW12-06, the thickness of the lower silty clay layer was 5.2 m, with the lower boundary of the silty clay encountered at a depth of 17.8 m (Elevation 303.4).

SPT N-values recorded in the lower silty clay ranged from 26 to 100 blows for 0.3 m penetration, indicating a very stiff to hard consistency.

The natural moisture content of samples of the lower silty clay ranged from 14 percent to 26 percent.

Four samples of the lower silty clay underwent laboratory gradation analysis and two 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 D and the grain size distribution curve for this sample is plotted on Figure D6 of Appendix D. The results of the Atterberg Limits tests are plotted on Figure D9.

Soil Particles	Lower Silty Clay (%)
Gravel	0
Sand	0 to 14
Silt	29 to 69
Clay	17 to 59

Index Property	
Liquid Limit	37 to 38
Plastic Limit	16 to 18
Plasticity Index	20

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

5.4.8 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Three standpipe piezometers were installed at this site, in Boreholes RW12-03, RW12-

04 and RW12-05 to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.4.1, along with the measurements in the open boreholes upon completion of drilling.

Table 5.4.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW12-01	N/A	N/A	N/A	Water level in open borehole not available. No cave-in observed.
RW12-02	N/A	N/A	N/A	Water level in open borehole not available. No cave-in observed.
RW12-03	May 16, 2018	8.3	316.9	Piezometer
	May 31, 2018	8.2	317.1	
	June 25, 2018	7.9	317.3	
RW12-04	April 19, 2018	13.4	311.7	Open borehole (Water reading N/A as piezometer was destroyed)
RW12-05	April 27, 2018	5.9	317.5	Piezometer
	May 16, 2018	6.0	317.5	
	May 31, 2018	5.9	317.5	
	June 25, 2018	5.6	317.8	
RW12-06	Oct 20, 2016	10.7	310.5	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.

5.5 Retaining Wall RW16 - Highway 85 SB/E-S Ramp (Station 18+800 to 18+880 – Appendix E)

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.



5.5.1 Asphalt

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

5.5.2 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.

5.5.3 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 E and on Figure E1 of Appendix E. The result of the grain size distribution analysis is summarized below:

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

5.5.4 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.

5.5.5 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 E and the grain size distribution curves for these samples are plotted on Figure E2 of Appendix E. The results of the Atterberg Limits tests are plotted on Figure E4.

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.

5.5.6 Silty Sand to 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 42 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 E and on E3 of Appendix E. 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

5.5.7 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 5.5.1.

Table 5.5.1 – 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.

5.6 Retaining Wall RW24 - E-N Ramp over Guelph Street (Station 19+412 to 19+500 – Appendix F)

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

5.6.1 Asphalt

Asphalt with thicknesses ranging from 125 mm to 200 mm was encountered at all boreholes at this site, Boreholes RW24-01 to RW24-03.

5.6.2 Granular Fill

Granular fill consisting of sand to sand and gravel fill was encountered immediately below the asphalt in all three boreholes at this site, Boreholes RW24-01 to RW24-03. A lower granular fill layer consisting of sand/silt fill was encountered below the sand and gravel fill.

The upper granular fill consisted of sand and gravel generally brown in colour, with some silt and clay. The lower granular fill consisted of sand or silt fill generally brown in colour, with trace to some clay and trace gravel.

The thickness of the granular fill ranged from 3.2 m to 3.9 m, with the lower boundary of this layer encountered at depths of 3.3 m to 4.1 m (Elevation 314.7 to 314.4).

SPT N-values recorded in the granular fill ranged from 11 to 49 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 11 percent.

Four samples of the granular fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix F and the grain size distribution curves for these samples are plotted on Figure F1 of Appendix F. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	2 to 42
Sand	35 to 80
Silt	12 to 42
Clay	1 to 11

5.6.3 Cohesive Fill

A layer of cohesive fill was encountered below the granular fill in Boreholes RW24-01 and RW24-02, at depths of 3.3 m and 3.4 m (Elevation 314.4 and 314.7), respectively.

The cohesive fill consisted of silty clay generally brown to grey in colour and contained some sand to sandy and trace gravel.

The thickness of the cohesive fill ranged from 0.7 m to 2.3 m, with the lower boundary of the layer encountered at a depth of 4.1 m to 5.6 m (Elevation 312.0 and 314.0).

The SPT N-value recorded in the cohesive fill ranged from 16 to 27 blows for 0.3 m penetration, indicating a very stiff consistency.

The moisture content of the samples of cohesive fill ranged from 12 percent to 16 percent.

One sample of the cohesive fill 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 F and the grain size distribution curves for these samples are plotted on Figure F2 of Appendix F. The results of the Atterberg Limits tests are plotted on Figure F6.

Soil Particles	Cohesive Fill (%)
Gravel	3
Sand	26
Silt	51
Clay	20

Index Property	
Liquid Limit	20
Plastic Limit	11
Plasticity Index	9

The above results indicate that the cohesive fill is low plasticity with a group symbol of CL.

5.6.4 Sand

A layer of native sand was encountered below the cohesive fill in Borehole RW24-02 and below the granular fill in Borehole RW24-03, at depths of 4.1 m for both boreholes (Elevation 314.0 and 314.5).

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

The thickness of the sand layer was 3.1 m for both boreholes, with the lower boundary of the sand encountered at a depth of 7.2 m for both boreholes (Elevation 310.9 and 311.5) for Boreholes RW24-02 and RW24-03, respectively).

SPT N-values within the sand varied from 23 to 57 blows for 0.3 m penetration, indicating compact to very dense relative density.

Measured moisture contents within the sand were 7 percent to 20 percent.

The result of grain size distribution analysis carried out on one sample of the sand is presented on the Record of Borehole Sheets included in Appendix F and on Figure F3 of Appendix F. The result of the grain size distribution analysis is summarized below:

Soil Particle	Sand (%)
Gravel	5
Sand	78
Silt	14
Clay	3

5.6.5 Sand and Silt

A layer of sand and silt to sandy silt was encountered below the cohesive fill in Borehole RW24-01, and below the sand layer in Boreholes RW24-02 and RW24-03. The sand and silt to sandy silt was generally brown in colour and contained trace to some clay and trace to some gravel.

The sand and silt layer was encountered at depths of 5.6 m, 7.2 m and 7.2 m (Elevation 312.0, 310.9 and 311.5) in Boreholes RW24-01, RW24-02 and RW24-03, respectively.

Borehole RW24-03 was terminated within the sand and silt layer at a depth of 11.3 m (Elevation 307.4).

The thickness of the sand and silt layer was 1.6 m and 3.0 m thick, with the lower boundary of this layer encountered at depths of 7.2 m and 10.2 m (Elevation 310.5 and 307.9) for Boreholes RW24-01 and RW24-02, respectively.

SPT N-values recorded in the sand and silt layer ranged from 3 to 69 blows for 0.3 m penetration, indicating a loose to very dense relative density.

Moisture content of samples of the sand and silt layer generally ranged from 10 percent to 28 percent.

One sample of the sand and silt underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix F and the grain size distribution curves for these samples are plotted on Figure F4 of Appendix F. The results of this testing are summarized as follows:

Soil Particles	Sand and Silt (%)
Gravel	3
Sand	56
Silt	36
Clay	5

5.6.6 Silty Clay

A layer of silty clay was encountered below the sand and silt layer in Boreholes RW24-01 and RW24-02 at the depth of 7.2 m and 10.2 m, respectively (Elevation 310.5 and 307.9).

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

Boreholes RW24-01 and RW24-02 were terminated within the silty clay layer at a depth of 12.8 m for both boreholes (Elevation 304.9 and 305.3, respectively).

SPT N-values recorded in the silty clay ranged from 11 to 32 blows for 0.3 m penetration, indicating a stiff to hard consistency.

Moisture content of samples of the silty clay generally ranged from 15 percent to 27 percent.

Two 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 F and the grain size distribution curves for these samples are plotted on Figure F5 of Appendix F. The results of the Atterberg Limits tests are plotted on F7.

Soil Particles	Silty Clay (%)
Gravel	0 to 1
Sand	1 to 31
Silt	43 to 46
Clay	22 to 56

Index Property	
Liquid Limit	22 to 37
Plastic Limit	12 to 17
Plasticity Index	10 to 20

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

5.6.7 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 5.6.1.

Table 5.6.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW24-01	Sept 6, 2019	10.1	307.6	Open borehole
RW24-02	Sept 6, 2019	10.1	308.0	Open borehole
RW24-03	Sept 6, 2019	10.2	308.4	Open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

Upon completion of drilling, Boreholes RW24-01 caved-in at 9.4 m, RW24-02 caved-in at 7.0 m and RW24-03 caved-in at 7.5 m.

5.7 Retaining Wall RW28 - Dumfries Ave (Station 21+030 to 21+120 – Appendix G)

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

5.7.1 Asphalt

Asphalt with thicknesses ranging from 100 mm to 125 mm was encountered at all boreholes at this site, Boreholes RW28-01 to RW28-03.

5.7.2 Granular Fill

Granular fill consisting of sand and gravel was encountered immediately below the asphalt at all three boreholes at this site, Boreholes RW28-01 to RW28-03.

The granular fill consisted of sand and gravel, generally brown in colour, with some silt and clay.

The thickness of the granular fill was 0.6 m, with the lower boundary of the layer encountered at depths of 0.7 m (Elevation 324.6 to 322.9) for all boreholes.

Moisture content of samples of the granular fill generally ranged from 2 percent to 4 percent.

One sample of the granular fill underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix G and the grain size distribution curves for these samples are plotted on Figure G1 of Appendix G. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	44
Sand	44
Silt and Clay	12

5.7.3 Sand

Native sand was encountered below the granular fill layer at a depth of 0.7 m in all three boreholes at this site, Boreholes RW28-01 to RW28-03 (Elevation 324.6, to 322.9).

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

The thickness of the sand layer ranged from 2.6 m to 3.5 m with the lower boundary of the sand encountered at a depth ranging from 3.3 m to 4.2 m (Elevation 321.1 to 320.4)

SPT N-values within the sand varied from 7 to 34 blows for 0.3 m penetration, indicating loose to dense relative density.

Measured moisture contents within the sand were 3% to 25%.

The result of grain size distribution analysis carried out on two samples of the sand is presented on the Record of Borehole Sheets included in Appendix G and on Figure G2 of Appendix G. The result of the grain size distribution analysis is summarized below:

Soil Particle	Sand (%)
Gravel	0 to 2
Sand	87 to 92
Silt	7 to 9
Clay	1 to 2

5.7.4 Silty Clay to Clayey Silt

A layer of silty clay to clayey silt was encountered below the native sand layer in all boreholes at this site, at depths ranging from 3.3 to 4.2 m (Elevation 321.1 to 320.4).

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

The thickness of the silty clay to clayey silt ranged from 3.6 m to 5.3 m, with the lower boundary of the layer encountered at depths ranging from 7.2 m to 8.6 m (Elevation 319.5 to 315.8)

SPT N-values recorded in the silty clay to clayey silt ranged from 13 to 100 blows for 0.3 m penetration, indicating a stiff to hard consistency.

Moisture content of samples of the silty clay to clayey silt generally ranged from 11 percent to 22 percent.

Two samples. of the silty clay to 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 G and the grain size distribution curves for these samples are plotted on Figure G3 of Appendix G. The results of the Atterberg Limits tests are plotted on Figure G5.

Soil Particles	Silty Clay to Clayey Silt (%)
Gravel	0 to 5
Sand	18 to 46
Silt	32 to 60
Clay	17 to 22

Index Property	
Liquid Limit	17 to 19
Plastic Limit	10 to 12
Plasticity Index	5 to 8

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

It should be noted that high sand contents observed in the silty clay to clayey silt layer indicate the possibility of sand lenses or pockets within the silty clay to clayey silt.

5.7.5 Sand and Silt

A layer of sand and silt was encountered below the silty clay in all boreholes at this site, at depths ranging from 7.2 m to 8.6 m (Elevation 317.4 to 315.8).

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

All three boreholes were terminated in the sand and silt layer at depths of 9.8 m, 9.8 m and 11.3 m (Elevation 315.5, 314.6 and 316.5) for Boreholes RW28-01, RW28-02 and RW28-03, respectively.

SPT N-values recorded in the sand and silt ranged from 18 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a compact to very dense relative density.



Moisture content of samples of the sand and silt generally ranged from 12 percent to 18 percent.

Three samples of the sand and silt underwent laboratory gradation analysis, and one sample of the silty sand underwent Atterberg limits testing. The results are summarized on the Record of Borehole sheets included in Appendix G and the grain size distribution curves for these samples are plotted on Figure G4 of Appendix G. The results of this testing are summarized as follows:

Soil Particles	Sand and Silt (%)
Gravel	0 to 5
Sand	37 to 62
Silt	32 to 59
Clay	1 to 17

5.7.6 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 5.7.1.

Table 5.7.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW28-01	Aug 11, 2019	2.7	322.5	Open borehole
RW28-02	Aug 11, 2019	2.4	322.0	Open borehole
RW28-03	Sept 6, 2019	2.4	321.2	Open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

Upon completion of drilling, Boreholes RW28-01 caved-in at 4.9 m, RW28-02 caved-in at 7.9 m and RW28-03 caved-in at 2.4 m.



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), sand fill from Boreholes RW02-04, SS3 (depth of 1.5 m), RW09-02, SS3 (depth of 1.5 m), RW10-04, SS4 (depth of 2.3 m), sandy silt from Borehole RW12-05, SS3 (depth of 1.5 m) and silty sand from Borehole RW24-02, SS4 (depth of 3.0 m) 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 H.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Test Results						
		RW01-02 SS4 2.3 m	RW02-04 SS3 1.5 m	RW09-02 SS3 1.5 m	RW10-04 SS4 2.3 m	RW12-05 SS3 1.5 m	RW16-01 SS2 0.8 m	RW24-02 SS4 3.0 m
		(Soil Sample)						
Corrosivity Index	none	9	5	4	3	4	4	11
Soil Redox Potential	mV	309	218	274	182	230	309	263
Sulphide	%	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Moisture Content	%	17.2	17.5	11.3	4.4	9.3	13.8	13.1
pH	pH Units	8.79	8.97	9.04	9.11	8.67	8.95	8.18
Chloride	µg/g	190	100	53	3.2	70	140	760
Sulphate	µg/g	13	5.8	13	1.1	15	12	31
Conductivity	uS/cm	543	356	150	59	217	117	1280
Resistivity (calculated)	ohms.cm	1840	2810	6670	17100	4610	8550	780

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. Interpretation of the data and preparation of the report was carried out by Ms. Judy Mei, EIT, and Dr. Nancy Berg, P.Eng.

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



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**FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED RETAINING WALLS
HIGHWAY 7 – NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

Geocres Number: 40P9-58

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

8.0 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team in selecting and designing suitable foundation systems for seven proposed retaining walls (RW1, RW2, RW10, RW12, RW16, RW24 and RW28) associated with the Highway 7 New Project and along the existing Kitchener-Waterloo Expressway (KWE - Highway 85) in the City of Kitchener, Ontario. The proposed purpose for each retaining wall is listed below:

- RW1 and RW2 are proposed for an additional lane and offramp from the northbound Highway 85 near Frederick Street onto Bruce Street.
- RW10 will be constructed on the north side of the proposed E-S Ramp near Wellington Street.
- RW12 will be constructed on the south side of the proposed S-E Ramp near Wellington Street.
- RW16 and RW28 are required to widen the southbound Highway 85 near Frederick Street.
- RW24 is proposed to widen the northbound Highway 85 north of Guelph Street to allow for the entrance of the proposed E-N ramp.



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

The Highway 7 New Project will involve construction of new divided eastbound and westbound lanes approximately 300 m north of the existing undivided Highway 7. Construction of seven new standalone retaining walls has been proposed in the vicinity of the Highway 7/Highway 85 Interchange. Wing walls associated with specific bridges will not be discussed in this report but instead will be discussed in the associated bridge reports.

Design details of the proposed retaining walls, as provided by WSP, are summarized in Table 8.1.

Table 8.1 – Design Details of Proposed Retaining Walls

Retaining Structure	Location	Approximate Chainages	Length (m)	Proposed Wall Height (m)	WSP's Proposed Wall Type
RW1	Frederick St - S/E - Becker Street Retaining Wall	~20+910 to 21+250	340	1.0 to 6.0	Concrete, Secant or RSS Wall
RW2	Frederick St - N/E - Ann Street Retaining Wall	~21+270 to 21+455	185	1.6 to 7.2	Concrete, Secant or RSS Wall
RW10	E-S Ramp Hwy 85 Overpass - N/E	~19+830 to 20+075	245	1.5 to 4.5	Concrete, or RSS Wall
RW12	S-E Ramp-Wellington St Overpass - S/E	~19+867 to 20+150	283	1.6 to 7.6	Concrete or RSS Wall
RW16	Highway 85 SB/E-S Ramp - north of	~18+800 to 18+880	80	1.0 to 5.5	Concrete, Secant or RSS Wall



	Frederick Street.				
RW24	E-N Ramp over Guelph Street - North Abutment	~19+412 to 19+500	88	2.1 to 3.5	Concrete or RSS Wall
RW28	Dumfries AVE	~21+030 to 21+120	90	1.0 to 2.8	Concrete or RSS Wall

The discussions and recommendations presented in this report are based on information provided by WSP and on the factual data obtained during the current investigation and selected data from previous investigations.

9.0 FOUNDATION DESIGN

9.1 Summary of Subsurface Stratigraphy

A general description of the subsurface stratigraphy and groundwater condition for each retaining wall is presented below.

Retaining Wall RW1 (Boreholes RW01-01 to RW01-07)

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. The groundwater level measured in piezometer RW01-04 was at a depth of 4.9 m below the ground surface (Elevation 321.9).

Retaining Wall RW2 (Boreholes RW-01 to RW-04 and RW02-02 to RE02-04)

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. Behind the existing NE Corner Retaining Wall of Frederick Street Underpass, the backfill materials consisted of heterogeneous fills such as silts, silty sands and clayey silts (Reference 1). The groundwater level measured in the open boreholes upon completion was at a depth of 1.5 m to 3.3 m below the ground surface (Elevation 319.0 to 317.6).

Retaining Wall RW10 (Boreholes RW09-02 and RW10-02 to RW10-06)

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



The groundwater level measured in piezometer RW10-03 ranged from 5.7 m to 6.2 m below the ground surface (Elevation 322.6 to 322.2).

Retaining Wall RW12 (Boreholes RW12-01 to RW12-06)

In general the soil stratigraphy at this site consisted of granular fill overlying a layer of upper native sand, an upper layer of silty clay or silty clay till, a lower sand or silt layer, and a lower layer of silty clay. The groundwater level measured in piezometers RW12-03 and RW12-05 ranged from 5.6 m to 8.2 m below the ground surface (Elevation 317.8 to 316.9).

Retaining Wall RW16 (Boreholes RW16-01 to RW16-03)

In general the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of cohesive fill or native sand, sand and silt and silty clay. The groundwater level measured in the open boreholes upon completion ranged from 3.7 m to 8.8 m below the ground surface (Elevation 316.7 to 311.1).

Retaining Wall RW24 (Boreholes RW24-01 to RW24-03)

In general the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of cohesive fill or native sand, sand and silt and silty clay. The groundwater level measured in the open boreholes upon completion ranged from 10.1 m to 10.2 m below the ground surface (Elevation 308.4 to 307.6).

Retaining Wall RW28 (Boreholes RW28-01 to RW28-03)

In general the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand, a layer of silty clay to clayey silt and sand and silt. The groundwater level measured in the open boreholes upon completion ranged from 2.4 m to 2.7 m below the ground surface (Elevation 322.5 to 321.2).

9.2 Retaining Wall and Foundation Alternatives

Selection of the type of wall should take into consideration the height and configuration of the retained soil, the subsurface conditions along the wall alignment, and construction constraints. Consideration has been given to the following retaining wall types being considered by WSP as follows:



- Cast in Place Concrete Wall on Spread Footings
- Retained Soil System (RSS) Wall
- Secant Pile Wall
- Concrete Toe Wall

Conventional concrete cantilever wall on spread footings

It is understood that this wall type is being considered for a portion of RW1 and RW2 and RW10, RW12, RW16, RW24 and RW28. Concrete cantilever wall supported on spread footings will require excavation upslope for backfill placement and drainage installation. Temporary shoring may be required to facilitate construction of this wall type.

Retained Soil System (RSS) Wall

It is understood that this wall type is also being considered for a portion of RW1 and RW2 and RW10, RW12, RW16, RW24 and RW28. RSS walls will require significant excavation upslope for reinforcing strip installation (up to the order of 0.7 to 1.0 times the wall height) and backfill placement. Temporary shoring may be required to facilitate construction of this wall type.

The RSS wall design, internal stability and construction are usually carried out by proprietary suppliers.

Secant Pile Wall

A secant pile wall is being considered for RW1, RW2 and RW16 where the property line is very close to the proposed retaining walls. This type of wall does not require excavation behind the wall and also serves the dual purpose of temporary shoring and a permanent wall.

Concrete toe wall

It is understood that concrete toe wall is being considered for locations where the wall height is less than 1.8m.

9.3 Retaining Wall Feasibility

Retaining Wall	Boreholes	Ground Soil Elevation	Native Soil Elevation	Concrete Cantilever Wall	RSS Wall	Secant Wall
RW01	RW01-01 RW01-02 RW01-03 RW01-04	326.0 324.9 327.8 326.8	324.1 322.7 324.6 324.5	Feasible if required space	Feasible if required space	Feasible



	RW01-05 RW01-06 RW01-07	321.4 320.5 320.0	320.7 319.9 319.4	is available	is available	
RW02	RW-01 RW-02 RW-03 RW-04 RW02-02 RW02-03 RW02-04	319.7 319.7 322.3 323.5 319.6 319.5 319.1	318.3 318.3 320.0 321.2 318.8 318.7 318.5	Feasible if required space is available	Feasible if required space is available	Feasible
RW10	RW09-02 RW10-02 RW10-03 RW10-04 RW10-05 RW10-06	322.8 329.1 328.4 326.9 324.7 318.6	322.8 325.3 324.6 323.9 324.7 318.6	Feasible if E-N Ramp excavation is done simultaneously	Feasible if E-N Ramp excavation is done simultaneously	Feasible if E-N Ramp excavation is not done simultaneously
RW12	RW12-01 RW12-02 RW12-03 RW12-04 RW12-05 RW12-06	324.6 325.1 325.3 325.1 323.4 321.2	322.3 322.1 323.1 323.7 321.3 320.5	Feasible	Feasible	Not Recommended Due to expense
RW16	RW16-01 RW16-02 RW16-03	321.3 320.4 319.9	320.5 319.7 319.3	Feasible if required space is available	Feasible if required space is available	Feasible
RW24	RW24-01 RW24-02 RW24-03	317.7 318.1 318.6	314.4 314.7 314.5	Feasible	Feasible	Not Recommended Due to expense
RW28	RW28-01 RW28-02 RW28-03	325.3 324.4 323.6	324.6 323.7 322.9	Feasible if required space is available	Feasible if required space is available	Feasible

For RW1 and RW2 a concrete cantilever wall or RSS wall is considered feasible if enough space is available. Where space is limited, a secant wall is considered feasible.

At the location of RW10 a concrete cantilever wall or RSS wall could be feasible, however more than 5 m of fill will need to be excavated to reach the required founding depth. Since a cut is



planning to be made for the E-N ramp near the RW10 location, this deep excavation may be acceptable if the permeant cut for the E-N ramp and the temporary cut to install RW10 are completed at the same time. Otherwise a secant wall is recommended to avoid the required deep excavation.

For RW12 and RW24 a secant wall is not recommended since there is no existing roads/structure nearby that limited the space available and it is less economical than an RSS wall or a concrete cantilever wall, both of which are considered feasible at these retaining wall locations.

For RW16 and RW28 a concrete cantilever wall or RSS wall is considered feasible if enough space is available. If space is limited a secant wall is considered feasible.

9.4 Concrete Cantilever Wall on Spread Footings

It is recommended that concrete cantilever wall footings be founded on the native undisturbed soil shown in Table 9.1. The highest permitted founding elevations for spread footings below frost depth are given in Table 9.1.

Table 9.1 – Geotechnical Resistance and Highest Permitted Founding Elevations

Retaining Wall	Borehole	Appr. Chainage	Estimated Subexcavation Depth (m)	Highest Founding Elevation (Soil Condition) (m)	Factored ULS (kPa)	Factored SLS (kPa)
RW01	RW01-01	20+920	3.0 to 5.5	323.5 (Dense Sand)	300	200
	RW01-02	20+980		322.5 (Compact Sand)		
	RW01-03	21+030		324.0 (Compact Sand)		
	RW01-04	21+080		324.0 (Compact Sand)		
	RW01-05	21+130		320.5 (Compact Silty Sand)		
	RW01-06	21+180		319.5 (Compact Sand)		
	RW01-07	21+230		319.0 (Dense Silty Sand)		
RW02	RW-01	21+260	5.0 to 8.0	318.0 (V.Stiff Silty Clay)	300	200
	RW-02	21+270		317.5 (Hard Silty Clay)		
	RW02-02	21+320		318.5 (Compact Silty Sand)		
	RW02-03	21+370		318.5 (Compact Sand)		
	RW02-04	21+420		318.0 (Compact Sand)		
RW10	RW09-02	19+830	2.0 to 5.0 (deep excavation through existing fill)	320.0 (V.Stiff Silty Clay)	350	225
	RW10-02	19+880		325.0 (Compact Sand)		
	RW10-03	19+930		324.5 (Compact Sand)		

	RW10-04 RW10-05 RW10-06	19+980 20+030 20+090		323.5 (Compact Sand) 324.0 (Compact Sand) 317.0 (V. Stiff Silty Clay)	300	200
RW12	RW12-01 RW12-02 RW12-03	19+870 19+920 19+970	1.0 to 3.5	322.0 (Compact Sand) 322.0 (Compact Sand) 323.0 (Compact Sand)	300	200
	RW12-04 RW12-05 RW12-06	20+020 20+100 20+180		323.0 (V. Stiff Silty Clay) 320.5 (V. Stiff Silty Clay) 319.5 (V. Stiff Silty Clay)	350	225
RW16	RW16-01 RW16-02 RW16-03	18+800 18+840 18+880	3.0 to 6.0 m	320.5 (Compact Sand) 319.0 (V. Stiff Silty Clay) 319.0 (V. Stiff Silty Clay)	350	225
RW24	RW24-01 RW24-02 RW24-03	19+410 19+450 19+495	1.0 to 2.0	311.5 (V. Dense Sandy Silt) 313.0 (Hard Silty Clay) 314.5 (Compact Silty Sand)	300	200
RW28	RW28-01 RW28-02 RW28-03	21+030 21+075 21+120	1.0 to 3.0	324.5 (Compact Sand) 323.5 (Compact Sand) 322.5 (Compact Silty Sand)	300	200

The values of the Factored Geotechnical Resistance at ULS were assessed assuming a Consequence Factor equal to 1 (Typical), and a Resistance Factor equal to 0.5 (Typical degree of understanding of the subsurface conditions), as per CHBDC 2019. The Factored Geotechnical Resistance at SLS was assessed assuming a factor of 0.8 for typical degree of understanding of the subsurface conditions.

Provided a minimum footing width of 2 m is maintained, the design of spread footings bearing on native undisturbed soil at or below elevations indicated in Table 9.1 should be designed using a factored geotechnical resistance shown in Table 9.1.

The geotechnical resistances quoted above are for concentric, vertical loads only. The retaining wall will impose eccentric or inclined loading and the geotechnical resistance must be modified as illustrated in the CHBDC (2019) Clause 6.10.2 to Clause 6.10.5.

The sliding resistance of mass concrete poured on the native very stiff to hard silty clay/silty clay till and the compact to dense sand and silty sand may be computed on the basis of an ultimate coefficient of friction of 0.45 and 0.4 respectively. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

9.5 Retained Soil System (RSS Wall)



Retained Soil Systems (RSS) are planned for this site. Details regarding the alignment, height or design founding levels of the retaining walls were provided on GA's provided by WSP dated November 2019.

RSS walls used for this project must be specified to be "High Performance" and "High Appearance". Therefore, it is important that the RSS walls be founded on soils capable of supporting the imposed loading and limiting settlements to within acceptable magnitudes. Reference should be made to CHBDC (2019) Clause 6.19 for design of the RSS walls.

Provided the RSS design takes into account the subsurface conditions at this site and proper foundation preparation is carried out prior to construction of the walls, RSS systems are expected to meet the aesthetic and structural requirements.

Provided a minimum strip length of 70% of the RSS wall height is maintained, the design of RSS wall bearing on native undisturbed soil at or below elevations indicated in Table 9.1 should be designed using a factored geotechnical resistance shown in Table 9.1.

If required, the RSS may be founded on engineered fill founded on the native, compact to dense sand and silt or stiff to hard silty clay/silty clay till. Engineered fill placed under the RSS mass to achieve the design founding level must consist of OPSS Granular "A" compacted to 100% of its SPMDD at a moisture content within 2% of optimum.

The geotechnical resistances provided above are for concentric, vertical loading. The effects of load inclination and eccentricity need to be taken into account according to the CHBDC (2019) Clauses 6.10.2 to 6.10.5.

As per MTO RSS Design Guidelines, the minimum soil cover to the underside of the levelling pad shall be at least 800mm, or 40% of the actual frost depth for the area, whichever is greater.

The entire block of reinforced earth must be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall or engineered granular fill in contact with the sand and silt and silty clay/silty clay till may be estimated using an ultimate friction coefficient of 0.4 and 0.45 respectively. As per Table 6.2 in CHBDC 2019, a resistance factor of 0.6 for cohesive soils and 0.8 for cohesionless soils should be applied to the above value.

Topsoil, organics, fill, and any soft/wet material must be stripped from the footprint of the RSS. The subgrade under the RSS foundation should be inspected and any soft spots sub-excavated



and replaced with compacted granular materials prior to placing fill. The subgrade preparation for the RSS wall and placement and compaction of the granular fill must be carried out in the dry.

The proprietary RSS system must meet MTO's specifications for performance and appearance. The RSS supplier/designer may specify more stringent criteria or other requirements related to the particular design. The internal stability of the RSS wall must be analyzed by the supplier/designer of the proprietary product selected for this site.

Lateral earth pressures acting on the walls should be computed as described in Section 9. If the wall is retaining sloping backfill, appropriate earth pressure parameters for sloping backfill should be used.

Reference should be made to MTO RSS Design Guideline (2008) and, the TAC Design, Construction, Maintenance and Inspection Guide for MSE Walls (2017) for design and construction of retaining wall structures.

RSS walls must be constructed in accordance with MTO RSS SP 599S22 and SP 599S23.

9.5.1 Global Stability of the Retained Soil System

Global stability of the RSS walls was conducted each retaining wall locations, for RSS wall founded on the native compact to dense sand and silt or stiff to hard silty clay/silty clay till.

Global stability analyses were carried out for the proposed embankment widening and retaining wall. The analyses were carried out utilizing the commercially available slope stability analysis program Slope/W (Version 2019) of the GeoStudio software package developed by Geo-Slope International with the option for Morgenstern-Price method of slices for the limit equilibrium analyses. Analyses were completed for both static and seismic loading conditions.

The soil parameters used in the analyses were estimated from empirical correlations using the results of the in situ Standard Penetration Tests (SPTs) and geotechnical laboratory testing. The groundwater level in our analysis was based on readings obtained from standpipe piezometers.

The stability of the RSS wall was also checked under seismic loading assuming an acceleration of 0.097 g.

Results of the stability analyses are presented in Appendix C to Appendix G. The results are also summarized in Table 9.2 below.



Table 9.2 Computed Factors of Safety

Retaining wall	Condition	Factor of Safety	Figure (Appendix G)
RW1	Static Undrained	1.7	A8
	Static Drained	1.7	A9
	Seismic = 0.097 g	1.6	A10
RW2	Static Undrained	2.0	B6
	Static Drained	2.0	B7
	Seismic = 0.097 g	1.8	B8
RW10	Static Undrained	2.6	C6
	Static Drained	2.6	C7
	Seismic = 0.097 g	1.8	C8
RW12	Static Undrained	2.2	D10
	Static Drained	2.2	D11
	Seismic = 0.097 g	2.0	D12
RW16	Static Undrained	1.7	E5
	Static Drained	1.7	E6
	Seismic = 0.097 g	1.6	E7
RW24	Static Undrained	2.1	F8
	Seismic = 0.097 g	1.9	F9
RW28	Static Undrained	2.0	G6
	Static Drained	1.9	G7
	Seismic = 0.097 g	1.8	G8

As per typical MTO requirements, a Factor of Safety (F.S.) of 1.3 is acceptable for short term conditions and for total stress (undrained) conditions. A F.S. of 1.5 is acceptable for long term (drained) conditions. Under the assumed seismic loading, the minimum acceptable factor of safety is 1.1. Accordingly, the computed factors of safety are considered to be acceptable for the proposed RSS wall configuration.

9.5.2 Settlement of the Retained Soil System

The new fill placed at this site will induce settlement in the general vicinity of the retaining walls. It is estimated that immediate settlement of the retaining walls will occur as the wall is constructed. It is expected that most of the settlement will occur shortly after the completion of embankment/RSS wall construction. Total settlement is expected to range from 10 mm to 30 mm as shown in Table 9.3. The RSS wall supplier must be consulted if the proprietary can accommodate the settlement.



Table 9.3 Estimated Settlement of RSS

Retaining Wall	Maximum Embankment Height from G.S (m)	Estimated Settlement (mm)
RW1	6.0	20 to 25
RW2	7.2	20 to 25
RW10	13.5	20 to 30
RW12	6.5	15 to 30
RW16	7.0	20 to 25
RW24	2.5	10 to 25
RW28	2.5	10 to 15

In general, inspection of the RSS walls and placing of additional granular material to re-establish grades should be implemented, as necessary, during and after construction.

9.6 Secant Pile Wall

Geotechnical parameters are provided below for lateral pile design of the secant pile walls. The actual pressure distribution acting on the secant pile wall is a function of the construction sequence, and the relative flexibility of the wall and these factors must be considered when designing the secant pile wall system. The structural designer must check whether the depth of caisson is sufficient to provide base fixity.

Table 9.4 – Geotechnical Design Parameters for Lateral Pile Resistance

Soil Unit	Elevation (m)		γ' (kN/m ³)	n_h (kN/m ³)	K_p	K_A	K_o	S_u (kPa)
	Top	Bottom						
RW1								
Compact Sand and Gravel Fill	327.5	324	21.0	1,900	3.0	0.3	0.5	-
Compact Sand/Silty Sand	324	320	10.0 (*)	3,000	3.2	0.3	0.5	-
Very Stiff to Hard Silty Clay/Silty Clay	320	316	10.0 (*)	-	3.3	0.3	0.4	175
Compact to Very Dense	316	312	11.0 (*)	4,500	3.4	0.3	0.3	-



Soil Unit	Elevation (m)		γ' (kN/m ³)	n_h (kN/m ³)	K_p	K_A	K_o	S_u (kPa)
	Top	Bottom						
Silty Sand/Sandy Silt								
RW2								
Fill / unknown Cut Slope material**	~324	320	20.0	1,000	2.8	0.4	0.5	-
Compact to Dense Sand Fill	320	315	10.0 (*)	1,900	3.0	0.3	0.4	-
Firm to Hard Silty Clay/Silty Clay	315	307	9.5 (*)	-	3.0	0.3	0.4	150
Dense to Very Dense Silt and Sand	307	304	10.0 (*)	8,000	3.9	0.3	0.2	-
RW10								
Very Loose to Compact Sand Fill	328.5	324.0	20.0	1,900	2.8	0.4	0.5	-
Compact to Dense Sand/Silty Sand	324.0	322.0	11.0 (*)	4,500	3.3	0.3	0.4	-
Stiff to Hard Silty Clay	322.0	317.0	10.0 (*)	-	3.0	0.3	0.4	150
Compact to Very Dense Sand/Silt	317.0	313.0	9.0 (*)	9,400	3.9	0.3	0.2	-
RW16								
Loose to Compact Sand	321	319	20.0	3,000	3.0	0.3	0.5	
Very Stiff to Hard Silty Clay	319	312	9.5 (*)	-	3.3	0.3	0.4	150
Compact to Dense Sandy Silt	312	309	10.0 (*)	5,500	3.5	0.3	0.4	
RW28								
Fill / unknown Cut Slope material**	329.0	324.0	20.0	1,000	2.8	0.4	0.5	-
Compact Sand	324.0	321.0	10.0 (*)	2,700	3.1	0.3	0.5	-
Hard Silty Clay	321.0	316.5	9.0 (*)	-	3.3	0.3	0.4	200
Very Dense Sand and Silt	316.5	312.5	9.0 (*)	9,400	4.0	0.2	0.3	-

Note: (*) Submerged Unit Weight

(**) Not able to drill at proposed RW02 and RW28 location due to ROW/access issues

The lateral resistance in the cohesionless soils may be calculated using coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = n_h z / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \gamma' z K_p \quad (\text{kPa})$$



Where: z = depth of embedment of caisson (m)
 D = caisson diameter (m)
 n_h = coefficient related to soil relative density (kN/m³)
 γ' = effective unit weight (kN/m³)
 K_p = passive earth pressure coefficient

The lateral resistance in the cohesive soils may be calculated using coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = 67 s_u / D \quad (\text{kN/m}^3)$$
$$p_{ult} = 9 s_u \quad (\text{kPa})$$

Where: s_u = undrained shear strength (kPa)
 D = caisson diameter (m)

The above equations and parameters provided in Table 9.4 below may be used to analyze the interaction between a caisson and the surrounding soil. Lateral pressures obtained from analysis must not exceed the ultimate lateral resistance.

The spring constant, K_s , for analysis may be obtained by the expression, $K_s = k_s L D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m³), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, P_{ult} , can be obtained from the expression, $P_{ult} = p_{ult} L D$. This represents the ultimate load at which the soil fails and will not support any additional load at greater pile displacement.

The group efficiency factors can be calculated based on side-by-side and line-by-line factors shown in Figures C6.22, C6.23 and C6.24 of the CHBDC (2019), S6:19 (Commentary).

Depending on the height and size of secant pile wall, tie back soil anchors may be considered to provide additional lateral resistance to earth pressures or lateral fixity to secant pile wall. Geotechnical parameters (i.e. soil anchor bond strength) can be provided if soil anchors are required.



It is important to note that ice jacking load should be considered in the secant pile wall design due to the presence of potential frost susceptible soils at the retaining wall sites. The frost susceptible soils will apply additional lateral pressure on the back of the secant pile walls if moisture is present. The existing wall backfill at the RW2 location was found to have fines in excess of 8% and is considered to be frost susceptible soils based on Reference 1. Similar conditions may be present at RW1 and RW16. At RW10 new fill will be placed, which will not be frost susceptible.

9.6.1 Caisson Installation

Caissons should be installed in accordance with OPSS.PROV 903 and SP 109F57.

Appropriate measures shall be employed, e.g. use of temporary steel liners and/or drilling fluid, to maintain base and sidewall stability in the caisson excavation. Caisson installation may encounter cobbles, boulders and/or large rock fragments in the soils. The installation methods and equipment must be capable of dislodging, removing or otherwise penetrating such obstructions.

The Contractor shall use appropriate means to clean and inspect the bottom of the excavation of all caissons. The base cleaning method, inspection method, and any additional measures required to satisfy the acceptance criteria must be selected by the Contractor to ensure direct contact between the concrete and undisturbed bearing stratum over the entire area of the base and sidewalls. The Contractor shall apply means necessary (such as air lift pump or hydraulic pump, etc.) to clean the base and sidewalls.

The bottom of the excavated shaft shall be inspected using a waterproof downhole colour camera (e.g., Drilled Shaft Inspection Device or SID), or an approved alternate to verify base cleanliness. The base of all shafts shall be clear of any base sediment at the time of concreting to ensure direct contact between the concrete and the founding base.

A shaft inspection field report shall be submitted by the Contractor to the Contract Administrator (CA) for acceptance prior to proceeding with concrete placement. Concrete shall be placed immediately after CA's approval of the caisson base.

9.7 Concrete Toe Wall

In low fill/cut situations where the retaining wall height is less than 1.8 m a toe wall may be appropriate. The toe wall design should be in accordance with OPSD 3120.100.



The highest permitted founding elevations for toe walls on native soils to achieve a factored geotechnical resistance of 300 kPa at ULS and 200 kPa at SLS are as presented for spread footings in Table 9.1. The toe walls cannot be founded on the existing fill onsite and are not suitable to retain sloping fill.

If the toe wall is required to be founded at higher elevations, it may be placed on an engineered fill pad founded at the elevations given in Table 9.1. The engineered fill must consist of OPSS Granular “A” compacted to 100% of the SPMDD at within 2% of the optimum moisture content.

The sliding resistance of mass concrete poured on the native very stiff to hard silty clay/silty clay till and the compact to dense silty sand may be computed on the basis of an ultimate coefficient of friction of 0.45 and 0.4 respectively. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

9.8 Frost Cover

The design depth of frost penetration at these retaining wall sites is 1.4 m. The base of footings and soils behind retaining walls must be provided with a minimum of 1.4 m of earth cover, or its thermal insulation equivalent, as protection against frost action.

10.0 BACKFILL TO RETAINING WALLS

Backfill to the retaining walls should consist of Granular A or Granular B Type II material meeting the requirements of OPSS.PROV 1010 and in accordance with OPSS 902. The backfill should be placed to the extents shown in OPSD 3121.150 where applicable. Backfill to the toe walls should be in accordance with OPSD 3120.100.

The design of the retaining walls must incorporate a subdrain as shown in OPSD 3121.150 and 3190.100. For RSS walls, supplier specifications should be followed.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with OPSS.PROV.501.

11.0 LATERAL EARTH PRESSURES

Earth pressures acting on the retaining walls may be assumed to be triangular and governed by the characteristics of the retaining wall backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC 2019 but are generally given by the expression:

$$p_h = K (\gamma h + q)$$

where:

- p_h = horizontal pressure on the wall at depth h (kPa)
- K = earth pressure coefficient (see Table 9.5)
- γ = unit weight of retained soil (see Table 9.5)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa).

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added. Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS.PROV 501.

Earth pressure coefficients for backfill to the retaining wall are dependent on the material used as backfill. Typical values are shown in Table 9.5.

Table 9.5 – Earth Pressure Coefficients

Wall Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.38	0.31	0.46
At rest (Restrained Wall)	0.43	0.62	0.47	0.68
Passive (Movement Towards Soil Mass)	3.7	-	3.2	-

If the support system allows yielding of the wall (unrestrained system), active horizontal earth pressure may be used in the geotechnical design of the structure. If the support system does not allow yielding (restrained system), at-rest horizontal earth pressures should be used.



In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall.

The factors in Table 9.5 are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to be used in the design can be estimated from Figure C6.27 in the Commentary to the CHBDC 2019.

12.0 SUBGRADE PREPARATION

After the foundation excavation reaches the design subgrade level for the Cast-in-place concrete wall, the exposed surface should be inspected by qualified foundation/geotechnical personnel to confirm that the subgrade is suitable, and uniformly competent and has been adequately prepared to receive concrete. Any unsuitable materials such as topsoil/organics, disturbed soils, loose/soft deposits and deleterious materials within the wall footprint must be removed. Where subexcavation is required to remove unsuitable material from below the design founding level, the founding surface should be re-established using engineered fill or mass concrete of the same class of concrete as used in the footing. The engineered fill must consist of OPSS Granular “A” placed in 150 mm lifts, compacted to 100% of its SPMDD at $\pm 2\%$ of optimum moisture content. All footing construction procedures should follow the guidelines provided in OPSS 902. Once the subgrade is prepared, the construction traffic and equipment must not travel on the subgrade. It is recommended that a 100 mm thick layer of mass concrete (i.e. working slab) be placed within 4 hours following completion of excavation to protect the subgrade. The working slab should be formed with the same class of concrete as that of the footings. The subgrade preparation should be carried out in the dry.

The RSS walls should be founded on a minimum 500 mm thick layer of bedding material conforming to OPSS Granular A requirements to form a uniform subgrade. Engineered fill placed under the RSS mass to achieve the design founding level should be compacted to 100% of its SPMDD at a moisture content within 2% of optimum. The engineered fill layer should extend at least 500 mm beyond the limits of the RSS mass. Where sub-excavation is required to reach competent bearing stratum, the sub-excavation will be backfilled with engineered Granular ‘A’ fill compacted to 100% of its SPMDD. Construction inspection should be carried out during construction by qualified geotechnical personnel.

13.0 SEISMIC CONSIDERATIONS

Based on the encountered subsurface conditions from the investigation, Site Class D should be assumed to evaluate the seismic site response, as per Table 4.1, Clause 4.4.3.2 of the CHBDC 2019.

The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.075 g as per the National Building Code of Canada (NBCC). Since this site is classified as Class D, the factored PGA for a 2% in 50-year probability of exceedance at this site is 0.097 g.

In accordance with Clause 6.14.7.2 of the CHBDC 2019, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in the following table may be used:

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I or Type III $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (2H:1V)
Active (K_{AE})*	0.31	0.51	0.35	0.65
Passive (K_{PE})	3.6	-	3.1	-
At-rest (K_{OE})**	0.55	0.76	0.60	0.83

* After Mononobe and Okabe

** After Woods

Based on review of the SPT data, seismically-induced liquefaction of foundation soils at the proposed retaining wall sites is not anticipated under the design earthquake.

14.0 EXCAVATION AND GROUNDWATER CONTROL

All excavations must be carried out in accordance with OPSS.PROV 902 and the Occupational Health and Safety Act (OHSA).

Earth excavations for retaining wall foundation required at these retaining wall sites will penetrate through the granular/cohesive fills and native compact to dense sand/silty sand, and stiff to very stiff silty clay/silty clay till. For the purposes of OHSA, the granular fill, compact to



dense silty sand, and stiff to hard silty clay/silty clay till above the groundwater level deposit are classified as Type 3 soils and as Type 4 soils below the water table.

The excavation for RW10 and RW28 foundation construction is generally expected to be below the groundwater level. Due to the presence of cohesionless soils below the water table, a dewatering system must be in place and effective to prevent instability due to sloughing, base boiling, and groundwater inflow. Seepage or perched water from the granular fill is to be expected. Surface runoff and precipitation must be diverted away from the excavations. All retaining wall foundations must be constructed in the dry. Unwatering must remain operational and effective until the footings/RSS engineered fill pads are constructed and backfilled.

The dewatering scheme must be effective to lower the groundwater level in the excavation to at least 0.5 m below the excavation base to facilitate a dry stable base for construction. The design of dewatering systems is the responsibility of the Contractor and the Contract Documents must alert them to this responsibility. However, suitable systems that might be considered include the use of a sheeted excavation (cofferdam) and vacuum well-points. Filtered sumps must be properly designed to control loss of fines/ground loss.

Dewatering of all excavations should be carried out in accordance with OPSS.PROV 517, SP 517F01 Amendment to OPSS 517, OPSS.PROV 902 and NSSP FOUN0003.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. Excavations should regularly be inspected for evidence of instability if they have been left open for extended periods of time and following periods of heavy rain or thawing. If required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers. Provision must be made for the handling of potential obstructions in the existing fill materials, and cobbles and boulders in the till. Labourer excavation should be anticipated in the very dense or hard native soils.

15.0 PERMINANT CUT

Permanent earth cuts may be required at RW1, RW2, RW16 and RW28 above the retaining walls and to accommodate expansion of the current Highway 85 lanes. The earth cut will be formed through the existing embankment on the east and west side of Highway 85. Any permanent cuts into the existing slope require properly designed roadway protection to prevent slope failure.



All permanent exposed cut slopes behind the retaining wall are expected to be stable at inclinations not steeper than 2H : 1V.

Permanent drainage will be required adjacent to the retaining wall to remove water originating from

- Surface (and storm) runoff and precipitation
- Seepage from the sides and base of the cut

The cohesionless sands and silts encountered at this site are permeable. Consequently, seepage from these soils into the cut will occur. It is recommended that surface runoff and seepage be managed by means of drains and weepholes incorporated behind and through the wall, and connected with sub-drains installed along the retaining walls in accordance with OPSD 3121.150 and 3190.100. The sub-drains along the retaining walls must be placed at 1.4 m depth or lower under the finished grade and must lead to a positive outlet.

It is recommended that all exposed slope surfaces be vegetated and seeded in accordance with current MTO practice and with reference to OPSS 804.

16.0 ROADWAY PROTECTION

Roadway protection may be required during construction of the retaining walls. An item titled "Protection System" as per OPSS 539 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.01.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the Contractor. However, one option that is considered to be suitable for use as temporary shoring at this site is soldier pile and lagging walls. It is anticipated that the soldier piles will need to be installed within the very stiff to hard silty clay in order to develop the required toe resistance. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable.

A temporary soldier pile and lagging wall may be designed using the parameters given below:

$$\begin{aligned}\gamma &= 20 \text{ kN/m}^3 \\ \gamma_w &= 10 \text{ kN/m}^3 \\ K_a &= 0.4(\text{fills and native silty sand}) \\ &= 0.33 (\text{silty clay})\end{aligned}$$



$$\begin{aligned} K_p &= 2.8 \text{ (fills and native silty sand)} \\ &= 3.0 \text{ (silty clay)} \end{aligned}$$

The designer of the roadway protection system should check whether the depth of pile is sufficient to provide base fixity.

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

17.0 CORROSION AND SULPHATE ATTACK POTENTIAL

The results of the corrosivity and sulphate analytical tests conducted on the native soil during the current investigation indicates the following conditions at the locations tested:

- The potential for sulphate attack on concrete foundations from the surrounding native soil is considered to be negligible due to the low concentration of sulphate and chloride in the samples tested. The selection of class of concrete should consider the effects of the road de-icing salts.
- The potential for soil corrosion on metal is considered to be very mild to mild at RW10, and RW16, moderate at RW12 and RW2 and severe to very severe at RW1 and RW24.
- Appropriate protection measures commensurate with the above are recommended if metal structural elements are used. The effects of road de-icing salts should be also considered.

18.0 ADJACENT STRUCTURES AND BURIED UTILITIES

The potential presence of underground utilities at these retaining wall sites must be confirmed prior to construction. It is recommended that the exact locations and elevations of any utilities be established by the designer and compared with the extent of the potential work zones related to the foundations of the proposed retaining wall structures and associated works. Protection and/or relocation of utilities may be required. Underground utilities should not be undermined or damaged during new retaining wall construction and fill placement.



19.0 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to, the following:

- The till deposits are very dense and contain cobbles and boulders. The existing fills may also contain obstructions. The Contractor must be equipped and prepared to remove, penetrate or otherwise handle these obstructions during construction.
- Based on water levels measured in the piezometers, excavations are generally above the groundwater level except at RW10 and RW28. However, effective sump pumping amongst other measures of groundwater and surface water control should be implemented to maintain a reasonably dry excavation base for construction. If excavation is carried out in cohesionless soil without prior implementation of adequate measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel working on site, or to a loss of bearing resistance in the soil. Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.
- Existing vegetation is likely having stabilizing effects on the existing slope and should be preserved. Any existing vegetation behind the wall (upslope) that is destroyed or otherwise disturbed must be reinstated after the retaining wall is constructed.

20.0 CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Dr. Nancy Berg, P.Eng.. The report was reviewed by Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



THURBER ENGINEERING LTD.

Nancy Berg, P.Eng.
Geotechnical Engineer



Jason Lee, P.Eng.
Principal, Senior Foundation Engineer



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





Appendix A

**Record of Borehole Sheets, Laboratory Test Results, Borehole Locations,
Soil Strata Drawing and Slope Stability Output**

**Retaining Wall 1
(RW01-01 to RW01-07)**

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


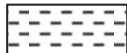



C_{pen} Shear Strength Determination by Pocket Penetrometer

- (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

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
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)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				
TERMS		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No RW01-01

1 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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
326.0	GROUND SURFACE												
0.0	ASPHALT: (100mm)												
0.1	SAND , some to trace gravel Compact Brown Moist (FILL)		1	GS									
			2	SS	12		325						
	clayey silt layer at 1.4m (500mm)												
324.1			3	SS	22		324						
1.9	SAND , some silt to silty, trace gravel, trace clay Compact to Dense Brown Wet		4	SS	34								
			5	SS	27		323						
							322						
			6	SS	37		321						
320.4													
5.6	Silty CLAY , trace sand Very Stiff Grey Moist		7	SS	21		320						
							319						
			8	SS	17		318						
316.9							317						
9.1	Silty SAND , trace gravel Dense to Very Dense Grey Moist		9	SS	37								
316.0													

Continued Next Page

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

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 NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) W _P W W _L				GR	SA	SI	CL
	Continued From Previous Page							20	40	60	80	100							
10.0	Silty SAND , trace gravel Dense to Very Dense Grey Moist						315							○					
	silt layer at 12.0m (600mm)						314												
313.4			11	SS	70									○					
12.6	Silty SAND , trace clay Very Dense Grey Wet						313							○					
							312								○				
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.																		

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

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
324.9	GROUND SURFACE					<div>▽</div>	<div>20406080100</div>	<div>204060</div>	<div>204060</div>	<div>204060</div>	<div>0 19 76 5</div>	<div>GR SA SI CL</div>	
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								
323.4													
1.5	SILT, some sand, trace clay Dense Brown Moist (FILL)		3	SS	36								
322.7													
2.3	SAND, some silt, trace gravel Compact to Loose Brown Moist to Wet		4	SS	15								
			5	SS	9								
320.7													
4.3	Silty CLAY, some sand, trace gravel Hard Grey Moist		6	SS	31								
319.3													
5.6	Sandy SILT, trace clay Very Dense Grey Moist		7	SS	57								
			8	SS	95								
			9	SS	106								

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+³, ×³: Numbers refer to Sensitivity
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 (%) 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									
	Continued From Previous Page																
314.7																	
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.																

RECORD OF BOREHOLE No RW01-03

1 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					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
327.8	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL (150mm)							20	40	60	80	100		
0.2	SAND and GRAVEL , some silt to silty, trace asphalt Compact Brown Moist (FILL)		1	SS	13		327						○	
			2	SS	20		326						○	
325.5														
2.3	SILT , some clay, trace sand Compact Brown Moist (FILL)		3	SS	19		325						○	
324.6														
3.2	SAND , some silt to silty, trace clay, trace gravel Compact Brown Wet		4	SS	25		324						○	
			5	SS	15		323						○	
			6	SS	19		322						○	
							321							
320.6														
7.2	Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist		7	SS	27		320						○	
			8	SS	100/ 0.175		319						○	
317.8							318							

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
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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									WATER CONTENT (%)			
								20 40 60 80 100									20 40 60			
Continued From Previous Page																				
10.0	SILT , some sand to sandy, some clay Dense to Very Dense Grey Moist		9	SS	47		317													
							316													
			10	SS	100/ 0.250		315									0 19 62 19				
							314													
313.7			11	SS	100/ 0.200															
14.1	END OF BOREHOLE AT 14.1m. WATER LEVEL AT 5.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																			

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 NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
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		326									
			2	SS	6		325									
324.5																
2.3	SAND , some silt to silty, trace clay Compact Brown Moist		3	SS	20		324									
			4	SS	21											0 79 19 2
							323									
			5	SS	24		322									
321.2																
5.6	Silty CLAY , trace sand, trace gravel Very Stiff to Hard Grey Wet		6	SS	7		321									
			7	SS	17		319									
							318									
			8	SS	39										0 5 47 48	
316.8							317									

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

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				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					
321.4	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (100mm)							20 40 60 80 100					
0.1	SAND and GRAVEL Brown Dry (FILL)		1	GS			321	20 40 60 80 100					
320.7								20 40 60 80 100					
0.7	Silty SAND , trace gravel Compact Brown Moist		2	SS	16		320	20 40 60 80 100					
								20 40 60 80 100					
			3	SS	16		320	20 40 60 80 100					
319.2								20 40 60 80 100					
2.2	Silty CLAY , trace sand Stiff to Hard Grey Moist		4	SS	11		319	20 40 60 80 100					
								20 40 60 80 100					
			5	SS	23		318	20 40 60 80 100					0 3 39 58
								20 40 60 80 100					
							317	20 40 60 80 100					
			6	SS	36		316	20 40 60 80 100					
								20 40 60 80 100					
315.1								20 40 60 80 100					
6.3	Silty SAND to Sandy SILT , trace clay Dense to Very Dense Grey Moist		7	SS	42		315	20 40 60 80 100					
								20 40 60 80 100					
							314	20 40 60 80 100					
			8	SS	67		313	20 40 60 80 100					
								20 40 60 80 100					
							312	20 40 60 80 100					
			9	SS	32			20 40 60 80 100					
311.4								20 40 60 80 100					

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


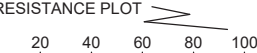












SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
	Continued From Previous Page							20	40	60	80	100	20	40	60	GR	SA	SI	CL			
10.0	Silty SAND , trace clay Dense Grey Moist					311															
			10	SS	45										○			0	71	28	1	
							310															
309.7																						
11.7	Silty CLAY , trace sand Hard Grey Moist																					
			11	SS	32		309								○							
							308															
			12	SS	42										○	—			0	2	39	59
307.1																						
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.																					

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
320.5	GROUND SURFACE													GR SA SI CL
0.0 0.1	ASPHALT: (75mm)		1	GS			○ UNCONFINED + FIELD VANE				w _P w w _L			
319.9	SAND and GRAVEL , trace silt, trace clay Brown						● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)			
0.7	Dry (FILL)		2	SS	15						○			
	SAND , some silt, trace clay, trace gravel Loose to Dense Brown Moist to Wet		3	SS	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	Sandy SILT to SILT and SAND , trace to some clay, trace gravel Compact to Dense Grey Moist to Wet		8	SS	30					○				
7.2			9	SS	32					○				

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										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
	Continued From Previous Page							20	40	60	80	100								
309.4			10	SS	30		310													
11.2	Silty CLAY , trace to some sand Hard Grey Moist						309													
			11	SS	33		308										0 10 45 45			
							307													
306.2			12	SS	33															
14.3	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.																			

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
320.0	GROUND SURFACE							20 40 60 80 100					
0.0 0.1	ASPHALT: (75mm)		1	GS			320						32 46 22 (SI+CL)
319.4 0.7	SAND and GRAVEL, some silt, trace clay Brown Dry (FILL)		2	SS	32		319						
318.8 1.3	Silty SAND, trace gravel Dense Brown Moist		3	SS	32		318						
	Silty CLAY, trace to some sand, trace gravel Very Stiff to Hard Grey Moist		4	SS	32		317						
			5	SS	35		316						
			6	SS	34		315						2 7 50 41
			7	SS	28		314						
			8	SS	24		313						
			9	SS	23		312						
							311						

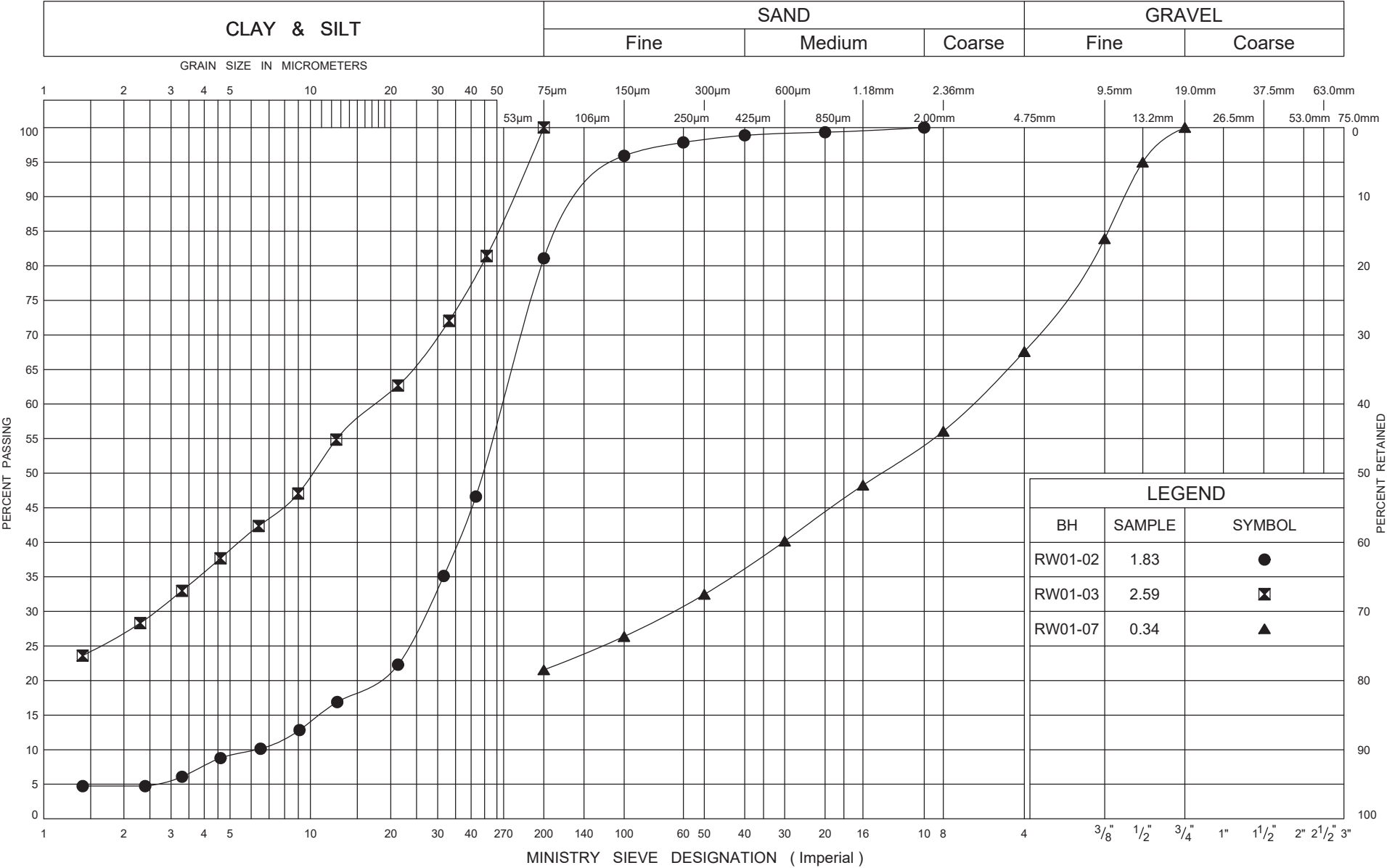
Continued Next Page

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

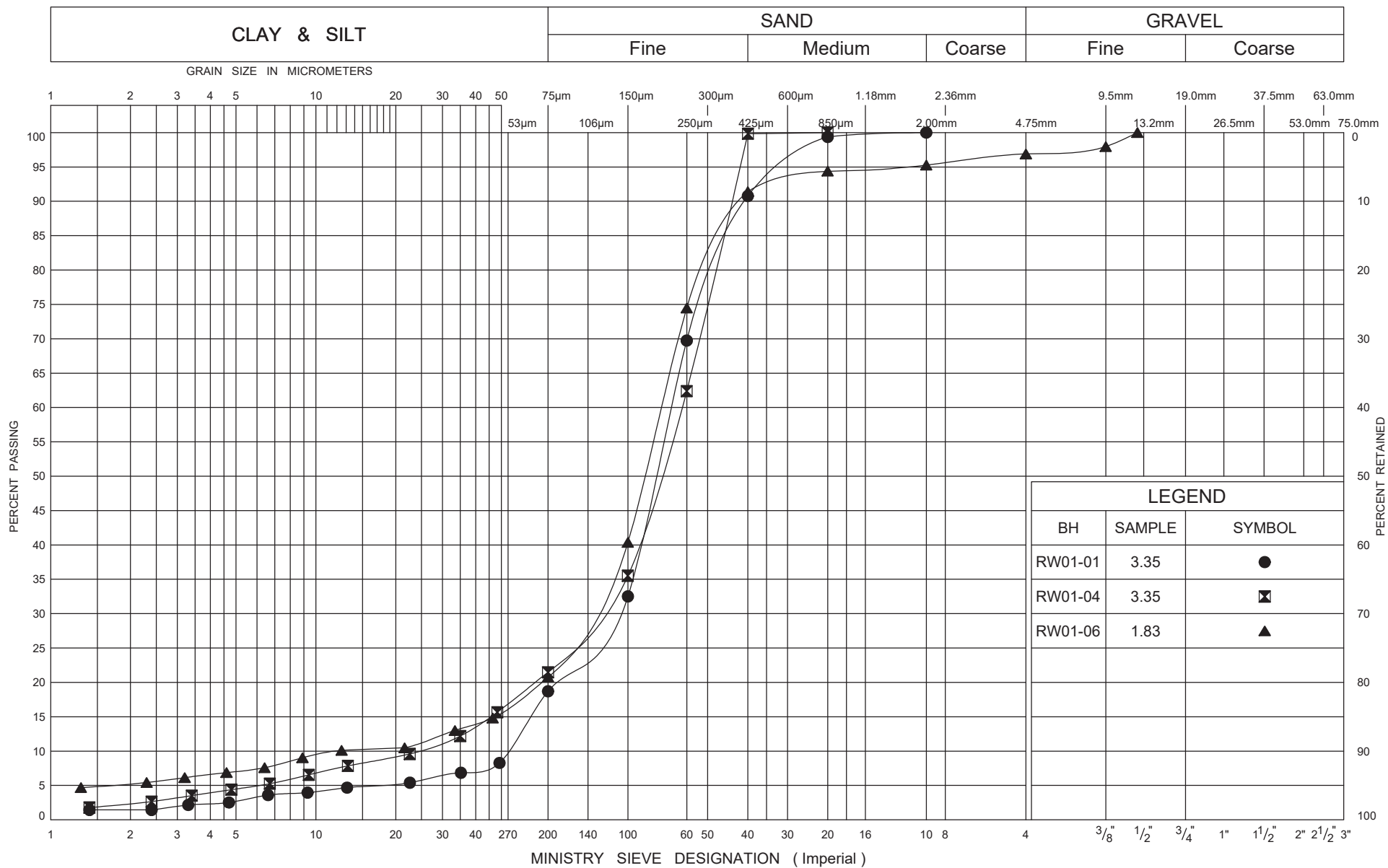
RECORD OF BOREHOLE No RW01-07 2 OF 2 METRIC

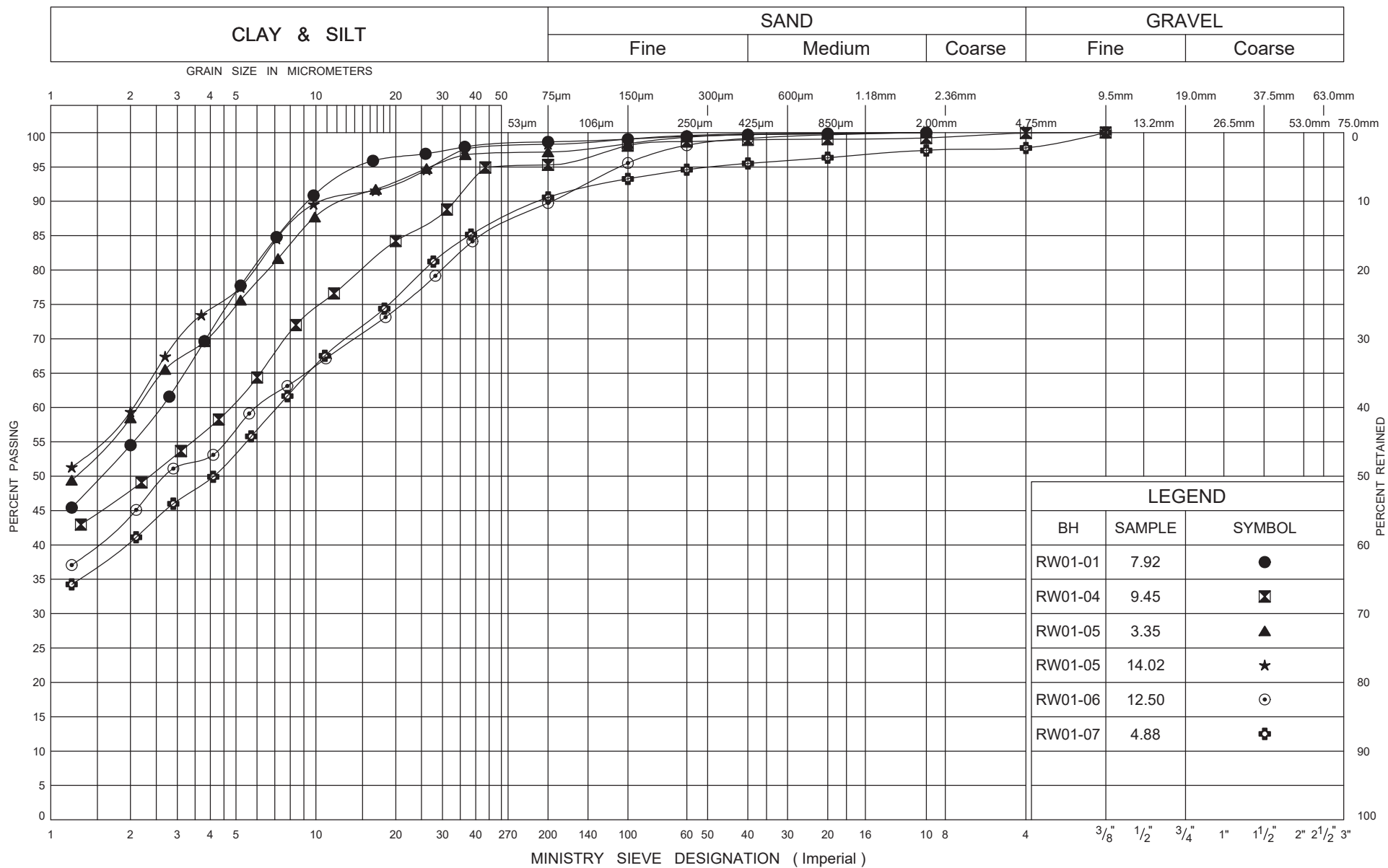
GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 661.7 E 226 221.5 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2019.08.14 - 2019.08.14 LATITUDE 43.458833 LONGITUDE -80.471043 CHECKED BY NB

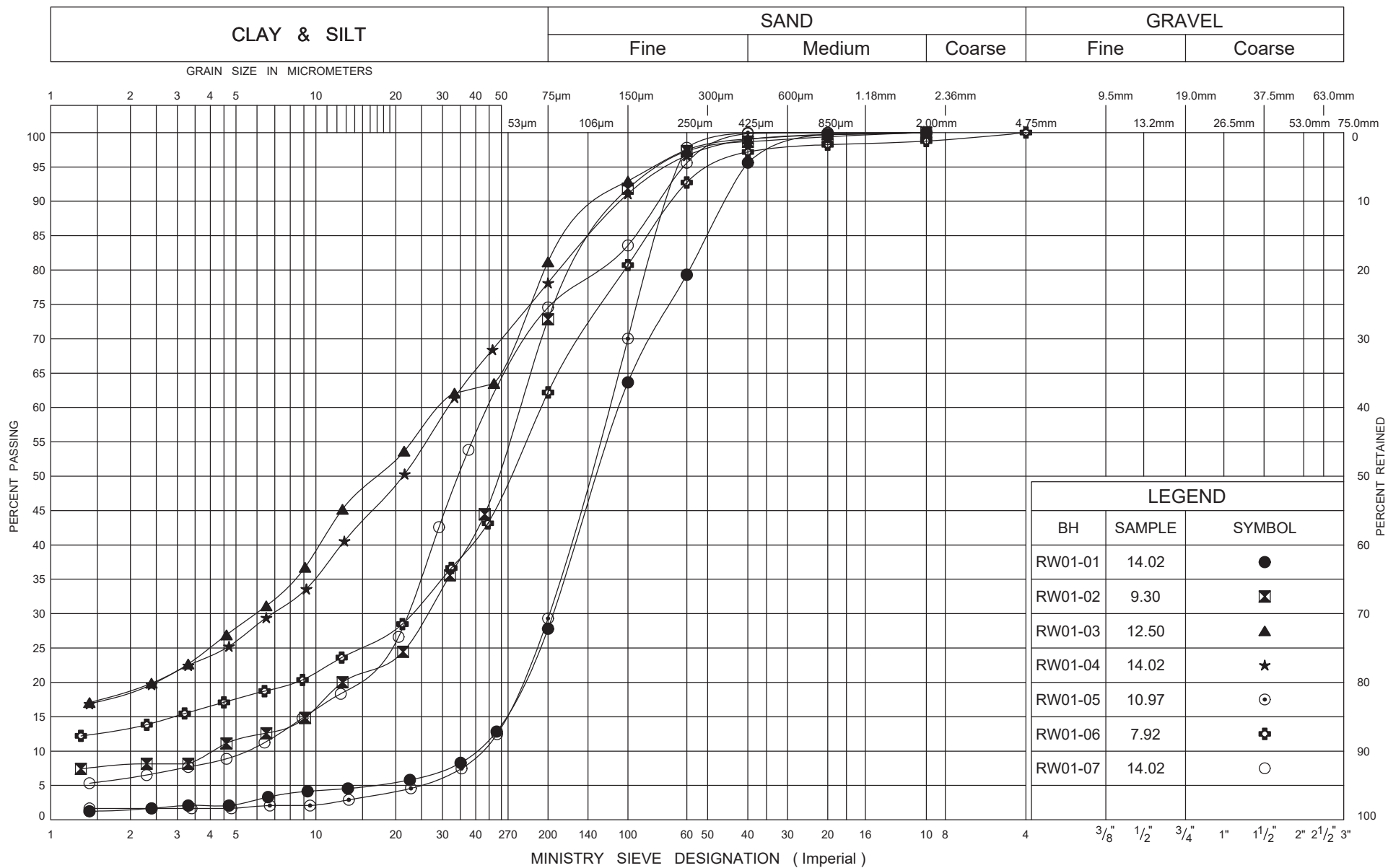
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
							WATER CONTENT (%) 20 40 60							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L							
Continued From Previous Page														
	Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist						310							
			10	SS	19		309							
308.3														
11.7	Sandy SILT , trace clay Dense to Very Dense Grey Moist						308							
			11	SS	31		307							
305.7			12	SS	55		306							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.													

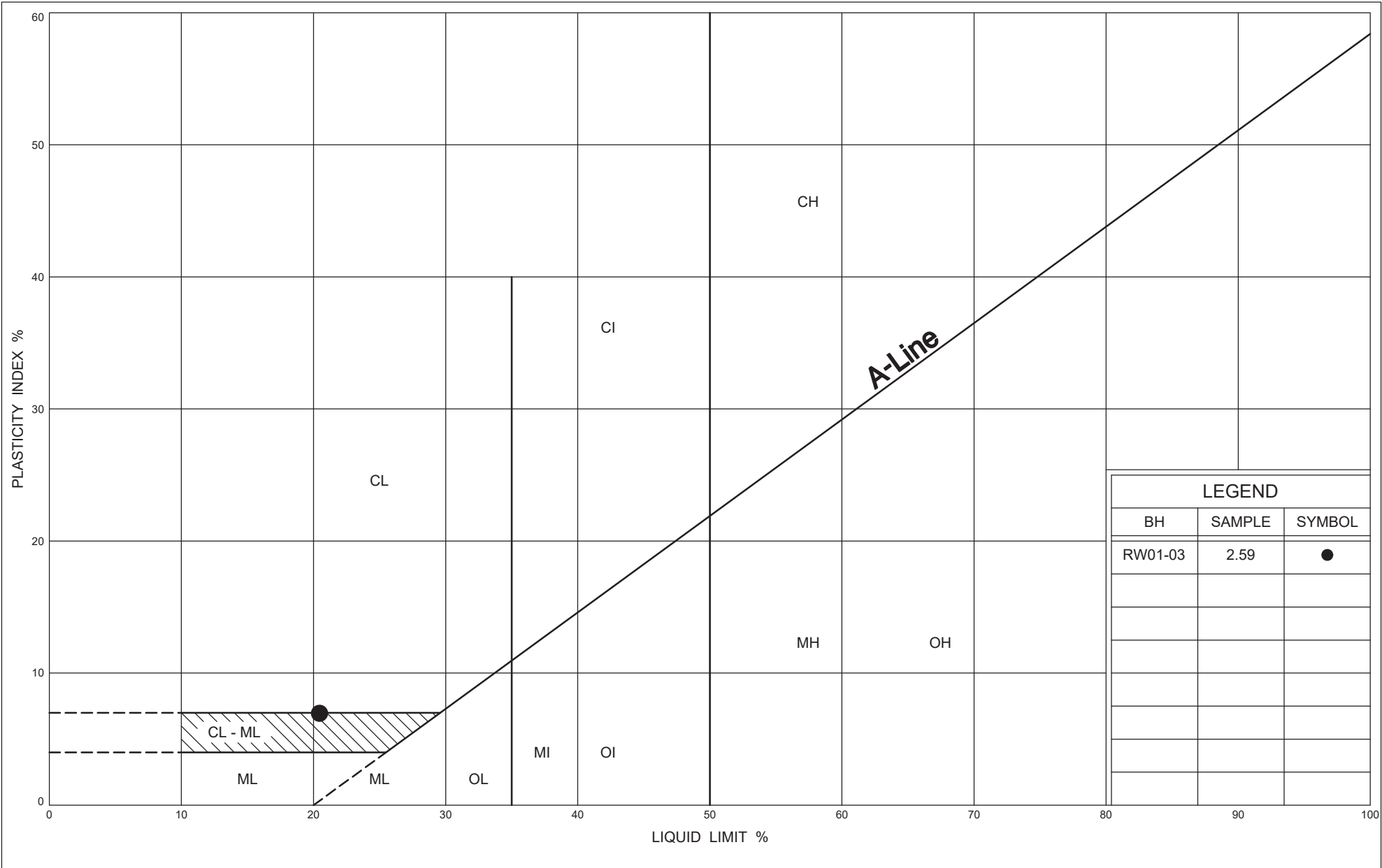


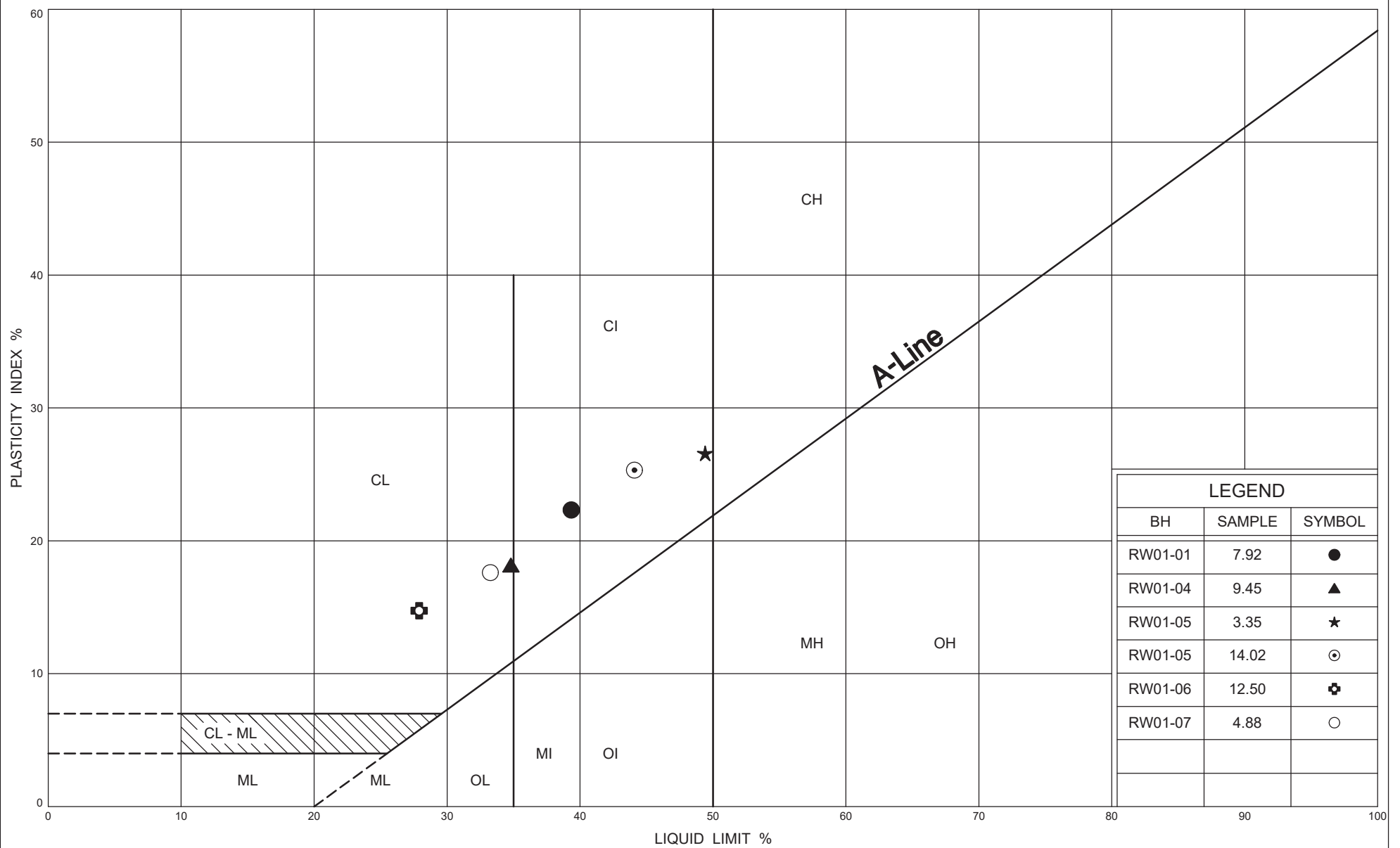
LEGEND		
BH	SAMPLE	SYMBOL
RW01-02	1.83	●
RW01-03	2.59	⊠
RW01-07	0.34	▲











PLASTICITY CHART Silty CLAY

FIG No A6

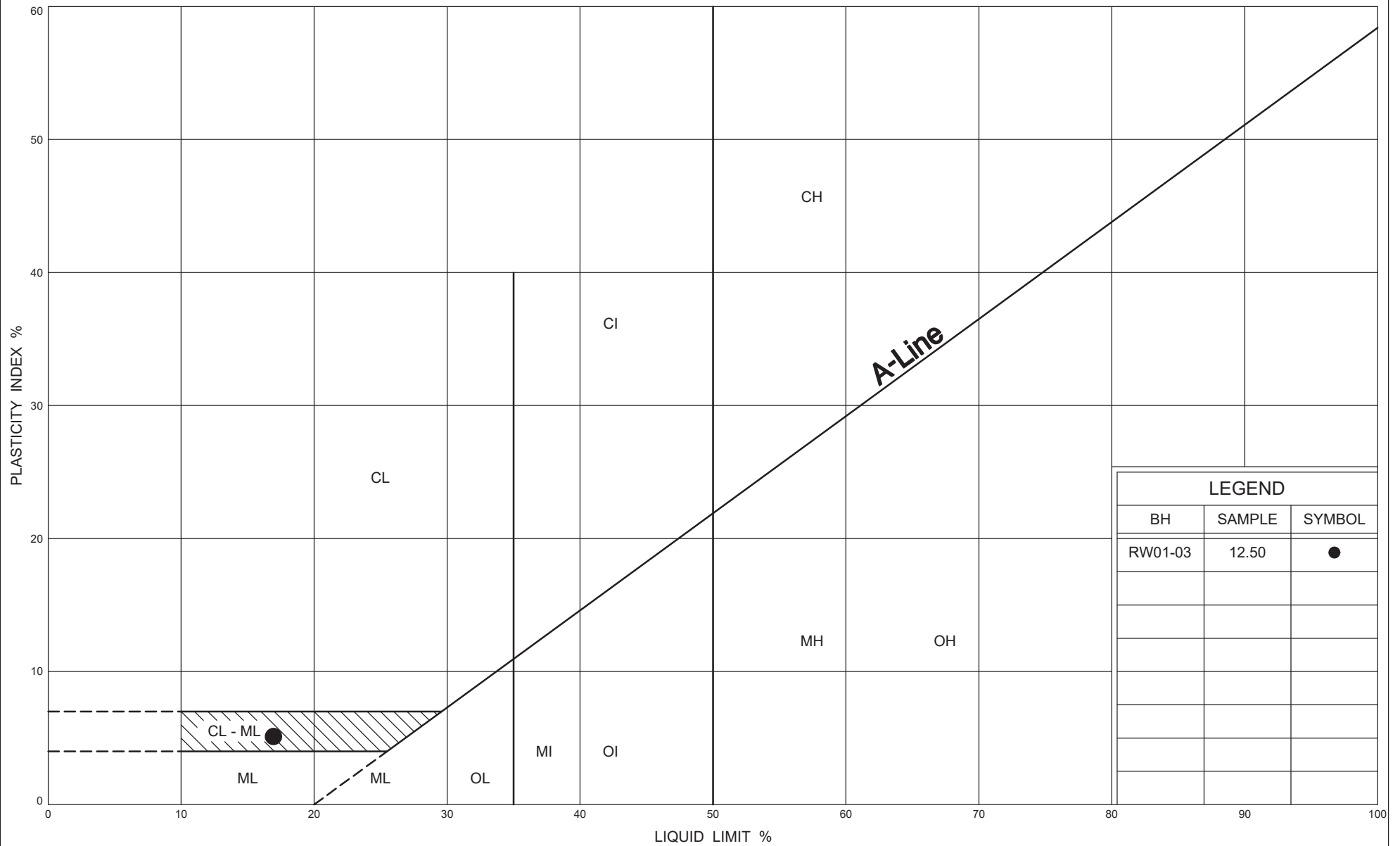
W P 408-88-00

Retaining Wall 1



Ministry of
Transportation

Ontario



Ministry of
Transportation

PLASTICITY CHART

Sandy SILT / Silty SAND

FIG No A7

W P 408-88-00

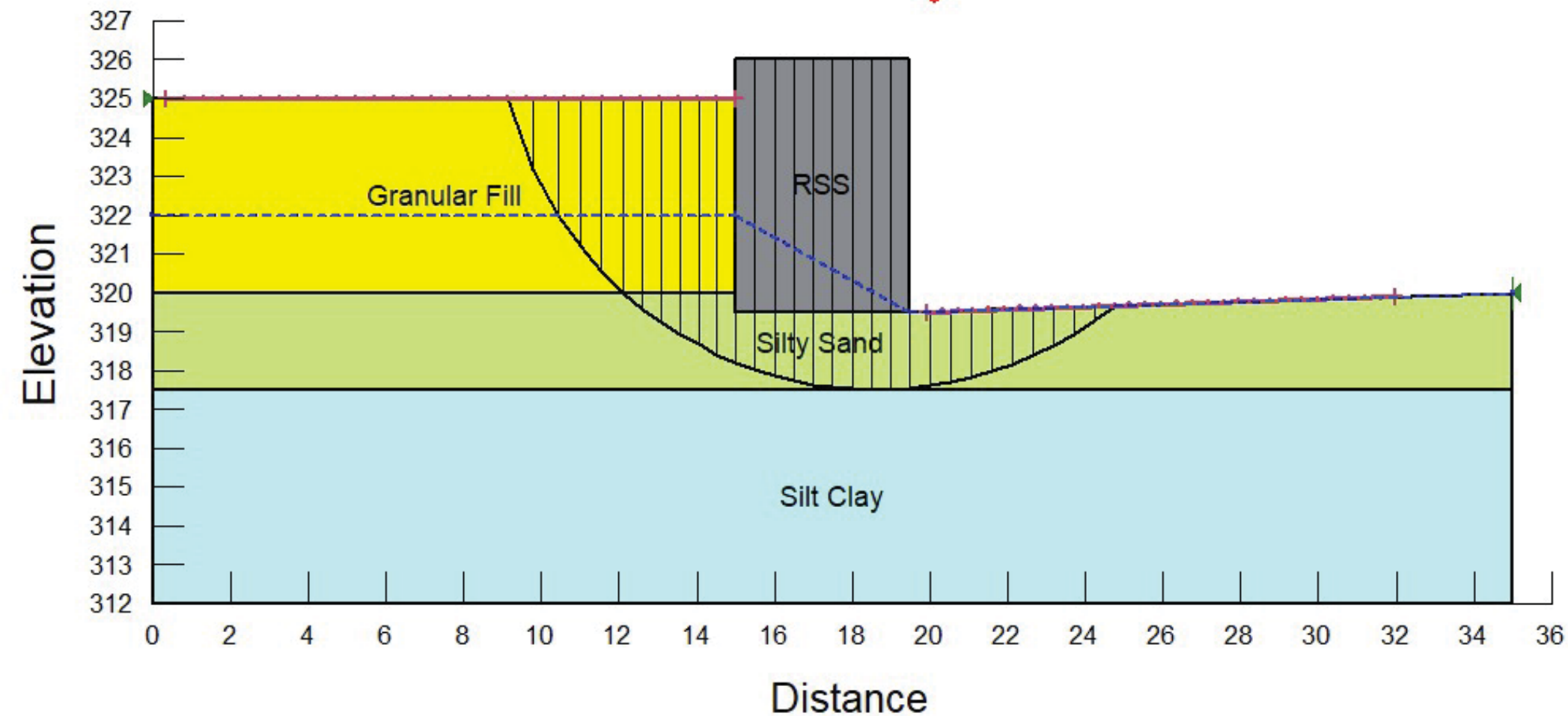
Retaining Wall 1

File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure A8

RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 35 °
Silty Sand 19 kN/m³ 0 kPa 30 °
Silt Clay 20 kN/m³ 120 kPa

1.73

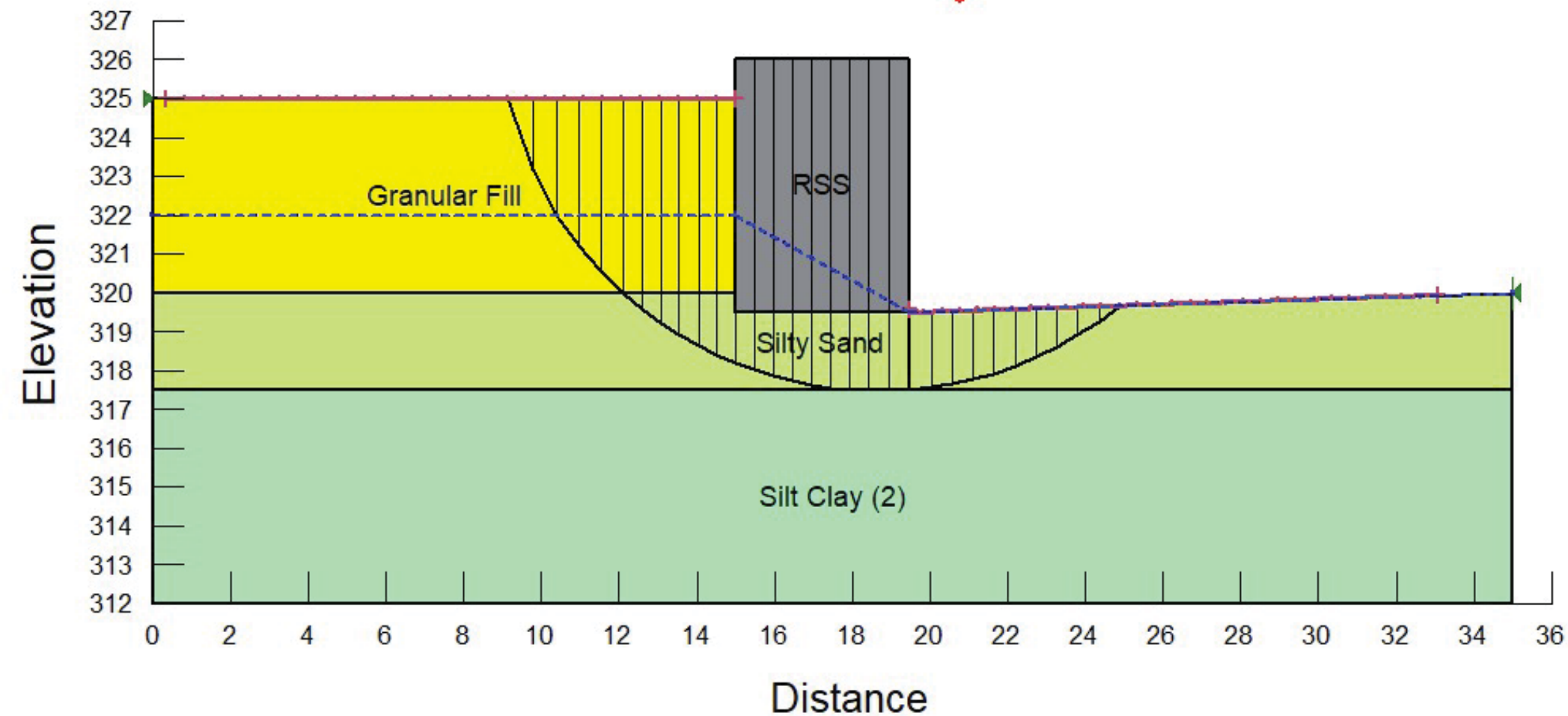


File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure A9

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	35 °
Silty Sand	19 kN/m ³	0 kPa	30 °
Silt Clay (2)	20 kN/m ³	5 kPa	30 °

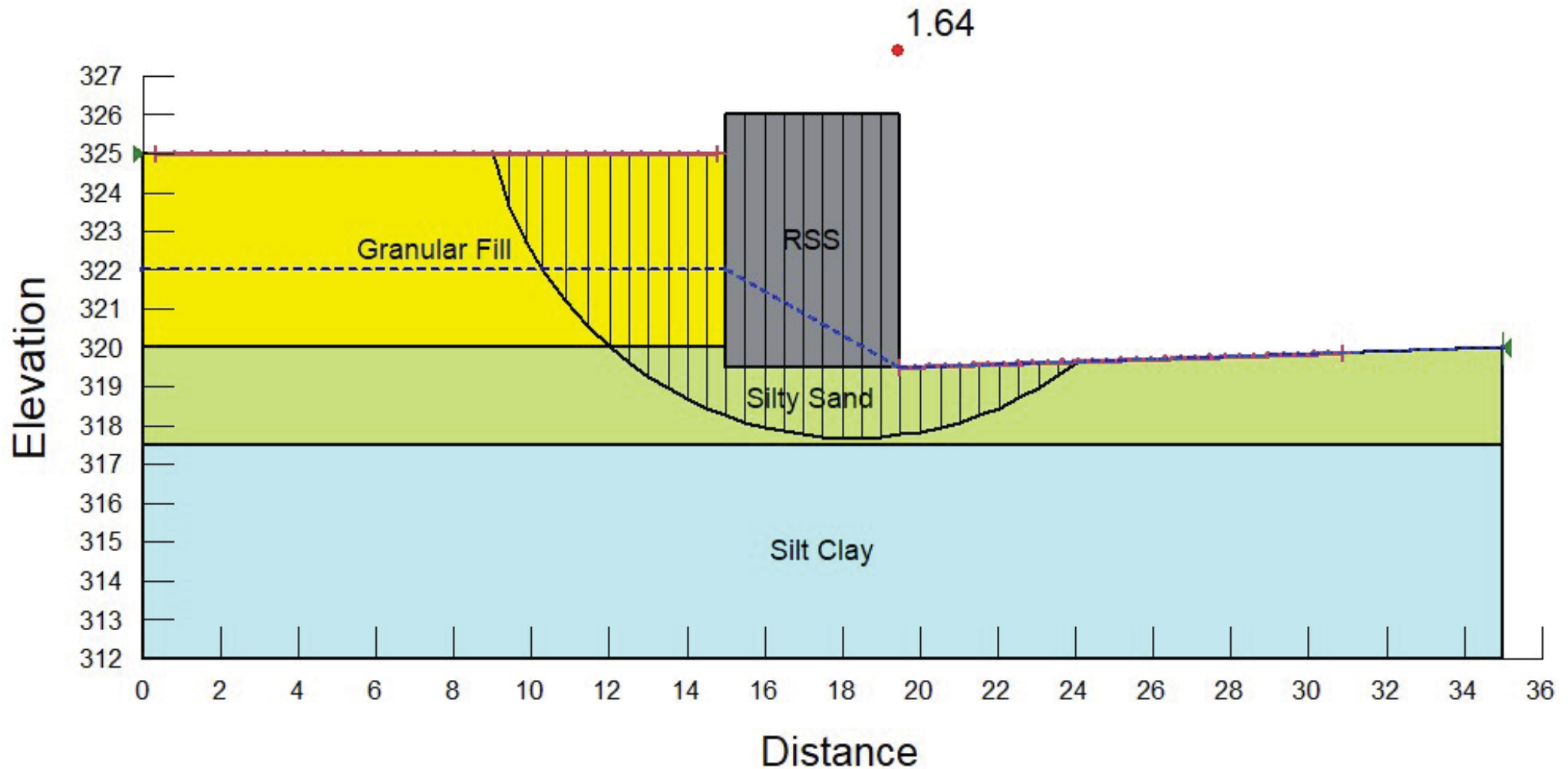
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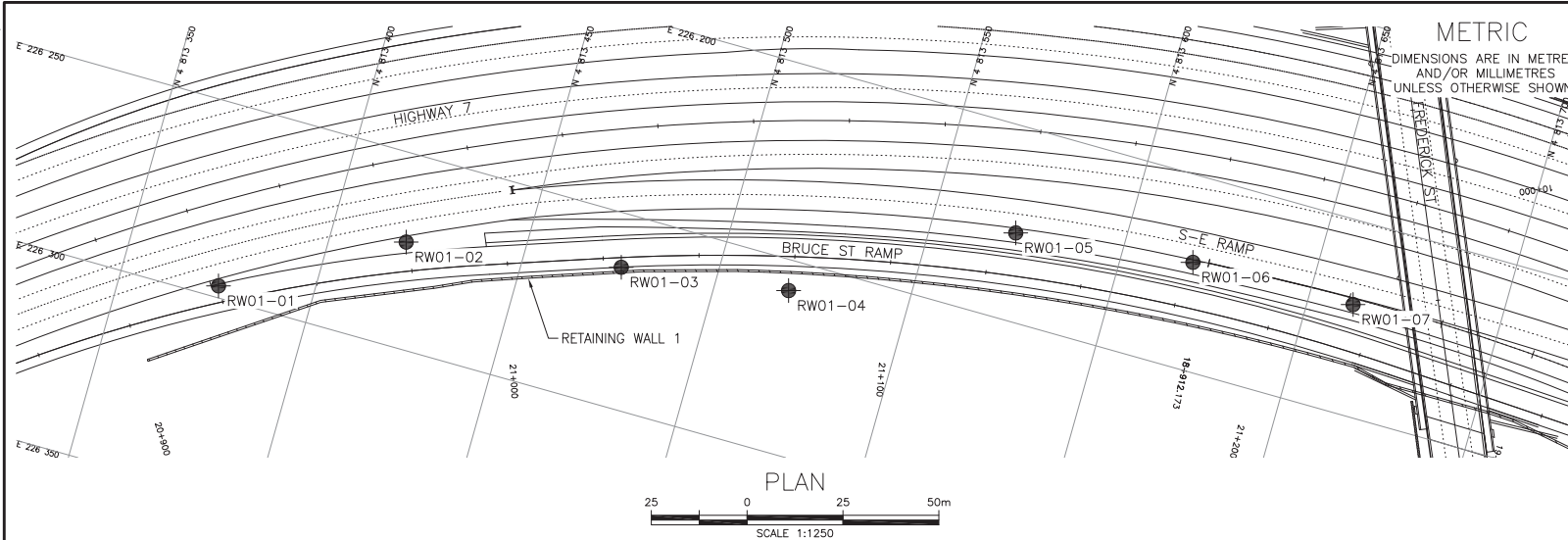


File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Horz. Seismic Coef.: 0.0485

Figure A10

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	35 °
Silty Sand	19 kN/m ³	0 kPa	30 °
Silt Clay	20 kN/m ³	120 kPa	





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

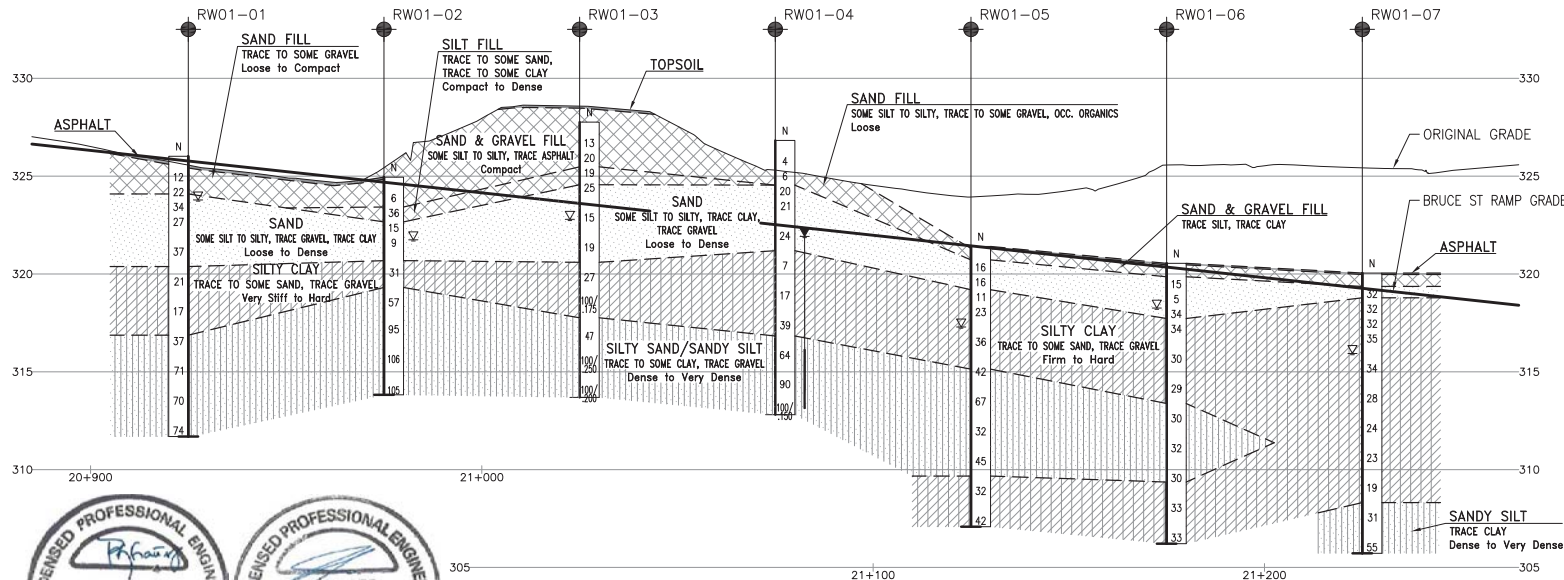
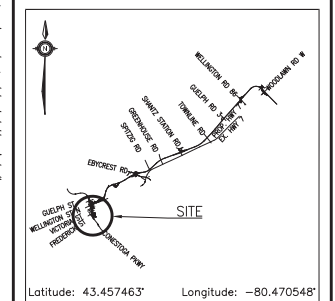
CONT No
GWP No 408-88-00

HIGHWAY 7
FREDERICK ST.-S/E-BECKER ST.
RETAINING WALL 1
BOREHOLE LOCATIONS AND SOIL STRATA

wsp

THURBER ENGINEERING LTD.

SHEET



LEGEND

- ◆ Borehole (Current Investigation)
- ◇ Borehole (by Others)
- N North
- CONE Blows /0.3m (Std Pen Test, 475J/blow)
- PH Blows /0.3m (60' Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

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	226 222.3
RW01-07	320.0	4 813 661.7	226 221.5

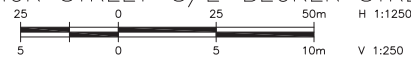
-NOTES-

- 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.

GEORES No. 40P9-58



PROFILE ALONG BRUCE STREET RAMP
FREDERICK STREET-S/E-BECKER STREET



REVISIONS

DATE	BY	DESCRIPTION
DESIGN	NB	CHK PKC
DRAWN	MFA	CHK NB
		SITE
		STRUCT
		DWG 1

DATE MAY 2020



Appendix B

**Record of Borehole Sheets, Laboratory Test Results and Borehole Locations,
Soil Strata Drawing and Slope Stability Output**

**Retaining Wall 2
(RW-01 to RW-04 and RW02-02 to RW02-04)**



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

1 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				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _p w w _L				GR	SA	SI	CL
319.6	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (200mm)							20	40	60	80	100							
0.2	Silty SAND , with gravel Brown Dry (FILL)		1	GS			319						○						
318.8																			
0.8	Silty SAND , trace clay, trace gravel Dense to Compact Brown Moist		2	SS	30		318						○						
			3	SS	34		317						○						
			4	SS	24		316						○						
			5	SS	21		315						○						
315.4																			
4.1	Silty CLAY , some to with sand, trace gravel Stiff to Hard Grey Moist		6	SS	14		314						○						
													○						
							313												
			7	SS	35		312						○						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
								20 40 60 80 100					
								WATER CONTENT (%)					
								W _p W W _L					
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT					

RECORD OF BOREHOLE No RW02-03

1 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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								20 40 60 80 100									20 40 60		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
319.5	GROUND SURFACE																		
0.0	ASPHALT: (200mm)																		
0.2	Silty SAND, with gravel Brown Dry (FILL)		1	GS			319												
318.7																			
0.8	SAND, trace to some silt, trace clay Compact Brown Wet		2	SS	26											0 91 8 1			
							318												
			3	SS	22														
			4	SS	16		317												
			5	SS	11		316												
							315												
314.5			6	SS	27														
5.0	Silty CLAY, trace sand Very Stiff Grey Moist						314												
			7	SS	6		313									Switch to tricore			
	Firm																		
							312												
			8	SS	29														
							311												
			9	SS	15		310									0 1 38 61			
309.5																			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

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 NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
	Continued From Previous Page							20	40	60	80	100		20	40	60					
10.0	Silty CLAY , trace to some sand, trace gravel Very Stiff to Hard Grey Moist Sandy silt layer at 11.0m (500mm)						309														
			10	SS	28									○							
							308							○							
			11	SS	68		307							○							
							306														
305.8																					
13.7	SAND , trace to some silt, trace clay Dense to Very Dense Grey Wet		12	SS	75		305							○							
														○							
							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.																				

ONTMT452 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 NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
319.1	GROUND SURFACE						20 40 60 80 100		20 40 60				GR SA SI CL	
0.0	ASPHALT:(112mm)													
0.1	SAND, with gravel Brown Moist (FILL)		1	GS										
318.5														
0.6	SAND, trace silt and clay, trace gravel Compact to Dense Brown Wet		2	SS	26									
			3	SS	32									
			4	SS	21									
			5	SS	34									
314.3			6	SS	17									
4.8	Silty CLAY, some sand to sandy, trace gravel Very Stiff Grey Moist													
			7	SS	16									
			8	SS	26									
			9	SS	17									
	Wet													

Continued Next Page

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

RECORD OF BOREHOLE No RW02-04

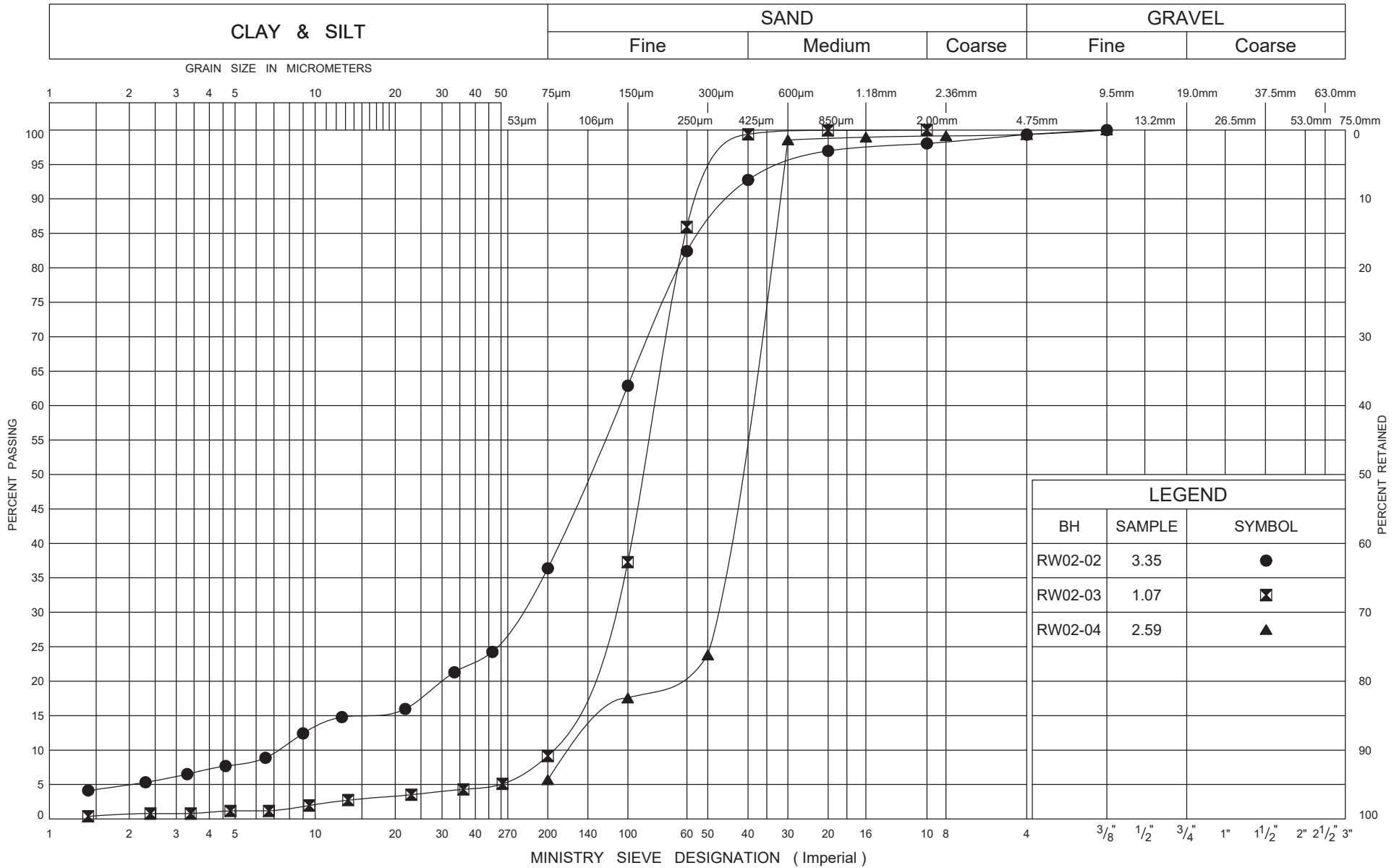
2 OF 2

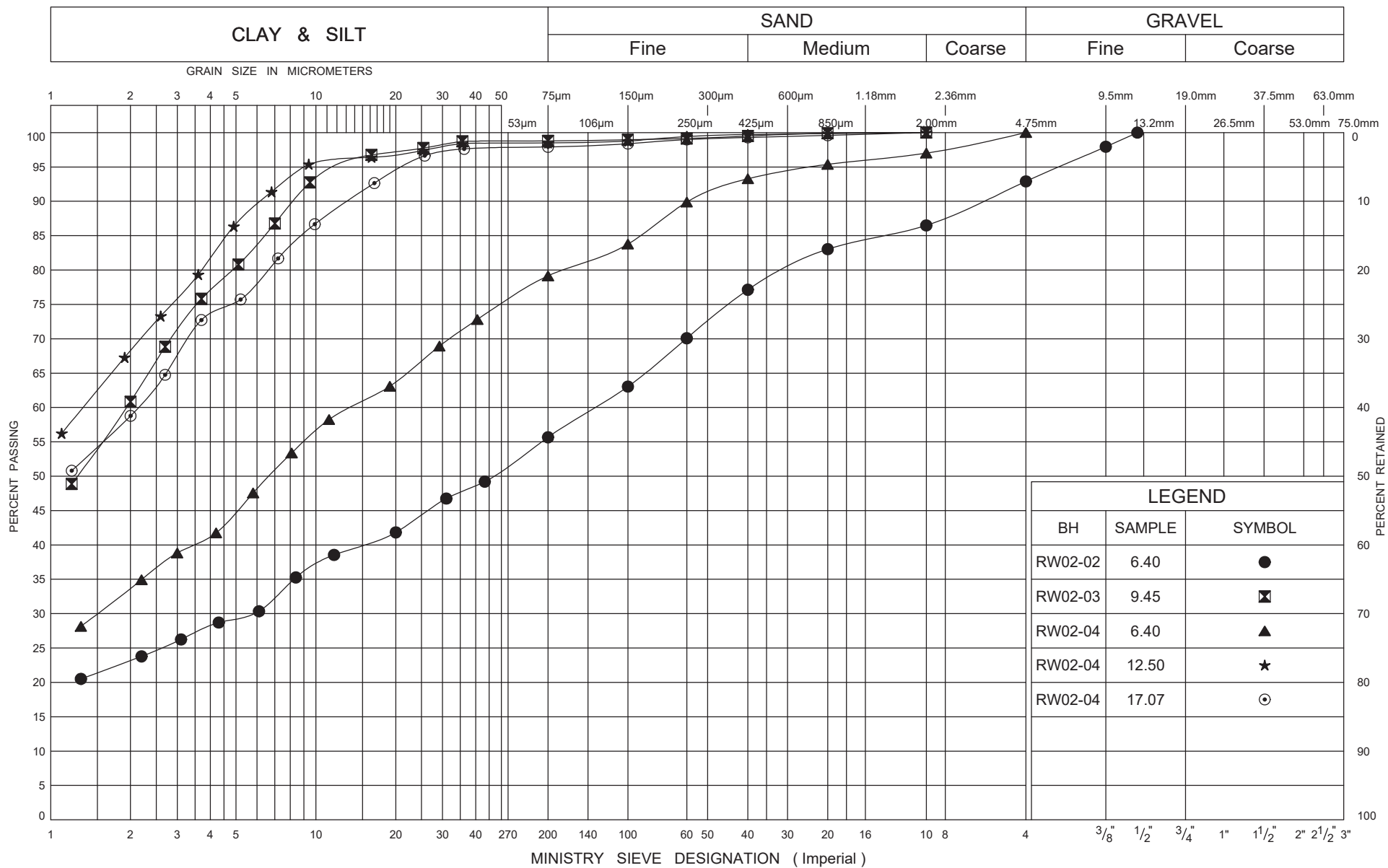
METRIC

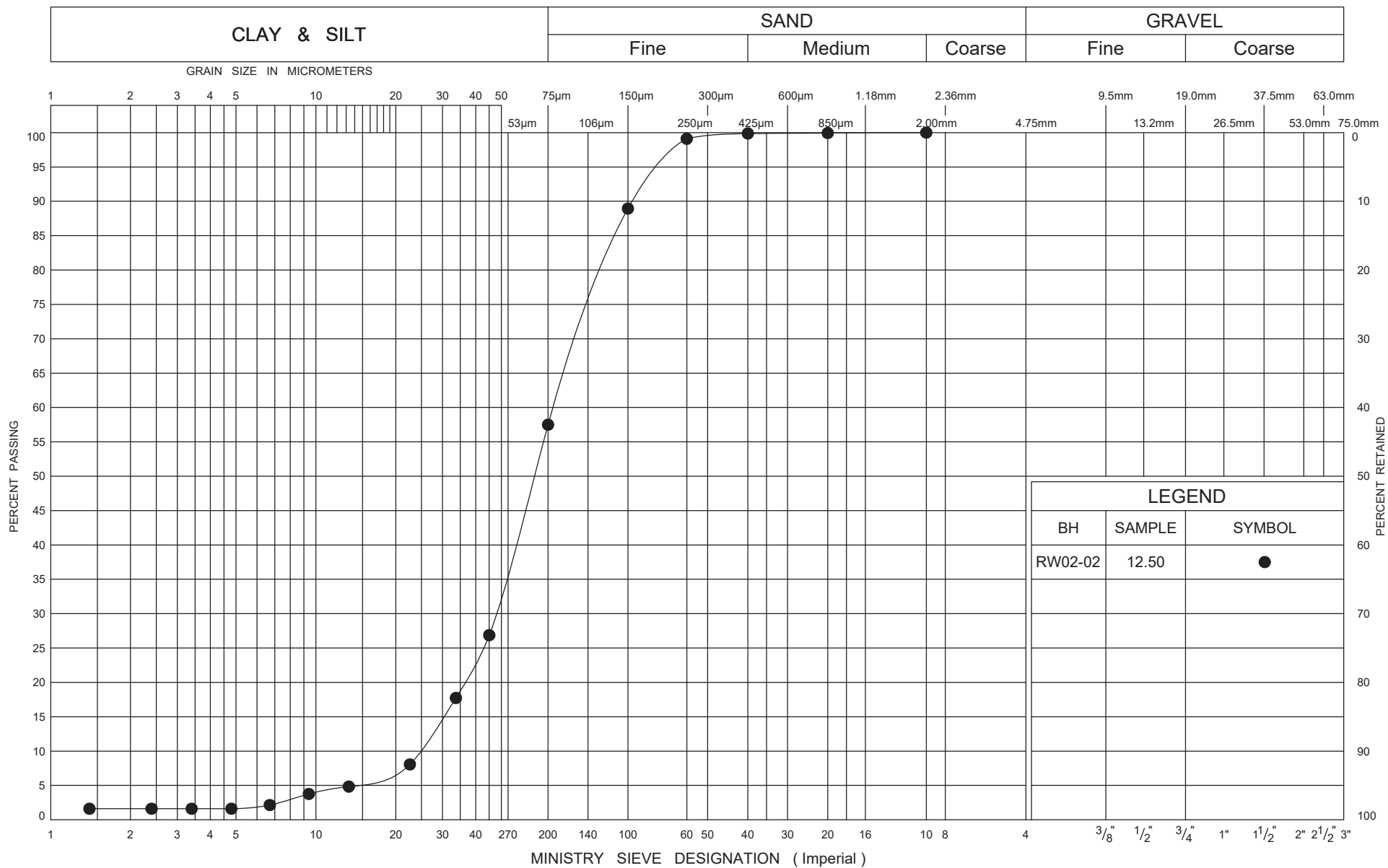
GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 856.9 E 226 242.2 ORIGINATED BY ES
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
DATUM Geodetic DATE 2019.09.23 - 2019.09.23 LATITUDE 43.460514 LONGITUDE -80.470774 CHECKED BY NB

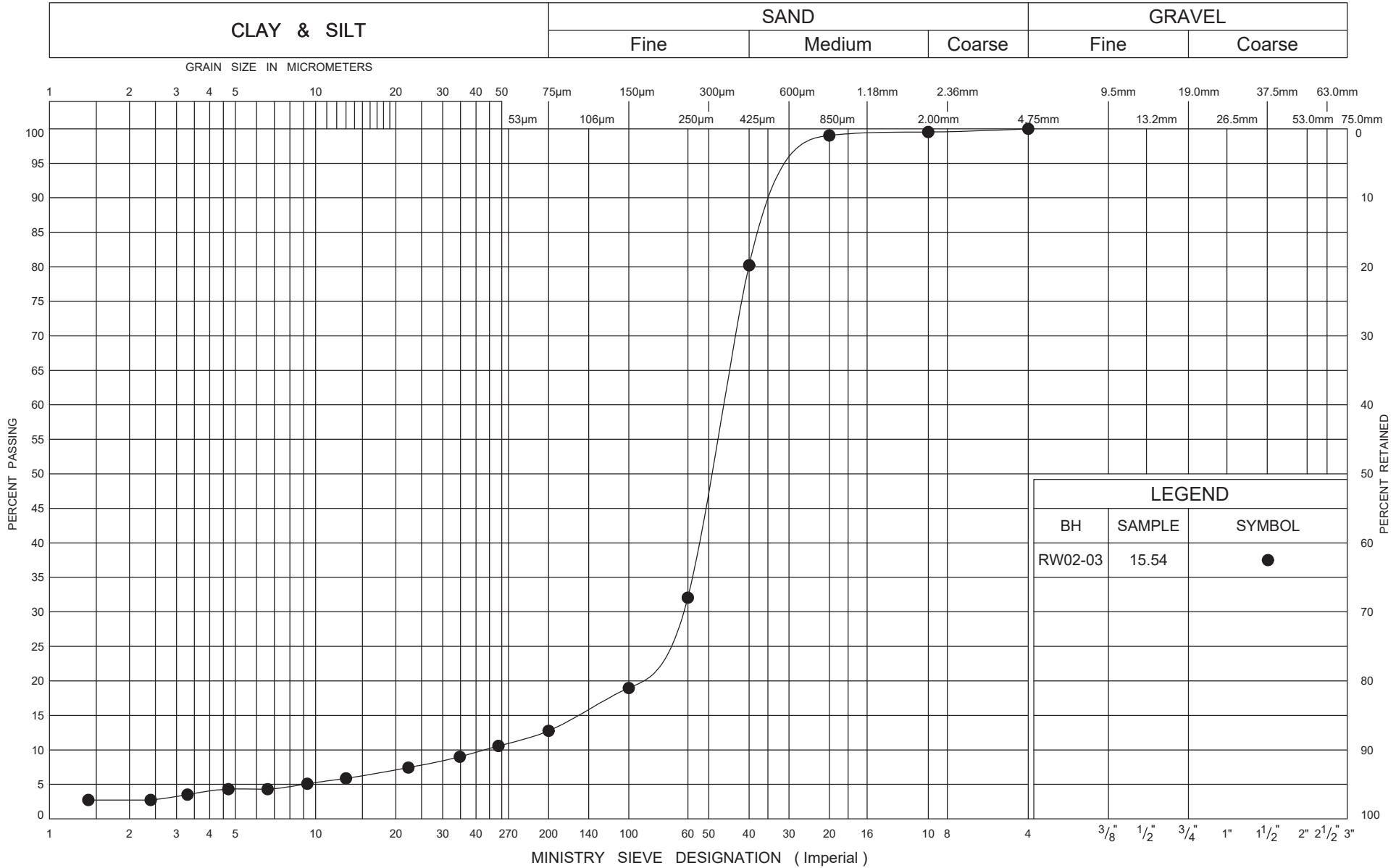
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W		W _L	GR	SA	SI	CL
	Continued From Previous Page																			
	Silty CLAY , some sand to sandy, trace gravel Very Stiff Grey Moist Hard		10	SS	37															
306.9																				
12.2	Silty CLAY , trace sand Stiff Grey Wet		11	SS	9												0	1	30	69

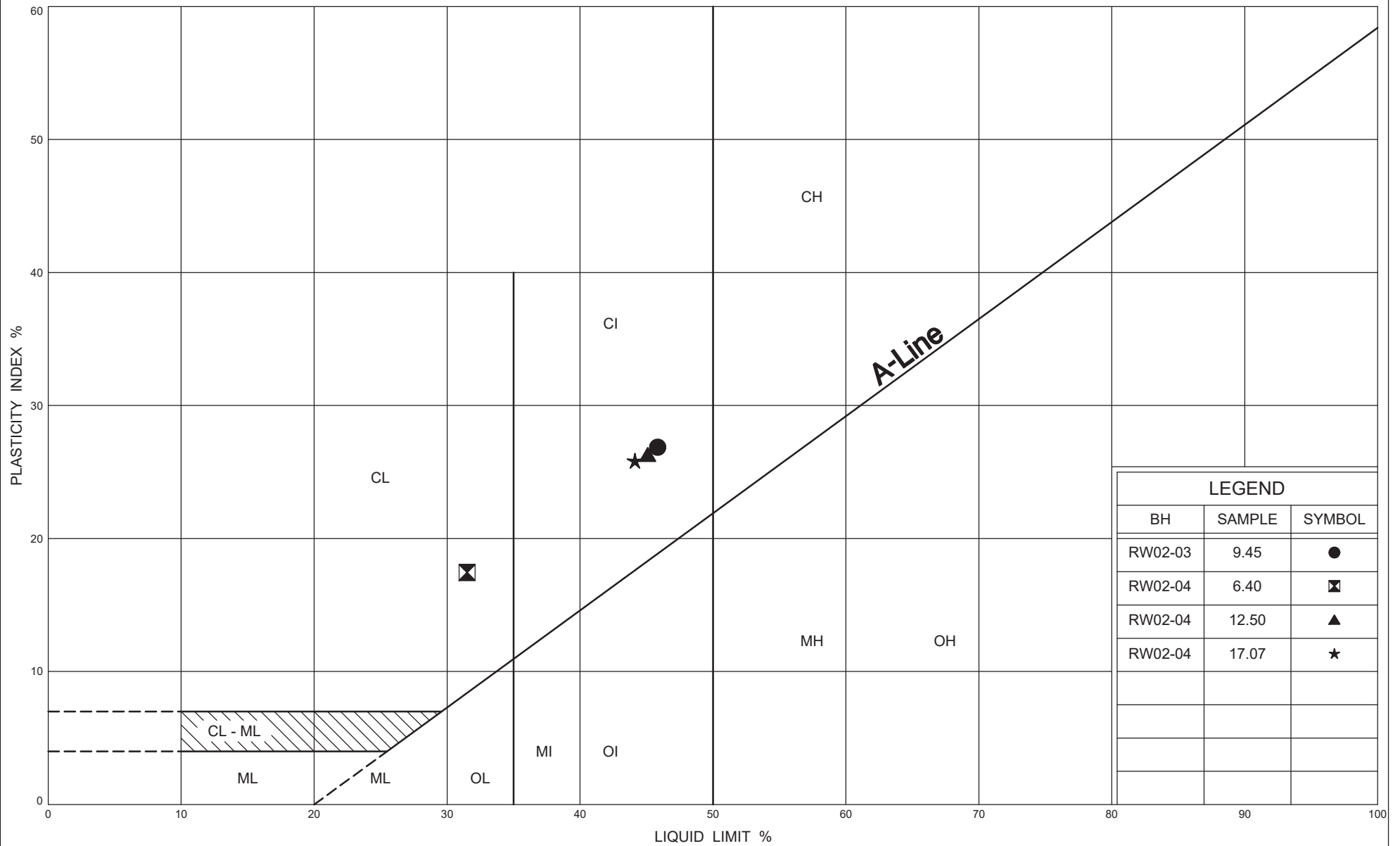
ONTMT452 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/13/19











Ministry of
Transportation

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 SILT)

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, 100mm+ 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	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	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_r	1	SENSITIVITY = $\frac{C_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m ³	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	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	1	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	1	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	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRYER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL	WTP		WETTER THAN PLASTIC LIMIT	j	kN/m ³	SEEPAGE FORCE
e	1, %	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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED		+ FIELD VANE							○	
								● QUICK TRIAXIAL		× LAB VANE								
319.7	Ground Surface						20	40	60	80	100	20	40	60				
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											(**)		
			4	SS	34													
			5	SS	25													
			6	SS	28													
			7	SS	37													
			8	SS	31													
			9	SS	33													
			10	SS	39													
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 Water Level Readings: Date Depth Elev. (m) (m) Apr. 08, '11 2.9 316.8 Piezometer Legend: 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										UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					WATER CONTENT (%)						
							○ UNCONFINED + FIELD VANE					w _p w w _L						
							● QUICK TRIAXIAL × LAB VANE											
319.7	Ground Surface						20	40	60	80	100							
0.0	Asphalt over sand and crushed gravel, trace silt Compact Brown Moist (FILL)		1	AS	-													
			2	SS	11													
318.3																		
1.4	Silty clay, trace gravel sand layers Stiff Dark Moist brown sand layers to 3.7m Hard Greyish brown		3	SS	9							225						(**)
			4	SS	31							225						
			5	SS	23							225						
			6	SS	44							225						
			7	SS	43							225						
			8	SS	35							225						
			9	SS	29							225						
309.9	End of borehole																	
9.8																		
										</								

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa												
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
322.3	Ground Surface						20	40	60	80	100							
0.0	Silty sand some clay, trace gravel organic inclusions		1	SS	14												8 37 37 18	
	Compact Grey Moist																	
	(FILL)																	
	clayey silt layers		2	SS	27								○				3 50 34 13	
																	4 26 45 25	
	gravelly sand												○				23 39 27 11	
	Compact Brown Damp		3	SS	20								○				4 25 42 29	
320.0	clayey silt layers												II					
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								○				(14*) 73 12 4	
317.9																		
4.4	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													
			9	SS	70/15cm								○					
315.9	End of borehole																	
6.4	Sample 9: Sampler bouncing																	
	* 2011 07 19																	
	▽ Water level observed during drilling																	
	(**) Base of footing -El.318.2																	
	Water Level Readings:																	
	Date Depth Elev. (m)																	
	July 19, '11 Dry ----																	
	Sept. 23, '11 3.3 319.0																	
	Oct. 08, '11 3.3 319.0																	
	Piezometer Legend:																	
	 Bentonite seal																	
	 Filter sand																	
	 30mm dia. PVC screen																	
	 Filter bed																	

RECORD OF BOREHOLE No RW-4

1 of 1

METRIC

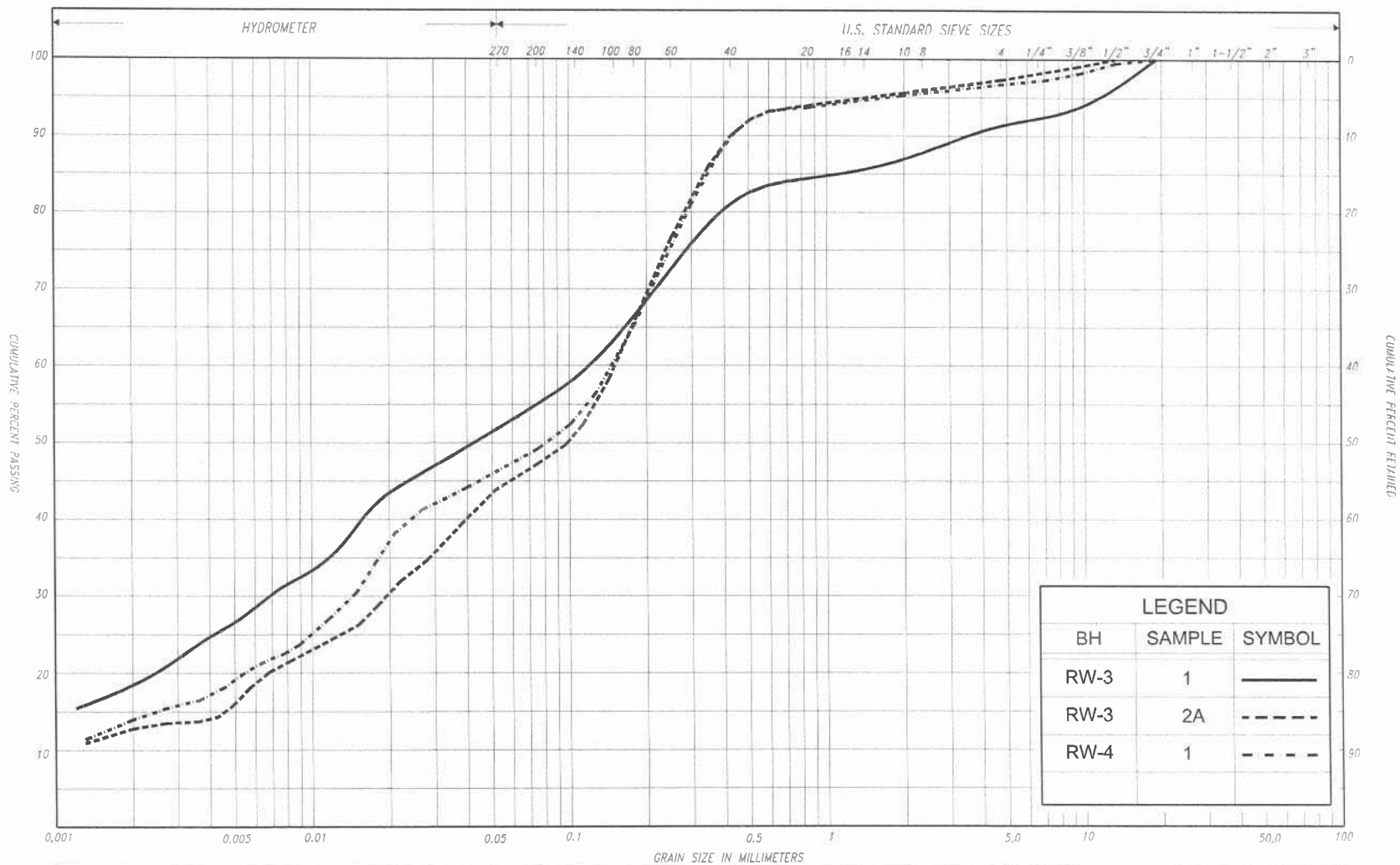
G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 705.4 N; 226 228.2 E **ORIGINATED BY** A.L.
DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Dynamic Ram Sounder **COMPILED BY** N.S.B.
DATUM Geodetic **DATE** July 20, 2011 **CHECKED BY** B.R.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL × LAB VANE										
323.5	Ground Surface						20	40	60	80	100							
0.0	Silty sand, some clay trace gravel, rootlets		1	SS	21								○				4 47 35 14	
	Compact Brown Moist (FILL)																	
	Silt with sand, trace gravel		2	SS	21									○			22 20 54	
	Compact Grey Sand, some silt some gravel, trace clay		3	SS	21									○			15 68 11 6	
321.2	Compact Brown Clayey silt, trace sand												125					
2.3	Very stiff Grey		4	SS	20	▽*							○				9 83 (8)	
	Sand trace to some gravel trace to some silt trace clay		5	SS	13									○			11 73 12 4	
	Compact Brown Moist to wet		6	SS	13									○			38 43 13 6	
	Gravelly to with gravel		7	SS	9									○			26 68 3 3	
			8	SS	14									○			(**)	
317.6	Silty clay, trace gravel cobbles		9	SS	49								175					
5.9	Stiff to Grey Moist hard		10	SS	52/15cm													
			11	SS	50/13cm													
316.5	End of borehole																	
7.0	Samples 10 and 11: Sampler bouncing																	
	* 2011 07 20																	
	▽ Water level observed during drilling																	
	(**) Base of footing -El.318.2																	
	Note: Borehole cave-in at 5.0m																	



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



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

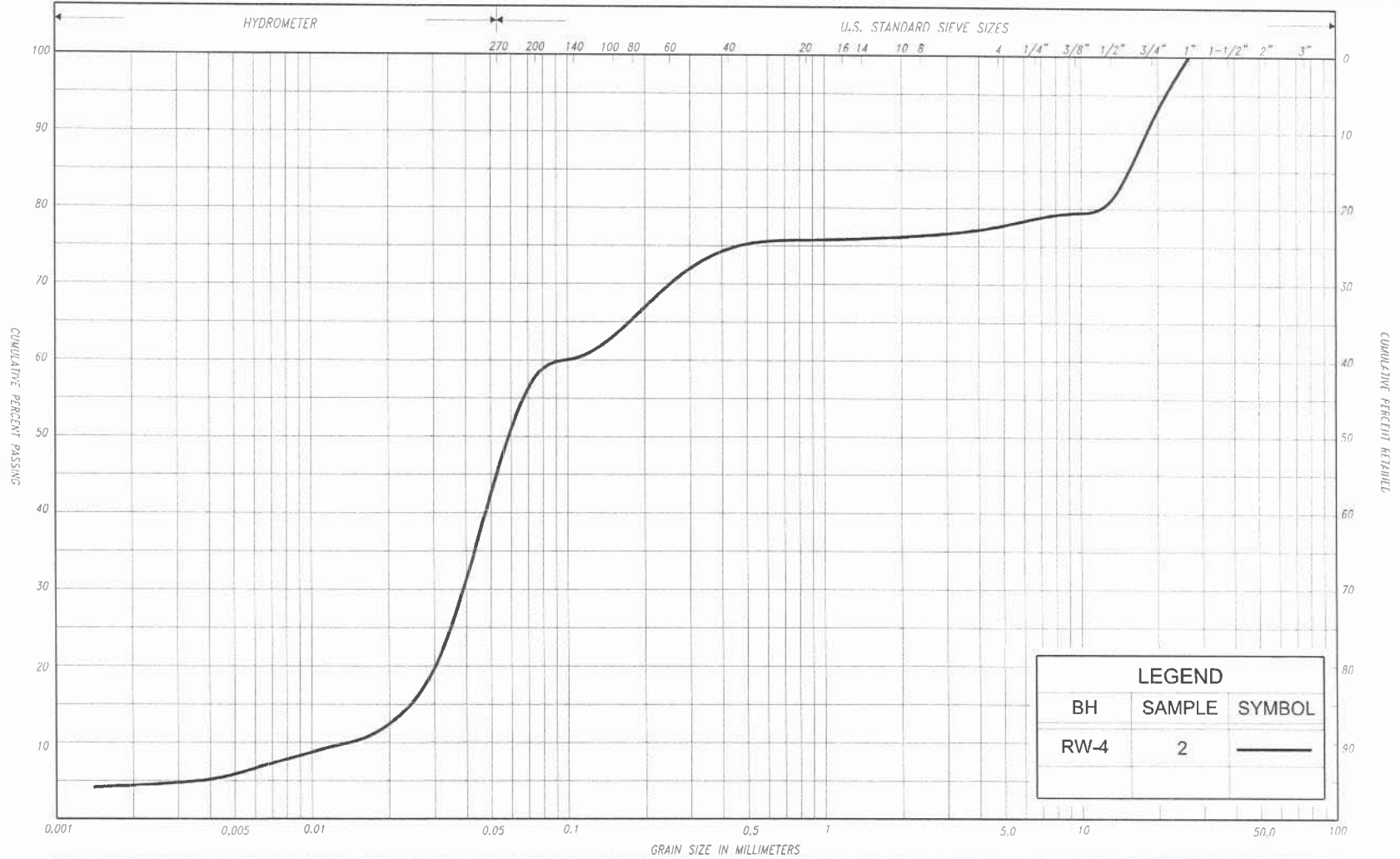
GRAIN SIZE DISTRIBUTION
SILTY SAND, some clay, trace gravel
(FILL)

FIG No. RW-GS-1

HWY: 7 / 85

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





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



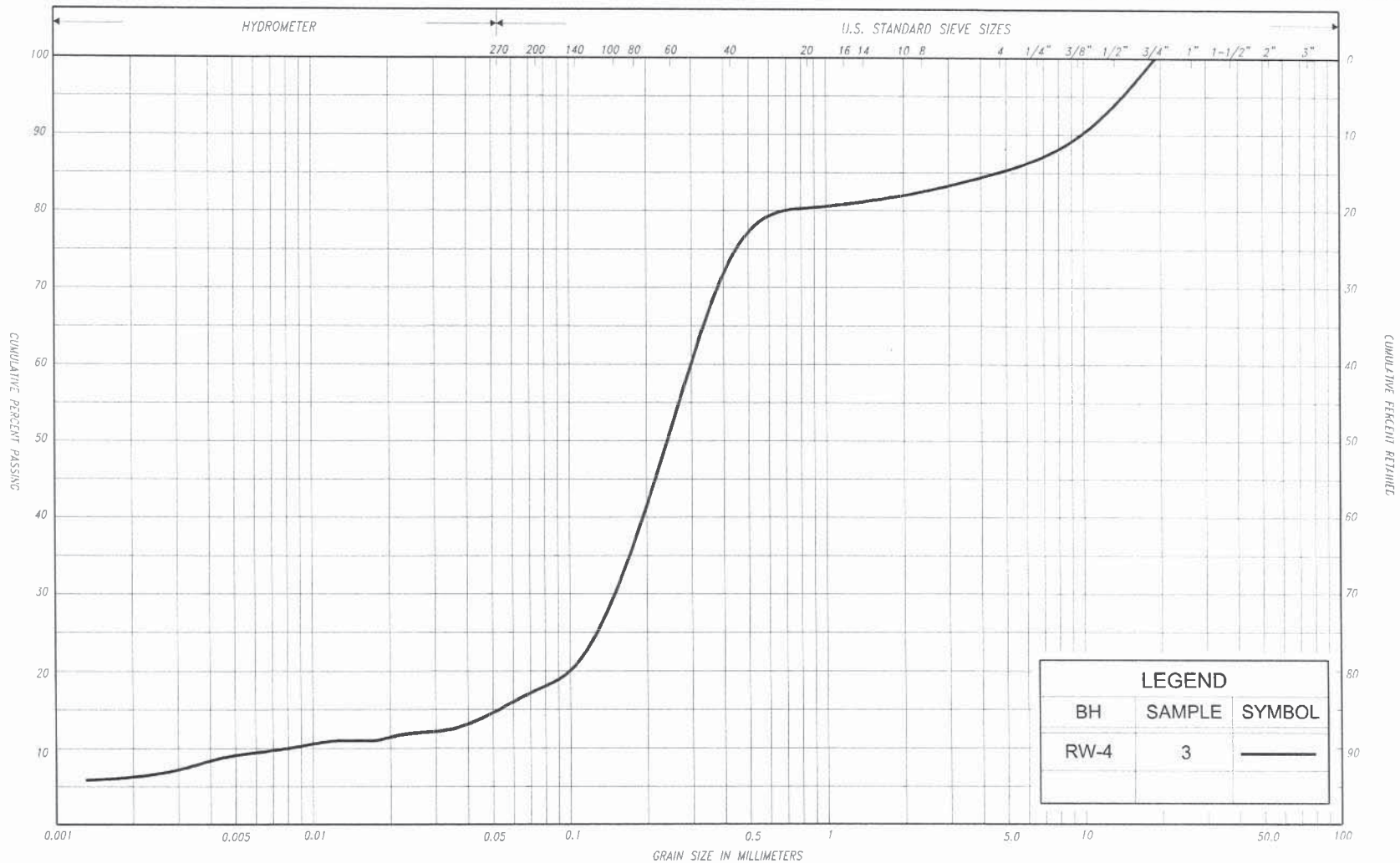
GRAIN SIZE DISTRIBUTION

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

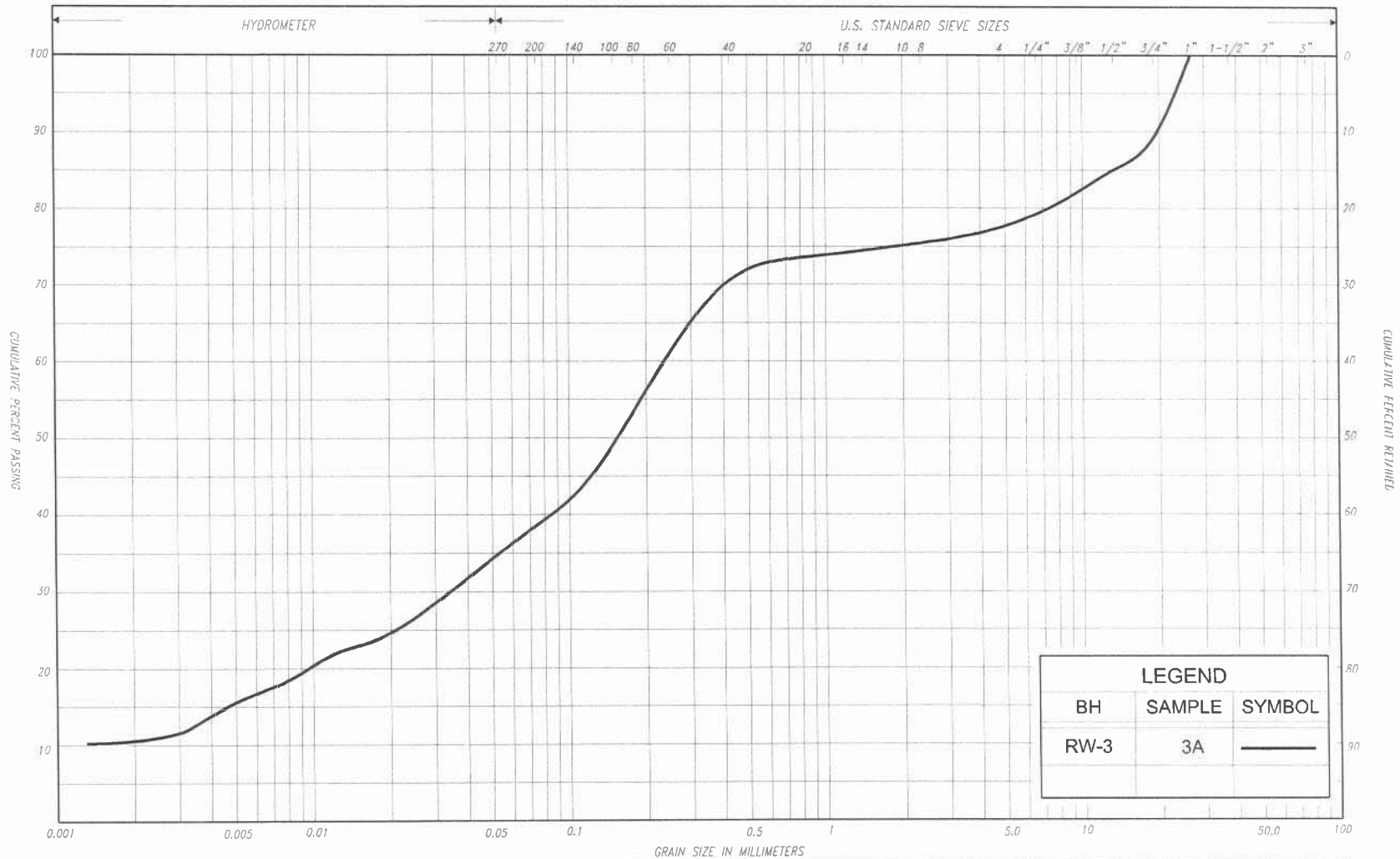
GRAIN SIZE DISTRIBUTION
 SAND, some silt, some gravel, trace clay
 (FILL)

FIG No. RW-GS-3

HWY: 7 / 85

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





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

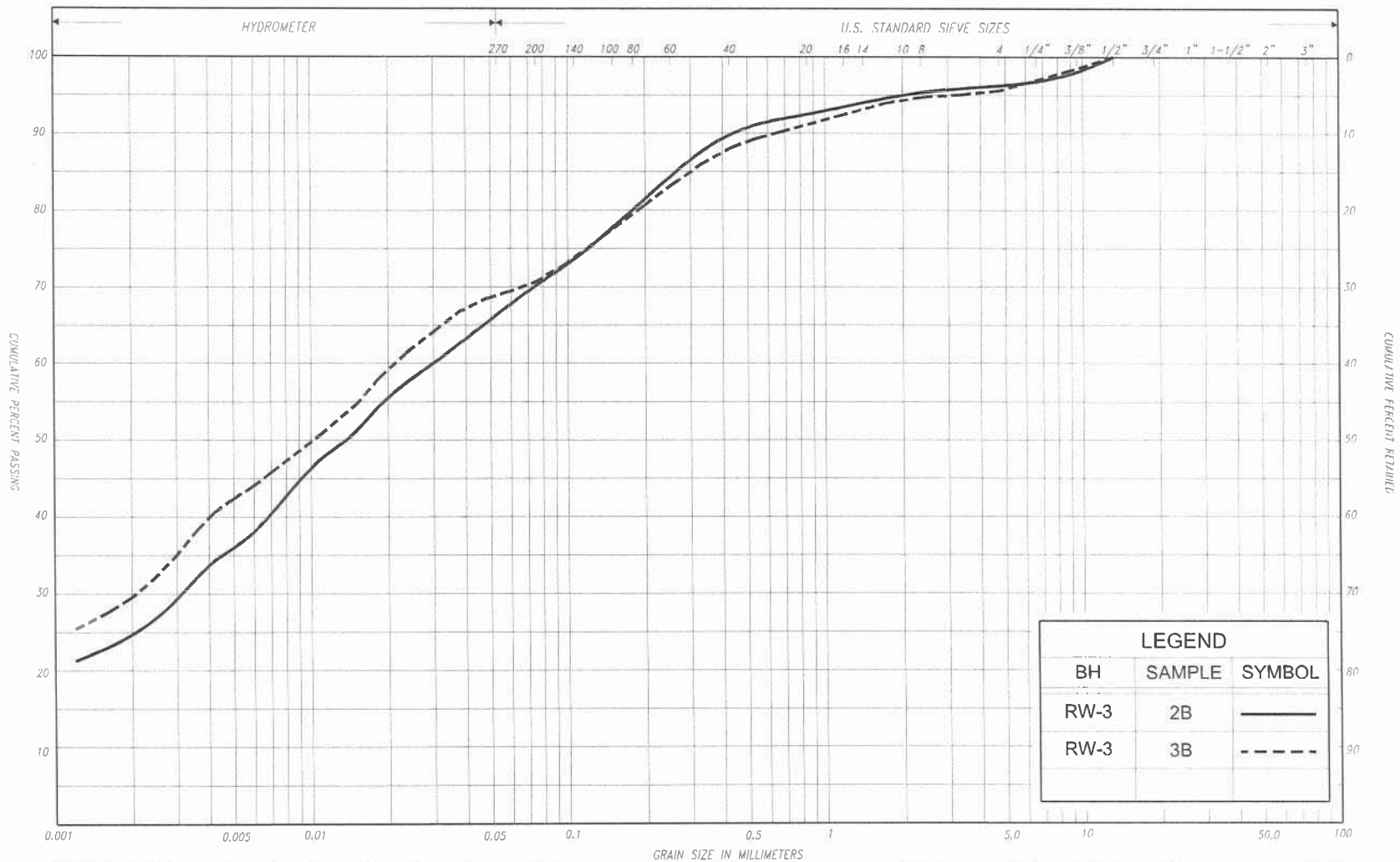


GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, with silt, some clay
(FILL)

FIG No. RW-GS-4

HWY: 7 / 85

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



SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL			COR BLES	UNIFIED	
				SAND										
CLAY	FINE		MEDIUM	COARSE	FINE	MEDIUM		COARSE		GRAVEL		CORBLES		
				SILT				SAND						
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL						
				SAND										

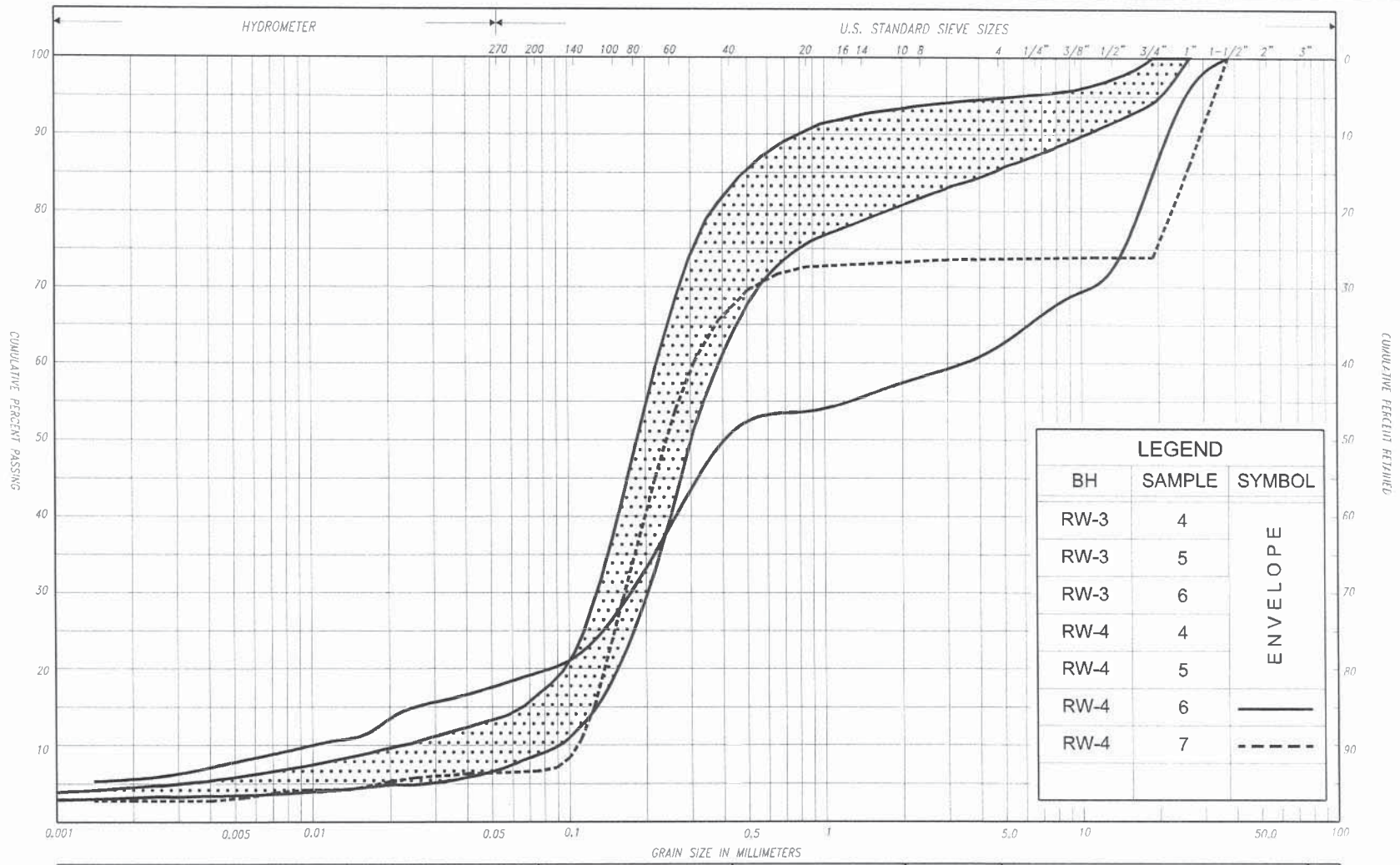
GRAIN SIZE DISTRIBUTION CLAYEY SILT, with sand, trace gravel (CI) (FILL)

FIG No. RW-GS-5

HWY: 7 / 85

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





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

GRAIN SIZE DISTRIBUTION

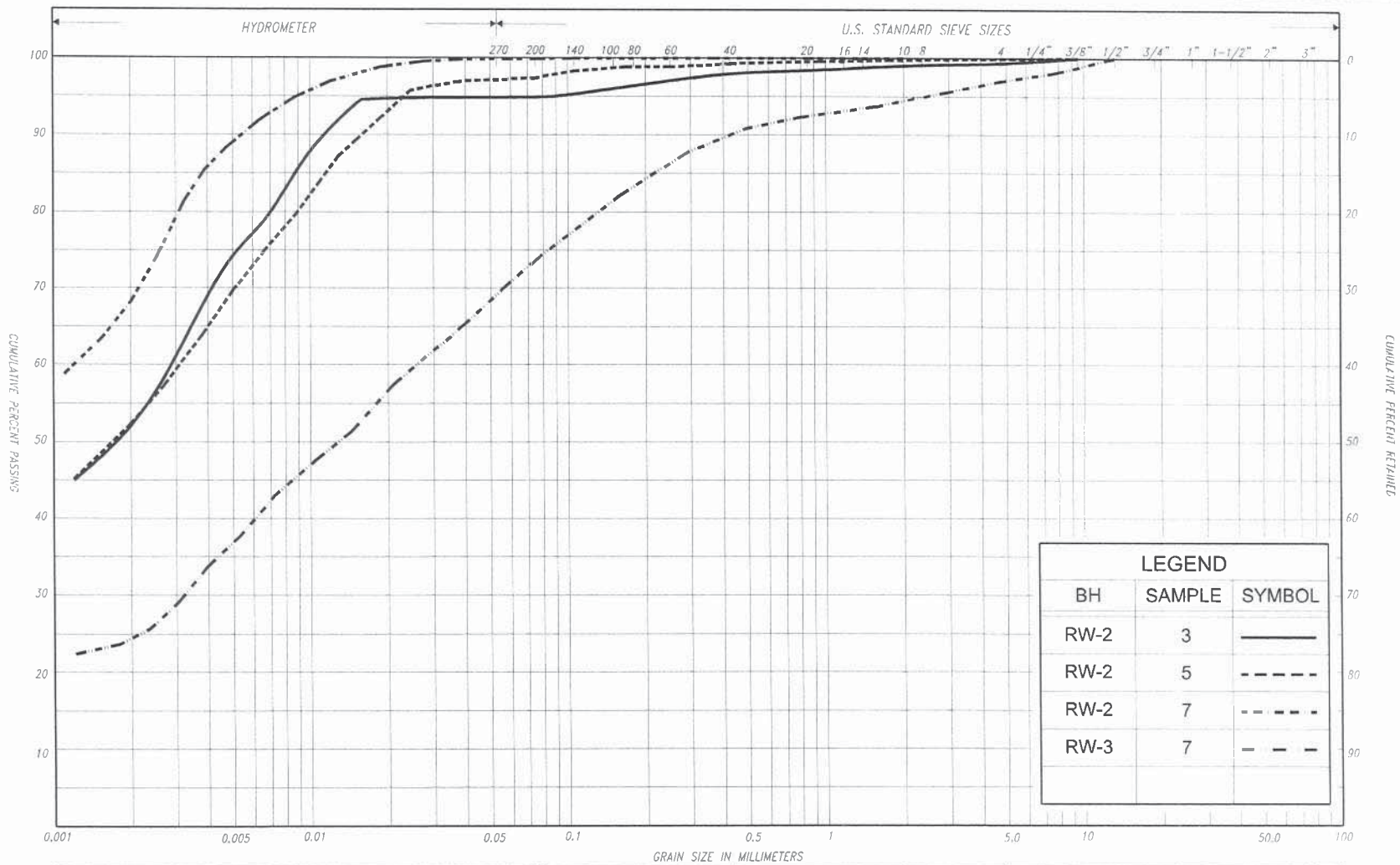
SAND, trace gravel to gravelly, trace to some silt, trace clay

FIG No. RW-GS-6

HWY: 7 / 85

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





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

GRAIN SIZE DISTRIBUTION

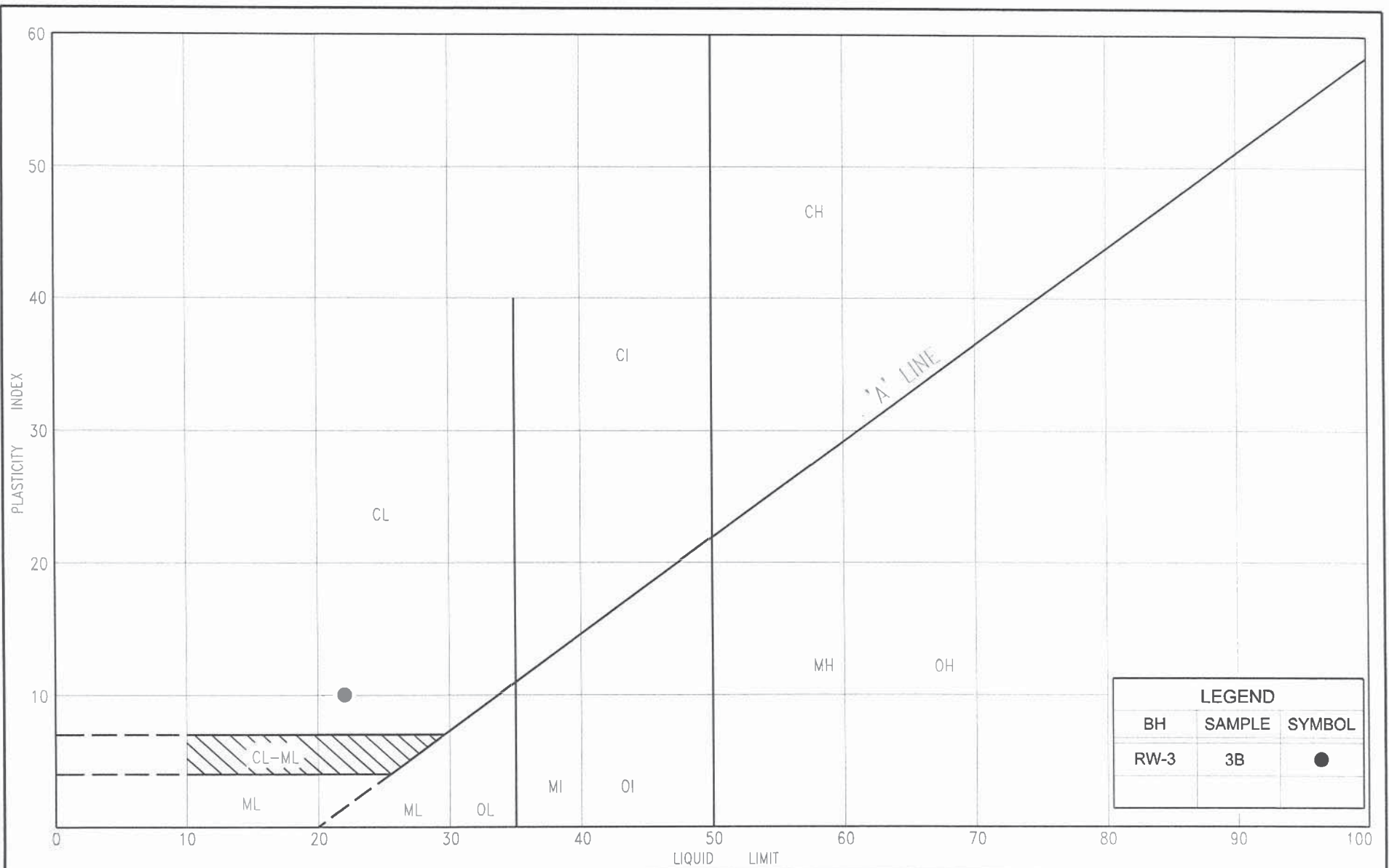
SILTY CLAY, trace to with sand, trace gravel (CI)

FIG No. RW-GS-7

HWY: 7 / 85

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





PLASTICITY CHART

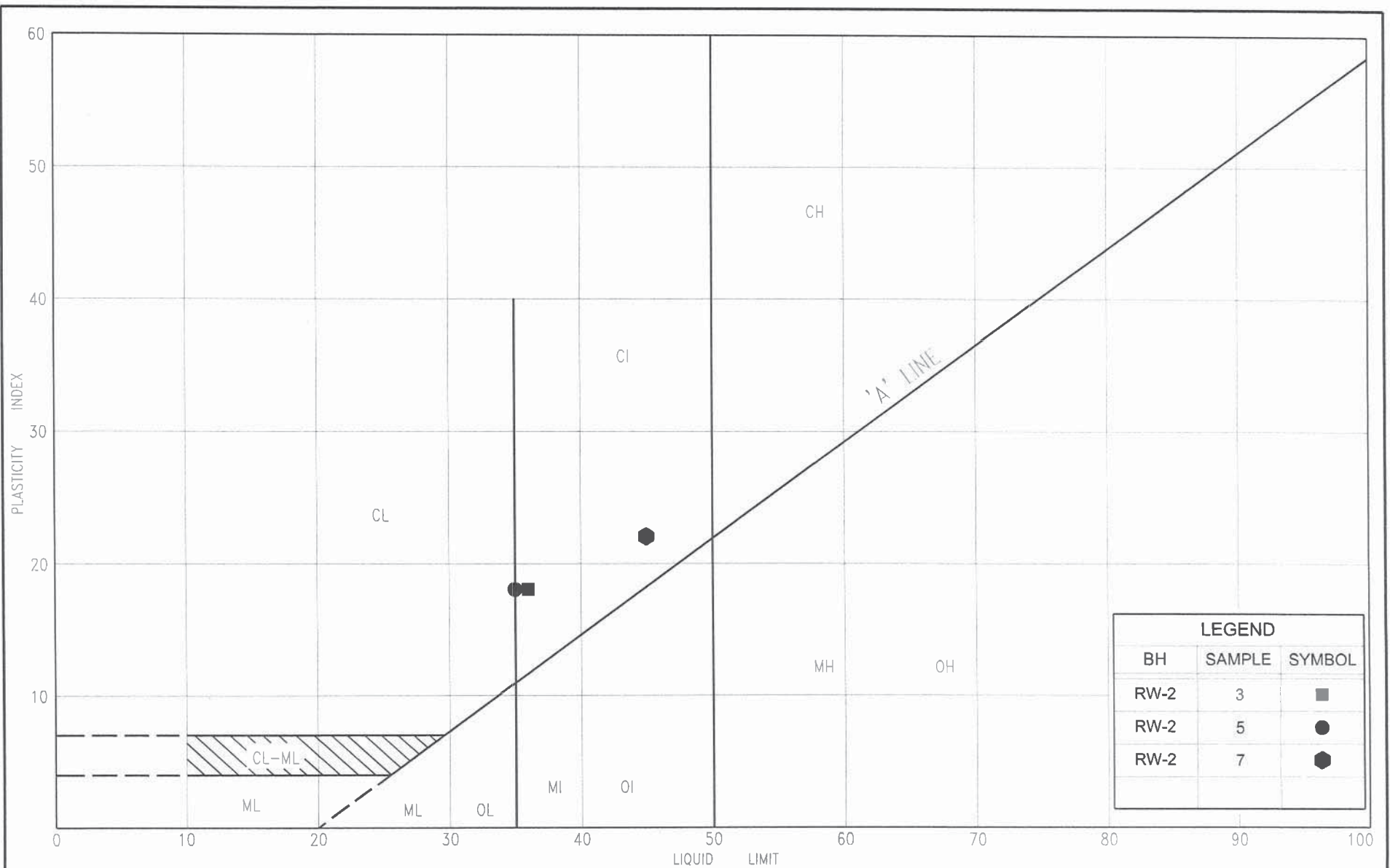
CLAYEY SILT, with sand, trace gravel (CL)
(FILL)

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)

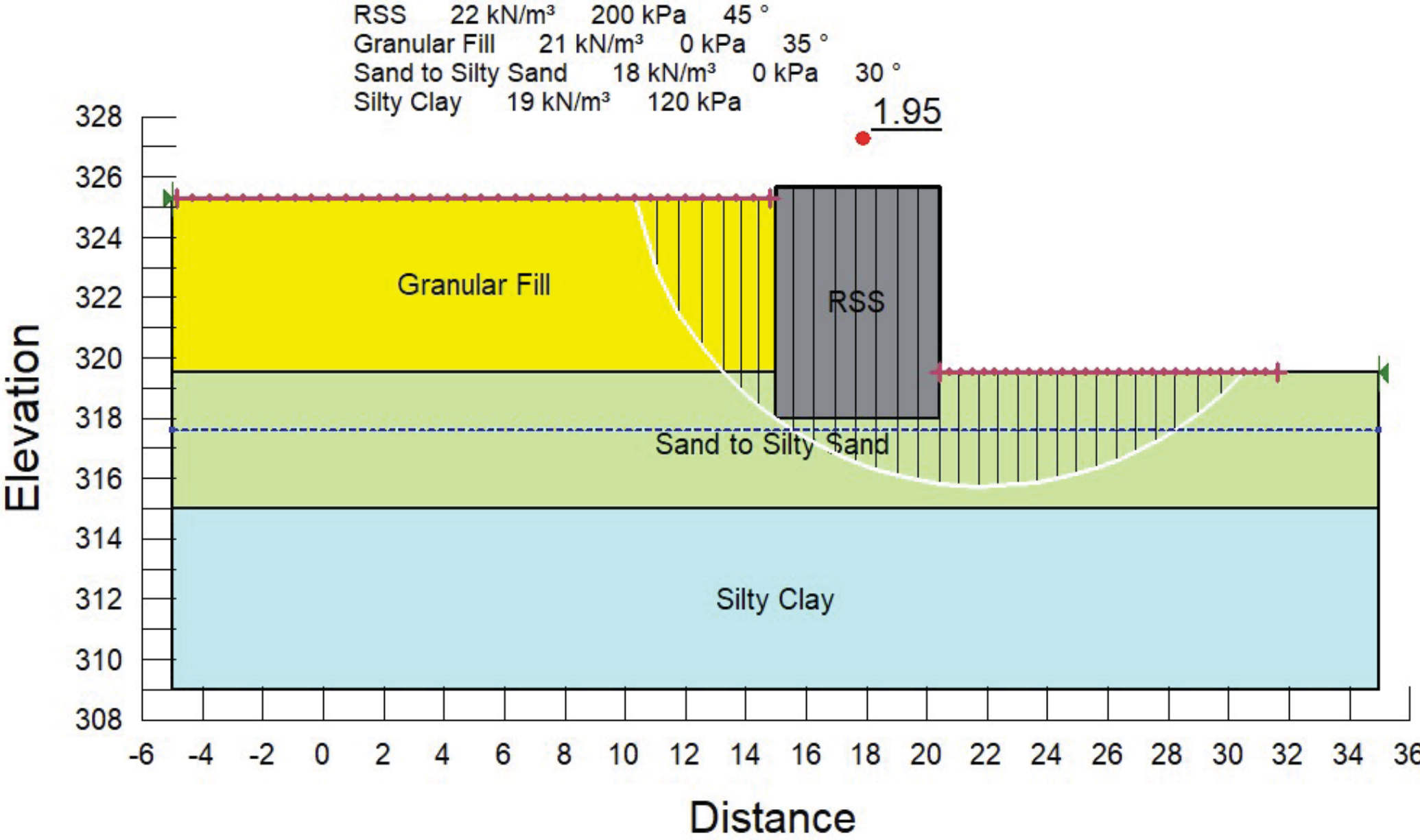
FIG No. RW-PC-2

HWY: 7 / 85

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

File Name: RW2 Sta 21+325.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure B6



File Name: RW2 Sta 21+325.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure B7

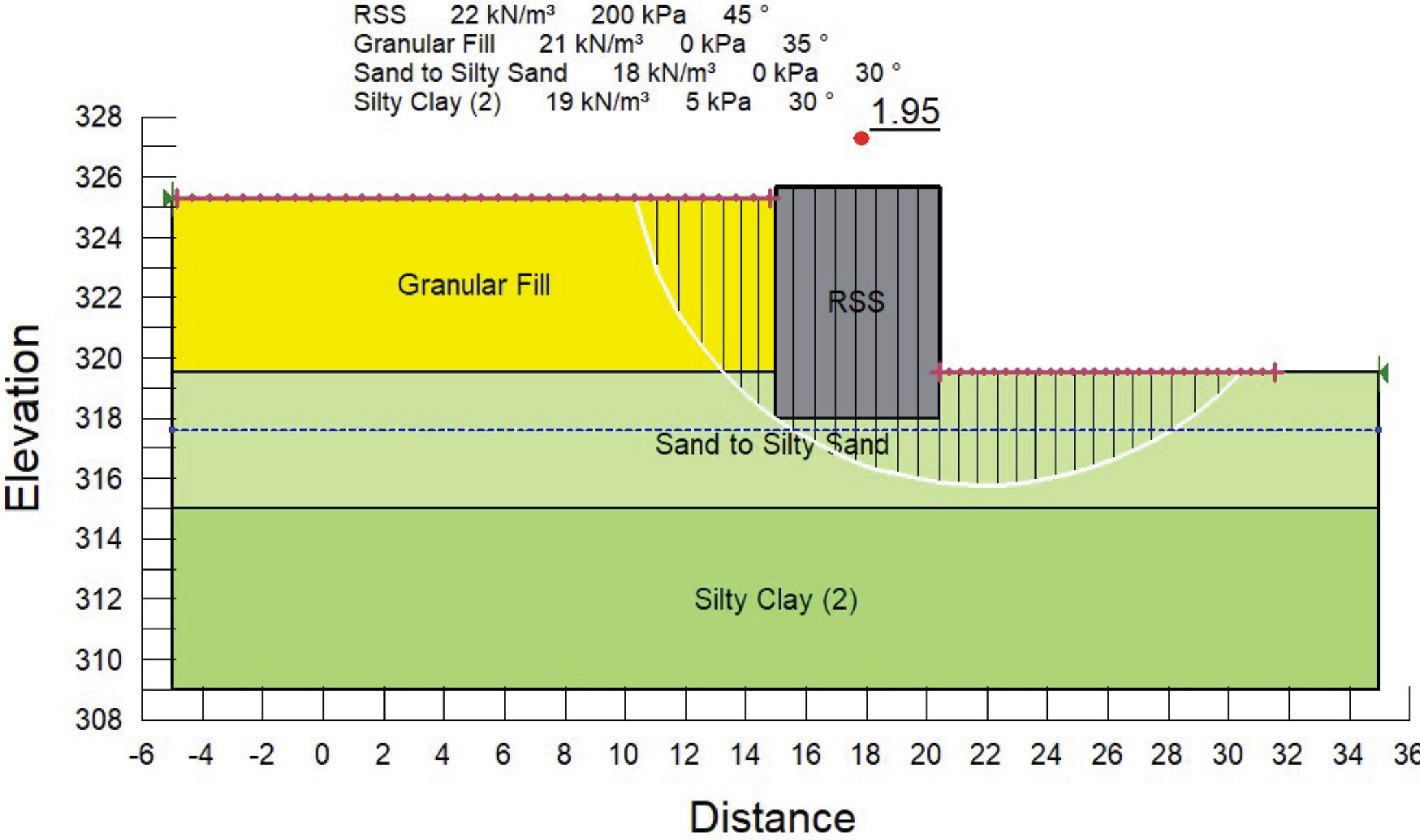


Figure B8

File Name: RW2 Sta 21+325.gsz

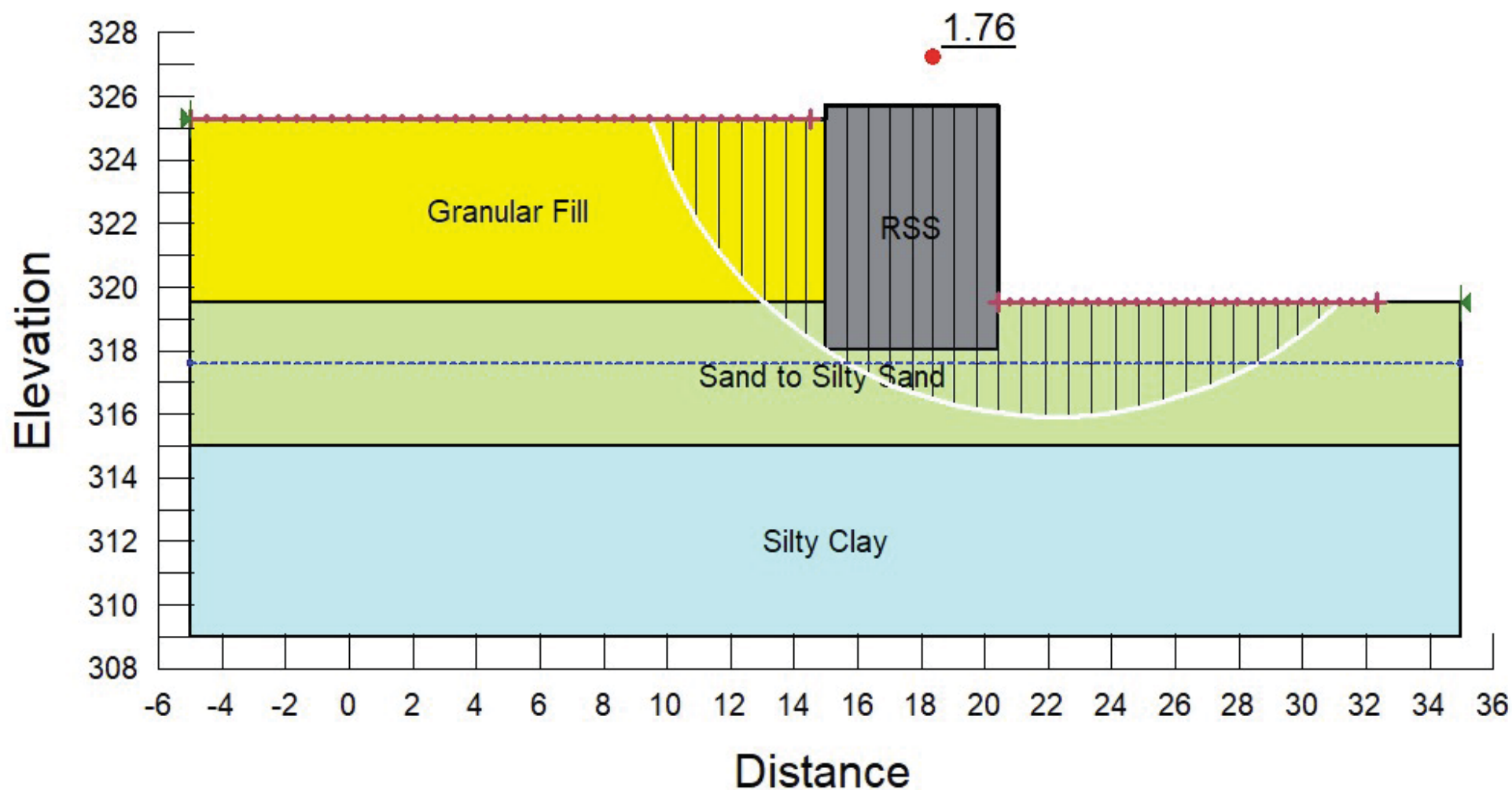
Last Edited By: Nancy Berg

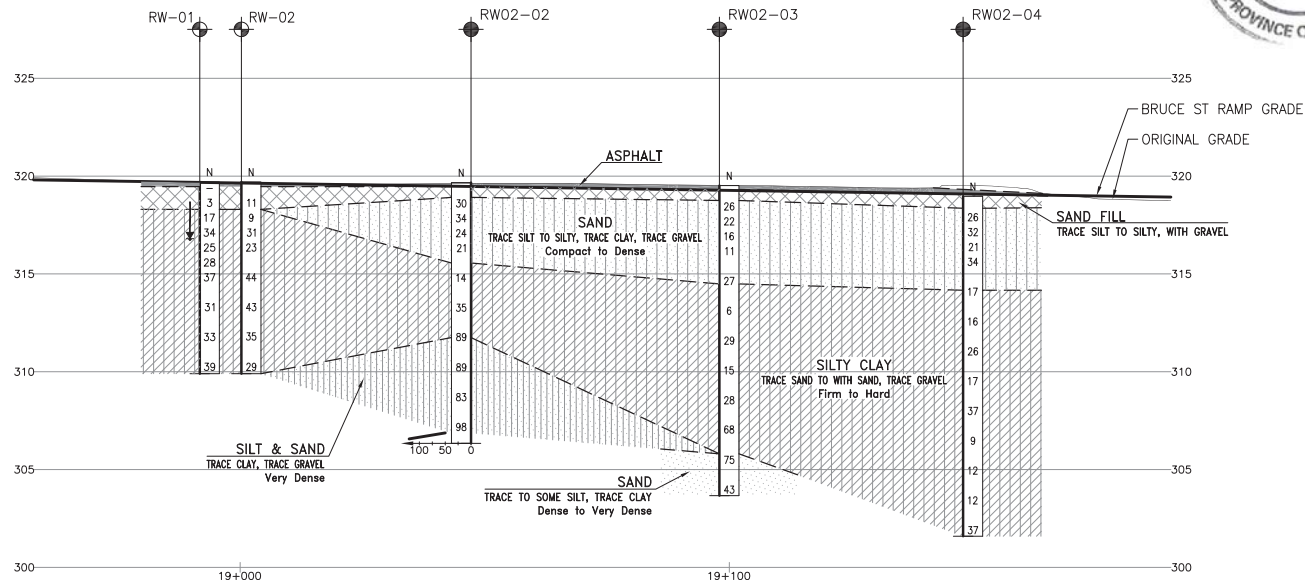
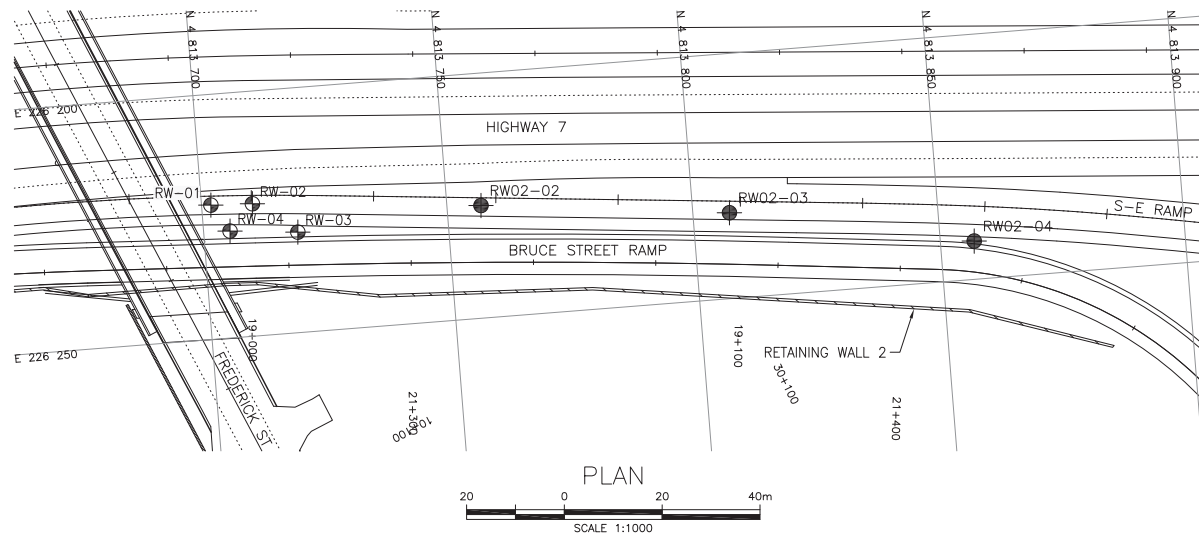
Date: 2020-01-03

Method: Morgenstern-Price

Minimum Slip Surface Depth: 1 m

Horz Seismic Coef.: 0.0485

RSS 22 kN/m³ 200 kPa 45 °Granular Fill 21 kN/m³ 0 kPa 35 °Sand to Silty Sand 18 kN/m³ 0 kPa 30 °Silty Clay 19 kN/m³ 120 kPa

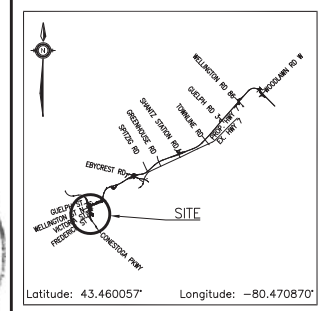


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
GWP No 408-88-00

HIGHWAY 7
FREDERICK ST.-N/E-ANN ST.
RETAINING WALL 2
BOREHOLE LOCATIONS AND SOIL STRATA



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

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.

GEOCRIS No. 40P9-58

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	NB	CHK	PKC
DRAWN	MFA	CHK	NB
DATE	MAY	2020	
DESCRIPTION	LOAD	DATE	MAY
STRUCT	LOAD	DATE	MAY
LOADS	1		



Appendix C

Record of Borehole Sheets, Laboratory Test Results, Borehole Locations, Soil Strata Drawing and Slope Stability Output

Retaining Wall 10 (RW09-02, RW10-02 to RW10-06)

RECORD OF BOREHOLE No RW09-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 9, MTM NAD 83 Zone 10: N 4 814 582.8 E 226 319.4 ORIGINATED BY GA
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.04.11 - 2018.04.11 LATITUDE 43.467045 LONGITUDE -80.469941 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)														
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _p w w _L														
322.8	GROUND SURFACE							20	40	60	80	100						GR	SA	SI	CL						
0.0	SAND , some silt, trace clay, trace gravel Loose to Compact Brown Moist		1	SS	8		322							○				2	79	14	5						
																○											
			2	SS	11			321								○											
			3	SS	6				320													○					
320.4	Silty CLAY , trace sand, trace gravel Very Stiff to Hard Brown Wet		4	SS	20	319									○												
			5	SS	33		318									○											
318.7	SAND and SILT , trace to some clay Very Dense Grey Wet		6	SS	109	317									○												

Continued Next Page

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

METRIC





[illegible]

RECORD OF BOREHOLE No RW10-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 10, MTM NAD 83 Zone 10: N 4 814 587.1 E 226 370.2 ORIGINATED BY MB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2018.04.19 - 2018.04.19 LATITUDE 43.467088 LONGITUDE -80.469313 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L								
329.1	GROUND SURFACE						20	40	60	80	100					GR	SA	SI	CL	
0.0	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	16															
328.4																				
0.6																				
	Silty SAND , trace to some clay Very Loose to Compact Brown Moist (FILL)		2	SS	3															
			3	SS	5														0 64 25 11	
			4	SS	20															
			5	SS	13															
325.3																				
3.7	SAND , trace gravel, trace silt and clay Compact to Dense Brown Moist		6	SS	27															
			7	SS	29														4 89 7 (SI+CL)	
			8	SS	32															
321.9																				
7.1	Silty CLAY , with sand Very Stiff to Hard Brown Moist																			
			9	SS	29															

Continued Next Page

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

METRIC

[illegible]

RECORD OF BOREHOLE No RW10-03

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 10, MTM NAD 83 Zone 10: N 4 814 591.8 E 226 418.6 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.04.18 - 2018.04.18 LATITUDE 43.467136 LONGITUDE -80.468717 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					
328.4	GROUND SURFACE												
0.0	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	11								13 64 17 6
327.8													
0.5	SAND , trace silt and clay, trace gravel Loose to Compact Brown Moist (FILL)		2	SS	6								
			3	SS	8								
			4	SS	13								
			5	SS	11								
324.6													
3.7	SAND , trace silt, trace gravel Compact Brown Moist		6	SS	25								1 89 10 (SI+CL)
			7	SS	28								
			8	SS	28								
321.4													
7.0	Silty CLAY , trace to some sand Hard Brown Wet to Moist												
			9	SS	30								
			10	SS	73								0 10 39 51
318.6													
9.8	END OF BOREHOLE AT 9.8m.												

Continued Next Page

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

RECORD OF BOREHOLE No RW10-03

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 10, MTM NAD 83 Zone 10: N 4 814 591.8 E 226 418.6 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.04.18 - 2018.04.18 LATITUDE 43.467136 LONGITUDE -80.468717 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	WATER CONTENT (%)																				
	Continued From Previous Page WATER LEVEL AT 6.2m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH(m)</th> <th>ELEV.(m)</th> </tr> </thead> <tbody> <tr> <td>2018.04.27</td> <td>6.2</td> <td>322.2</td> </tr> <tr> <td>2018.05.16</td> <td>6.1</td> <td>322.3</td> </tr> <tr> <td>2018.05.31</td> <td>6.0</td> <td>322.4</td> </tr> <tr> <td>2018.06.25</td> <td>5.7</td> <td>322.6</td> </tr> </tbody> </table>	DATE	DEPTH(m)	ELEV.(m)	2018.04.27	6.2	322.2	2018.05.16	6.1	322.3	2018.05.31	6.0	322.4	2018.06.25	5.7	322.6													
DATE	DEPTH(m)	ELEV.(m)																											
2018.04.27	6.2	322.2																											
2018.05.16	6.1	322.3																											
2018.05.31	6.0	322.4																											
2018.06.25	5.7	322.6																											

RECORD OF BOREHOLE No RW10-04

1 OF 2

METRIC


GWP# 408-88-00 LOCATION Retaining Wall 10, MTM NAD 83 Zone 10: N 4 814 601.3 E 226 470.5 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.04.18 - 2018.04.18 LATITUDE 43.467227 LONGITUDE -80.468076 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															
326.8	GROUND SURFACE							20	40	60	80	100											
0.0 326.6	TOPSOIL (200mm)							20	40	60	80	100											
0.3	SAND, trace to some silt, trace clay Very Loose to Loose Brown Moist (FILL)		1	SS	4		326																
			2	SS	2																		
323.9			3	SS	2				325														
			4	SS	5																		
3.0	SAND, trace silt, trace gravel Compact to Dense Brown Moist		5	SS	15						324												
			6	SS	31																		
322.1			7	SS	30		322																
			8	SS	17																		
4.7	Silty CLAY, trace sand Very Stiff Brown Moist		9	SS	48				321														
			10	SS	72																		
317.3	Hard										320												
9.5	END OF BOREHOLE AT 9.5m. BOREHOLE OPEN TO 5.3m AND WATER LEVEL AT 4.9m UPON						319																
									318														
																							
																							
																							
																							
																							

Continued Next Page

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

METRIC

ELEV DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			 <p>20 40 60 80 100</p>			
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			GR SA SI CL

[illegible]

RECORD OF BOREHOLE No RW10-05

1 OF 1

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 814 614.5 E 226 513.4 ORIGINATED BY JB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2016.10.26 - 2016.10.26 LATITUDE 43.467350 LONGITUDE -80.467548 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					
324.7	GROUND SURFACE							20 40 60 80 100					
0.0	TOPSOIL (400mm)		1	SS	8			20 40 60 80 100					
324.3								20 40 60 80 100					
0.4	SAND, some silt to silty Compact to Loose Brown Moist		2	SS	23		324	20 40 60 80 100					
								20 40 60 80 100					
	Clayey silt layer at 1.10m (400mm)		3	SS	9		323	20 40 60 80 100					
322.5								20 40 60 80 100					
2.2	Silty CLAY Very Stiff Grey Moist		4	SS	27		322	20 40 60 80 100					
								20 40 60 80 100					
			5	SS	25		321	20 40 60 80 100					
								20 40 60 80 100					
							320	20 40 60 80 100					
			6	SS	18			20 40 60 80 100					
								20 40 60 80 100					
319.1							319	20 40 60 80 100					
5.6	SAND and SILT, trace to some clay Dense to Very Dense Grey Wet		7	SS	41			20 40 60 80 100					
							318	20 40 60 80 100					
								20 40 60 80 100					
			8	SS	61		317	20 40 60 80 100					
316.6								20 40 60 80 100					
8.1	END OF BOREHOLE AT 8.1m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE AND AUGER CUTTINGS TO SURFACE.							20 40 60 80 100					

0 49 41 10

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/16/19

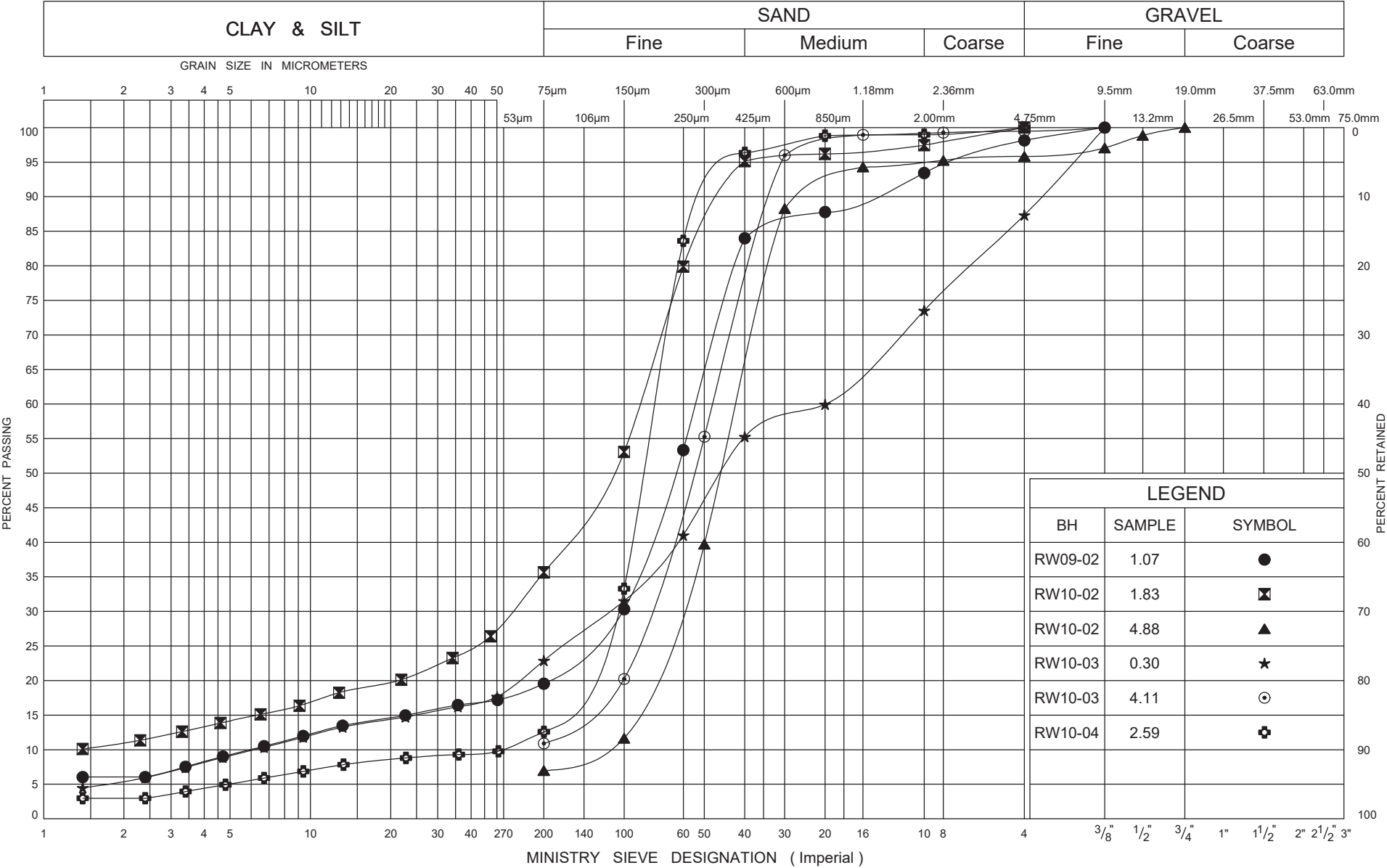
RECORD OF BOREHOLE No RW10-06

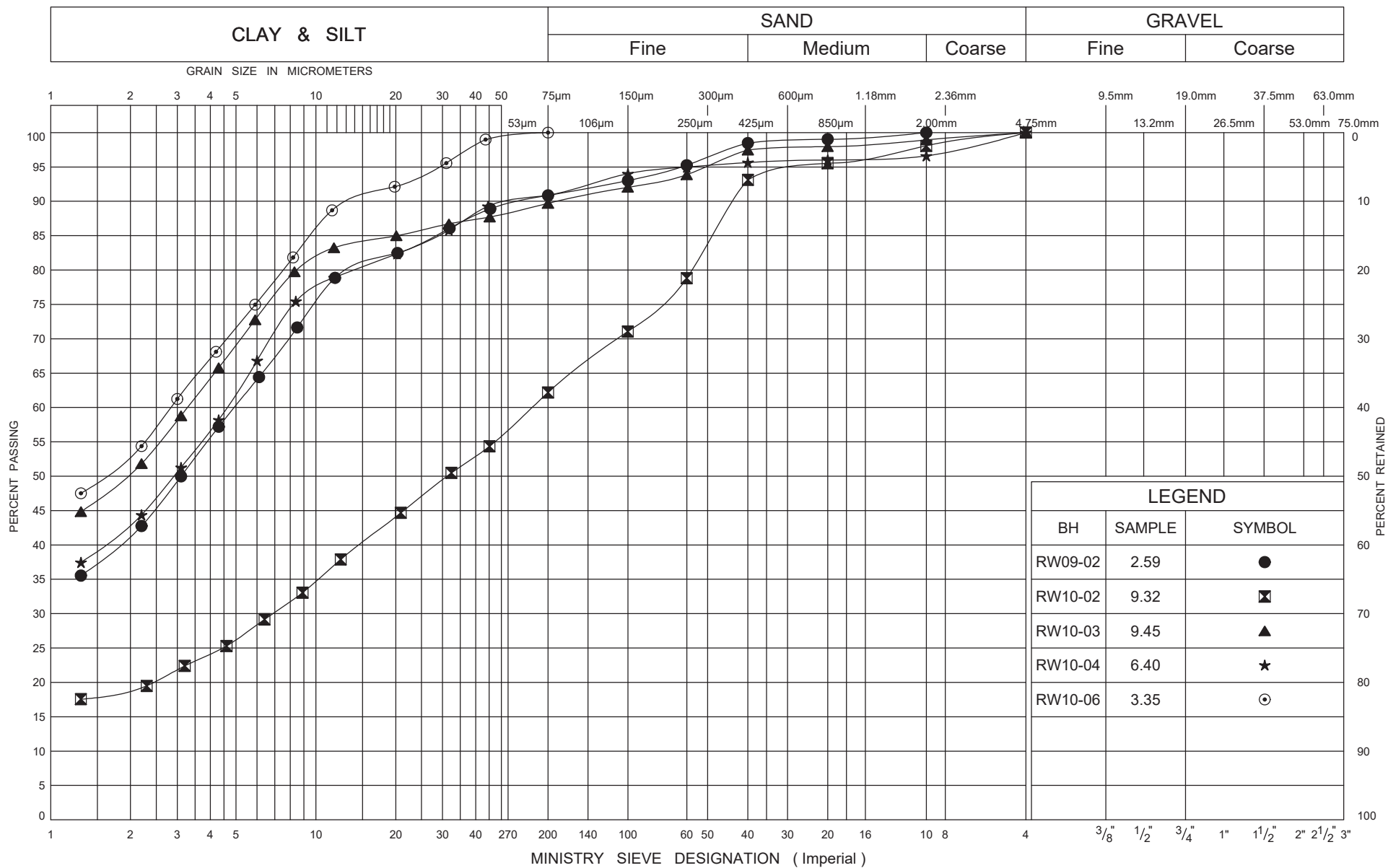
2 OF 2

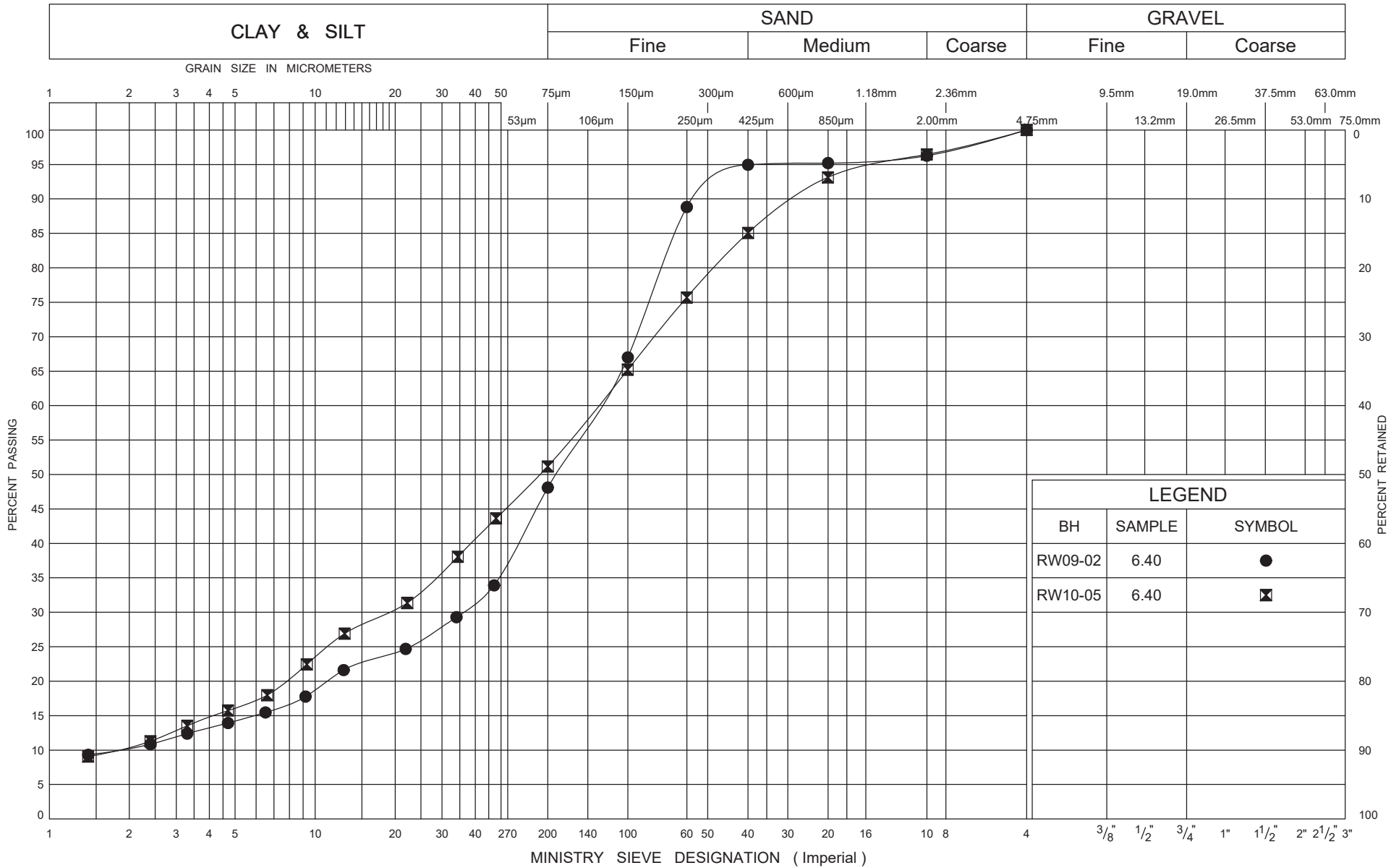
METRIC

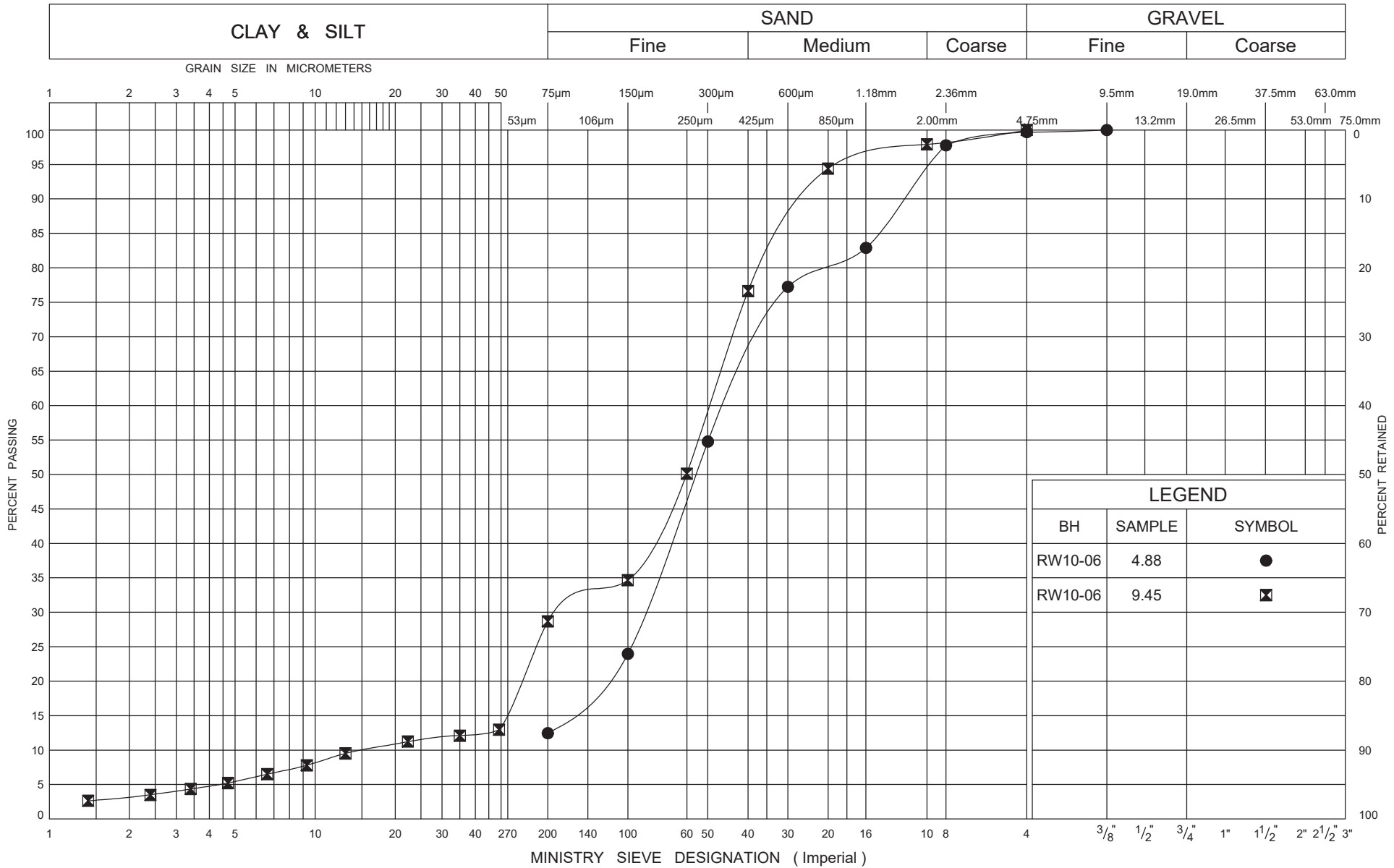
GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 814 638.7 E 226 573.6 ORIGINATED BY JB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
DATUM Geodetic DATE 2016.10.24 - 2016.10.25 LATITUDE 43.467574 LONGITUDE -80.466808 CHECKED BY NB

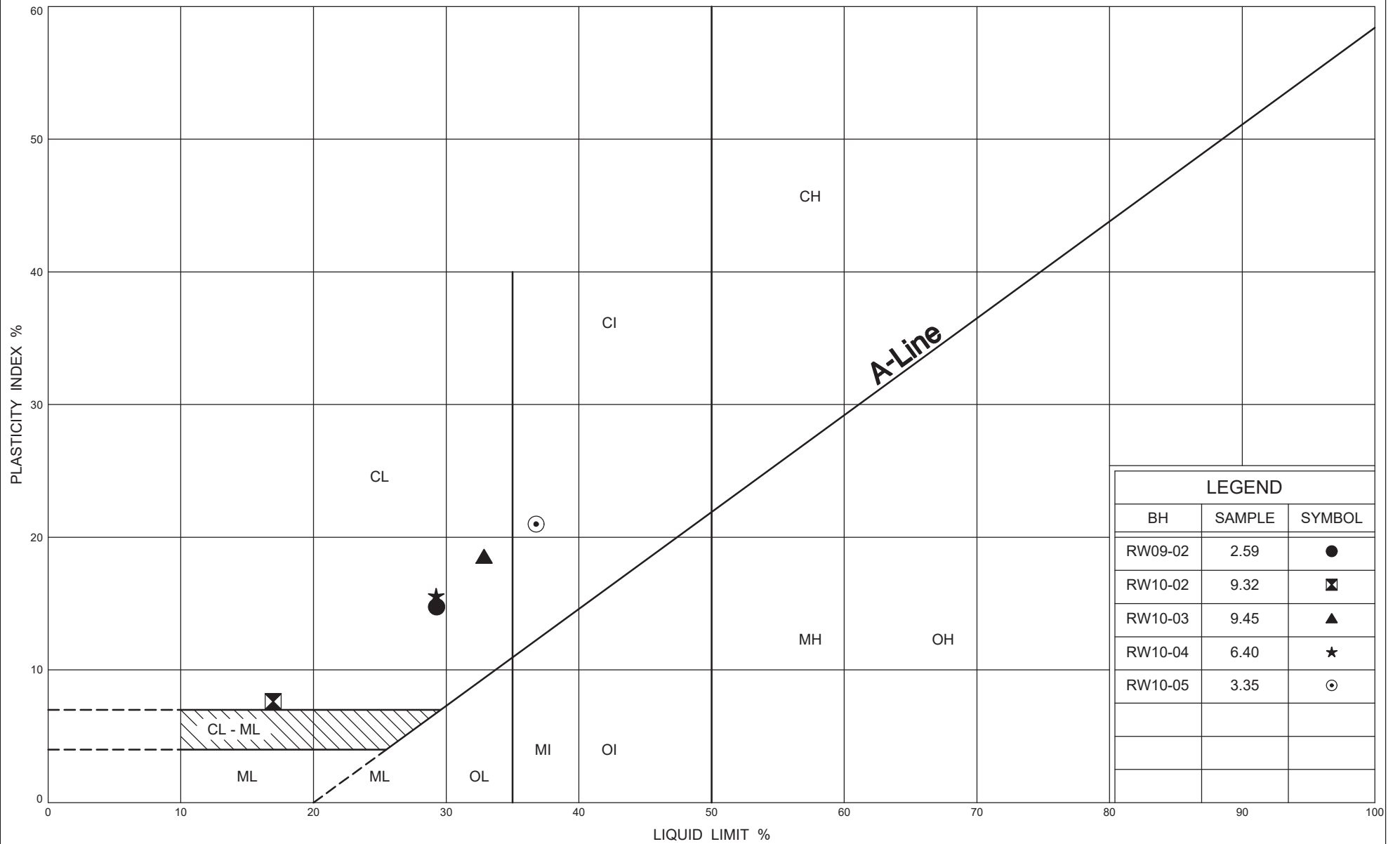
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
				○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE															
	Continued From Previous Page							20	40	60	80	100	w _p	w	w _L				
			10	SS	72		308							○					
	Loose		11	SS	9		307												
	DCPT from 12.9m to 13.5m						306							○					
305.1																			
13.5	END OF BOREHOLE AT 13.5m UPON DCPT REFUSAL. WATER LEVEL AT 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE AND AUGER CUTTINGS TO SURFACE.																		











File Name: RW10 Sta 19+830.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure C6

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	32 °
Silty Clay	20 kN/m ³	120 kPa	
Sand and Silt	18 kN/m ³	0 kPa	38 °
Sand	18 kN/m ³	0 kPa	28 °

2.60

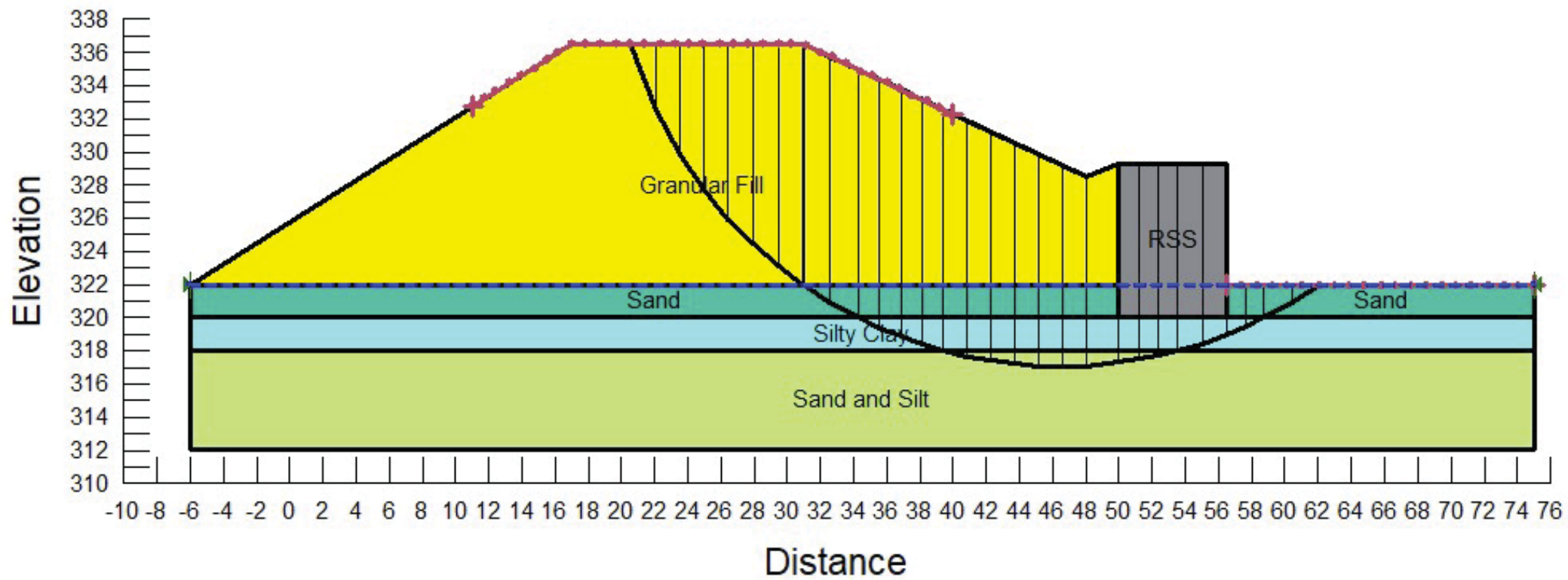


Figure C7

File Name: RW10 Sta 19+830.gsz

Last Edited By: Nancy Berg

Date: 2020-01-03

Method: Morgenstern-Price

Minimum Slip Surface Depth: 1 m

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	32 °
Sand and Silt	18 kN/m ³	0 kPa	38 °
Silty Clay (2)	20 kN/m ³	5 kPa	30 °
Sand	18 kN/m ³	0 kPa	28 °

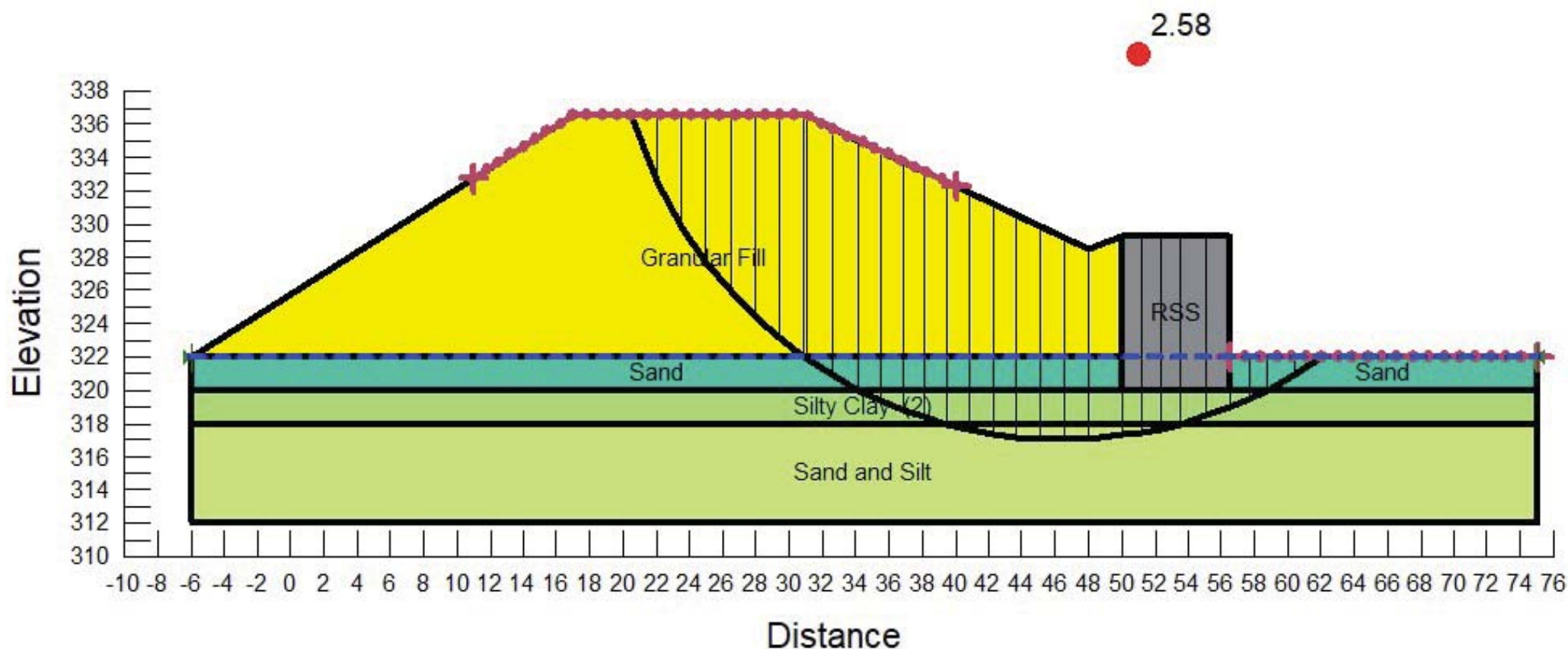
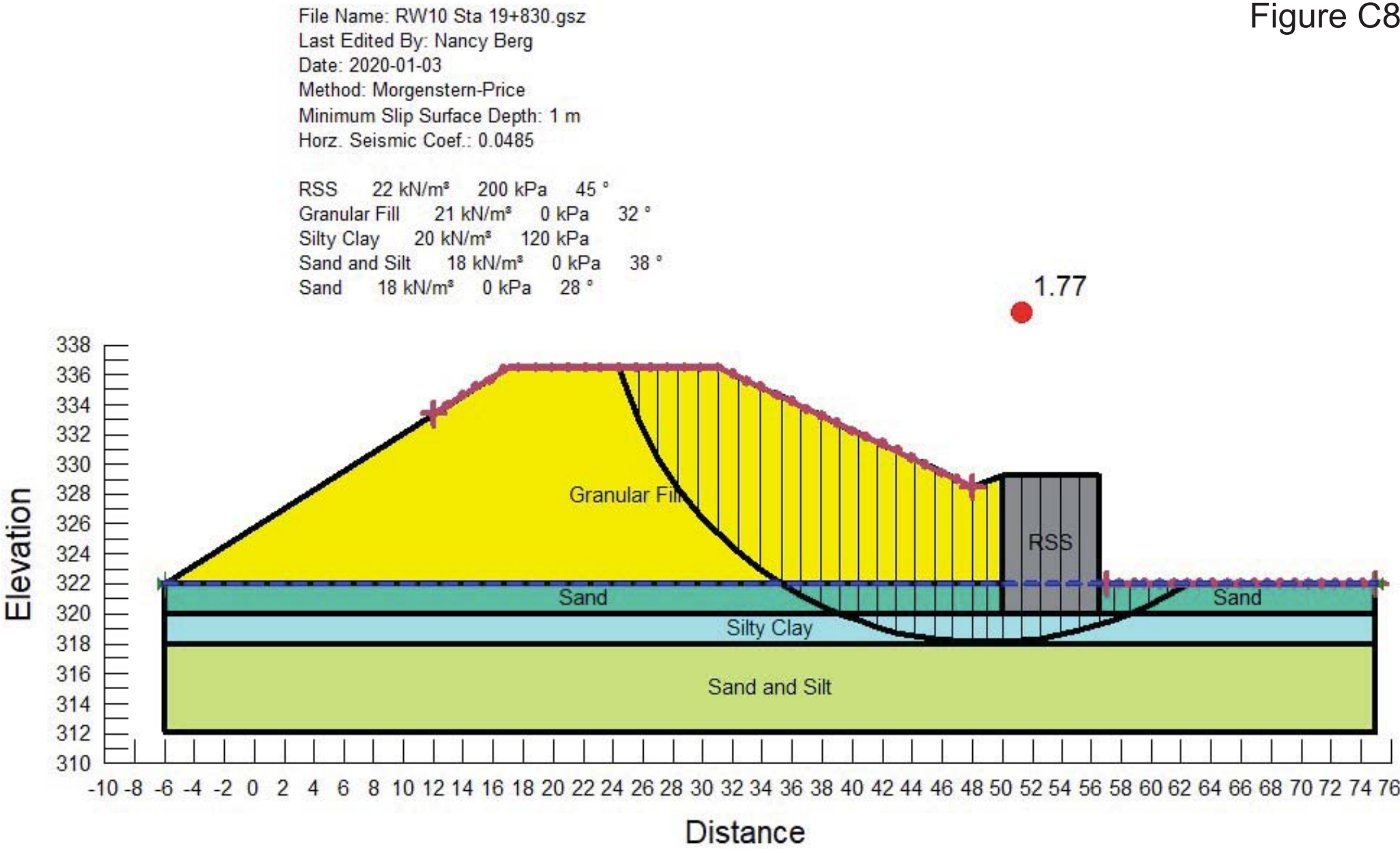
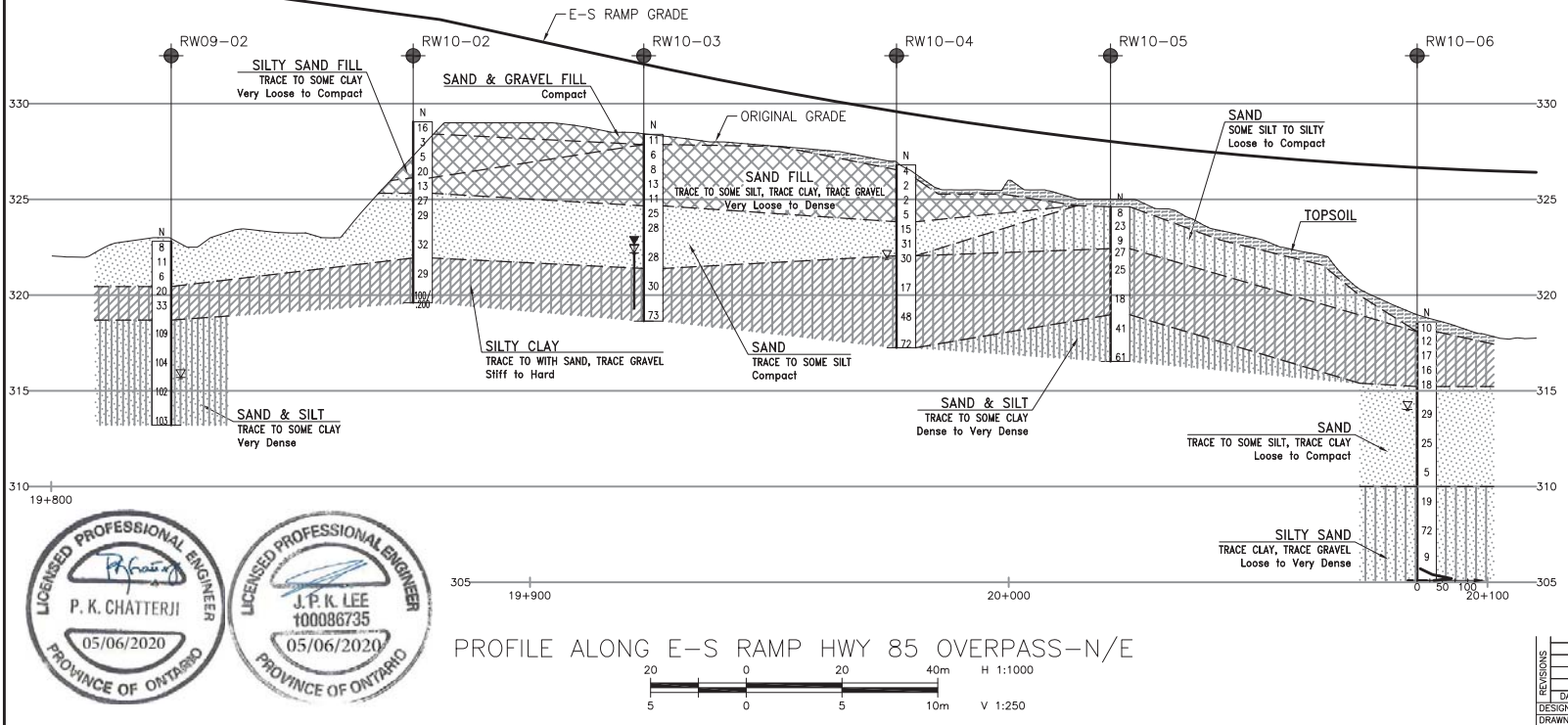
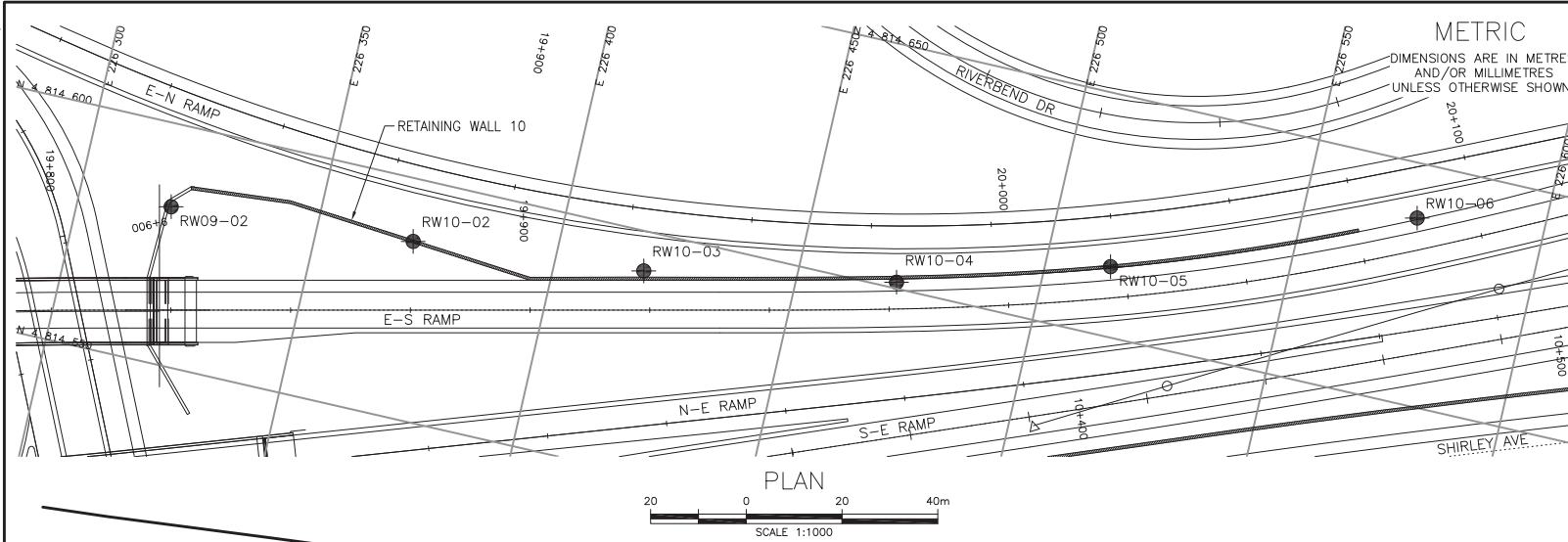
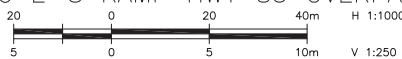


Figure C8



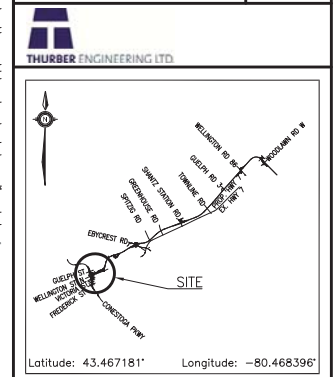







PROFILE ALONG E-S RAMP HWY 85 OVERPASS-N/E



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

CONT No GWP No 408-88-00	SHEET
HIGHWAY 7 E-S RAMP HWY 85 OVERPASS-N/E RETAINING WALL 10 BOREHOLE LOCATIONS AND SOIL STRATA	
wsp	



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
RW09-02	322.8	4 814 582.8	226 319.4
RW10-02	329.1	4 814 587.1	226 370.2
RW10-03	328.4	4 814 591.8	226 418.6
RW10-04	326.8	4 814 601.3	226 470.5
RW10-05	324.7	4 814 614.5	226 513.4
RW10-06	318.6	4 814 638.7	226 573.6

- 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. 40P9-58			
DATE	BY	DESCRIPTION	
DESIGN	NB	CHK PKC	CODE
DRAWN	MFA	CHK NB	SITE
			STRUCT
			DWS 1



Appendix D

Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing and Slope Stability Output





Retaining Wall 12 (RW12-01 to RW12-06)

RECORD OF BOREHOLE No RW12-01

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 519.7 E 226 387.0 ORIGINATED BY MB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2018.05.04 - 2018.05.04 LATITUDE 43.466492 LONGITUDE -80.469093 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _p w w _L					
324.6	GROUND SURFACE							20	40	60	80	100					
0.0	SAND , some gravel, trace silt and clay, occasional organics Compact Brown Moist (FILL)		1	SS	12		324							○			
			2	SS	20									○			
			3	SS	15		323							○			
322.3																	
2.2	SAND , trace silt, trace clay, trace gravel Compact to Loose Brown Moist		4	SS	19		322							○			
			5	SS	4		321							○			
320.4																	
4.1	Silty CLAY , some sand, trace gravel Very Stiff Brown Moist (TILL)		6	SS	21		320							○			
							319										
			7	SS	19		318							○			7 19 39 35
			8	SS	19		317							○			
315.9							316										
8.7	SAND , trace gravel, trace silt, trace clay Dense to Very Dense Brown Moist		9	SS	38		315							○			
314.6																	

Continued Next Page



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

RECORD OF BOREHOLE No RW12-01

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 519.7 E 226 387.0 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.05.04 - 2018.05.04 LATITUDE 43.466492 LONGITUDE -80.469093 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _P w w _L WATER CONTENT (%)		
	Continued From Previous Page							20 40 60 80 100							
10.0	SAND , trace gravel, trace silt, trace clay Very Dense Brown Moist						314								
			10	SS	74										1 84 8 7
312.2							313								
12.3	Silty CLAY Hard Brown Moist		11	SS	100		312								
			12	SS	64										0 0 43 57
							310								
			13	SS	52		309								
308.7															
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m, THEN AUGER CUTTINGS TO SURFACE.														

ONTMT452 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 RW12-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 541.0 E 226 436.3 ORIGINATED BY JP
 DIST HWY 7 BOREHOLE TYPE Casing Advance COMPILED BY MP
 DATUM Geodetic DATE 2018.05.07 - 2018.05.07 LATITUDE 43.466678 LONGITUDE -80.468481 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
								20 40 60 80 100				w _P w w _L						
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
325.1	GROUND SURFACE																	
0.0	SAND , trace silt and clay, trace gravel Compact Brown Moist (FILL)		1	SS	18													
			2	SS	18													
			3	SS	15													
			4	SS	18													
322.1																		
3.0	SAND , trace silt, trace gravel Compact Brown Wet		5	SS	14													
321.0																		
4.1	Silty CLAY , some sand to sandy, trace gravel Hard Brown to Grey Moist (TILL)		6	SS	30													
			7	SS	34													
317.9																		
7.2	SAND , trace to some silt, trace clay Very Dense Grey to Brown Wet		8	SS	64													
			9	SS	72													
315.1																		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW12-02

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 541.0 E 226 436.3 ORIGINATED BY JP
DIST HWY 7 BOREHOLE TYPE Casing Advance COMPILED BY MP
DATUM Geodetic DATE 2018.05.07 - 2018.05.07 LATITUDE 43.466678 LONGITUDE -80.468481 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL	
	Continued From Previous Page							20	40	60	80	100								
10.0	SAND , trace to some silt, trace clay Very Dense Grey Wet		10	SS	80		315							○						
							314							○						
							313													
312.9																				
12.2	Silty CLAY , trace sand Hard Grey Moist		11	SS	90		312							○						
							311							○						
							310													
			12	SS	62															
			13	SS	31									○				0	7 35 58	
309.2																				
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																			

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No RW12-04

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 584.9 E 226 524.5 ORIGINATED BY MB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY MP
DATUM Geodetic DATE 2018.04.19 - 2018.04.19 LATITUDE 43.467045 LONGITUDE -80.467331 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						
325.1	GROUND SURFACE							20 40 60 80 100						
0.0	Silty SAND , trace gravel, trace clay, occasional organics Dense to Compact Brown Moist (FILL)		1	SS	38			○ UNCONFINED + FIELD VANE						
			2	SS	15			● QUICK TRIAXIAL × LAB VANE						0 64 28 8
323.7														
1.4	SAND , trace silt Compact Brown Moist		3	SS	16									
323.1														
2.0	Silty CLAY , trace to some sand Very Stiff Grey Moist		4	SS	23									
			5	SS	26									0 10 43 47
	layer of silty sand at 4.6m (100mm)		6	SS	28									
			7	SS	30									0 0 39 61
317.9														
7.2	SAND and SILT , trace clay Very Dense Brown Moist		8	SS	61									
	occasional cobbles													
			9	SS	100/ 0.250									0 40 53 7
315.1														

Continued Next Page

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

RECORD OF BOREHOLE No RW12-04

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 584.9 E 226 524.5 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY MP
 DATUM Geodetic DATE 2018.04.19 - 2018.04.19 LATITUDE 43.467045 LONGITUDE -80.467331 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L				GR	SA	SI	CL	
	Continued From Previous Page							20	40	60	80	100								
10.0	SAND and SILT , trace clay Very Dense Brown Moist						315													
			10	SS	69		314							○						
313.3																				
11.7	Silty CLAY Hard Brown Moist						313							○						
			11	SS	37		312													
			12	SS	51		311							○						
							310													
			13	SS	51									○						
309.2																				
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 14.0m AND WATER LEVEL AT 13.4m UPON COMPLETION. DCPT FROM GROUND SURFACE TO 3.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) Piezometer was destroyed																			

ONTMT452 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

RECORD OF BOREHOLE No RW12-05

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 607.0 E 226 600.3 ORIGINATED BY MB
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY MP
DATUM Geodetic DATE 2018.04.20 - 2018.04.20 LATITUDE 43.467165 LONGITUDE -80.466762 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						
323.4	GROUND SURFACE							20 40 60 80 100	20 40 60					
0.0	Silt SAND , to SAND and SILT , trace clay, trace gravel Compact Brown Moist to Wet (FILL)		1	SS	11		323							
			2	SS	13		322							
			3	SS	16		321							
321.3														
2.1	SAND Compact Grey Wet		4	SS	26		320							
320.5														
2.9	Silty CLAY , with sand, trace gravel Very Stiff Brown to Grey Moist		5	SS	24		319							
			6	SS	28		318							
							317							
			7	SS	23		316							
							315							
			8	SS	39		314							
314.7														
8.7	SAND , trace silt and clay, trace gravel Compact to Dense Brown Moist		9	SS	11									
313.4														

Continued Next Page

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

RECORD OF BOREHOLE No RW12-05

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 607.0 E 226 600.3 ORIGINATED BY MB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/DCPT COMPILED BY MP
 DATUM Geodetic DATE 2018.04.20 - 2018.04.20 LATITUDE 43.467165 LONGITUDE -80.466762 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	SHEAR STRENGTH kPa			WATER CONTENT (%)			GR	SA	SI	CL
	Continued From Previous Page							○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL × LAB VANE											
								20 40 60 80 100											
10.0	SAND , trace silt and clay, trace gravel Compact to Dense Brown Moist						313												
			10	SS	40								○						
							312												
	Very Dense		11	SS	100/ 0.275		311						○				0	94 6 (SI+CL)	
							310												
			12	SS	76								○						
							309												
308.6																			
14.8	Silty CLAY , some sand Hard Brown Moist																		
			13	SS	100/ 0.250		308						○				0	14 69 17	
307.8																			
15.6	END OF BOREHOLE AT 15.6m. WATER LEVEL AT 6.05m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. DCPT FROM GROUND SURFACE TO 4.6m. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.04.27 5.9 317.5 2018.05.16 6.0 317.5 2018.05.31 5.9 317.5 2018.06.25 5.6 317.8																		

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

RECORD OF BOREHOLE No RW12-06

1 OF 3

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 12, MTM NAD 83 Zone 10: N 4 814 632.6 E 226 676.8 ORIGINATED BY JB
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2016.10.20 - 2016.10.20 LATITUDE 43.467360 LONGITUDE -80.466142 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					
321.2	GROUND SURFACE							20 40 60 80 100					
0.0	Silty SAND , occasional organics Very Loose Brown Moist (FILL)		1	SS	3		321						
320.5													
0.7	Silty CLAY Stiff to Very Stiff Brown Moist		2	SS	11		320						
			3	SS	21		319						
			4	SS	26		318						
			5	SS	21		317						
			6	SS	23		316						
			7	SS	21		315						
			8	SS	18		314						
							313						
			9	SS	38		312						
311.2	Hard												

Continued Next Page

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

METRIC

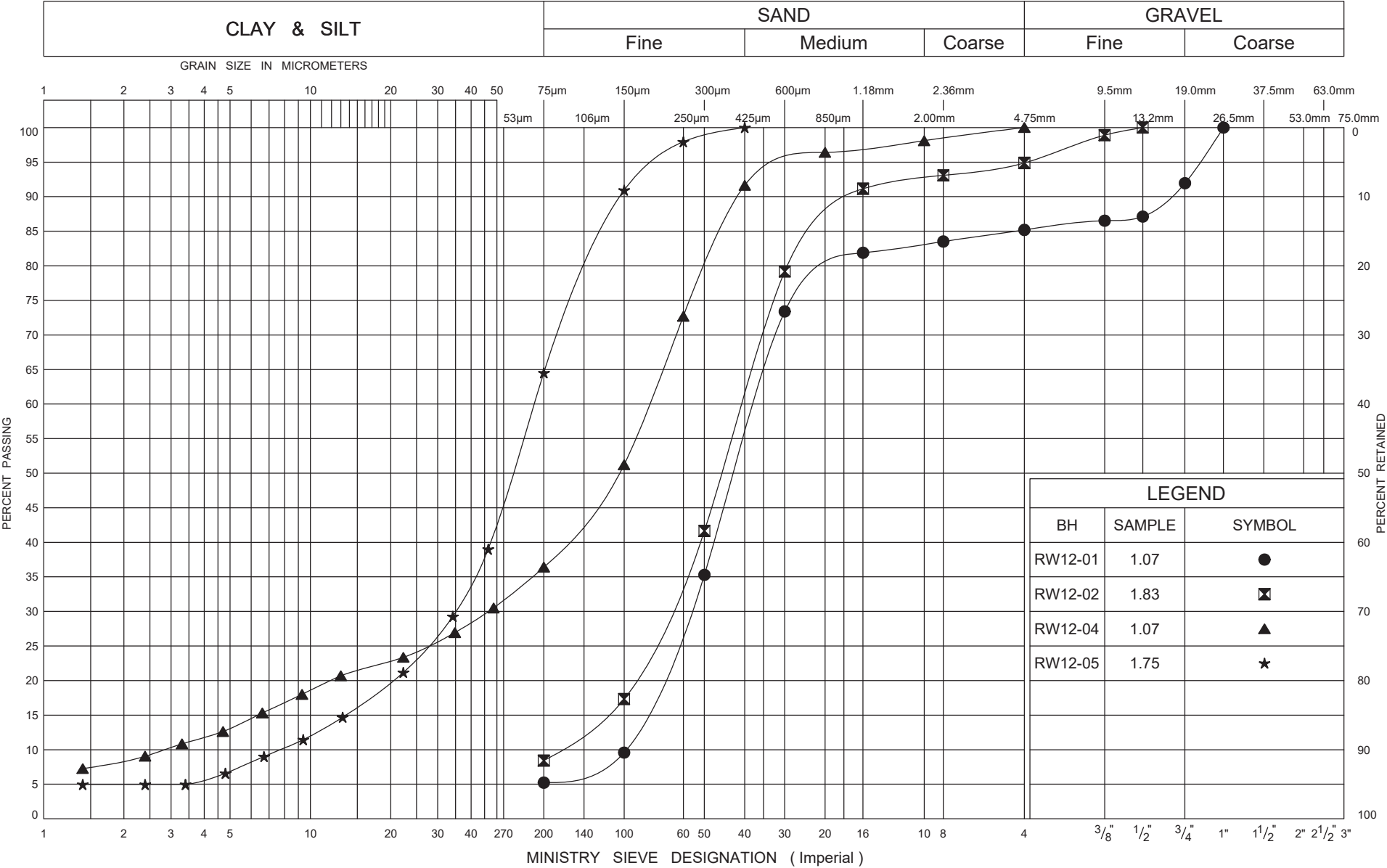
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			SHEAR STRENGTH kPa			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	20 40 60 80 100			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			w _p w w _L				
								20 40 60 80 100			20 40 60							
10.0	Continued From Previous Page																	
310.7	Silty CLAY Hard Grey Moist						311											
10.5	SAND , trace silt Compact Grey Wet		10	SS	14		310											
	layer of silt at 12.5m (100mm) Very Dense		11	SS	72		309											
308.6																		
12.6	Silty CLAY Very Stiff to Hard Grey Wet						308											
			12	SS	30													
							307											
			13	SS	26		306											
			14	SS	40		305											
							304											
303.4																		
17.8	SAND , some silt, trace clay, trace gravel Very Dense Grey Wet						303											
			15	SS	50													
							302											

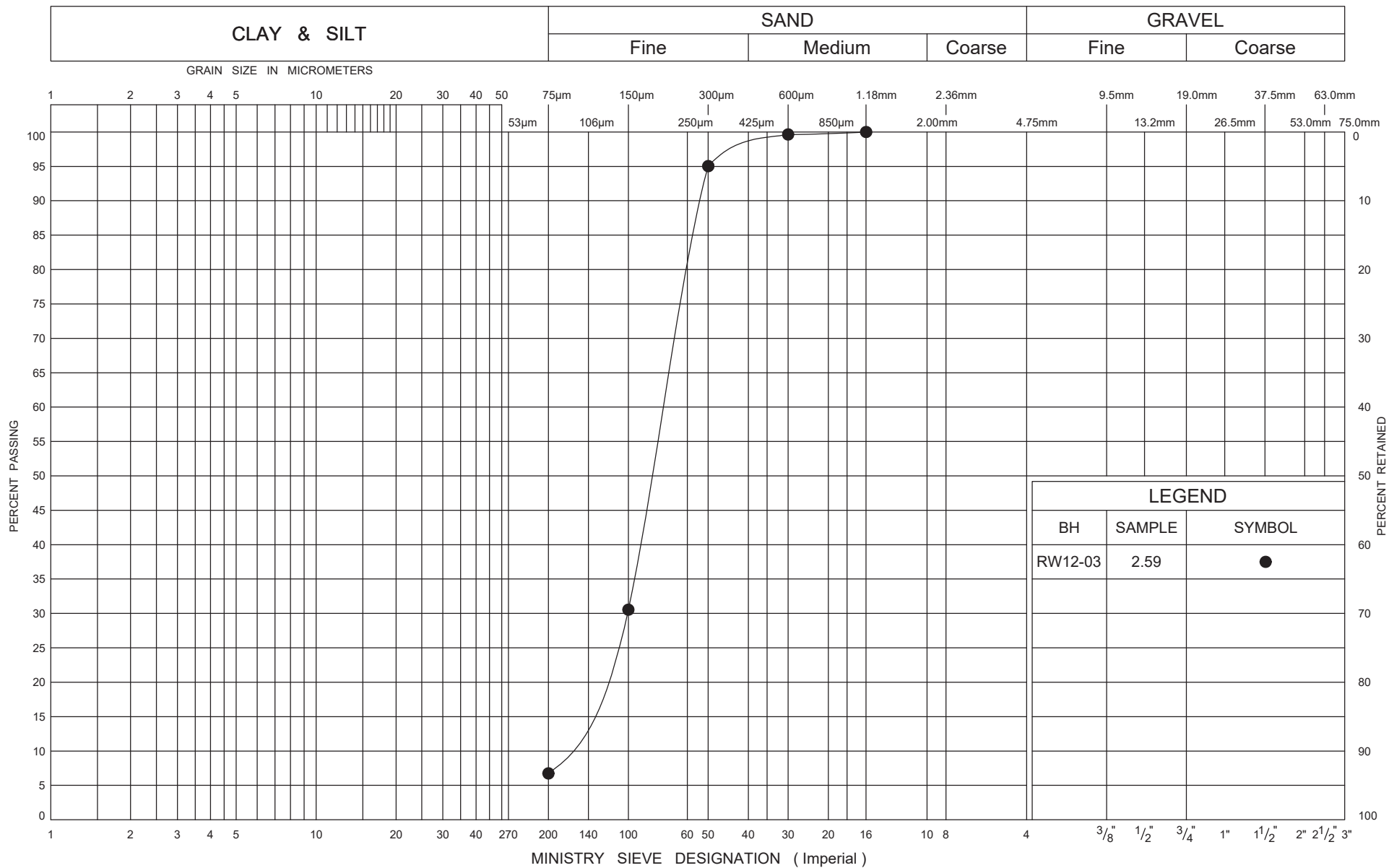
+³, ×³: Numbers refer to Sensitivity

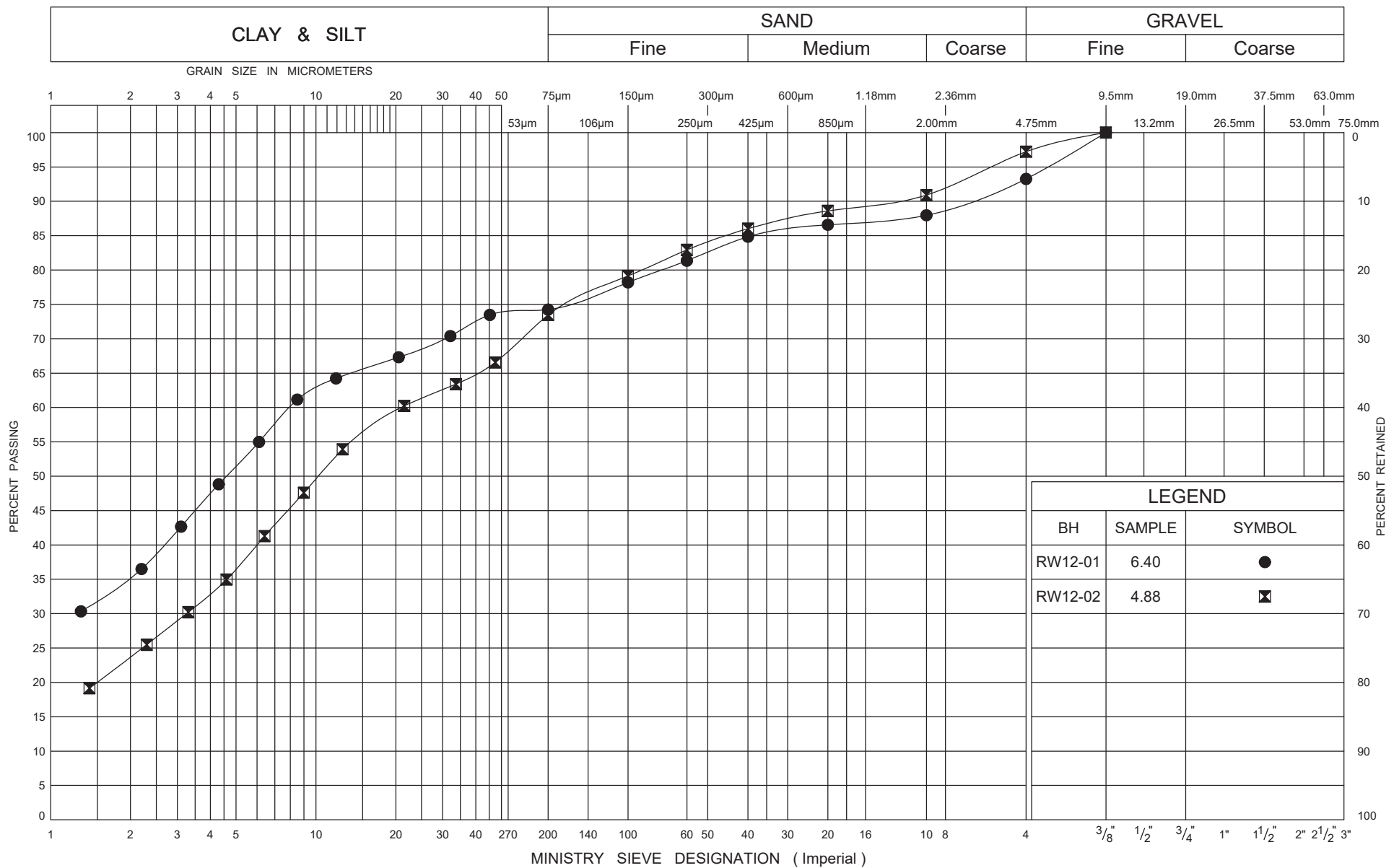
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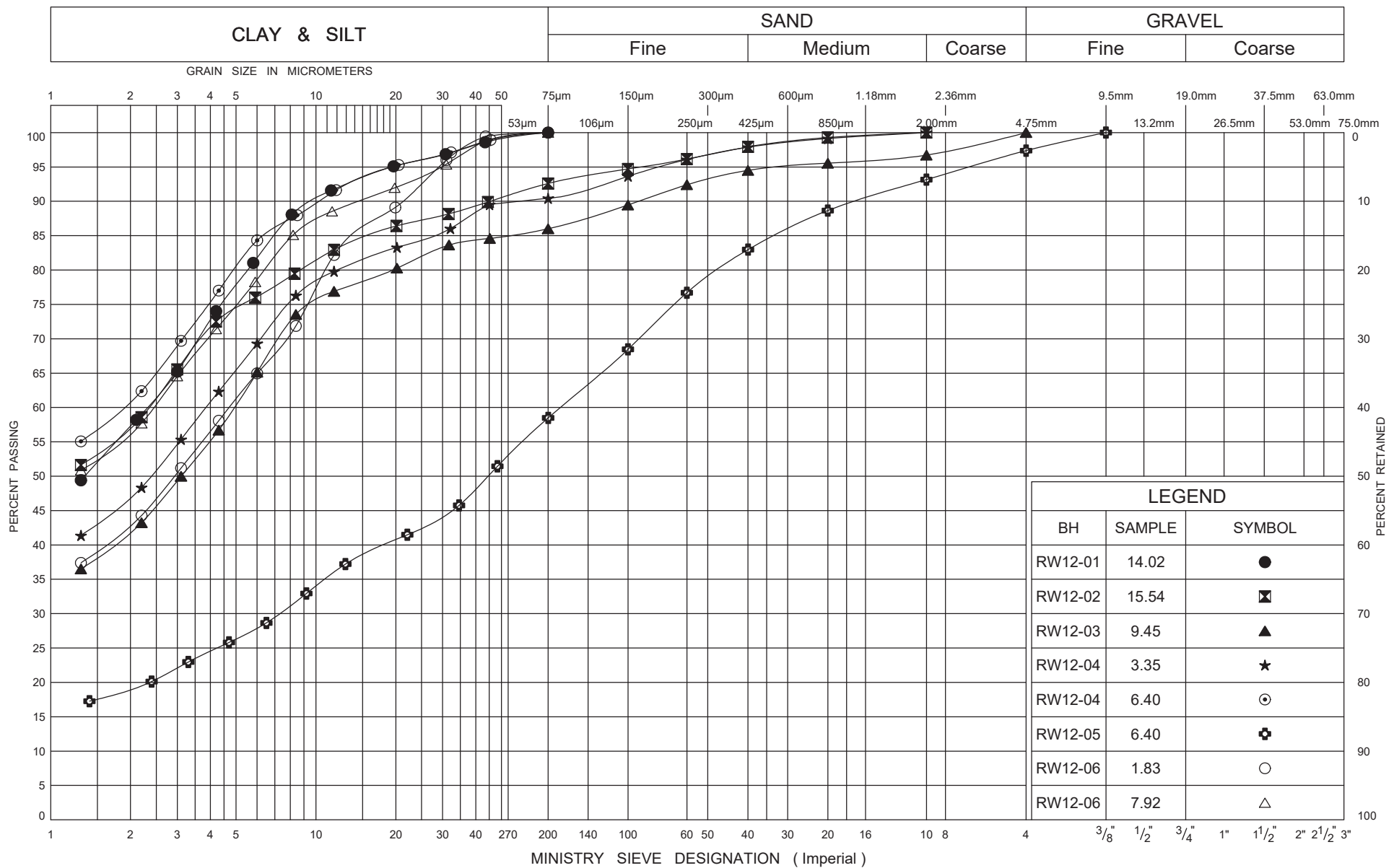
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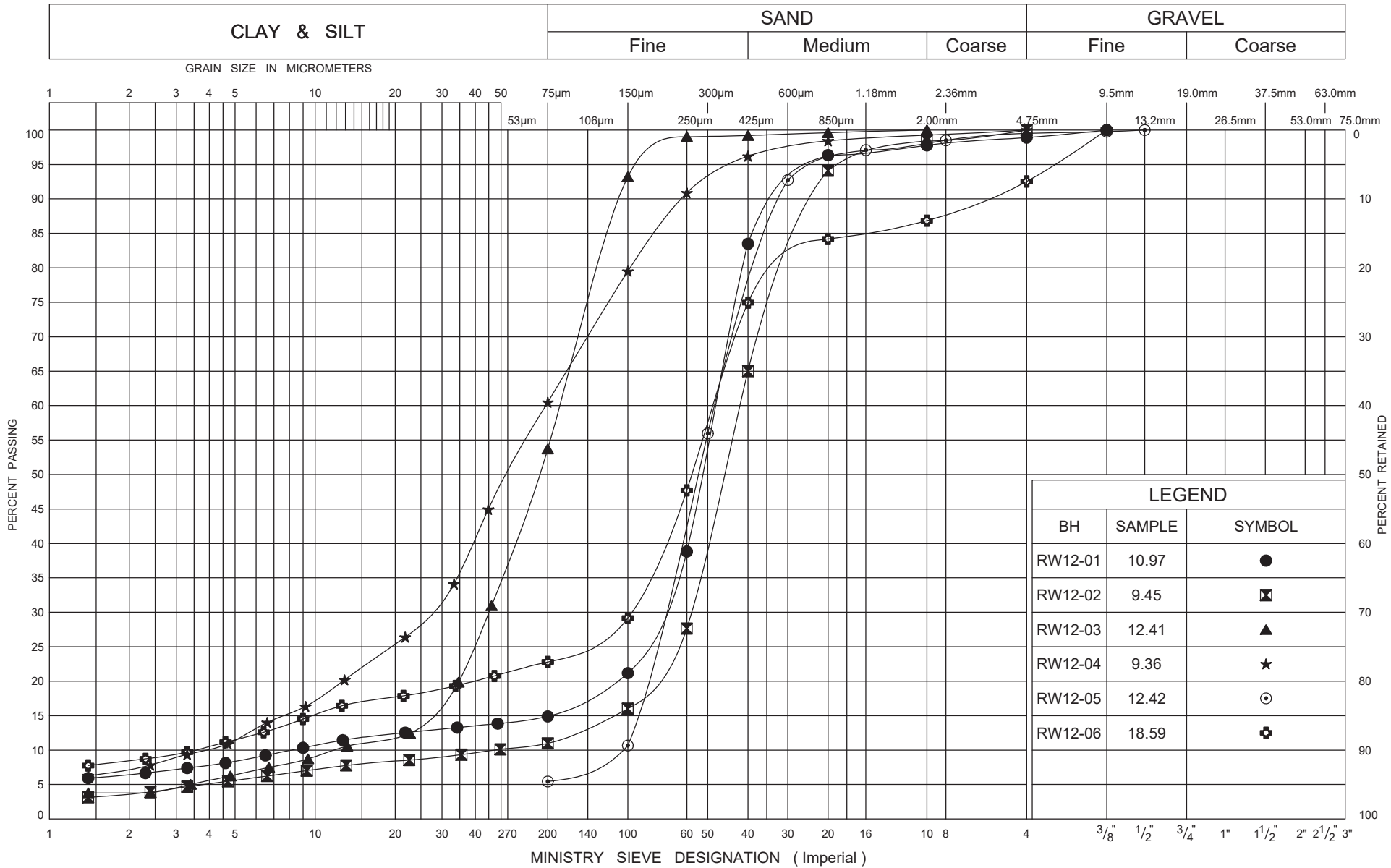
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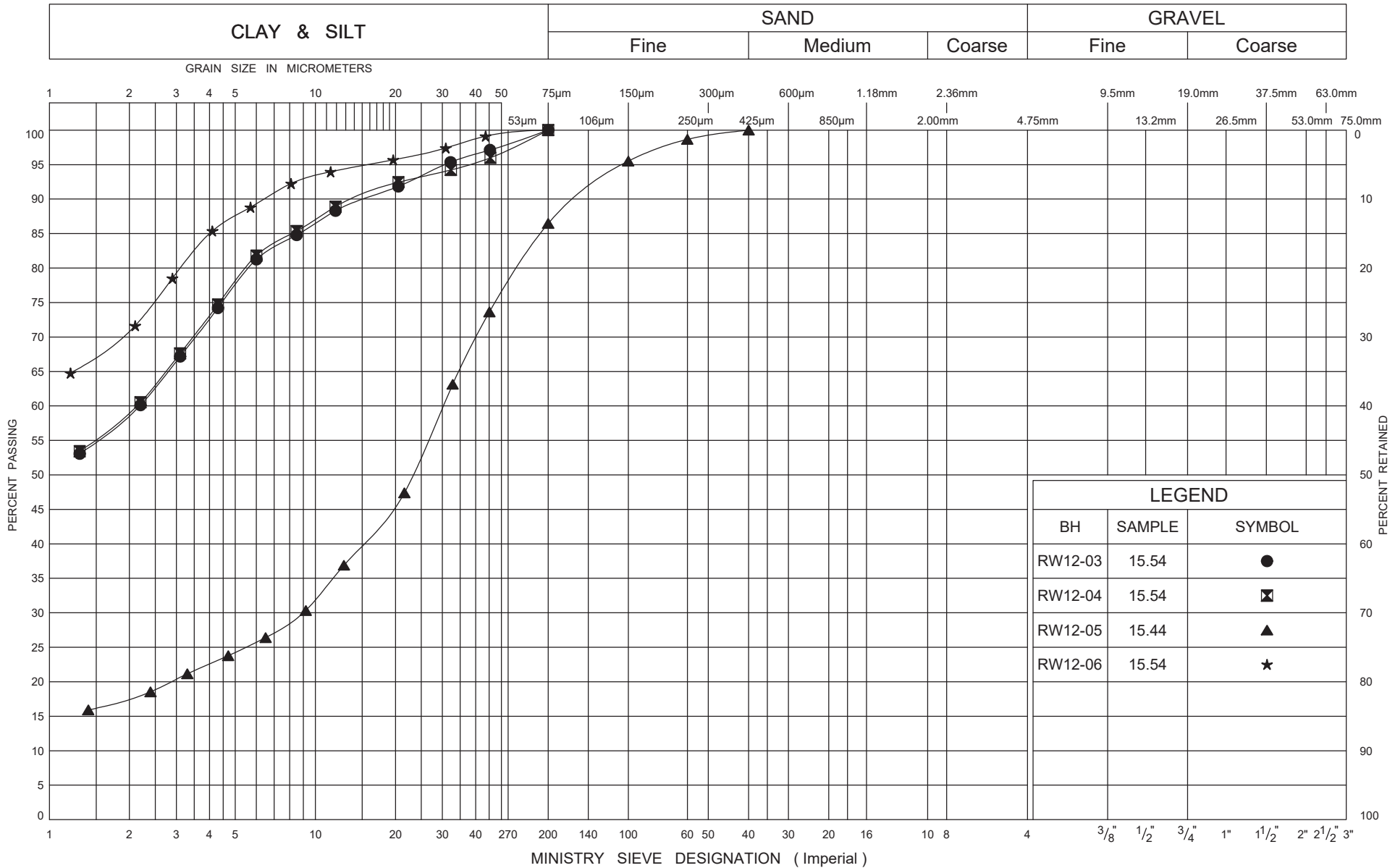


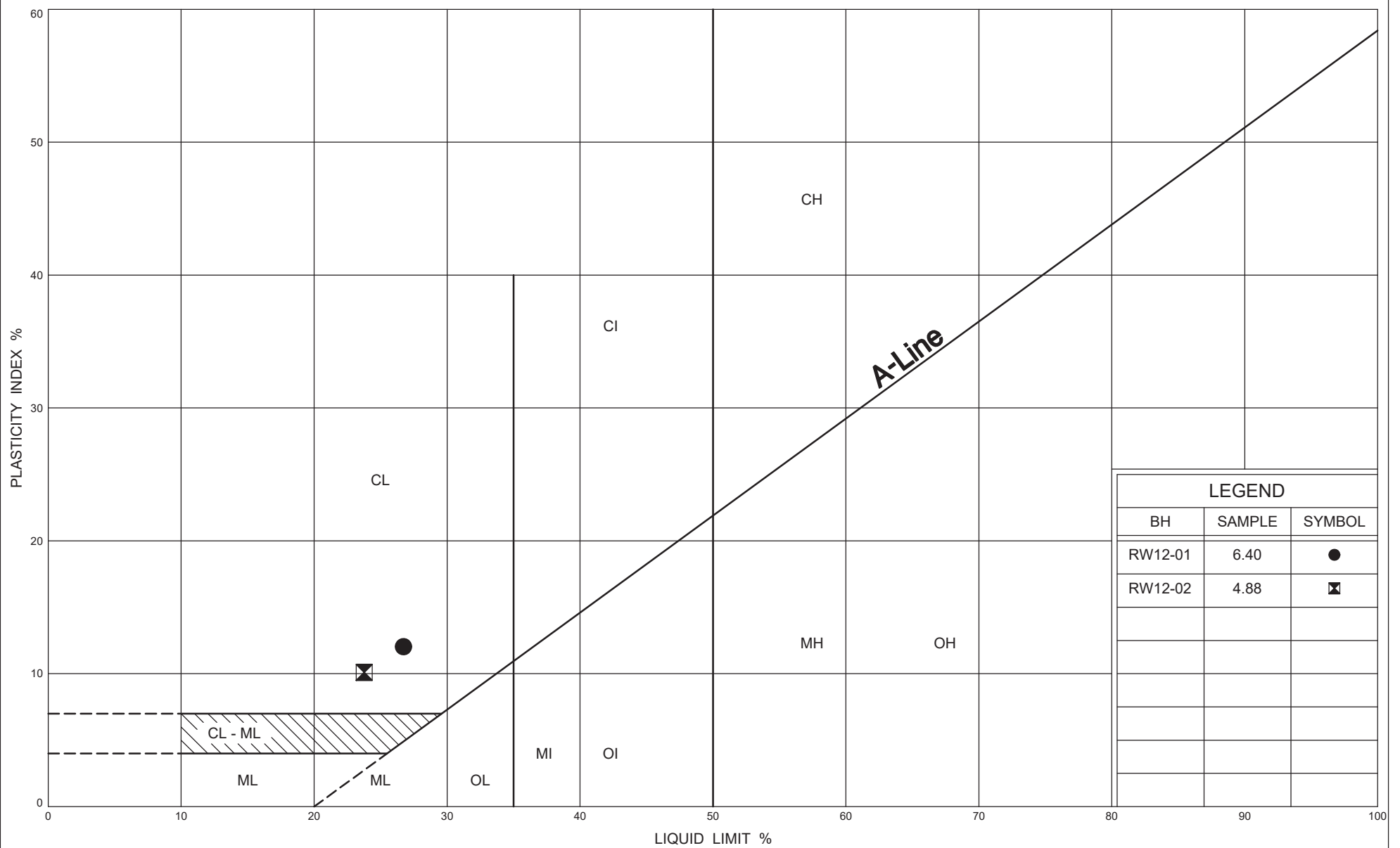


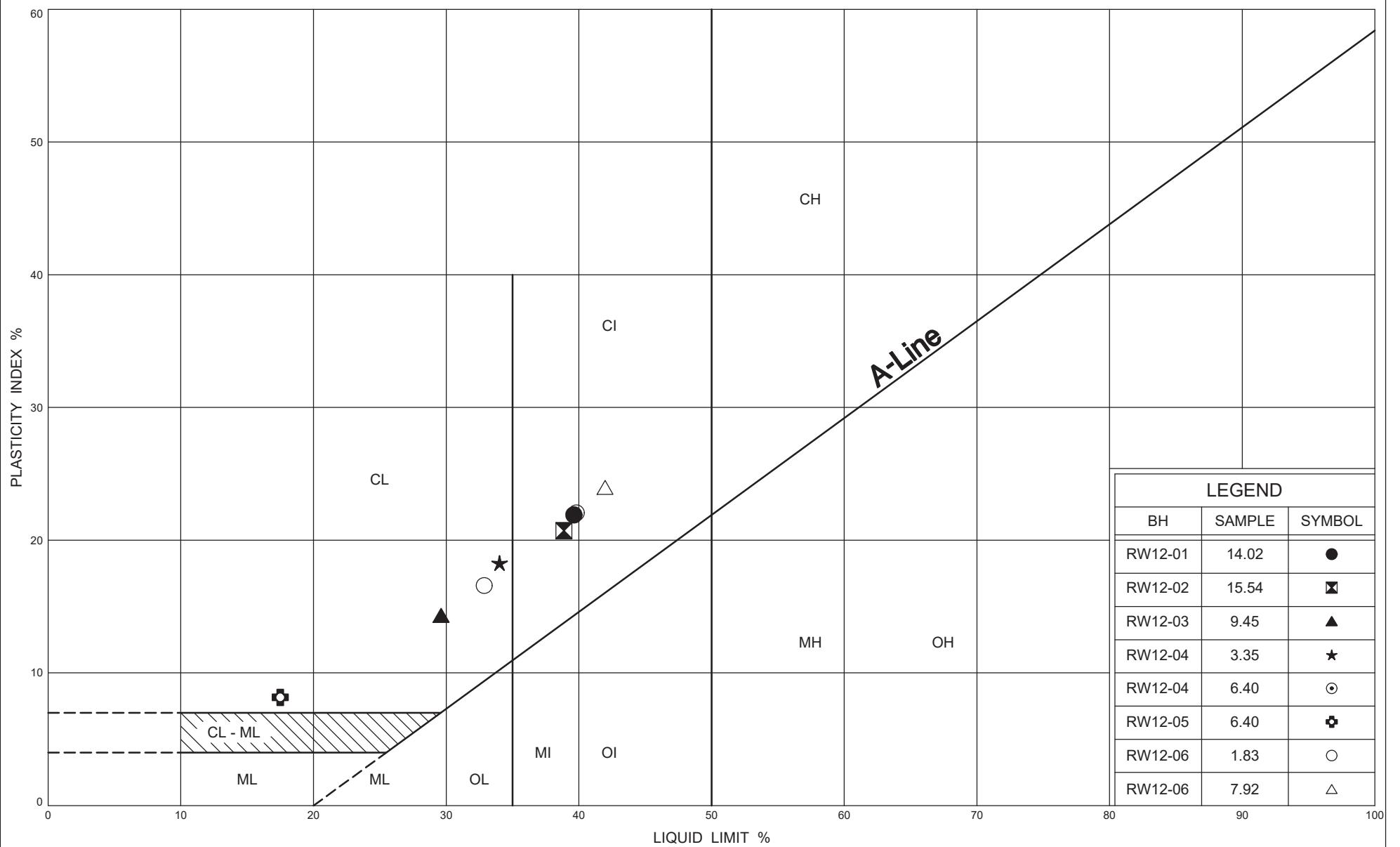












PLASTICITY CHART Upper Silty CLAY

FIG No D8

W P 408-88-00

Retaining Wall 12



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Transportation

Ontario

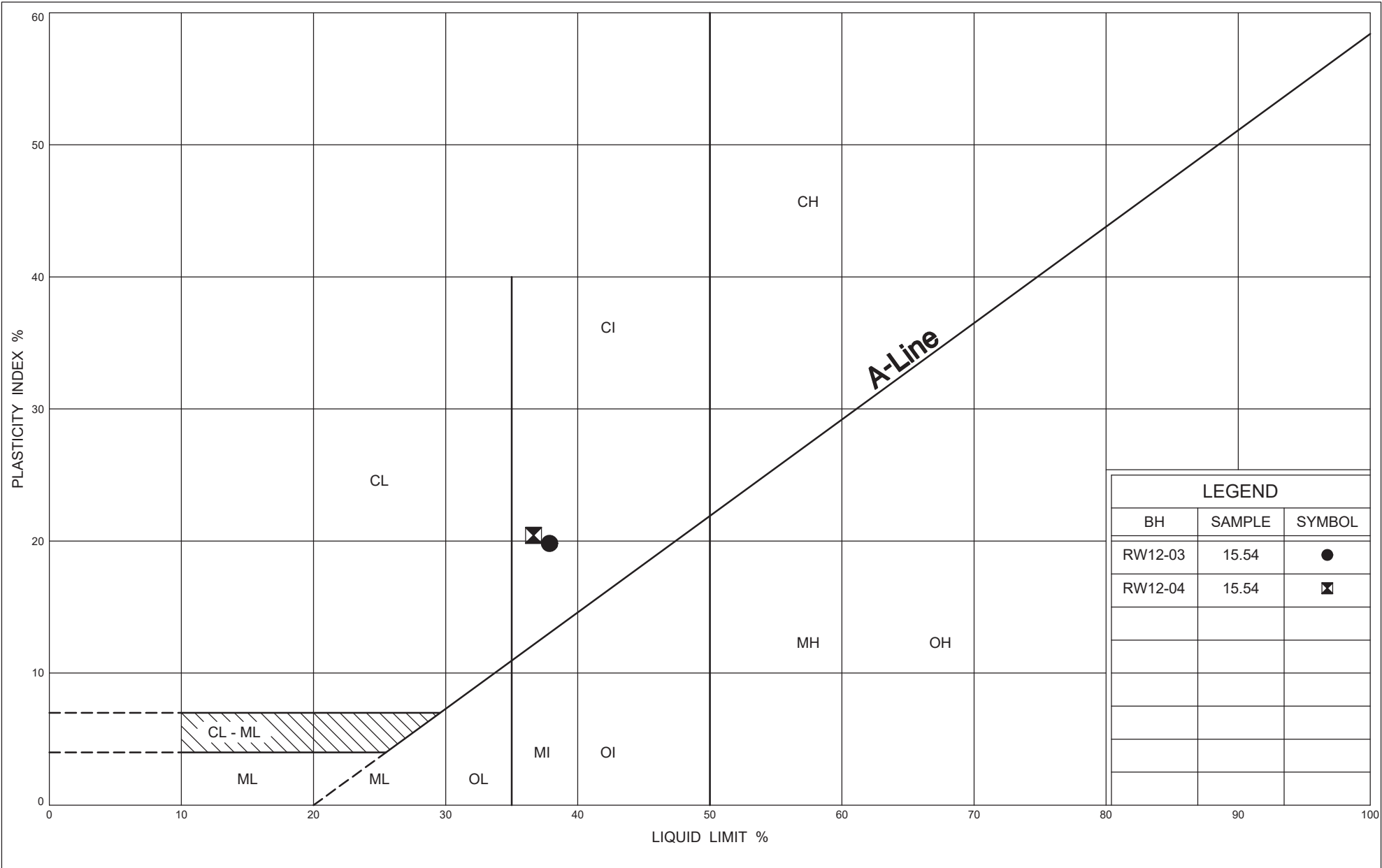
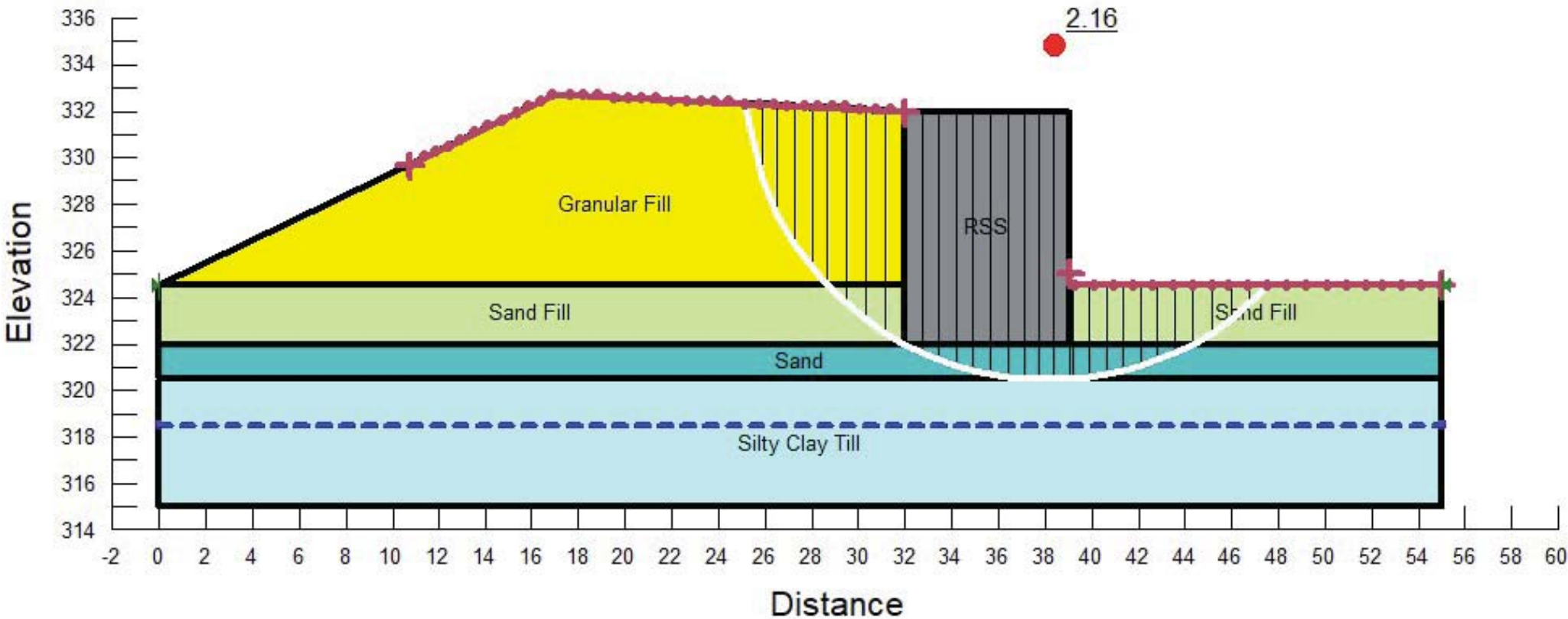


Figure D10

File Name: RW12 Sta 19+867.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 32 °
Sand Fill 20 kN/m³ 0 kPa 28 °
Silty Clay Till 20 kN/m³ 120 kPa 0 °
Sand 20 kN/m³ 0 kPa 30 °



File Name: RW12 Sta 19+867.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure D11

RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 32 °
Sand Fill 20 kN/m³ 0 kPa 28 °
Silty Clay Till (2) 20 kN/m³ 5 kPa 30 °
Sand 20 kN/m³ 0 kPa 30 °

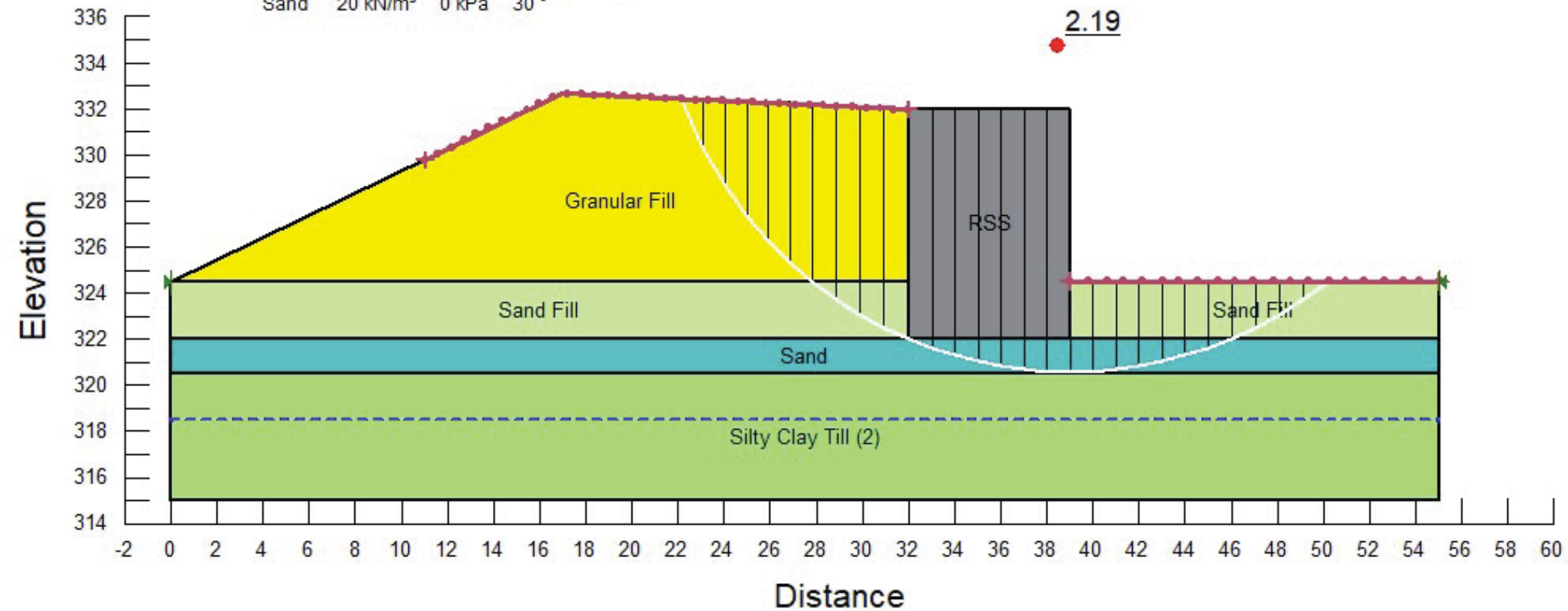
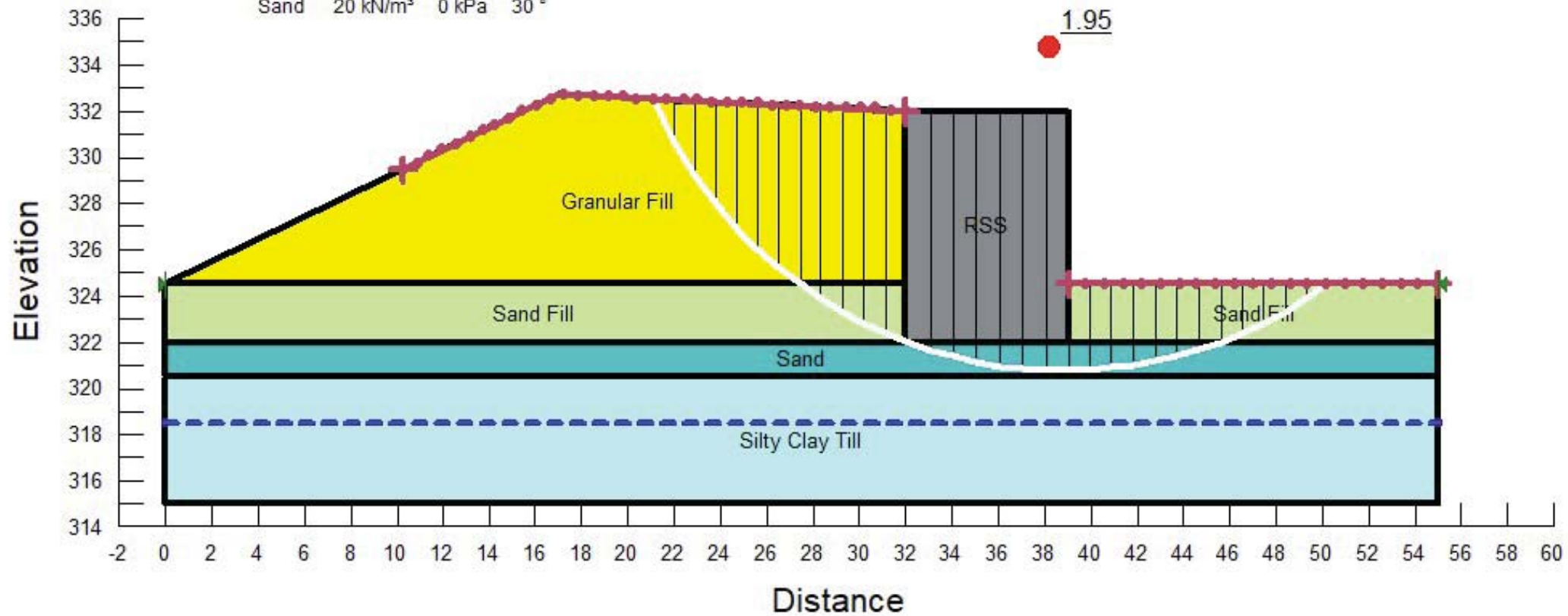
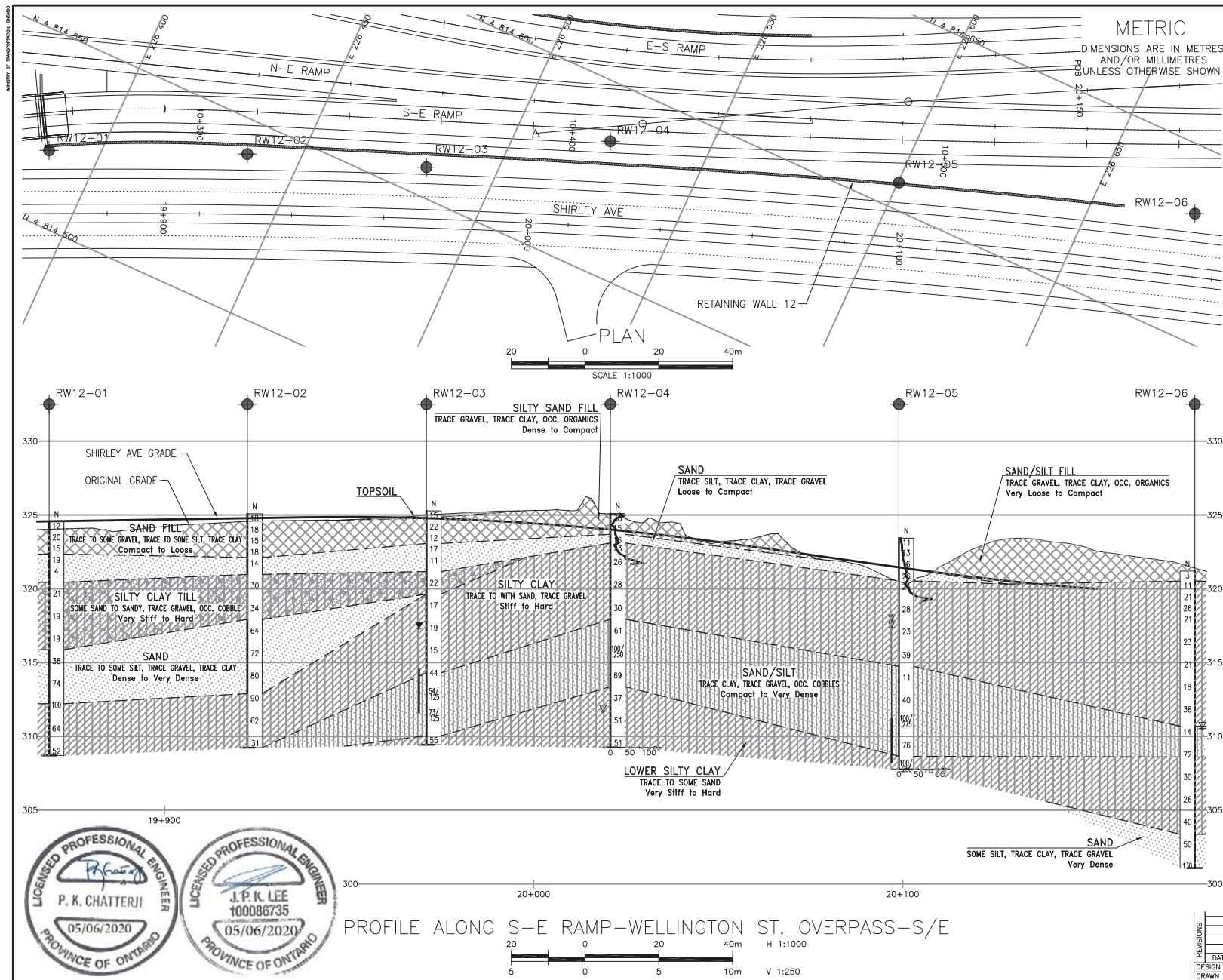


Figure D12

File Name: RW12 Sta 19+867.gsz
 Last Edited By: Nancy Berg
 Date: 2020-01-03
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Jorj. Seismic Coef.: 0.0485

RSS 22 kN/m³ 200 kPa 45 °
 Granular Fill 21 kN/m³ 0 kPa 32 °
 Sand Fill 20 kN/m³ 0 kPa 28 °
 Silty Clay Till 20 kN/m³ 120 kPa 0 °
 Sand 20 kN/m³ 0 kPa 30 °





CONT No
GWP No 408-88-00

HIGHWAY 7
S-E RAMP-WELLINGTON ST. OVERPASS-S/E
RETAINING WALL 12
BOREHOLE LOCATIONS AND SOIL STRATA

wsp

THURBER ENGINEERING LTD

SHEET

KEYPLAN

Latitude: 43.466941° Longitude: -80.467629°

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
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW12-01	324.6	4 814 519.7	226 387.0
RW12-02	325.1	4 814 541.0	226 436.3
RW12-03	325.3	4 814 557.8	226 482.0
RW12-04	325.1	4 814 584.9	226 524.5
RW12-05	323.4	4 814 607.0	226 600.3
RW12-06	321.2	4 814 632.6	226 676.8

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.

GEOCRIS No. 40P9-58

REVISIONS

DATE	BY	DESCRIPTION
DESIGN	NB	CHK PKC
DRAWN	MFA	CHK NB
		ISTRUC
		LDWG

DATE MAY 2020



FILENAME: H:\Spatial\11000\11375\11375-11375-BWP-RW12.dwg
 PLOTDATE: 5/6/2020 4:24 PM



Appendix E

Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing and Slope Stability Output

Retaining Wall 16 (RW16-01 to RW16-03)

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
321.3	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (150mm)												
0.2	Sandy SILT , with gravel Brown Dry (FILL)		1	GS			321						
320.5													
0.8	SAND , some silt to silty, trace clay, trace gravel Compact Brown Wet		2	SS	25		320						
			3	SS	26								2 78 16 4
319.0							319						
2.3	Silty CLAY , trace sand, trace gravel Very Stiff Grey Moist		4	SS	25								
			5	SS	22		318						
							317						
			6	SS	21								
							316						
			7	SS	28		315						0 1 32 67
							314						
			8	SS	58		313						
312.5													
8.8	Sandy SILT , trace clay Dense Grey Wet		9	SS	42		312						

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										WATER CONTENT (%)		
								20	40	60	80	100						20	40	60
	Continued From Previous Page																			
							311													
			10	SS	45											0 24 70 6				
310.0																				
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.																			

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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
320.4	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (150mm)							20 40 60 80 100					
0.2	SAND and GRAVEL, granular Brown Dry (FILL)		1	GS			320	20 40 60 80 100					
319.7								20 40 60 80 100					
0.7	Silty SAND, some clay, occasional cobbles Loose Brown Moist		2	SS	8			20 40 60 80 100					
319.0							319	20 40 60 80 100					
1.4	Silty CLAY, trace sand, trace shale Very Stiff to Hard Brown Dry to Moist		3	SS	25			20 40 60 80 100					
							318	20 40 60 80 100					0 5 53 42
	Grey		4	SS	35			20 40 60 80 100					
							317	20 40 60 80 100					
			5	SS	39			20 40 60 80 100					
							316	20 40 60 80 100					
			6	SS	38			20 40 60 80 100					
							315	20 40 60 80 100					
							314	20 40 60 80 100					
			7	SS	21			20 40 60 80 100					
							313	20 40 60 80 100					
			8	SS	32			20 40 60 80 100					
							312	20 40 60 80 100					
							311	20 40 60 80 100					0 1 45 54
310.4			9	SS	41			20 40 60 80 100					

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					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 CLAY , trace sand, trace shale Very Stiff to Hard Brown Dry to Moist						310										
309.1			10	SS	21												
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.																

RECORD OF BOREHOLE No RW16-03

1 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				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
319.9	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (150mm)							20 40 60 80 100					
0.2	SAND and GRAVEL, granular Brown Dry (FILL)		1	GS				20 40 60 80 100					
319.3								20 40 60 80 100					
0.7	Clayey SILT, some sand and gravel Hard Grey Moist		2	SS	39		319	20 40 60 80 100					
318.5								20 40 60 80 100					
1.4	Silty CLAY, trace sand Very Stiff Grey Moist		3	SS	18		318	20 40 60 80 100					
								20 40 60 80 100					
			4	SS	16		317	20 40 60 80 100					
								20 40 60 80 100					
			5	SS	21		316	20 40 60 80 100					
							315	20 40 60 80 100					Auger grinding
			6	SS	15		314	20 40 60 80 100					Auger grinding
								20 40 60 80 100					
			7	SS	23		313	20 40 60 80 100					Auger grinding
								20 40 60 80 100					
			8	SS	23		312	20 40 60 80 100					0 2 36 62
								20 40 60 80 100					
311.3	Sandy SILT to Silty SAND Compact Grey Wet						311	20 40 60 80 100					Auger grinding
8.7			9	SS	18		310	20 40 60 80 100					

Continued Next Page

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

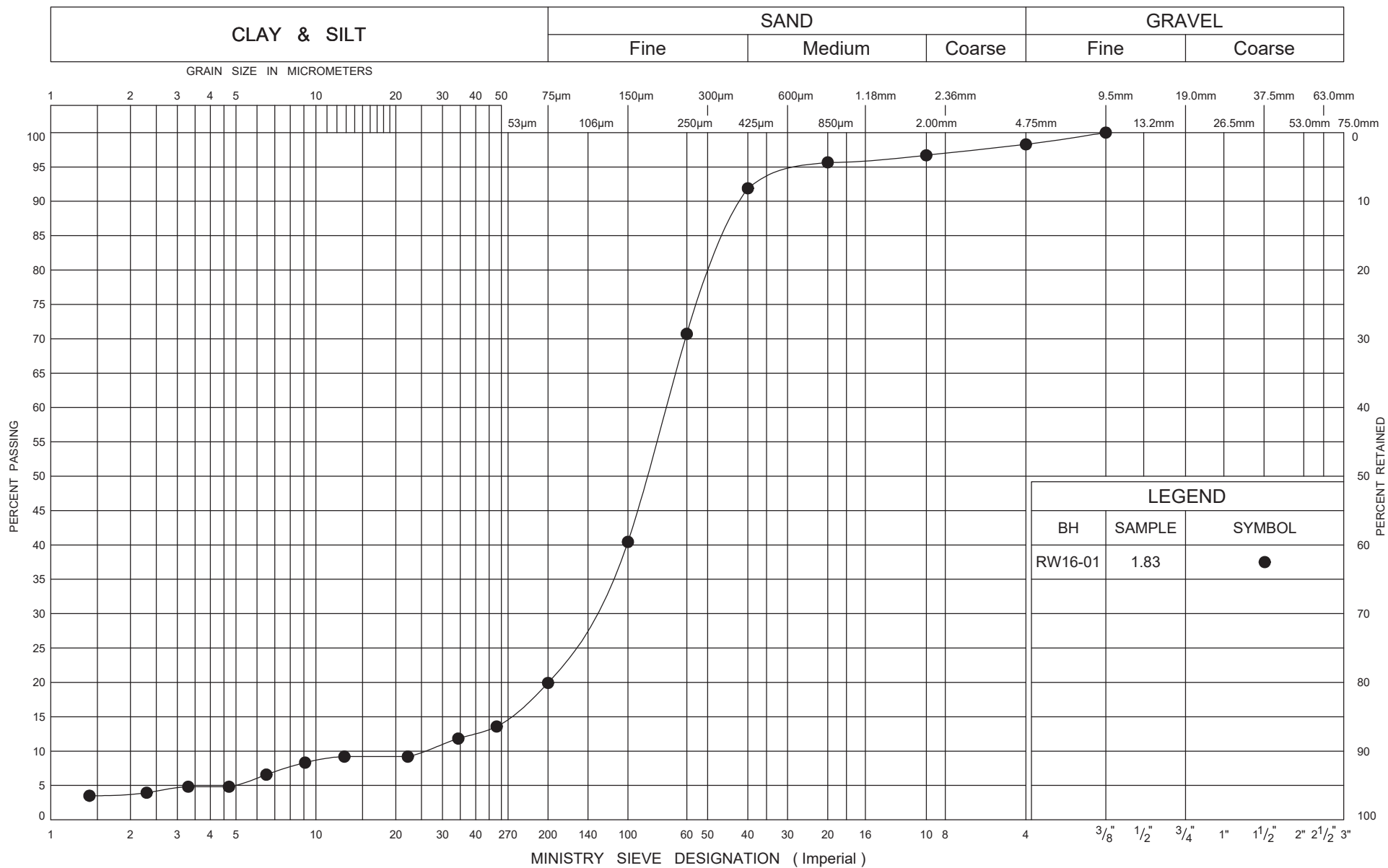
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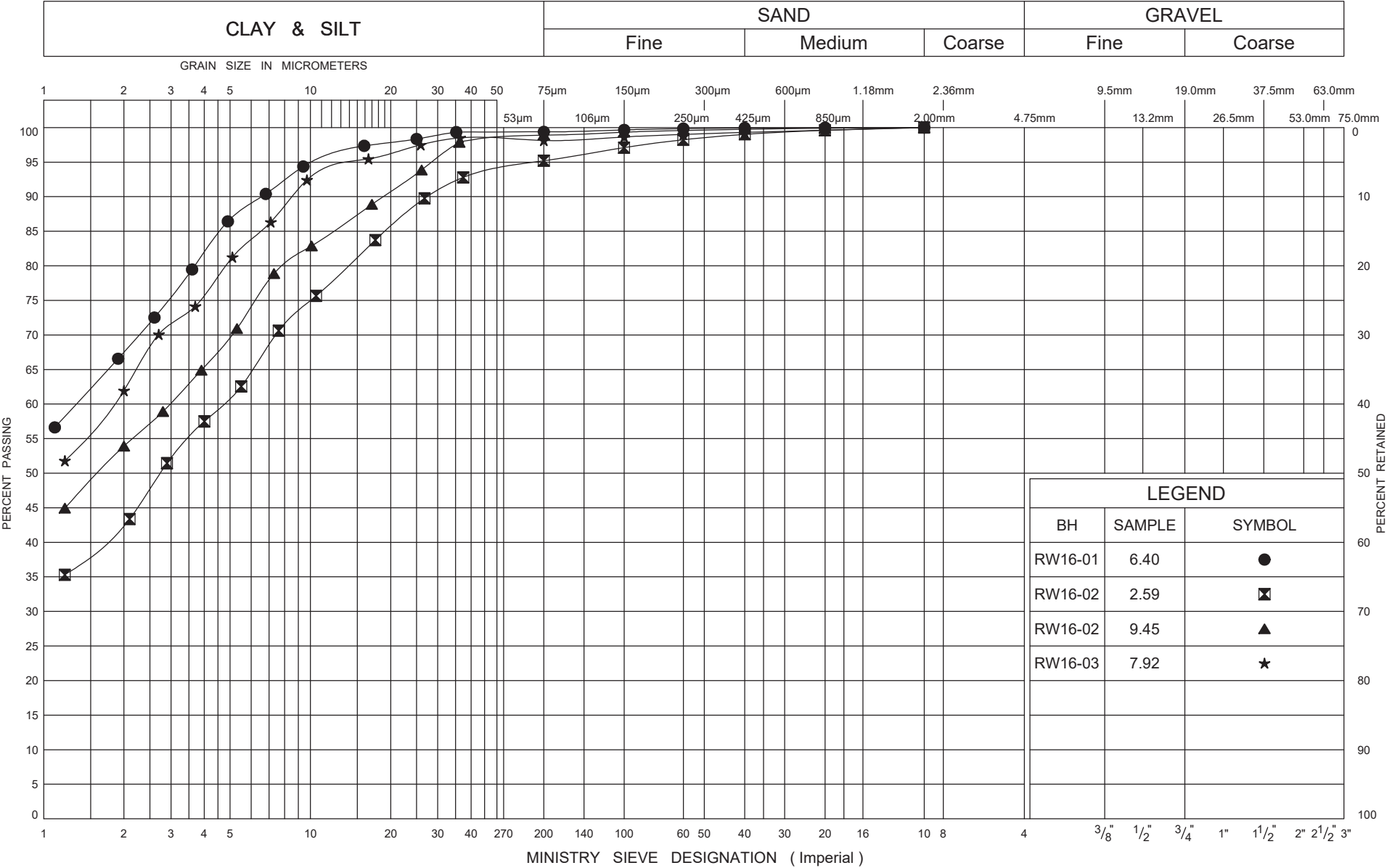
2 OF 2

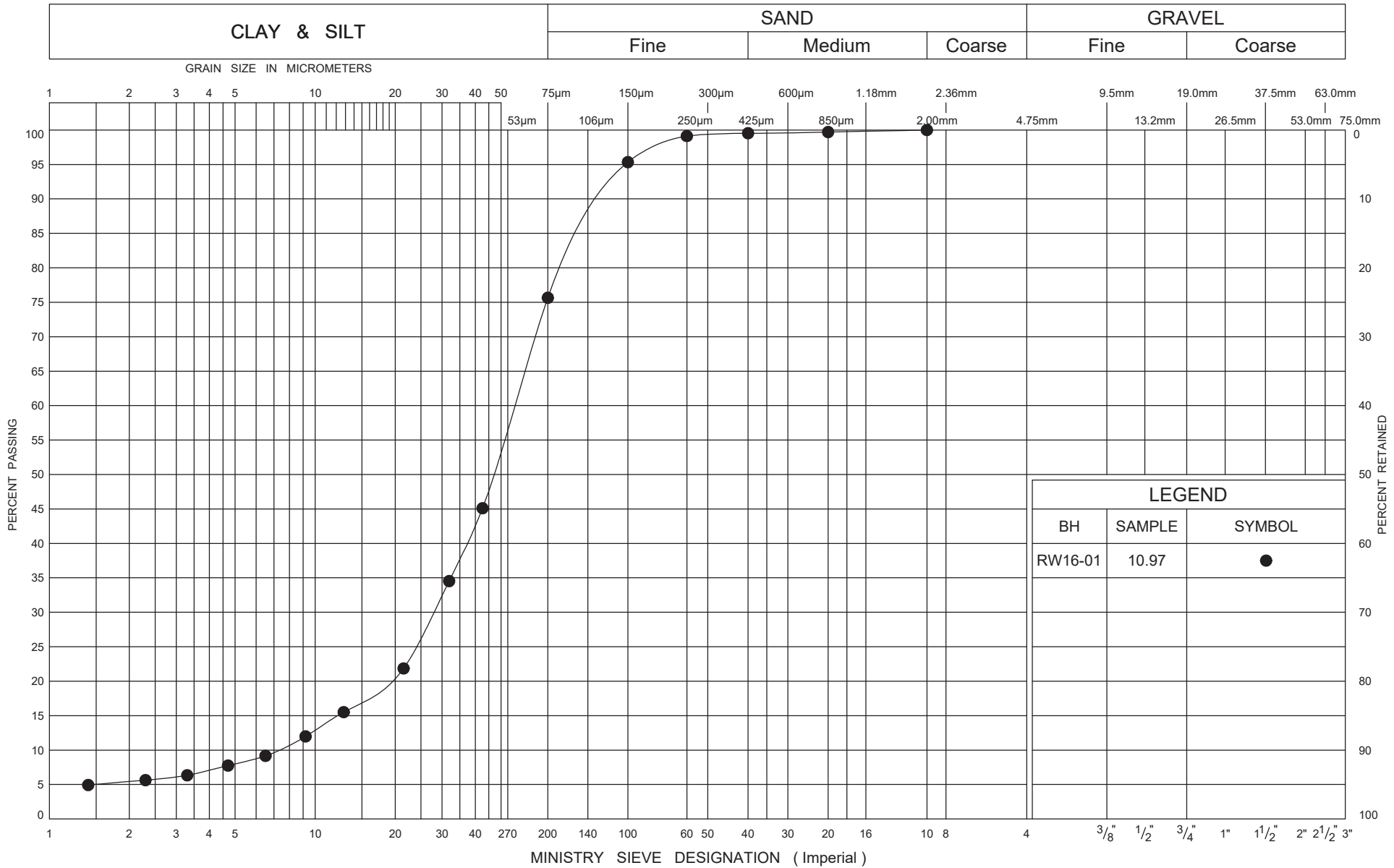
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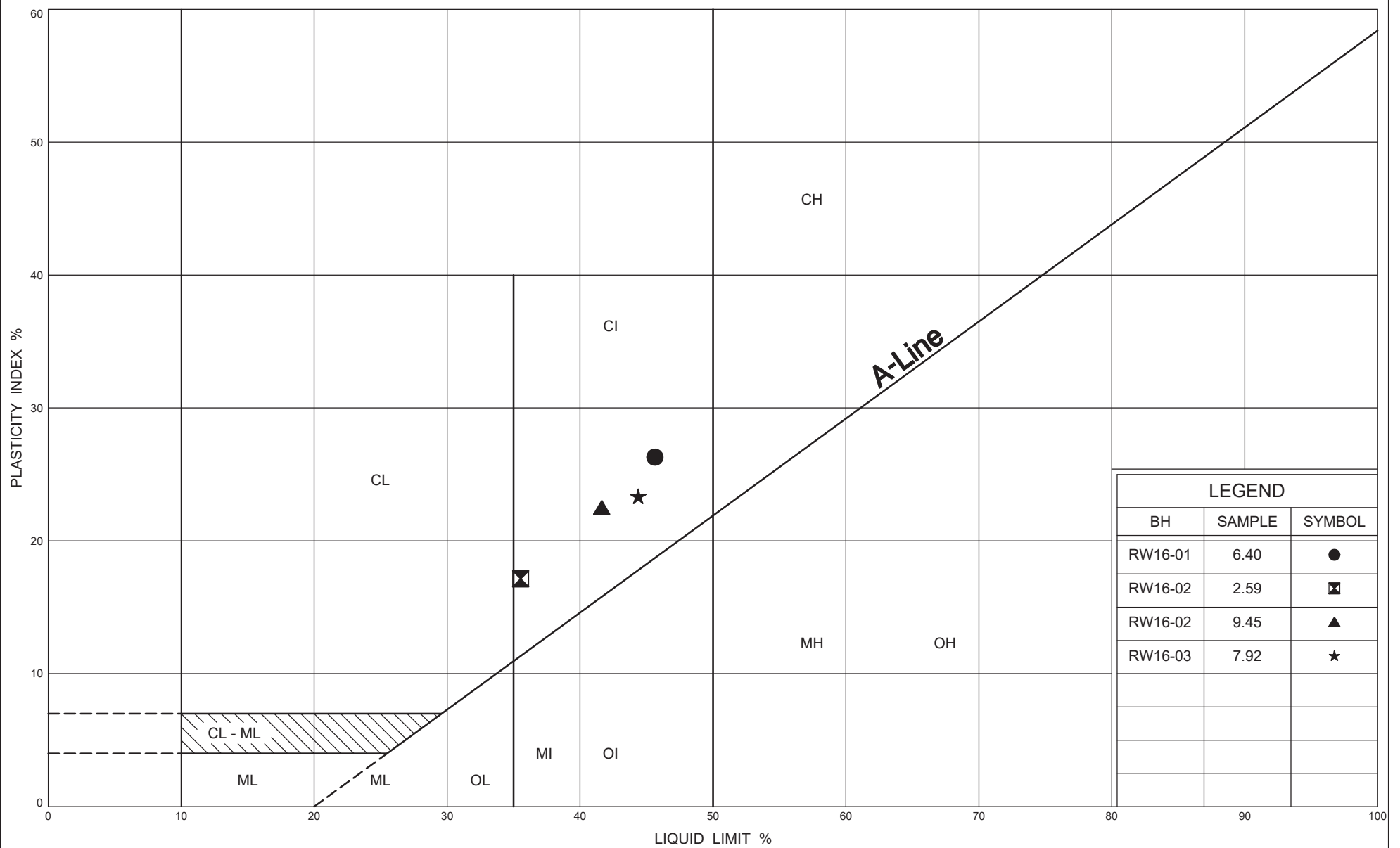
GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 755.4 E 226 164.5 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.15 - 2019.08.15 LATITUDE 43.459582 LONGITUDE -80.471709 CHECKED BY NB

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	WATER CONTENT (%)					
	Continued From Previous Page													
308.7	Sandy SILT to Silty SAND Compact Grey Wet		10	SS	27		309							Auger grinding
11.3	End of sampling DCPT from 11.3m to 12.5m						308							
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.													









PLASTICITY CHART Silty CLAY

FIG No E4

W P 408-88-00

Retaining Wall 16



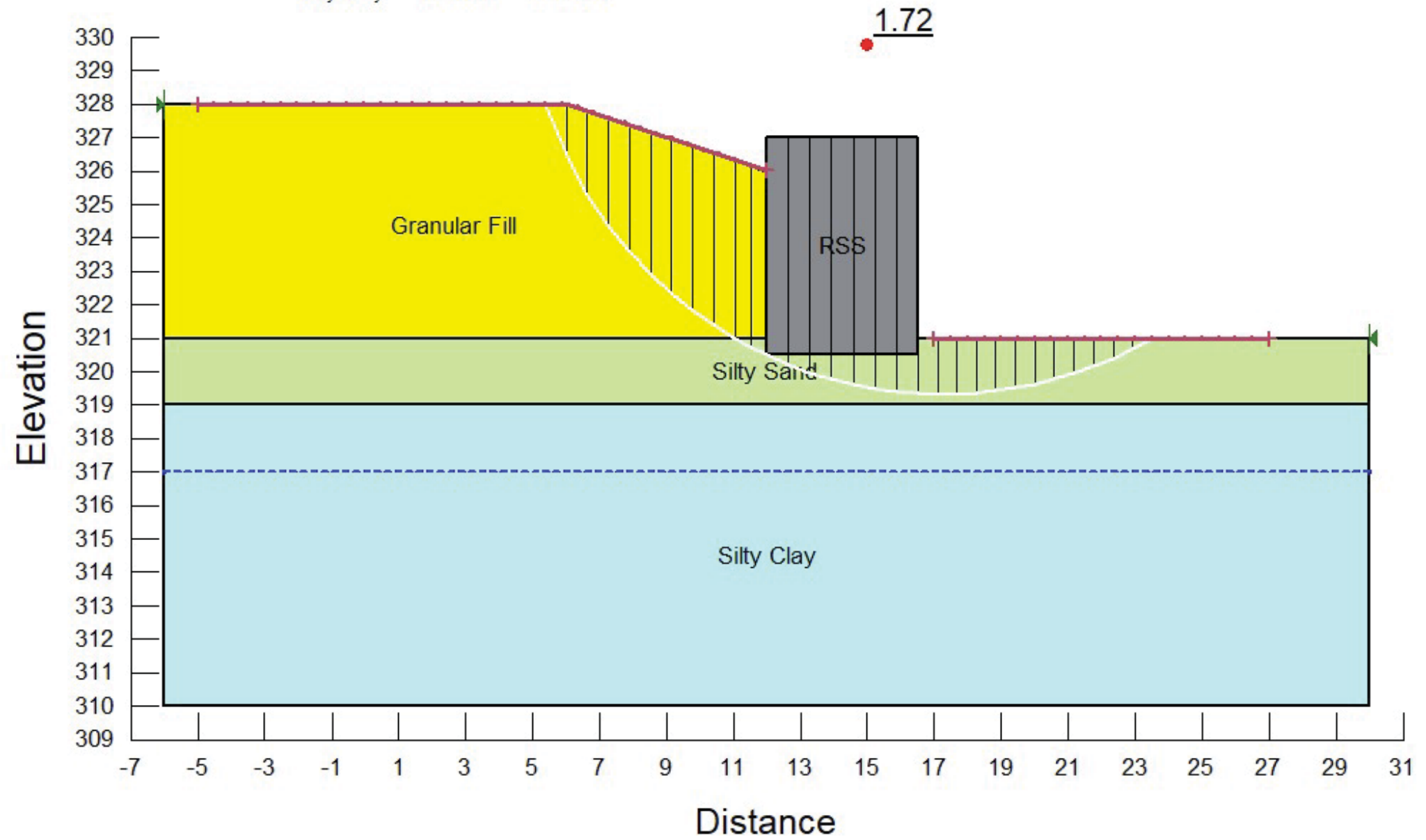
Ministry of
Transportation

Ontario

File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

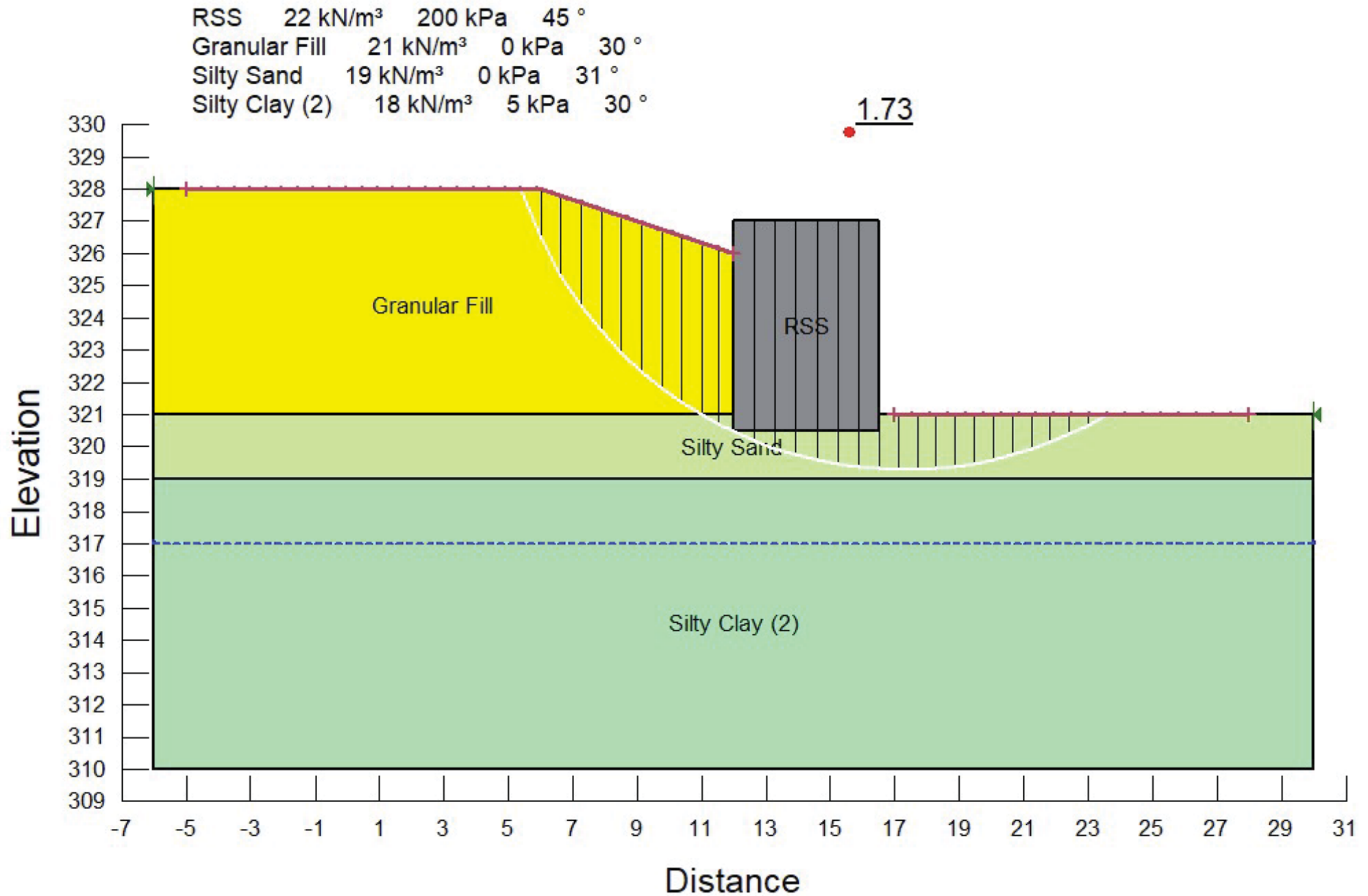
Figure E5

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	30 °
Silty Sand	19 kN/m ³	0 kPa	31 °
Silty Clay	18 kN/m ³	120 kPa	



File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

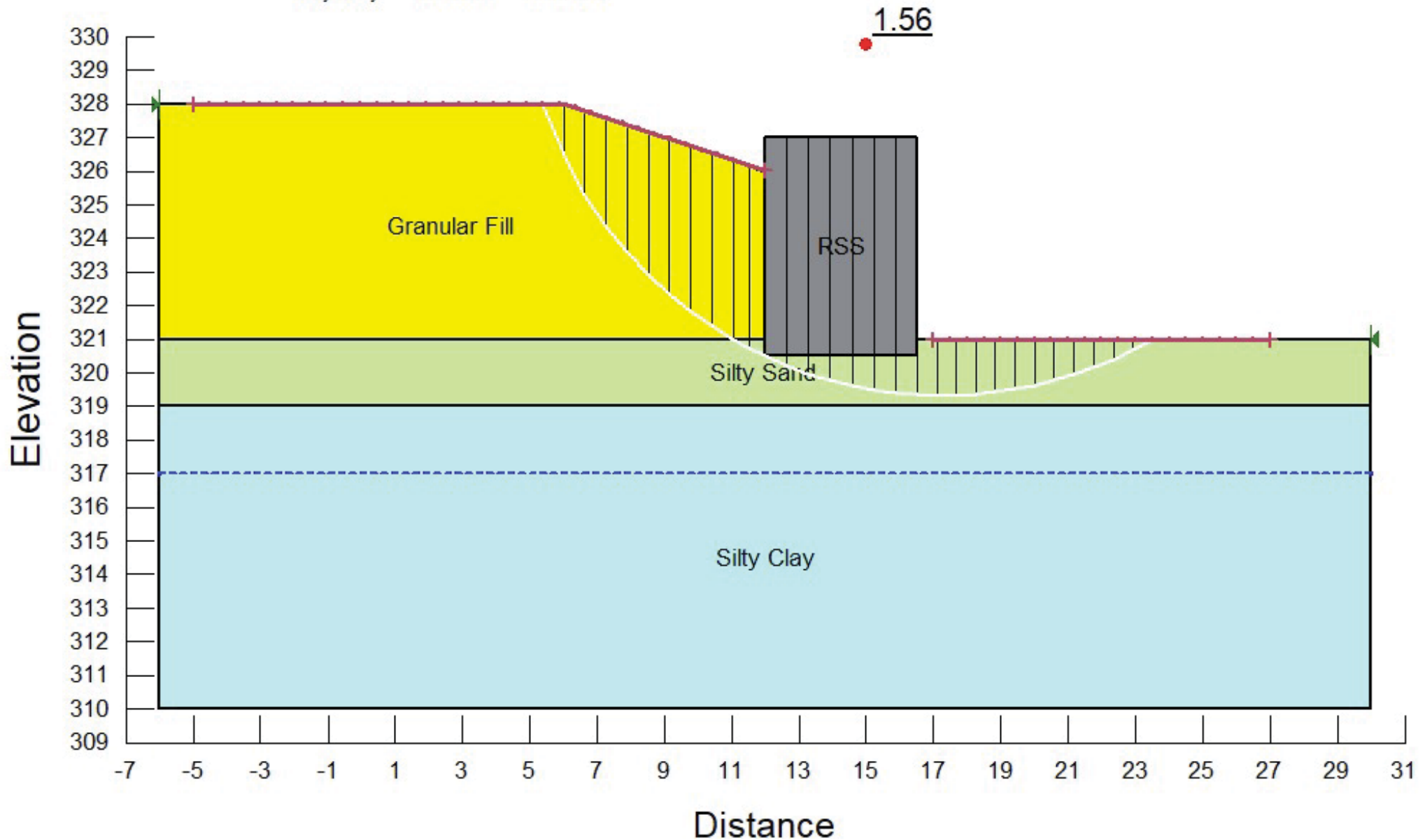
Figure E6

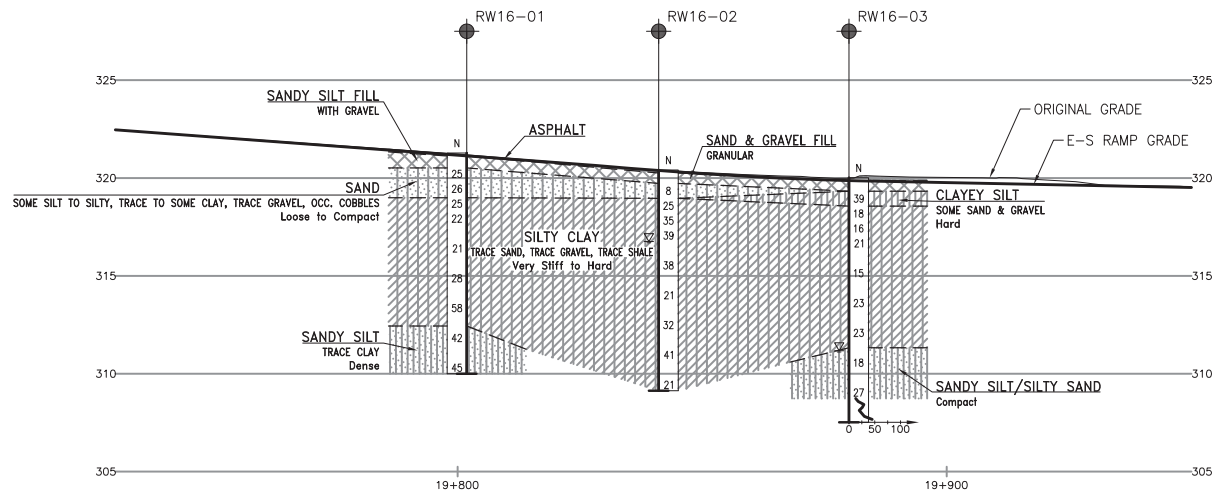
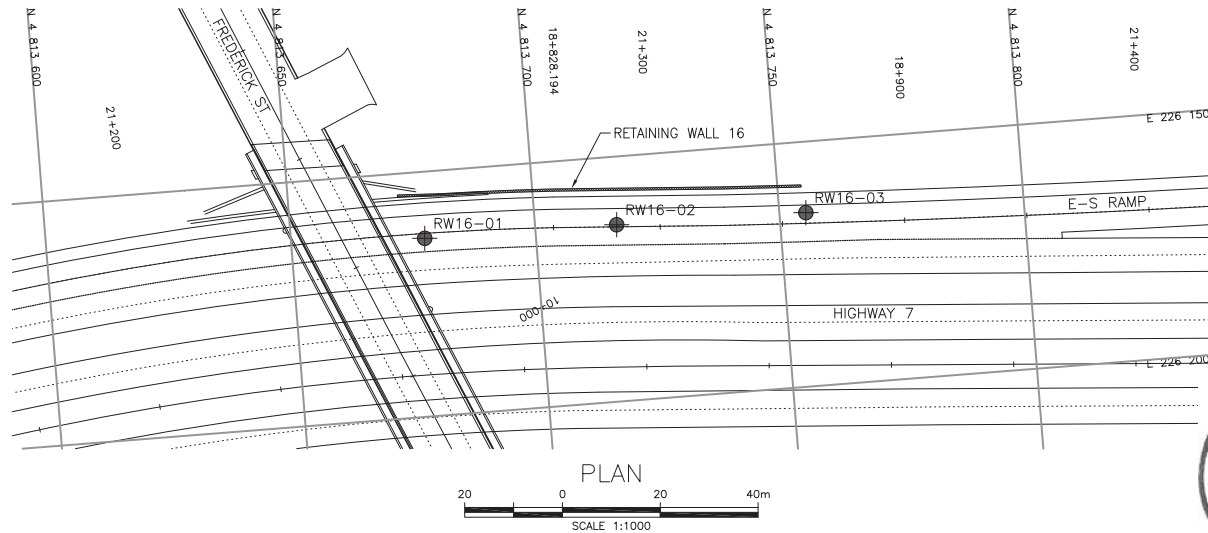


File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Horz. Seismic Coef.: 0.0485

Figure E7

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	30 °
Silty Sand	19 kN/m ³	0 kPa	31 °
Silty Clay	18 kN/m ³	120 kPa	



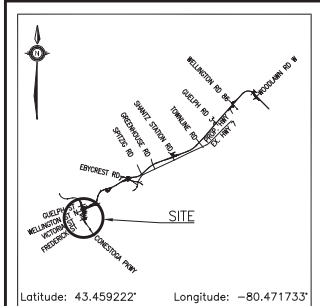


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00



HIGHWAY 7
HWY 85 SB/E-S RAMP
RETAINING WALL 16
BOREHOLE LOCATIONS AND SOIL STRATA



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

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-**
- 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. 40P9-58

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	NB	CHK PKC	CODE
DRAWN	MFA	CHK NB	SITE
		ISTRUCT	DWG 1



Appendix F

Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing and Slope Stability Output


**Retaining Wall 24
(RW24-01 to RW24-03)**

METRIC

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No RW24-01 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 24, MTM NAD 83 Zone 10: N 4 814 847.4 E 226 015.2 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH
DATUM Geodetic DATE 2019.09.06 - 2019.09.06 LATITUDE 43.469400 LONGITUDE -80.473725 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							20	40	60	80	100					
304.9	Silty CLAY , trace sand Very Stiff to Hard Grey Moist						307										
			10	SS	19												
			11	SS	30												
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 9.4m AND WATER LEVEL AT 10.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS, THEN ASPHALT TO SURFACE.						305										

RECORD OF BOREHOLE No RW24-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 24, MTM NAD 83 Zone 10: N 4 814 806.8 E 226 031.5 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH
 DATUM Geodetic DATE 2019.09.06 - 2019.09.06 LATITUDE 43.469038 LONGITUDE -80.473502 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)							
								○ UNCONFINED + FIELD VANE		● QUICK TRIAXIAL × LAB VANE		W _P	W	W _L					
318.1	GROUND SURFACE						20	40	60	80	100					GR	SA	SI	CL
0.0	ASPHALT(150mm)																		
0.2	SAND and GRAVEL Brown Moist (FILL)		1	GS															
317.4																			
0.7	SAND, some silt to silty, trace gravel, trace clay Dense Brown Moist (FILL)		2	SS	28														
316.2			3	SS	31														
1.9	Sandy SILT to Silty SAND, trace to some gravel, trace clay Dense Brown Moist (FILL) clayey silt layer at 2.8m (200mm)		4	SS	49														
314.7			5	SS	26														
3.4	Silty CLAY, sandy Very Stiff Brown Moist (FILL)																		
314.0																			
4.1	SAND, some silt to silty, trace to some gravel, occasional cobbles Dense to Very Dense Brown Moist		6	SS	57														
			7	SS	33														
310.9																			
7.2	SAND and SILT Compact Brown Moist		8	SS	21														
			9	SS	7														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW24-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 24, MTM NAD 83 Zone 10: N 4 814 806.8 E 226 031.5 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH
DATUM Geodetic DATE 2019.09.06 - 2019.09.06 LATITUDE 43.469038 LONGITUDE -80.473502 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					
Continued From Previous Page							<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><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ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

RECORD OF BOREHOLE No RW24-03

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 24, MTM NAD 83 Zone 10: N 4 814 766.3 E 226 047.4 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH
 DATUM Geodetic DATE 2019.09.06 - 2019.09.06 LATITUDE 43.468679 LONGITUDE -80.473272 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _p w w _L				GR	SA	SI	CL
318.6	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT(200mm)							20	40	60	80	100							
0.2	SAND and GRAVEL, some silt and clay Compact Brown Dry to Moist (FILL)		1	GS															40 47 13 (SI+CL)
			2	SS	21														
			3	SS	22														
			4	SS	12														42 46 12 (SI+CL)
			5	SS	11														
314.5																			
4.1	Silty SAND, trace to some gravel, occasional cobbles Compact Brown Moist		6	SS	24														
			7	SS	40														
311.5																			
7.2	SAND and SILT, trace clay, trace gravel Loose to Dense Brown Moist to Wet clayey silt layer at 7.5m (500mm)		8	SS	23														
			9	SS	3														3 56 36 5

Continued Next Page

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

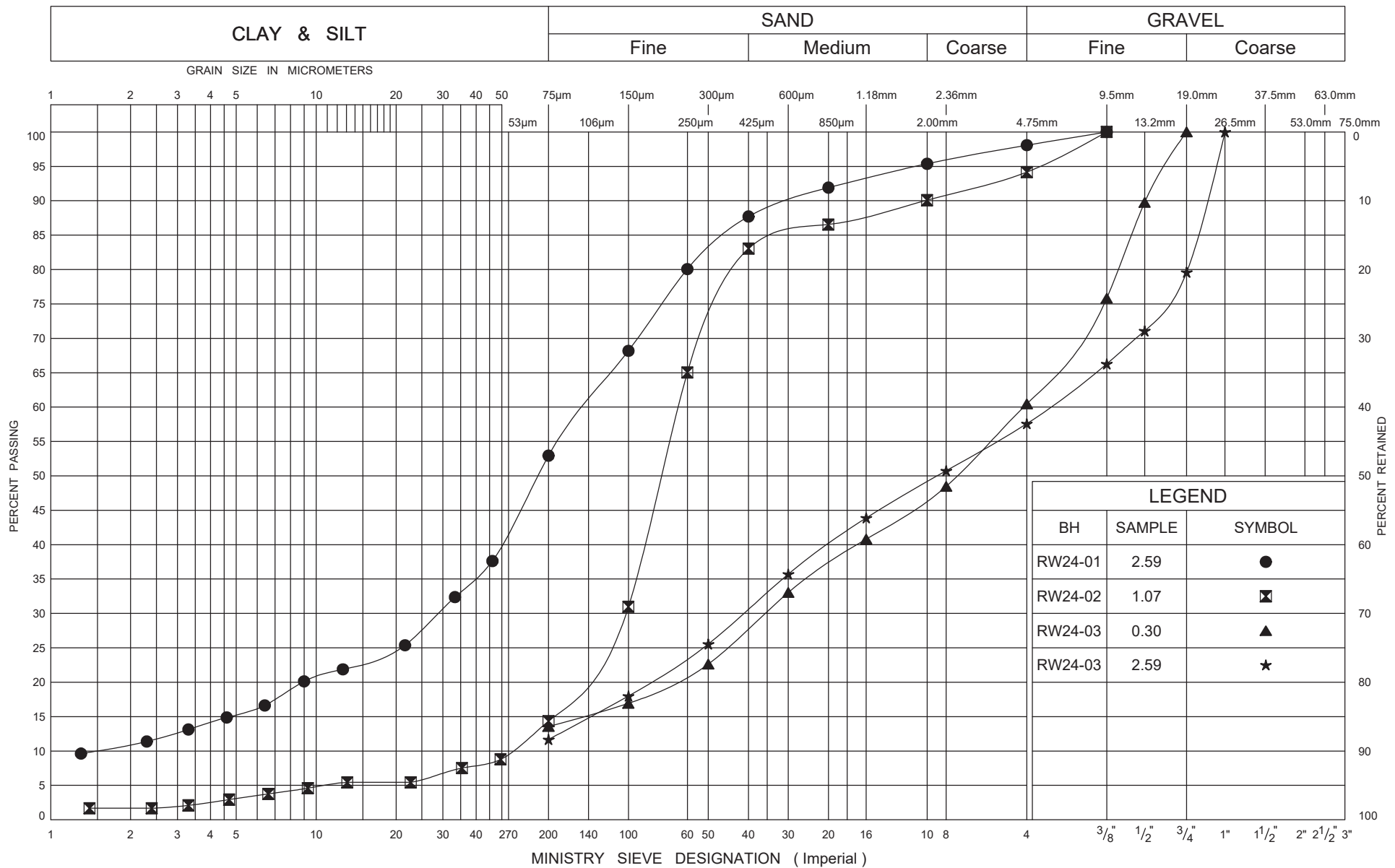
RECORD OF BOREHOLE No RW24-03

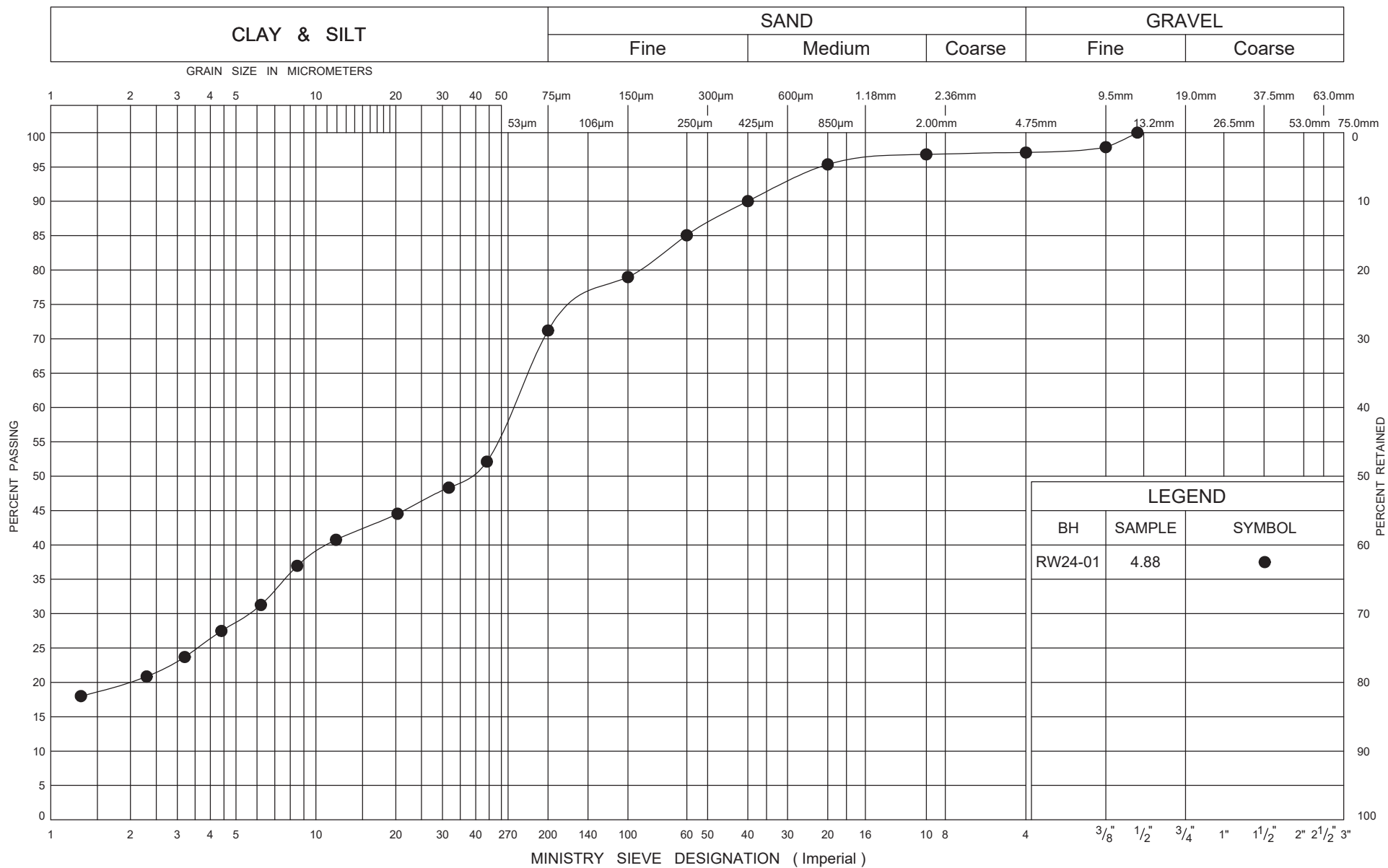
2 OF 2

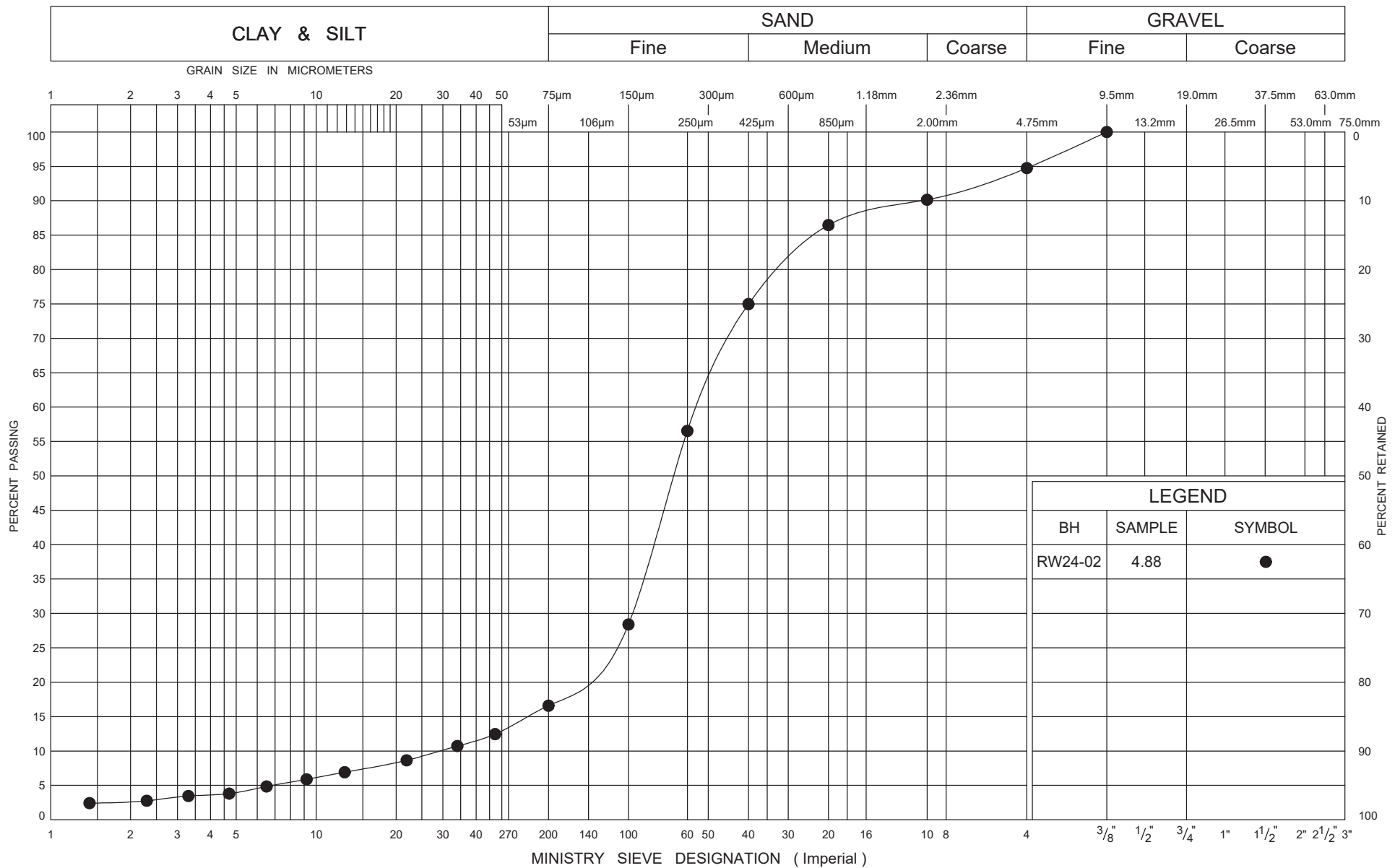
METRIC

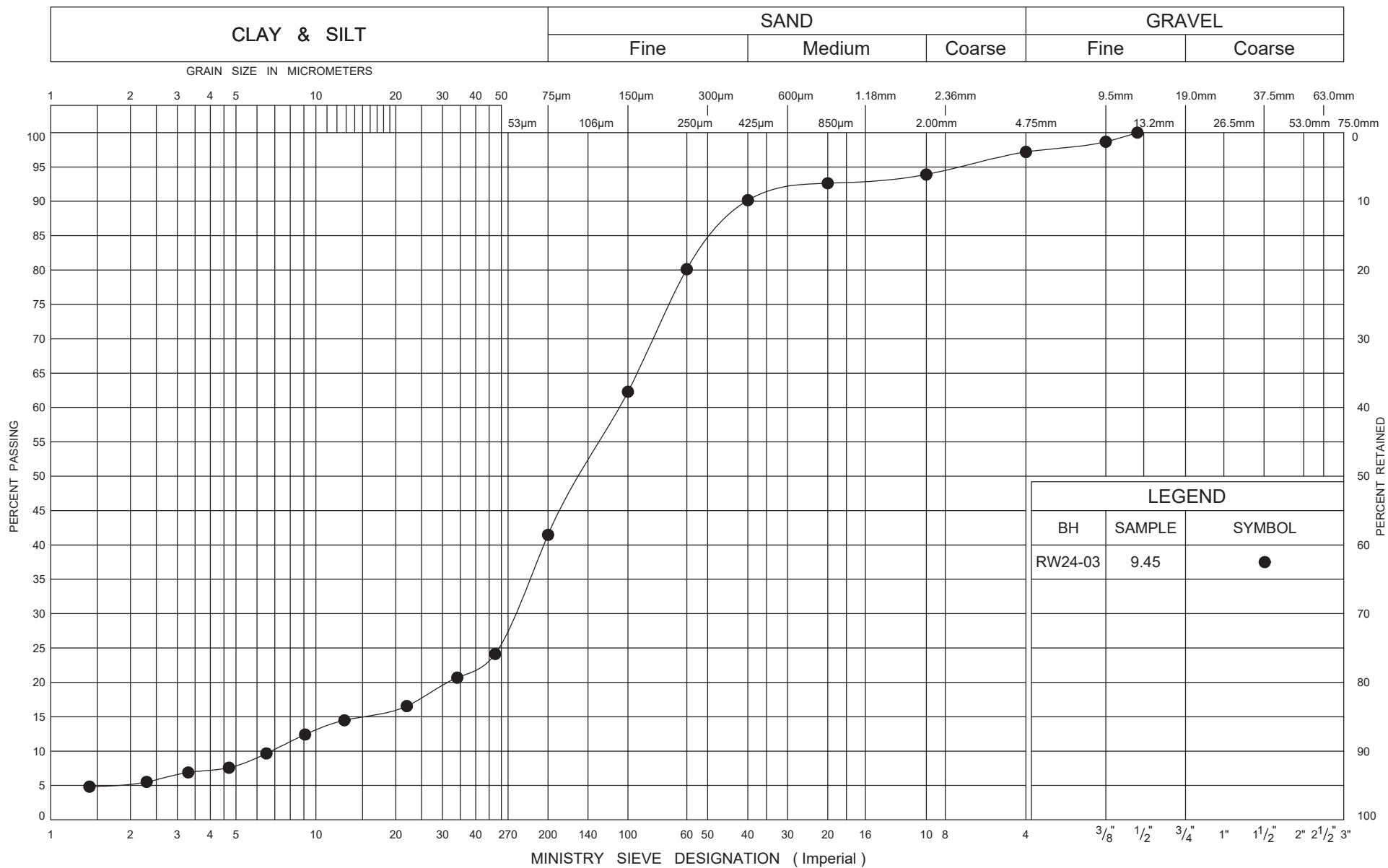
GWP# 408-88-00 LOCATION Retaining Wall 24, MTM NAD 83 Zone 10: N 4 814 766.3 E 226 047.4 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BH
DATUM Geodetic DATE 2019.09.06 - 2019.09.06 LATITUDE 43.468679 LONGITUDE -80.473272 CHECKED BY NB

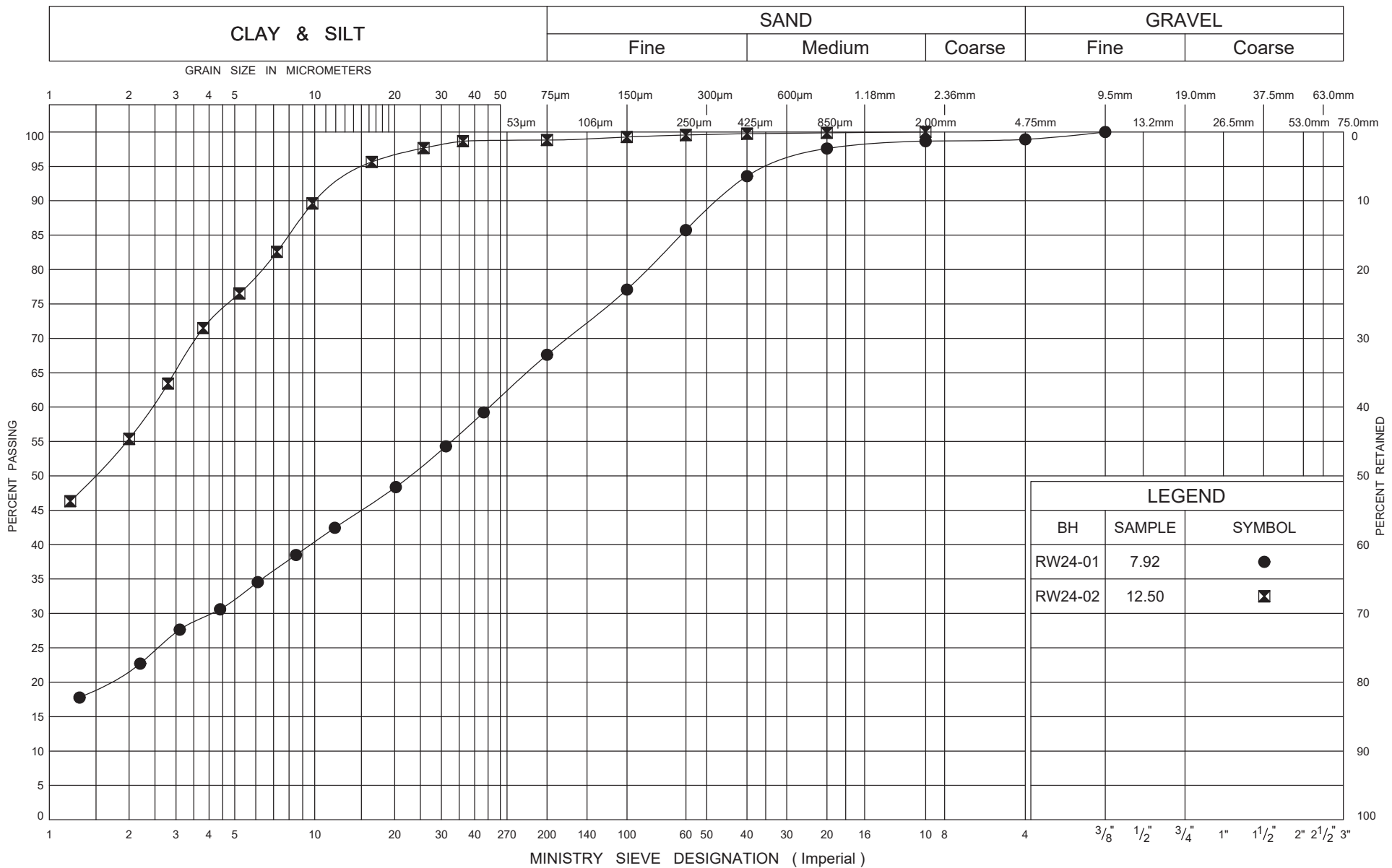
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
307.4			10	SS	38		308										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 7.5m AND WATER LEVEL AT 10.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS, THEN ASPHALT TO SURFACE.																

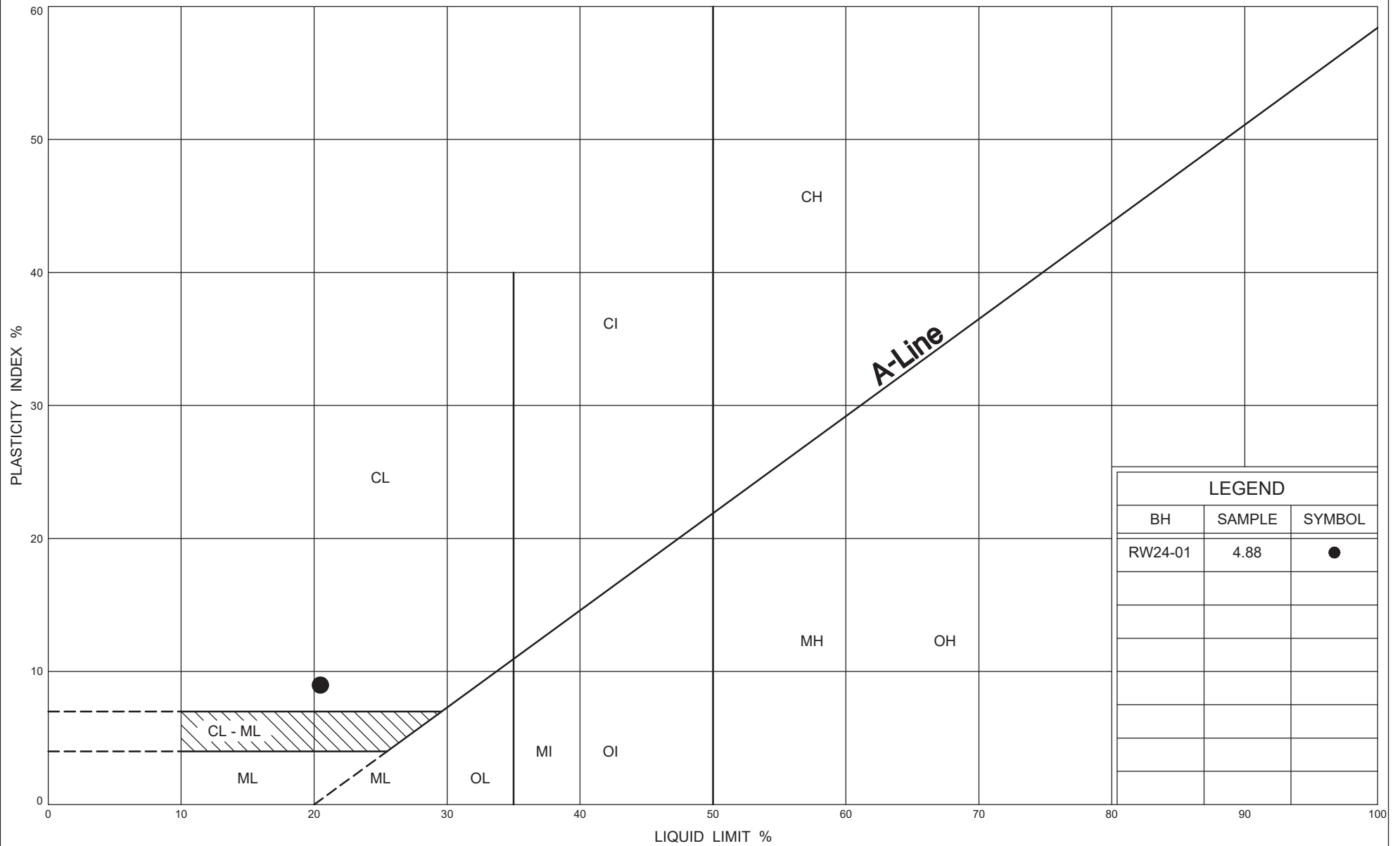


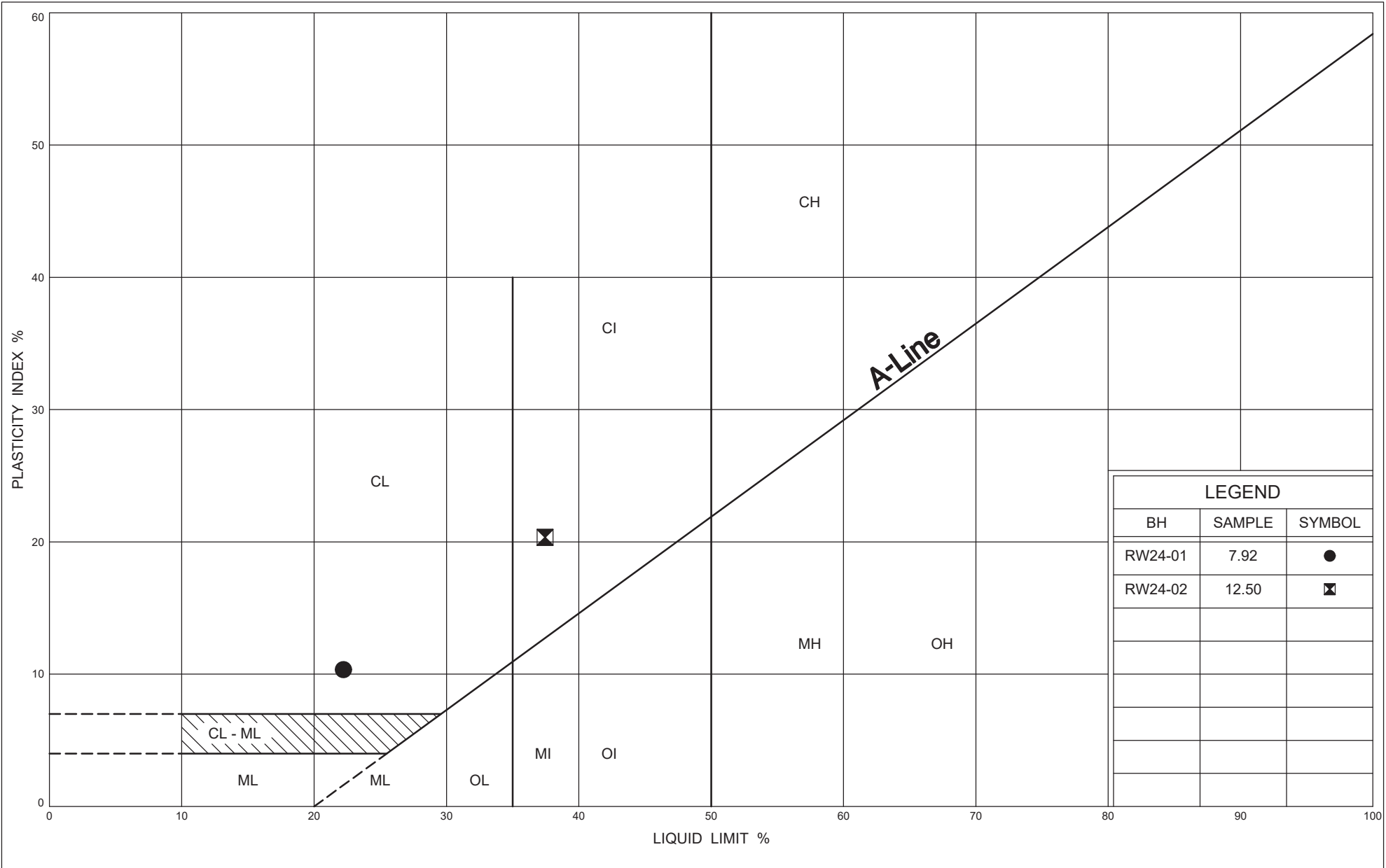








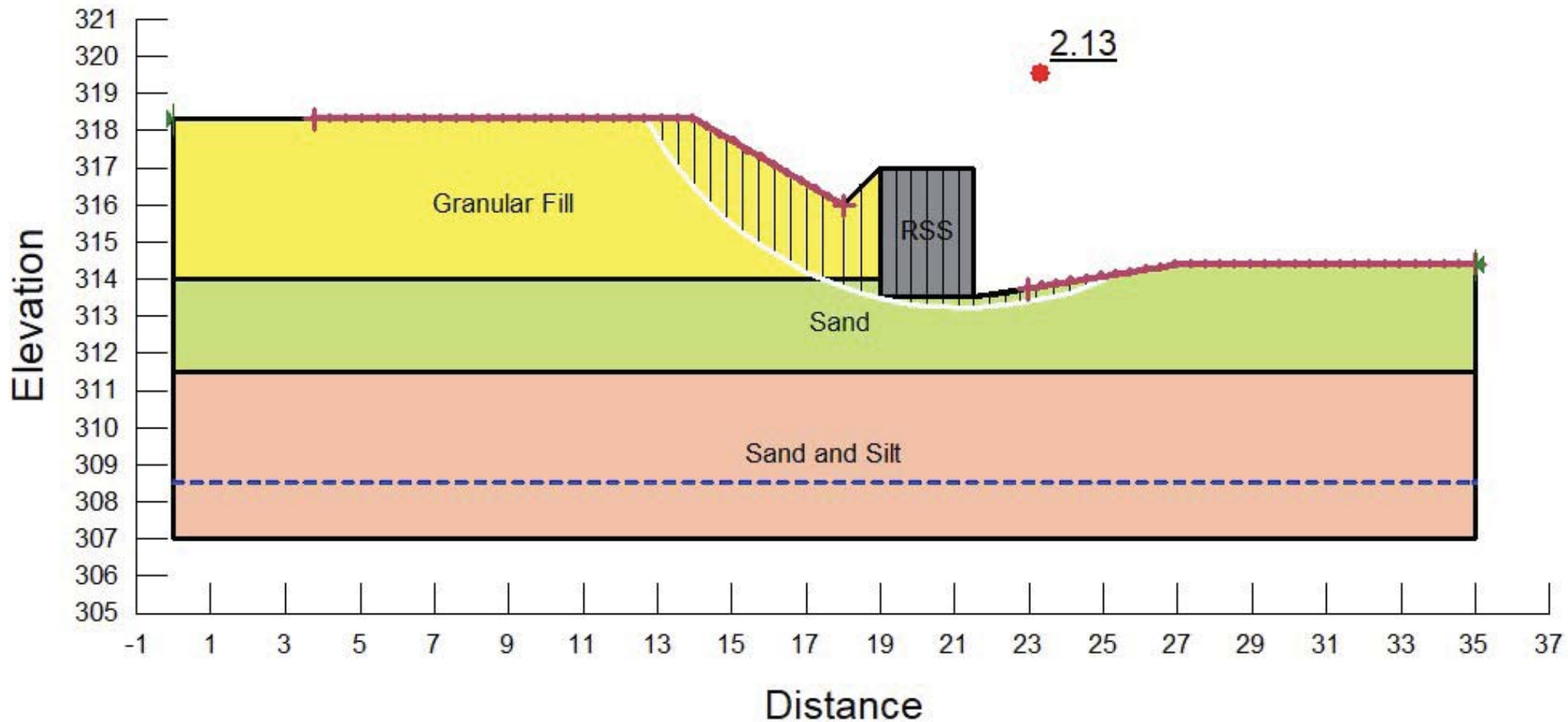




File Name: RW24 Sta 19+480.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure F8

RSS	22 kN/m ³	200 kPa	45 °
Granular Fill	21 kN/m ³	0 kPa	32 °
Sand and Silt	20 kN/m ³	0 kPa	30 °
Sand	22 kN/m ³	0 kPa	34 °



File Name: RW24 Sta 19+480.gsz

Last Edited By: Nancy Berg

Date: 2020-01-03

Method: Morgenstern-Price

Minimum Slip Surface Depth: 1 m

Horz. Seismic Coef.: 0.0485

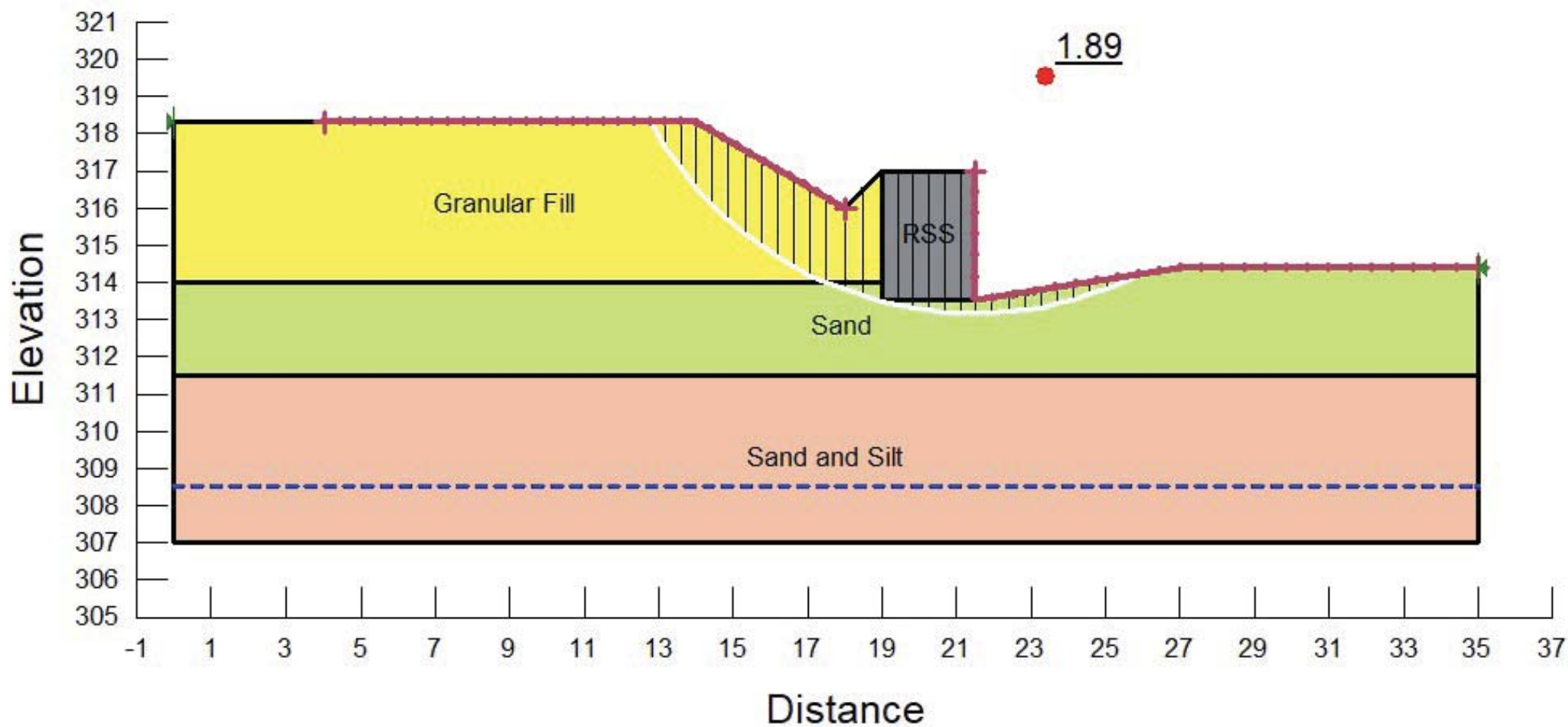
Figure F9

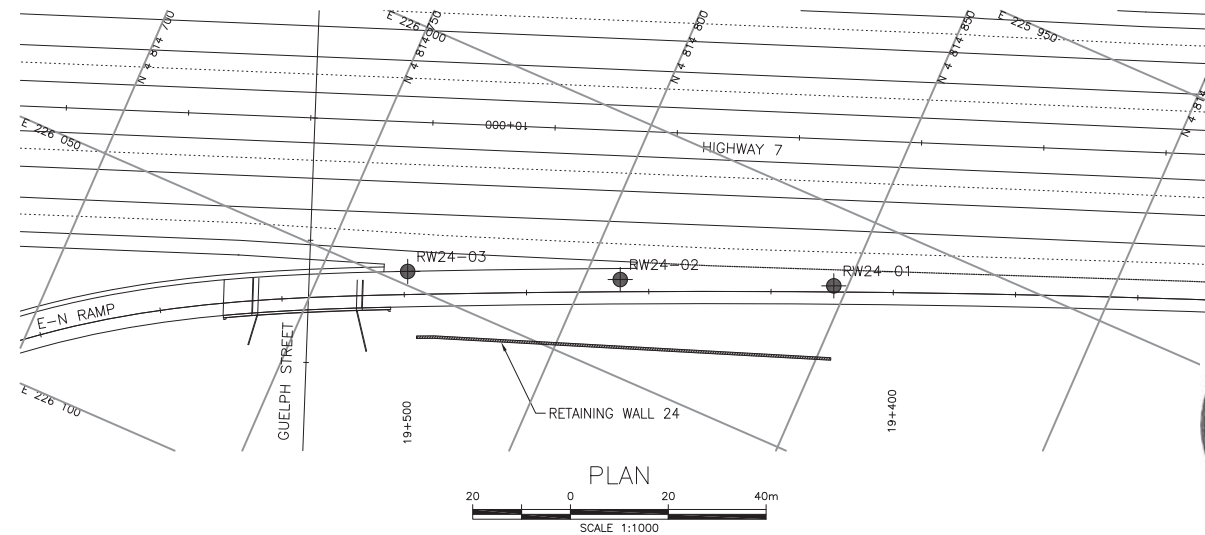
RSS 22 kN/m³ 200 kPa 45 °

Granular Fill 21 kN/m³ 0 kPa 32 °

Sand and Silt 20 kN/m³ 0 kPa 30 °

Sand 22 kN/m³ 0 kPa 34 °

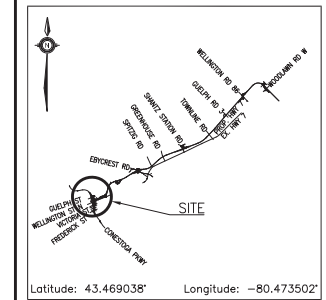









METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

HIGHWAY 7 E-N RAMP OVER GUELPH ST. RETAINING WALL 24 BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN
LEGEND

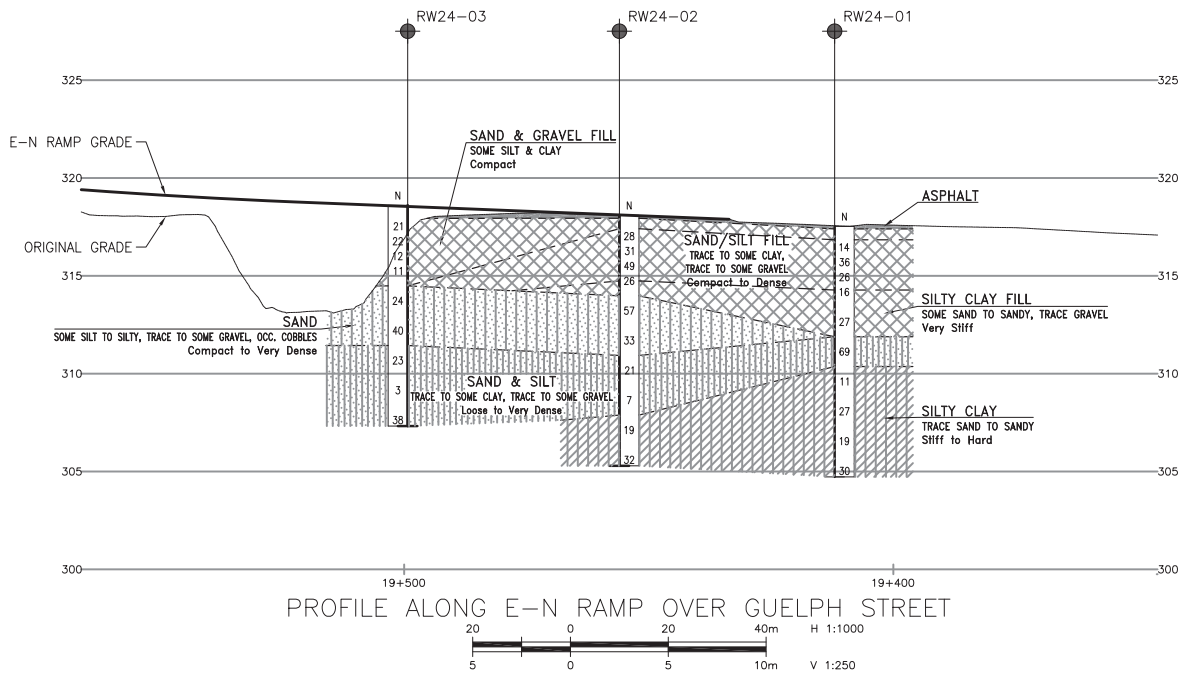
	Borehole (Current Investigation)
	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[illegible]

-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. 40P9-58



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Appendix G

Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing and Slope Stability Output

Retaining Wall 28 (RW28-01 to RW28-03)

RECORD OF BOREHOLE No RW28-01

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 453.3 E 226 205.0 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.456836 LONGITUDE -80.471249 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _p w w _L					
325.3	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (125mm)																
0.1	SAND and GRAVEL Brown Dry (FILL)		1	GS			325										
324.6																	
0.7	SAND, trace to some silt, trace clay Compact Brown Dry to Moist		2	SS	22		324										
			3	SS	21		323										
			4	SS	22		322										
	Loose Wet		5	SS	7		321										
321.1																	
4.2	Silty CLAY to Clayey SILT, some sand to sandy, trace gravel Hard Grey Moist		6	SS	47		320										
			7	SS	61		319										
							318										
317.4																	
7.8	SAND and SILT, trace clay Very Dense Grey Moist		8	SS	65		317										
			9	SS	65		316										
315.5																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW28-01

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 453.3 E 226 205.0 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.456836 LONGITUDE -80.471249 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																
	BOREHOLE OPEN TO 4.9m. WATER LEVEL AT 2.7M UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.																

RECORD OF BOREHOLE No RW28-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 494.5 E 226 191.0 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.457223 LONGITUDE -80.471445 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L				GR	SA	SI	CL			
324.4	GROUND SURFACE					▽	324															
0.0	ASPHALT: (100mm)																					
0.1	SAND and GRAVEL Brown Dry (FILL)		1	GS																		
323.7																						
0.7	SAND, trace to some silt, trace gravel, trace clay Compact Brown Dry to Wet		2	SS	23													2	87	9	2	
			3	SS	17																	
			4	SS	10																	
321.1	Occasional cobbles		5	SS	18																	
3.3	Silty CLAY to Clayey SILT, with sand, trace gravel Very Stiff to Hard Brown/Grey Moist																					
			6	SS	47														5	46	32	17
	Grey		7	SS	46																	
	Some sand		8	SS	100/ 0.275												0	18	60	22		
315.8	SAND and SILT, trace gravel Very Dense Brown Wet		9	SS	100/ 0.275																	
8.6																						
314.6																						
9.8																						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW28-02 **2 OF 2** **METRIC**

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 494.5 E 226 191.0 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.457223 LONGITUDE -80.471445 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						
	Continued From Previous Page																
	END OF BOREHOLE AT 9.8m. BOREHOLE CAVED TO 7.9m AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.																

RECORD OF BOREHOLE No RW28-03

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 538.7 E 226 177.8 ORIGINATED BY BL
DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.457615 LONGITUDE -80.471620 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										
323.6	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT: (125mm)																	
0.1	SAND and GRAVEL, some silt and clay		1	GS														
322.9	Brown																	
0.7	Dry (FILL)																	
	Silty SAND, trace gravel		2	SS	34													
	Compact to Dense																	
	Brown																	
	Dry to Moist																	
			3	SS	26													
			4	SS	30													
	Wet																	
320.4			5	SS	13													
3.3	Silty CLAY to Clayey SILT, some sand to sandy, trace gravel																	
	Stiff to Hard																	
	Brown/Grey																	
	Moist																	
			6	SS	38													
			7	SS	100/ 0.275													

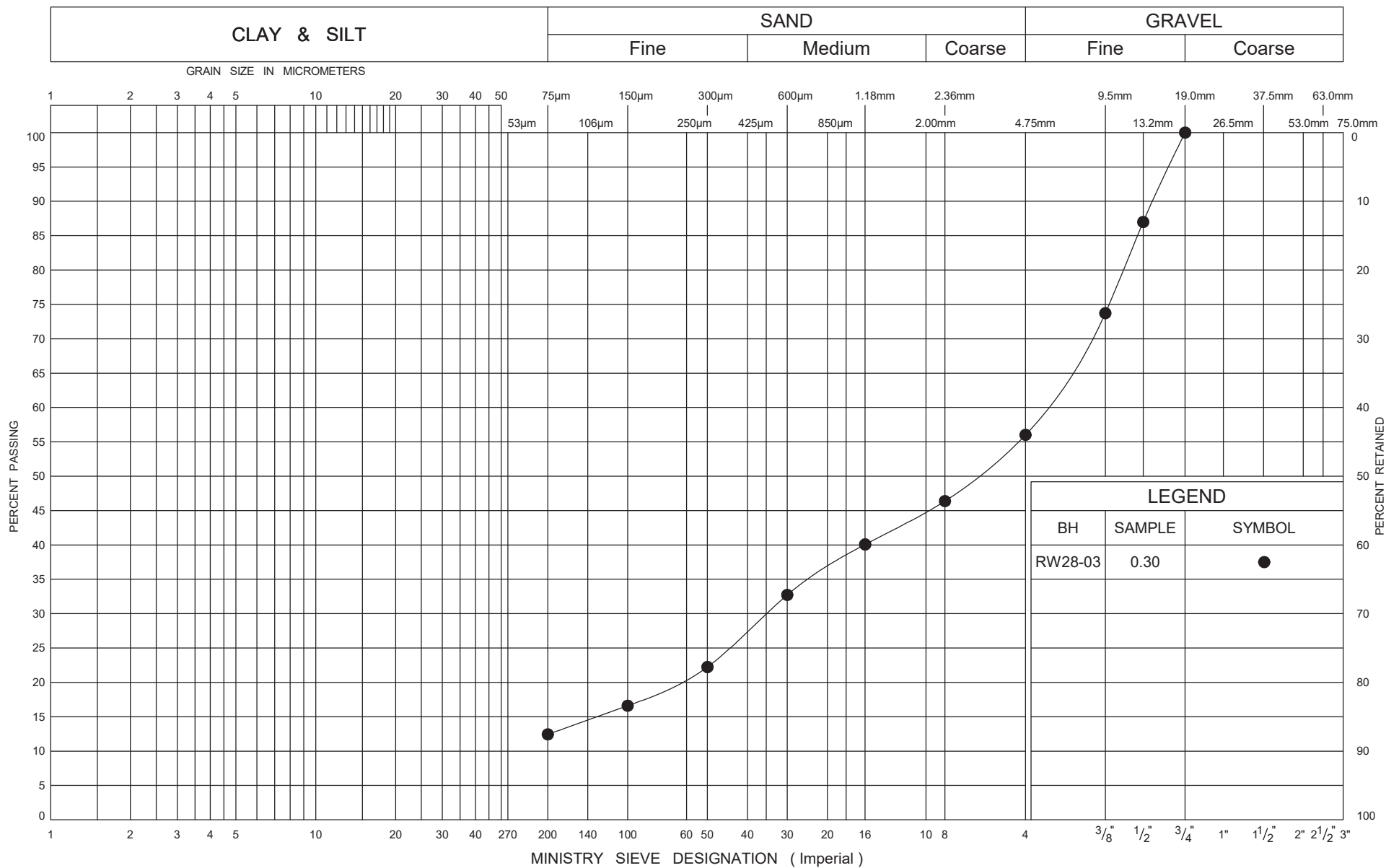
Continued Next Page

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

RECORD OF BOREHOLE No RW28-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 28, MTM NAD 83 Zone 10: N 4 813 538.7 E 226 177.8 ORIGINATED BY BL
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2019.08.11 - 2019.08.11 LATITUDE 43.457615 LONGITUDE -80.471620 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										WATER CONTENT (%)		
								20	40	60	80	100						20	40	60
Continued From Previous Page																				
312.4	SAND and SILT , trace clay Dense Brown Moist		10	SS	31		313										0 62 37 1			
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED TO 2.4m AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.																			



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Transportation

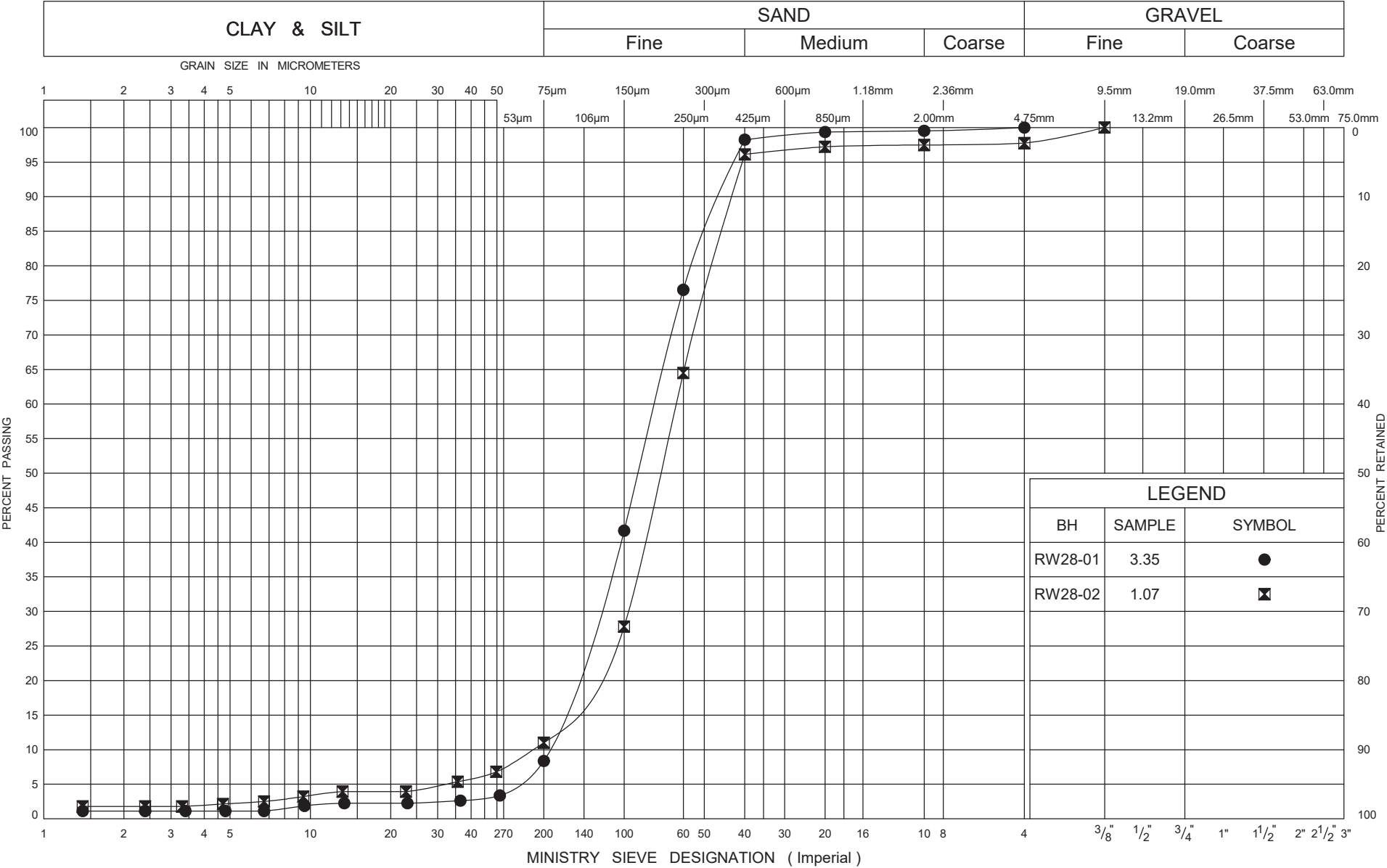
GRAIN SIZE DISTRIBUTION

Granular FILL

FIG No G1

W P 408-88-00

Retaining Wall 28

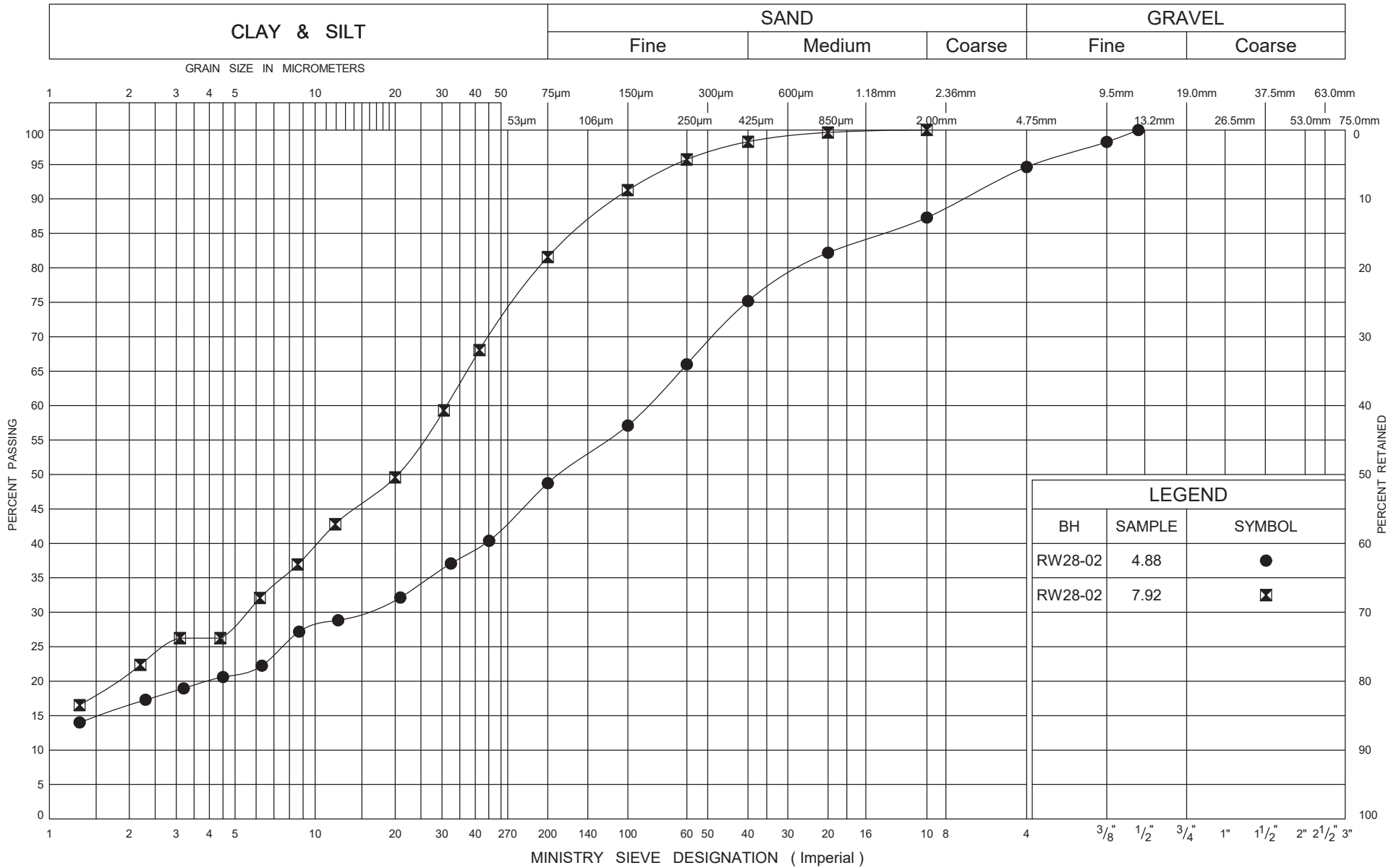


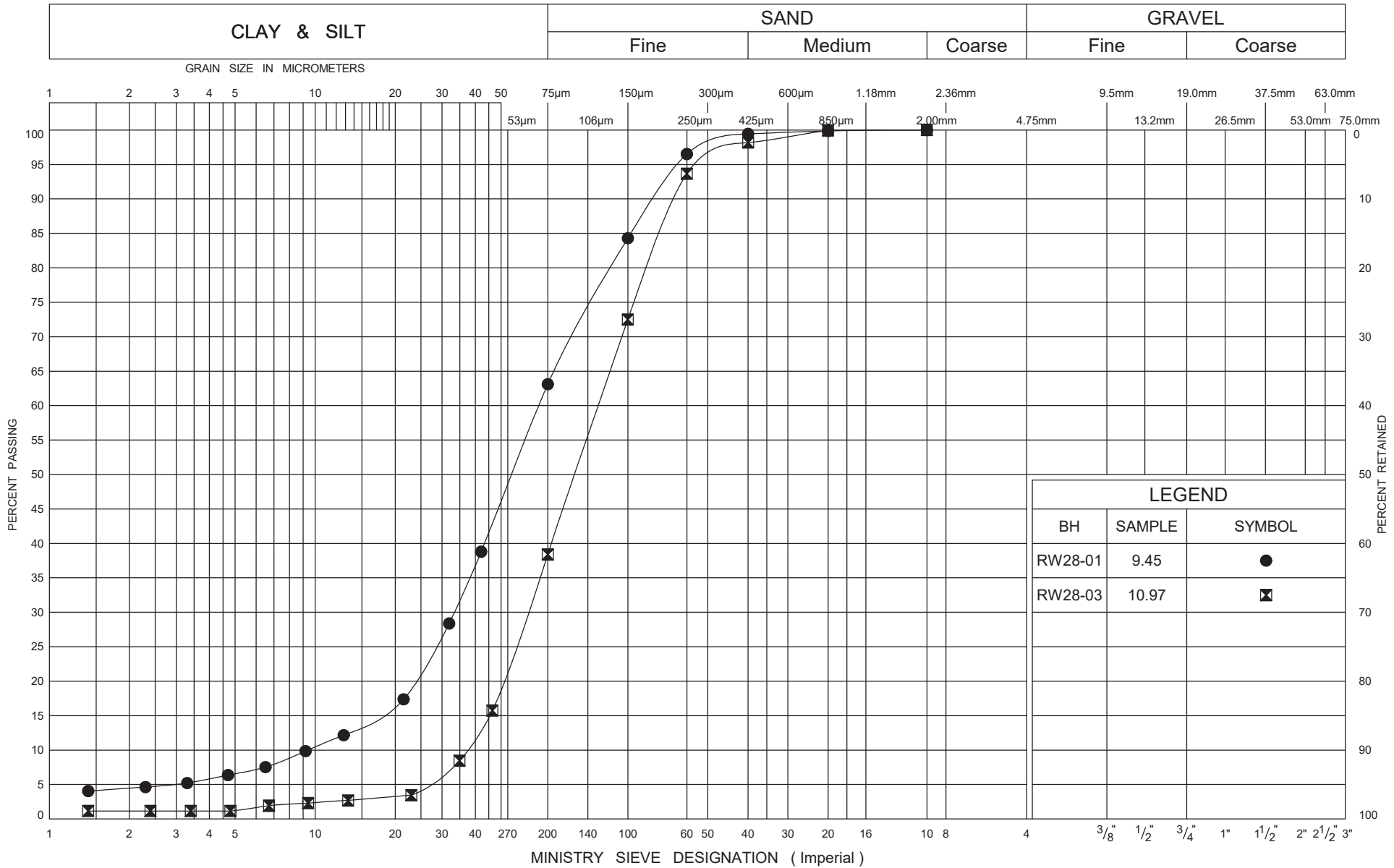
LEGEND		
BH	SAMPLE	SYMBOL
RW28-01	3.35	●
RW28-02	1.07	⊠

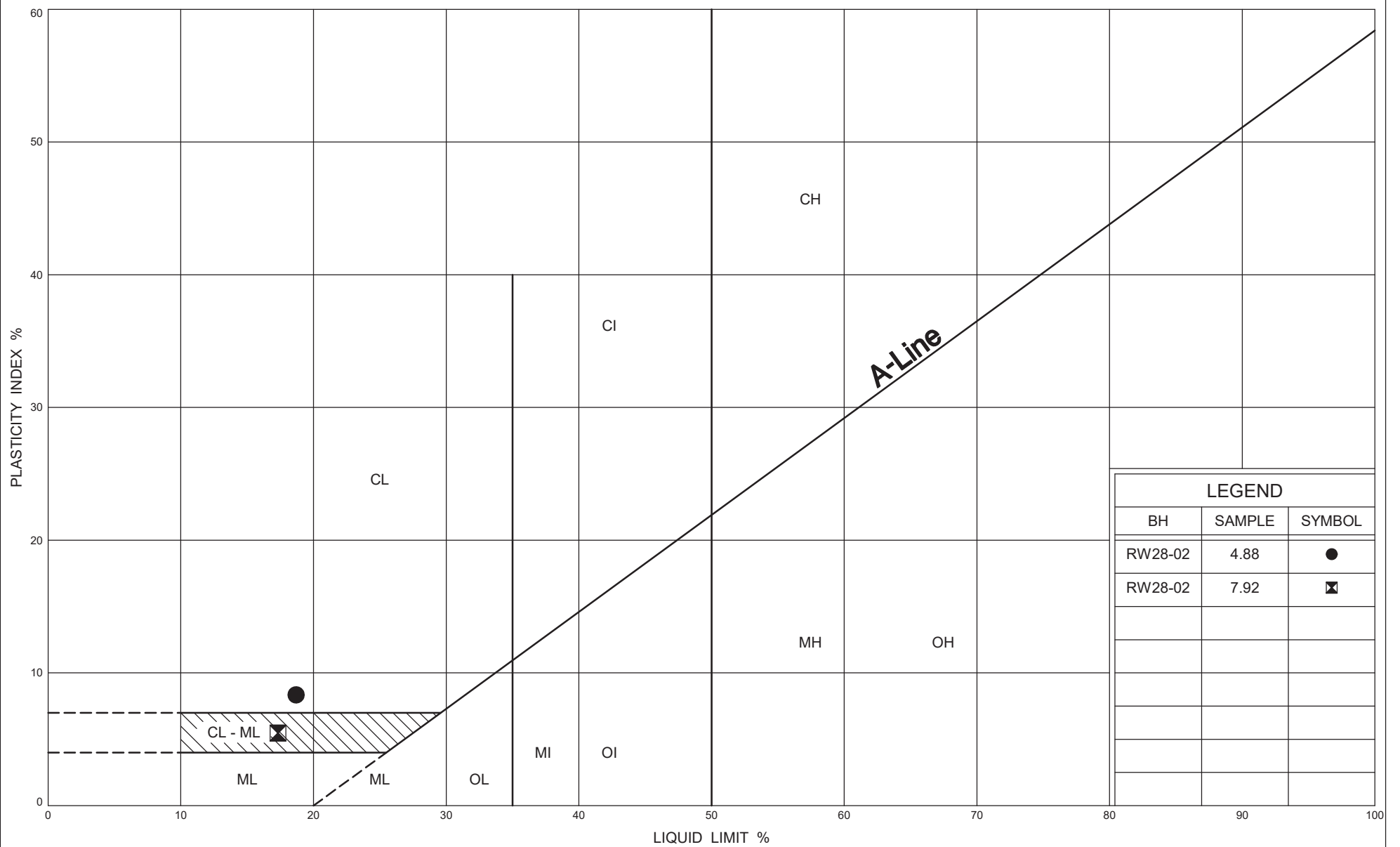


GRAIN SIZE DISTRIBUTION
SAND

FIG No G2
W P 408-88-00
Retaining Wall 28







PLASTICITY CHART

Silty CLAY to Clayey SILT

FIG No G5

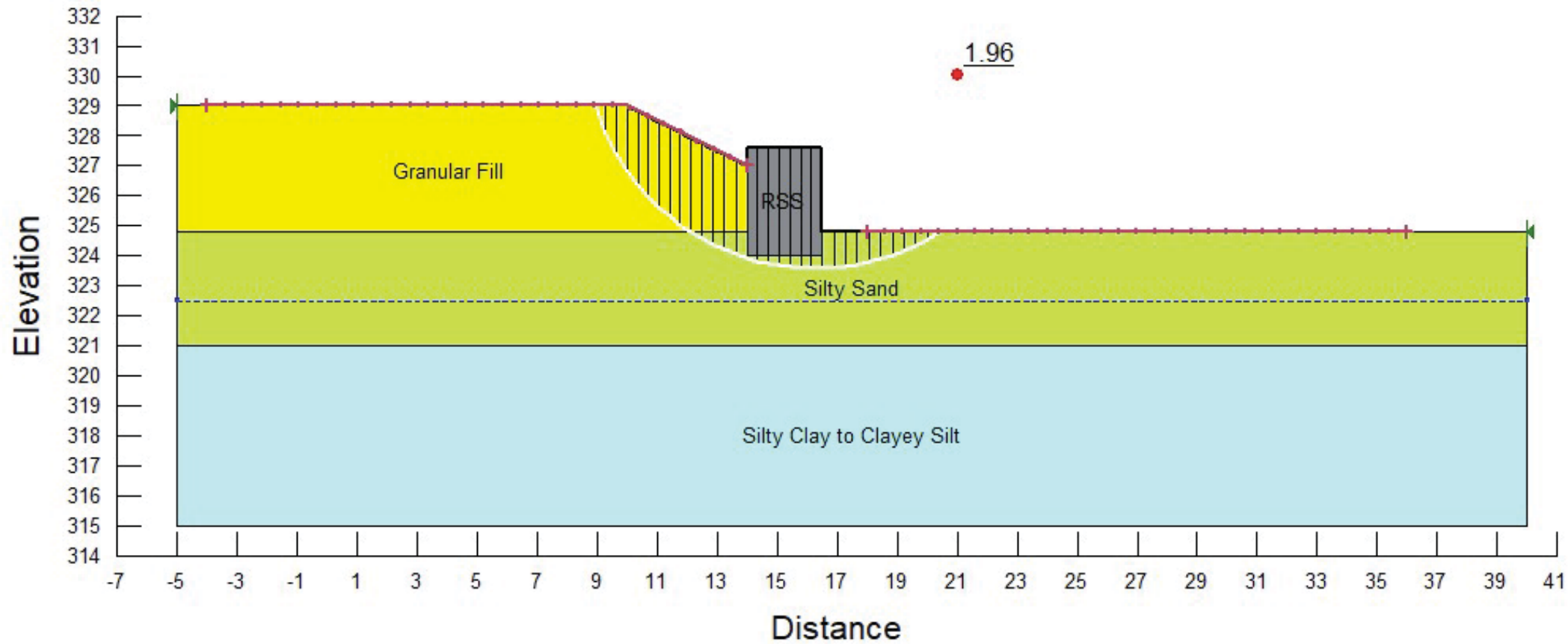
W P 408-88-00

Retaining Wall 28

File Name: RW28 Sta 21+063.12.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure G6

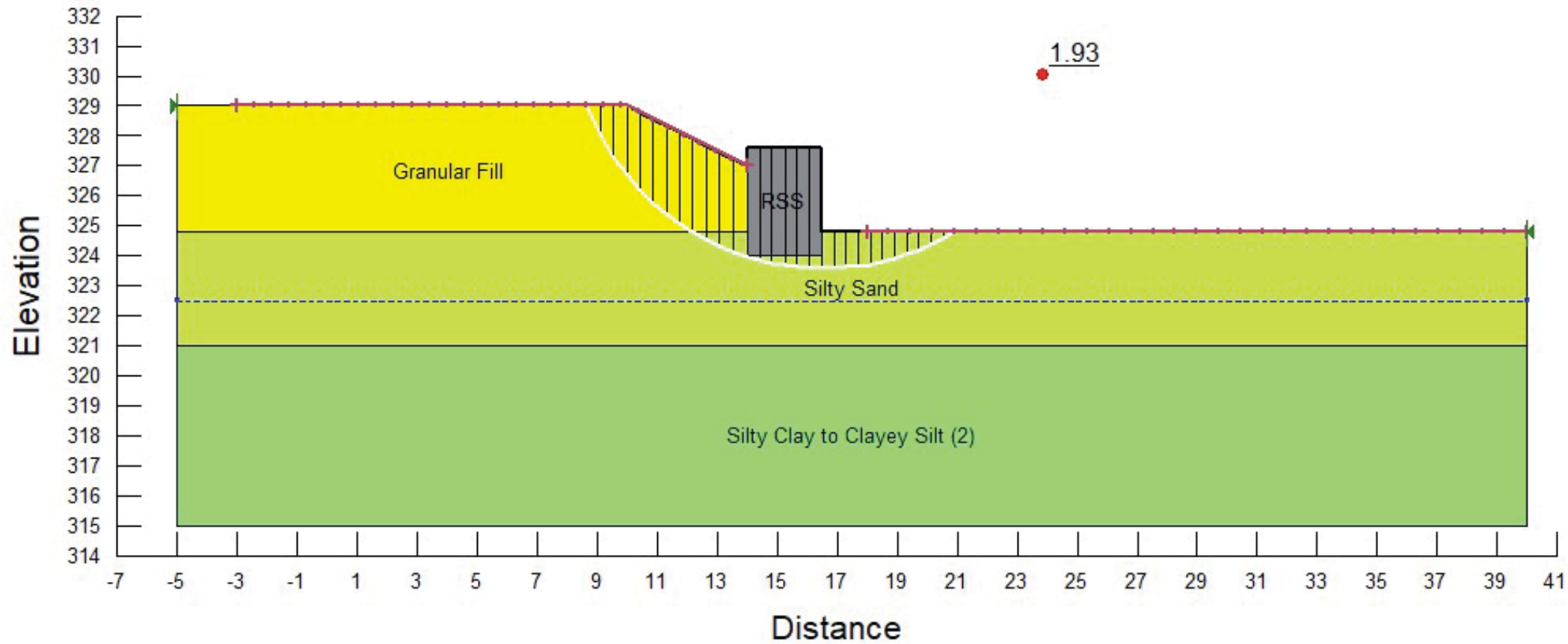
Silty Sand 20 kN/m³ 0 kPa 31 °
RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 30 °
Silty Clay to Clayey Silt 20 kN/m³ 200 kPa



File Name: RW28 Sta 21+063.12.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure G7

Silty Sand 20 kN/m³ 0 kPa 31 °
RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 30 °
Silty Clay to Clayey Silt (2) 20 kN/m³ 5 kPa 34 °



File Name: RW28 Sta 21+063.12.gsz

Last Edited By: Nancy Berg

Date: 2020-01-03

Method: Morgenstern-Price

Minimum Slip Surface Depth: 1 m

Horz. Seismic Coef.: 0.0485

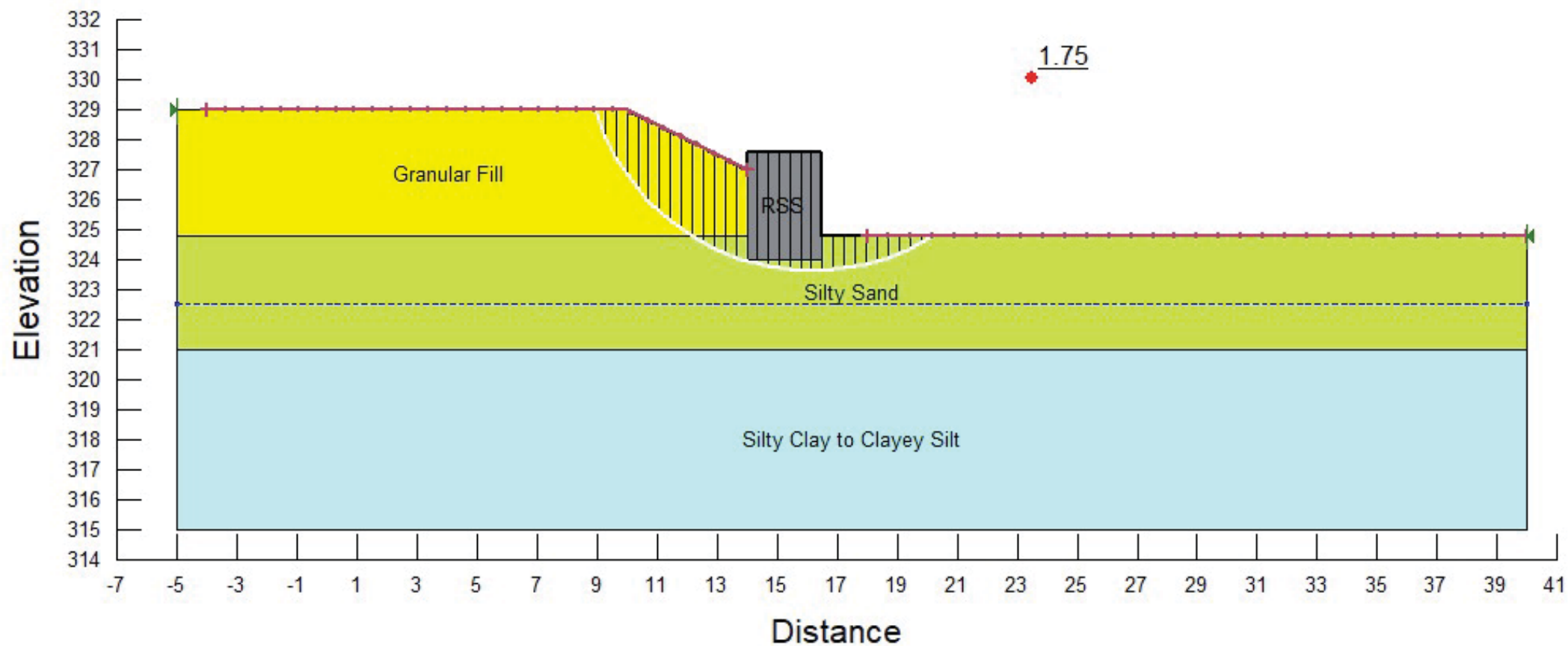
Figure G8

Silty Sand 20 kN/m³ 0 kPa 31 °

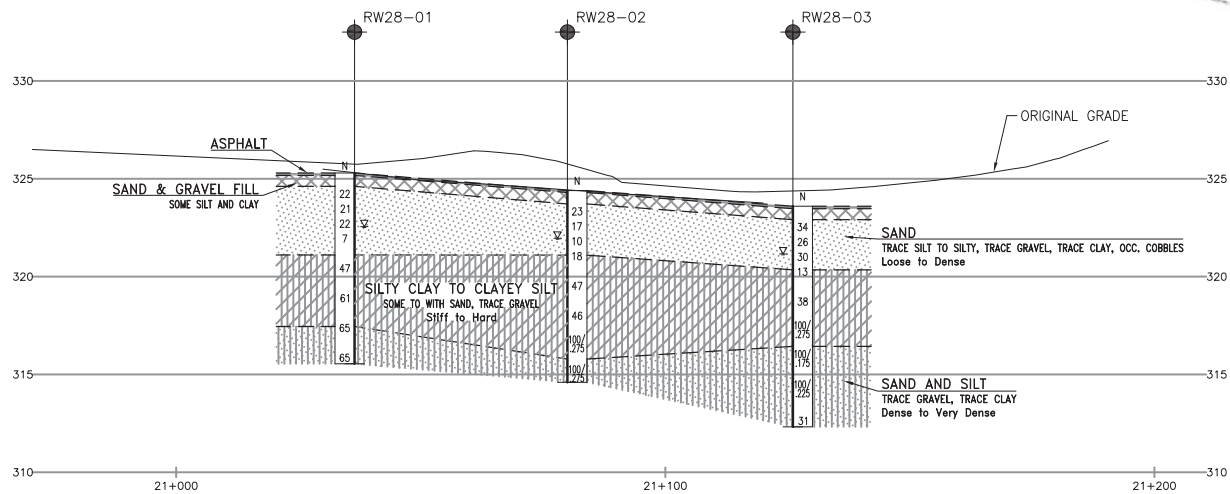
RSS 22 kN/m³ 200 kPa 45 °

Granular Fill 21 kN/m³ 0 kPa 30 °

Silty Clay to Clayey Silt 20 kN/m³ 200 kPa



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Appendix H

Corrosivity and Sulphate Test 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
<p>Temperature of Sample upon Receipt: 8 degrees C</p> <p>Cooling Agent Present: No</p> <p>Custody Seal Present: No</p> <p>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.</p>


SIGNATORIES
<p>Deanna Edwards, B.Sc, C.Chem</p> 

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QC Summary.....	5-6
Legend.....	7
Annexes.....	8-9



FINAL REPORT

CA14058-MAY18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocio Palomeque

Samplers: N/A

PACKAGE: - Corrosivity Index (SOIL)

Parameter Corrosivity Index

Parameter	Units	RL	Sample Number	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result
Corrosivity Index	none	1	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Soil Redox Potential	mV	-	230	182	182	274	274	164	164	133	133	232	232	215	215	215	215	215	215	215
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 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	9.11	9.04	9.04	9.19	9.19	8.50	8.50	9.11	9.11	9.25	9.25	9.25	9.25	9.25	9.25	9.25
Resistivity (calculated)	ohms.cm	-9999	4610	17100	17100	6670	6670	13200	13200	5250	5250	13400	13400	10100	10100	10100	10100	10100	10100	10100

PACKAGE: - General Chemistry (SOIL)

Parameter General Chemistry

Parameter	Units	RL	Sample Number	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result
Conductivity	uS/cm	2	217	59	59	150	150	76	76	190	190	75	75	99	99	99	99	99	99	99

PACKAGE: - Metals and Inorganics (SOIL)

Parameter Metals and Inorganics

Parameter	Units	RL	Sample Number	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result	Sample Name	Sample Matrix	Sample Date	Result
Moisture Content	%	0.1	9.3	4.4	4.4	11.3	11.3	8.3	8.3	13.4	13.4	4.1	4.1	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Sulphate	µg/g	0.4	15	1.1	1.1	13	13	5.5	5.5	11	11	4.0	4.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7



Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Other (ORP) (SOIL)

Parameter	Units	RL	Result	Result	Result	Result

Parameter

Other (ORP)

4 / 9



FINAL REPORT

CA14058-MAY18 R1

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIIC-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 (%)	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 (%)	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 (%)	Low	High
pH	EWL0048-MAY18	no unit	0.05	NA	1		100			NA		



FINAL REPORT

CA14058-MAY18 R1

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

No:

Page 1 of 1

SGS Environmental Services

- Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Toll Free: 877-747-7658 Fax: 705-652-6365

- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com

Received By: /s/ mail

Received Date (mm/dd/yyyy): 05/02/18 (mm/dd/yyyy)

Received Time: 11:00 AM

Received By (signature):

Custody Seal Present: ☐ No ☐ NoCustody Seal Intact: ☐ No ☐ No

Laboratory Information Section - Lab use only

Cooling Agent Present: ☐ No

Temperature Upon Receipt (°C) 12.1/1.0

LAB LIMS #:

8x3

CA14058-May 19

REPORT INFORMATION

Company: Thirber Eng.

Contact: Rojo Palomede Reyna

Address: 103-2010 Winston Park Dr

Oakville, ON L6H 5R7

Phone:

Fax:

Email: rreyna@thirber.ca

INVOICE INFORMATION

(same as Report Information)

Company:

Contact:

Address:

Phone:

Email:

PROJECT INFORMATION

Quotation #:

11375

Project #:

P.O. #:

Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☐ Regular TAT (5-7 days) TAT's are quoted in business days (exclude statutory holidays & weekends).

Samples received after 3pm on weekends: TAT begins the next business day

☐ RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

Rush Confirmation ID:

REGULATIONS

Regulation 153 (2011):

☐ Table 1 ☐ Res/Park ☐ Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

Other Regulations:

☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA

Sewer By-Law:

☐ Sanitary☐ Storm

Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

SAMPLE IDENTIFICATION

DATE SAMPLED

TIME SAMPLED

OF BOTTLES

MATRIX

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	RW12-05	Apr 24/18		1	Soil
2	RW10-04	Apr 18/18		1	"
3	RW09-02	Apr 11/18		1	"
4	NE16-16	Apr 13/18		1	"
5	RW13-01	Apr 14/18		1	"
6	SE16-05	Apr 12/18		1	"
7	ES16-06	Apr 23		1	"
8					
9					
10					

Observations/Comments/Special Instructions

ANALYSIS REQUESTED

PHC F1-F4 BTEX

O.Reg 153 Metals (CP & hydride metals)

☐ Hg ☐ B-HWS ☐ Cr(VI)

O.Reg 153 VOCs

COMMENTS:
Field Filtered (F)
Preserved (P)

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

Sampled By (NAME):

Signature:

Relinquished by (NAME):

Signature:

Revision #: 1.0

Date of Issue: 01 June, 2014

Date:

(mm/dd/yy)

Pink Copy - Client

Date:

(mm/dd/yy)

Yellow & White Copy - SGS



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

Sediment Log

- | | | | | | | | |
|----------------------------------------------------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Groundwater samples contain visible sediment / particulate | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Groundwater contains greater than 1cm of sediment / particulate matter in bottle | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Additional Comments/Remarks:

No Issues upon receipt



Initials:

BM



FINAL REPORT

CA14209-NOV19 R1

11375, Hwy 7 New, Kitchener

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Brad Moore Hon. B.Sc
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7, Canada	Laboratory	SGS Canada Inc.
Contact	Nancy Berg	Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	905-829-8666 x 228	Telephone	705-652-2143
Facsimile		Facsimile	705-652-6365
Email	nberg@thurber.ca	Email	brad.moore@sgs.com
Project	11375, Hwy 7 New, Kitchener	SGS Reference	CA14209-NOV19
Order Number		Received	11/07/2019
Samples	Soil (3)	Approved	11/13/2019
		Report Number	CA14209-NOV19 R1
		Date Reported	11/13/2019

COMMENTS
<p>Temperature of Sample upon Receipt: 18 degrees C</p> <p>Cooling Agent Present: Yes</p> <p>Custody Seal Present: No</p> <p>Chain of Custody Number: 009973</p> <p>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.</p>

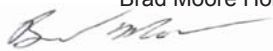
SIGNATORIES
<p>Brad Moore Hon. B.Sc</p> 

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Legend.....	8
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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

Ut hds: 3EPA/ 55.UA/ 55-Ni b1/ RRRHt a l fñt I3UE-CA-DEM INC-LAK-AM-551

Utids: 3AQURE1817-52A
Id: 1E-CA-NEM 1AFD-LAK-AM-505

5 / 9

Utlds: 30UR0715PFWIt al fnt 13UE-CA-DEM 1EWL-LAK-AM-559

Model name	Type of RFI	Side	FL	Units: RFI	Duplication		LCQ: Qdct RFI			UI: Qdct RFI		
					FPD	AC (%)	Qdct RFI (%)	Ftcsvt æRlndbR (%)		Qdct RFI (%)	Ftcsvt æRlndbR (%)	
								Lsw	Hgd		Lsw	Hgd
Csi : uch	EWL51/ 2-MY 18	uQ.cm	0	6R	/	15	151	85	115	MA		
Csi : uch	EWL5128-MY 18	uQ.cm	0	6R	550	5	15	88	85	115	MA	

Ut hds: 30UR755RNN It a l fcl l 3UE-CA-DEM IEWL-LAK-AM-551

Parameter	Turbidity Filtration	Silt Load	Flow Rate	Units: R B/L	Duplicate		LCQ: Qpdt R/B/L			UI: Qpdt R/B/L		
					FPD	AC (%)	Qpdt Ftcsvt æ (%)	Ftcsvt æ R (%)		Qpdt Ftcsvt æ (%)	Ftcsvt æ R (%)	
								Lsw	Hgd		Lsw	Hgd
pH	EWL51/2-MY 18	pH: 5.1	5/57	MA	5		155			MA		
pH	EWL5128-MY 18	pH: 5.1	5/57	MA	5		155			MA		



TCSUAFn

Ut hds: Bfl i k3R fyll i kRnl hœRdl HœRdl aad: RldasugdRdt Ri hat Ri i felhel ffpasct: ua |RStbt: RSRbbt bbR ysa hsæRsi H mœ l hsi |

Dupfœl It 3ÆRl at: Ri i febdœR[R Rbt pl d It fœsæsi R[Rdt Rbl mt Rbl mpft Rdl HœRdl aad: RldasugdRdt Ri hat Ri i felhel ffpasct: ua |RStbt: RSRvl ful It Rnt l bua mt i Hpa cœasi |

LCQ.Qpdt Bfl i k3Rl ysa hsæRsi hasffbl mpft RæRpdkt fyll i kRl [t æR R fyll i kRnl hœR RvdœdR Ri swi Rmsui Hs[Ri i felt Rl bÿt t i R:: t: |RStbt: RSRvl ful It Ri i felt Rl csvt æRi: Rl ysa hsæRccua ceRvdœsulRl mpft Rnl hœRl[[t chb]

Ul hœRQpdt 3ÆR Rbl mpft R RvdœdR Ri swi Rmsui Hs[Rdt Ri i felt Rl [R It æ bRl bÿt t i R:: t: |RStbt: RSRvl ful It Rl ysa hsæRccua ceRvdœRl mpft Rnl hœRl[[t chb]

Ft [t æ i ct RU It æ 3Æ Rnl It æ fœaBuybH i ct Rnl hœRnl hœdt: RSRdt Rbl mpft bRdl Hæsi H œ bR Ri swi Rmsui Hs[Rdt Ri i felt Rl [R It æ b]RæRl [t æ i ct Rnl It æ fœRl eÿt Rbt: R Rnl ct R[R Rnl hœRpdkt |

FL3Æ t psæ gRœdœ

FPD3Æ t fl hœt Rbt act i R R [t æ i ct

AC3Æ cœt pH i ct Rædt æb

Uufœl It mt l Hœl l R ul fœ æR bRdt R umyt æR[Ri i felt bR R Rcl i Rœ cat l bt b,RsRst bRdt Rdl i ct R[R RœndRœ xct t: l i ct fœRl i: smRdl i ct R bRppsbt: RSR Rl fRnt hds: fœasyt m[Rœdub,Rœ Rnuftœ It mt i Hœl i b,RsæRdt R CœRi: Rnl hœRpdkt , RœpR R 5% R[Rdt R

l i i felt bRnl eRœt t: Rdt Rœst: Rœndb fœRœpR R 5% R ybsfult Ri: Rdt Rpdkt RœRsi bo t æ: Rœct pH yft |

Dupfœl It R ul fœ æR æR upfœl It bR bRdt Rnt l bua: Rl buftRppæ l cœt bRdt R L,Rdt Rœi ct æl œ hœR bbsœ It: RvdœRdt Rl fut Rœ cat l bt bR æ ml hœl fœ,RœubR upfœl It Rœct pH i ct RœndbRppfœRi fœRvdt æ Rdt Rvt æ gt R[Rdt RœsR upfœl It bRœgæ l It æRl i Rœt Rœnt bRdt R L|R

Ul hœRQpdt R ul fœ æR æR hœRpdkt b,R bRdt Rœi ct i hœ hsi R[Rdt Rl hœt Ri i felt Rœ cat l bt b,Rdt Rœi ct æl œ hœR[Rdt Rnl hœRpdkt Rl csvt æRœ cat l bt b]Rœdub,Rdt Rnl hœRpdkt Rœct pH i ct RœndbRppfœRi fœRvdt i Rdt Rœi ct i hœ hsi R[Rdt Rnl hœRpdkt Rœgæ l It æRl i RœR t qul RœRdt Rœi ct i hœ hsi R[Rdt Rl hœt Ri i felt |



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 Detected

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 --

Request for Laboratory Services and CHAIN OF CUSTODY

No: 009973

Page ____ of ____

Received By: Amrmed Al-Madallawi
 Received Date (mm/dd/yyyy): 11/03/19 (mm/dd/yyyy)
 Received Time: 4:15

Received By (signature): [Signature]
 Custody Seal Present: ☒ Yes
 Custody Seal Intact: ☒ Yes

Cooling Agent Present: ☒ Yes
 Temperature Upon Receipt (°C): 18.18, 18.1

LAB LIMS #: CA 14209-NORM19

REPORT INFORMATION

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

INVOICE INFORMATION

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

REGULATIONS

Regulation 153/04:
☐ Table 1 ☐ R/P/I ☐ Soil Texture: _____
☐ Table 2 ☐ I/C/C ☐ Coarse ☐ PW/O ☐ M/MER
☐ Table 3 ☐ A/O ☐ Medium ☐ C/CME ☐ Other: _____
☐ Table _____ ☐ Fine ☐ MISA _____

Sewer By-Law:

☐ Sanitary
☐ Storm
☐ Municipality: _____

RECORD OF SITE CONDITION (RSC)

☐ YES ☐ NO

SAMPLE IDENTIFICATION

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1 RW02-04 SS#3	Sept. 23/19		1	Soil
2 RW16-04 SS#2	Aug 28/19		1	Soil
3 RW01-02 SS#4	Sept 24/19		1	Soil
4				
5				
6				
7				
8				
9				
10				
11				
12				

Observations/Comments/Special Instructions

Sampled By (NAME): Nancy Berg
 Relinquished by (NAME): _____

Signature: [Signature]
 Signature: _____

Date: 11/05/19 (mm/dd/yyyy)
 Date: ____/____/____ (mm/dd/yyyy)

Pink Copy - Client
 Yellow & White Copy - SGS

Quotation #: _____

Project #: 11375

P.O. #: _____

Site Location/ID: Hwy 7 New, Kitchener

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7 days)

TAT's are quoted in business days (exclude statutory holidays & weekends).
 Samples received after 6pm or on weekends: TAT begins next business day

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: _____

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

ANALYSIS REQUESTED

Field Filtered (Y/N)	
Metals & Inorganics	
PAH <input type="checkbox"/> ABN <input type="checkbox"/> SVOC(all) <input type="checkbox"/>	
PCB Total <input type="checkbox"/> Aroclor <input type="checkbox"/>	
PHC F1-F4 <input type="checkbox"/> VOC <input type="checkbox"/>	
BTEX <input type="checkbox"/> BTEX/F1 <input type="checkbox"/> F2-F4 <input type="checkbox"/>	
VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM <input type="checkbox"/>	
Pesticides OC <input type="checkbox"/> OP <input type="checkbox"/>	
TCLP M&I <input type="checkbox"/> VOC <input type="checkbox"/> PCB <input type="checkbox"/>	
B(a)P <input type="checkbox"/> ABN <input type="checkbox"/> Ignit. <input type="checkbox"/>	
Water Pkg Gen. <input type="checkbox"/> Ext. <input type="checkbox"/>	
Sewer Use: <u>corrosivity</u>	

COMMENTS:



FINAL REPORT

CA14437-AUG19 R1

11375 Hwy 7 New, Kitchener

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Rob Irwin B.Sc., C.Chem
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7, Canada	Laboratory	SGS Canada Inc.
Contact	Nancy Berg	Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	905-829-8666 x 228	Telephone	705-652-2361
Facsimile		Facsimile	705-652-6365
Email	nberg@thurber.ca	Email	rob.irwin@sgs.com
Project	11375 Hwy 7 New, Kitchener	SGS Reference	CA14437-AUG19
Order Number		Received	08/13/2019
Samples	Soil (5)	Approved	08/19/2019
		Report Number	CA14437-AUG19 R1
		Date Reported	08/19/2019

COMMENTS
<p>Temperature of Sample upon Receipt: 4 degrees C</p> <p>Cooling Agent Present: yes</p> <p>Custody Seal Present: no</p> <p>Chain of Custody Number: 009972</p> <p>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.</p>

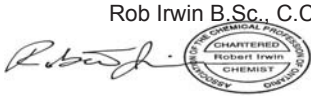
SIGNATORIES
<p>Rob Irwin B.Sc., C.Chem</p> 

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FINAL REPORT

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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
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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



FINAL REPORT

CA14437-AUG19 R1

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		



FINAL REPORT

CA14437-AUG19 R1

QC SUMMARY

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	EWL0246-AUG19	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

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

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

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. 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 --



Environment, Health & Safety

Request for Laboratory Services and CHAIN OF CUSTODY

- Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment

- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 009972

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: Oleg Mozhin
 Received Date (mm/dd/yyyy): 8/13/19 (mm/dd/yyyy)
 Received Time: 11:05

Received By (signature): [Signature]Custody Seal Present: ☒ NOCustody Seal Intact: ☒ NOCooling Agent Present: ☒ iceTemperature Upon Receipt (°C): 90, 90, 90LAB LIMS #: CA14437-Aug19

REPORT INFORMATION	INVOICE INFORMATION	PROJECT INFORMATION
Company: <u>Thurber Engineering Ltd</u>	<input type="checkbox"/> (same as Report Information)	Quotation #: _____ P.O. #: _____
Contact: <u>Nancy Berg</u>	Company: _____	Project #: <u>11375</u> Site Location/ID: <u>Hwy 7 New, Kitchener</u>
Address: <u>103 - 2010 Winston Park Dr</u> <u>Oakville On L6H 5A7</u>	Contact: _____	TURNAROUND TIME (TAT) REQUIRED
Phone: <u>647-633-8417</u>	Address: _____	<input checked="" type="checkbox"/> Regular TAT (5-7 days) TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day
Email: <u>nberg@thurber.ca</u>	Phone: _____	RUSH TAT (Additional Charges May Apply): <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3 Days <input type="checkbox"/> 4 Days
Email: _____	Email: _____	PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION
		Specify Due Date: _____ Rush Confirmation ID: _____

REGULATIONS					NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY																								
Regulation 153/04: <input type="checkbox"/> Table 1 <input type="checkbox"/> R/P/I <input type="checkbox"/> Soil Texture: <input type="checkbox"/> Table 2 <input type="checkbox"/> I/C/C <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> A/O <input type="checkbox"/> Medium <input type="checkbox"/> Table <input type="checkbox"/> Fine					Other Regulations: <input type="checkbox"/> Reg 347/558 (3 Day min TAT) <input type="checkbox"/> PWQO <input type="checkbox"/> MMER <input type="checkbox"/> CCME <input type="checkbox"/> Other: <input type="checkbox"/> MISA					Sewer By-Law: <input type="checkbox"/> Sanitary <input type="checkbox"/> Storm Municipality: _____					ANALYSIS REQUESTED														
RECORD OF SITE CONDITION (RSC) <input type="checkbox"/> YES <input type="checkbox"/> NO					COMMENTS:																								
SAMPLE IDENTIFICATION		DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH <input type="checkbox"/> ABN <input type="checkbox"/> SVOC(all) <input type="checkbox"/>	PCB Total <input type="checkbox"/> Aroclor <input type="checkbox"/>	PHC F1-F4 <input type="checkbox"/> VOC <input type="checkbox"/>	BTEX <input type="checkbox"/> BTEX/F1 <input type="checkbox"/> F2-F4 <input type="checkbox"/>	VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM <input type="checkbox"/>	Pesticides OC <input type="checkbox"/> OP <input type="checkbox"/>	TCLP M&I <input type="checkbox"/> VOC <input type="checkbox"/> PCB <input type="checkbox"/>	B(a)P <input type="checkbox"/> ABN <input type="checkbox"/> Ignit. <input type="checkbox"/>	Water Pkg Gen. <input type="checkbox"/> Ext. <input type="checkbox"/>	Sewer Use: <input type="checkbox"/>	Corrosivity											
1	CN16-10 SS5	July 19/19		1	soil																								
2	CN16-04 SS4	July 23/19		1	soil																								
3	CN16-15 SS4	July 18/19		1	soil																								
4	RW24-02 SS4	Aug 6/19		1	soil																								
5	NE16-09 SS4	Aug 7/19		1	soil																								
6																													
7																													
8																													
9																													
10																													
11																													
12																													

Observations/Comments/Special Instructions

Sampled By (NAME): Nancy BergSignature: [Signature]Date: 08/12/19 (mm/dd/yyyy)

Pink Copy - Client

Relinquished by (NAME): Nancy BergSignature: [Signature]Date: 08/13/19 (mm/dd/yyyy)

Yellow & White Copy - SGS

Revision #: 1.1

Date of Issue: 04 April, 2018



Appendix I

List of SPs and OPSS, and Suggested Text for Selected NSSP



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

- OPSS PROV 501 Construction specification for compacting
- OPSS.PROV 517 Construction specification for dewatering
- SP 517F01 Amendment to OPSS 517
- OPSS PROV 539 Construction specification for temporary protection systems
- OPSS PROV 804 Construction specification for seed and cover
- OPSS PROV 902 Construction specification for excavating and backfilling – Structures
- SP 109S12 Amendment to OPSS 902
- OPSS PROV 903 Construction specification for deep foundations
- SP 109F57 Amendment to OPSS 903
- OPSS PROV 1010 Material specification for aggregates - base, subbase, select subgrade, and backfill material
- OPSD 3120.100 Concrete Toe Wall
- OPSD 3121.150 Retaining, Backfill Minimum Granular Requirements
- OPSD 3190.100 Retaining and Abutment Wall Drain
- OPSD 3090.101 Frost Depths for Southern Ontario