



**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 400 NBL/McKINSTRY ROAD RETAINING WALL AND
BRADFORD BYPASS TO HIGHWAY 400 E-S RAMP/8TH LINE
CEMETERY TOE WALL
SITE NO. 30X-0889/W0
BRADFORD WEST GWILLIMBURY, ONTARIO
Assignment No. 2023-E-0068, GWP 2026-23-00
GEOCRES No. 31D04-019**

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PART A: FOUNDATION INVESTIGATION REPORT

1. INTRODUCTION

Thurber Engineering Ltd. (Thurber) was retained by AECOM on behalf of the Ministry of Transportation Ontario (MTO) to carry out detail foundation investigation services for the western segment of the new Bradford Bypass (BBP) under Assignment No. 2023-E-0068. The proposed BBP will be a four-lane rural divided freeway connecting Highway 400 to Highway 404 and will be able to accommodate future widening of up to eight lanes.

The proposed work for this assignment involves the design of a 6.5 km stretch of BBP from Highway 400 to west of Artesian Industrial Parkway. This report only addresses the foundation investigation carried out for the construction of a retaining wall along the future Highway 400 NBL/McKinstry Road and for the construction of a toe wall along the future BBP to Highway 400 E-S Ramp/8th Line Cemetery in the Town of Bradford West Gwillimbury, Ontario.

The purpose of this investigation is to establish the subsurface conditions at the locations of the proposed 200 m long Retained Soil System (RSS) wall and 45 m long concrete toe wall by means of borehole drilling, in situ testing, and laboratory testing on selected soil samples.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement for Use and Interpretation of Report.

2. SITE DESCRIPTION

The site of the future retaining walls is located adjacent to Highway 400, between Simcoe County Road 88 and 9th Line, but more specifically near 8th Line, in the Town of Bradford West Gwillimbury, Ontario.

Highway 400 at the site is currently a six-lane highway oriented in a north to south direction, with three lanes in each direction, separated by a raised median with guardrails. The finished grade at the centreline of Highway 400 is at approximately Elev. 253 m. McKinstry Road runs parallel to Highway 400 (on the east side of the highway) between Simcoe County Road 8 and 8th Line. McKinstry Road is an unpaved gravel road. The finished grade at the centreline of the existing McKinstry Road is between approximately Elev. 250 m and Elev. 251 m. Overhead wires traverse along 8th Line and over Highway 400. The 8th Line Cemetery (also known as Rogers United Cemetery) is located west of Highway 400, near 8th Line.

The land adjacent to the site consists of farmland and the vegetative cover generally consists of tall grass, shrubs, occasional trees, particularly on the west side of Highway 400, and crop residue. The overall site topography is relatively flat.

Photographs of the sites where the future walls will be constructed are presented in Appendix A.

2.1 Site Geology

Based on published geological information, the Town of West Gwillimbury is located within three major physiographic regions of southern Ontario: the Simcoe Lowlands, the Schomberg Clay Plains, and the Peterborough Drumlin Field.

The Simcoe Lowlands form part of the larger Great Lakes–St. Lawrence Lowlands and are characterized by flat to gently undulating terrain. This region predominantly consists of clayey to silty glaciolacustrine deposits overlying till or glaciofluvial materials. In general, the soils have low permeability, and the area is often associated with poor drainage, wetlands, and organic deposits in depressions.

The Schomberg Clay Plains extend across parts of southern Simcoe County, northern York Region, and adjacent areas. These clay plains are characterized by flat to gently undulating topography and are underlain predominantly by glaciolacustrine silts and clays, which were deposited in the post-glacial Lake Algonquin and Lake Iroquois basins. In the West Gwillimbury area, particularly west and southwest of Bradford, the Schomberg Clay Plain dominates the surface geology, forming thick, cohesive deposits with low permeability.

The Peterborough Drumlin Field covers approximately 900 km² on a Paleozoic limestone plain and is one of the largest drumlin fields in southern Ontario. This physiographic region is located between the Oak Ridges Moraine and the area of shallow overburden on the limestones of the Gull River Formation, extending from Hastings County in the east to Simcoe County in the west, and including the drumlins south of the moraine in Northumberland County. The surficial soils in the Peterborough Drumlin Field consist primarily of sand with gravel till or sand and gravel deposits. Deposits of silt, clay or peat may be found in the low-lying areas between drumlins.

The bedrock in this region is predominantly composed of limestone belonging to the Lindsay and Verulam Formations, which are part of the Upper Ordovician sequence. These formations are typically softer, more thinly bedded, and less massive than the older Gull River Formation, which lies stratigraphically below.

3. SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing program completed for the proposed retaining wall was carried out from December 8th to 9th, 2024, and from July 8th to 9th, 2025 for the proposed toe wall. The site investigation consisted of advancing eight boreholes – five boreholes along the proposed RSS wall and three boreholes along the proposed toe wall.

Details of the borehole locations, ground surface elevations, and termination depths are

summarized in Table 3.1.

Table 3.1: Borehole Details

Wall	Borehole	Co-ordinates MTM NAD 83 Zone 10 ⁽¹⁾		Ground Surface Elevation (m)	Depth of Borehole (m)
		Northing	Easting		
Highway 400 NBL / McKinstry Road RSS Wall	RW1-01	4,885,715.4 ⁽²⁾	294,131.5 ⁽²⁾	251.5 ⁽²⁾	11.3
	RW1-02	4,885,667.6 ⁽²⁾	294,140.3 ⁽²⁾	249.7 ⁽²⁾	11.3
	RW1-03	4,885,620.0 ⁽²⁾	294,148.1 ⁽²⁾	248.4 ⁽²⁾	11.3
	RW1-04	4,885,571.2 ⁽²⁾	294,156.6 ⁽²⁾	248.7 ⁽²⁾	11.3
	RW1-05	4,885,521.7 ⁽²⁾	294,165.3 ⁽²⁾	249.7 ⁽²⁾	11.3
BBP to Highway 400 E-S Ramp / 8 th Line Cemetery Toe Wall	RW2-01	4,885,799.4	294,034.0	253.3	11.3
	RW2-02 ⁽³⁾	4,885,783.7	294,042.9	252.7	11.3
	RW2-03	4,885,764.0	294,047.4	252.3	11.3

Notes: 1. Survey of as-drilled RW1-series borehole locations was completed by AECOM.

2. The RW2-series borehole coordinates and ground surface elevations are approximate and were established based on CAD drawings provided by AECOM. The accuracy of the borehole coordinates and ground surface elevations is +/-3 m and +/-0.5 m, respectively. As-drilled borehole locations could not be surveyed due to site access restrictions and grading activities carried out between Highway 400 NBL and McKinstry Road by a civil contractor.

3. Groundwater monitoring well installed in borehole.

The locations of the boreholes are shown on the Borehole Location Plan and Soil Strata drawings in Appendix B. The Record of Borehole sheets are provided in Appendix C.

The coordinates and elevations of the boreholes are presented on the Borehole Location Plan and Soil Strata drawings and record of borehole sheets.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The boreholes were advanced using both track- and truck-mounted drill rigs. Hollow stem augers were used to advance the boreholes until termination. Soil samples were obtained at selected intervals of depth (in accordance with MTO's Guideline for Foundation Engineering Services (2022)) using a 50 mm outside diameter split-spoon sampler driven in conjunction with the Standard Penetration Test (SPT) which was performed in accordance with ASTM D1586.

The field investigation and testing was observed on a full-time basis by a member of Thurber's technical staff who marked/staked the boreholes in the field, directed the drilling, soil sampling and in-situ testing operations, logged the boreholes, and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout and upon completion of drilling operations. A monitoring well was installed in Borehole RW2-02. The monitoring well consists

of 50 mm outside diameter Schedule 40 PVC pipe with 3.0 m long slotted screen, enclosed in a column of filtered sand to permit monitoring of groundwater level. The bottom of the well was sealed with a well cap. Well installation details are summarized in Table 3.2.

Table 3.2: Monitoring Well Installation Details

Wall	Borehole	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
BBP to Highway 400 E-S Ramp / 8 th Line Cemetery Toe Wall	RW2-02	11.3 / 241.5	4.8 / 247.9	Monitoring well was installed in Borehole RW2-02. Monitoring well with 3.0 m slotted screen installed with sand filter from depths of 1.2 m to 4.8 m, then backfilled with sand and bentonite from a depth of 1.2 m to ground surface.

All boreholes without monitoring well installations were backfilled upon completion of drilling in accordance with O.Reg. 903 (as amended). The monitoring well installed as part of the investigation was left in place to permit groundwater level measurements prior to and during construction operations and is to be decommissioned by the Contractor with O.reg. 903 (as amended).

4. LABORATORY TESTING

The recovered soil samples were subjected to visual and tactile identification and natural moisture content determination. Approximately 25% of soil samples were subjected to grain size distribution analyses (sieve and/or hydrometer), and Atterberg Limits testing. Geotechnical laboratory testing results are summarized on the Record of Borehole sheets in Appendix C and are presented in the figures in Appendix D.

To assess the potential for sulphate attack on the concrete walls, as well as the potential for metal corrosion associated with the structures, selected samples of the native soils were collected and submitted to SGS Canada Inc., a Canadian Association for Laboratory Accreditation (CALA) certified analytical laboratory in Lakefield, Ontario, for analytical testing for corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 5.4 and are presented in Appendix E.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered subsurface stratigraphy from the investigation are presented and on the Borehole Locations and Soil Strata drawings in Appendix B and on the Record of Borehole

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

More detailed descriptions of the individual stratum are presented below.

5.1 Highway 400 NBL/McKinstry Road RSS Wall

In general, the subsurface conditions at the site consist of a layer of compact to dense/stiff to very stiff embankment fill (between Highway 400 and McKinstry Road) underlain by a deposit of firm to very stiff clay or firm to very stiff till comprised of sandy silty clay to clay with sand to clay. In places, the cohesive till deposit includes an interlayer of sandy silt till.

5.1.1 Embankment Fill

Cohesionless embankment fill, consisting of silty sand with gravel to silty sand, was encountered at ground surface in Boreholes RW1-01 to RW1-04. While cohesive embankment fill, consisting of sandy silty clay and clay with sand, was encountered beneath the cohesionless fill in Borehole RW1-02 and at ground surface in Borehole RW1-05. The embankment fill extends to depths ranging from 1.0 m to 2.4 m below ground surface (Elev. 251.5 m to 246.0 m).

SPT N-values recorded in the cohesionless fill ranged from 20 blows to 33 blows per 0.3 m penetration, indicating a compact to dense condition. SPT N-values recorded in the cohesive fill ranged from 10 blows to 12 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

The natural moisture content measured on samples of the cohesionless fill ranged from 2 per cent to 11 per cent. The natural moisture content measured on samples of the cohesive fill ranged from 4 per cent to 24 per cent

The results of grain size analyses carried out on two samples of the cohesionless fill and two samples of the cohesive fill are presented in Figures 1 and 2, respectively, in Appendix D and are summarized in Table 5.1.

Table 5.1: Grain Size Distribution of Embankment Fill

Particle Size	Percentage (%)	
	Silty Sand with Gravel to Silty Sand Fill	Sandy Silty Clay to Clay with Sand Fill
Gravel	18 and 19	0 and 5
Sand	54 and 62	18 and 43
Silt	15 and 18	38 and 64
Clay	5 and 9	14 and 18

The results of Atterberg Limits tests carried out on two samples of the silty sand with gravel fill recovered from Boreholes RW1-01 and RW1-03 indicate that the fine-grained portion of the fill is non-plastic. The results of Atterberg Limits tests carried on samples of the cohesive fill are presented in Figure 3 of Appendix D and are summarized in Table 5.2. The results indicate that the material is a clay of low plasticity (CL-ML) to medium plasticity (CI).

Table 5.2: Atterberg Limits of Cohesive Embankment Fill

Parameter	Value	
	Sandy Silty Caly Fill (CL-ML)	Clay with Sand Fill (CI)
Liquid Limit	18	47
Plastic Limit	11	23
Plasticity Index	7	24

5.1.2 Clay

A deposit of clay, approximately 6.1 m thick, was encountered beneath the layer of silty sand with gravel fill in Borehole RW1-01. The base of the clay was encountered at a depth of about 7.2 m below ground surface (Elev. 244.3 m).

SPT N-values recorded in the clay ranged from 7 blows to 17 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

The natural moisture content measured on the clay ranged from 13 per cent to 27 per cent.

The results of grain size analyses carried out on a sample of the clay are presented in Figure 4 in Appendix D and are summarized in Table 5.3.

Table 5.3: Grain Size Distribution of Clay

Particle Size	Percentage (%)
Gravel	3
Sand	5
Silt	62
Clay	30

The results of an Atterberg Limits test carried on a sample of the clay are presented in Figure 5 in Appendix D and are summarized in Table 5.4. The results indicate that the material is a clay of low plasticity (CL).

Table 5.4: Atterberg Limits of Clay

Parameter	Value
Liquid Limit	30
Plastic Limit	18
Plasticity Index	12

5.1.3 Sandy Silty Clay to Clay with Sand to Clay Till

A cohesive till deposit comprised of sandy silty clay to clay with sand to clay was encountered beneath the embankment fill in all boreholes, except in Borehole RW1-01 where the clay with sand till was encountered beneath the clay. All boreholes were terminated within the cohesive till deposit at a depth of about 11.3 m below ground surface (between Elev. 240.2 m and Elev. 237.1 m). Although not encountered at the borehole locations, cobbles and boulders are commonly present within glacially derived soils and should be expected within this deposit.

SPT N-values recorded in the cohesive till deposit ranged from 7 blows to 34 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

The natural moisture content measured on the cohesive till deposit ranged from 8 per cent to 25 per cent, except on a sample recovered from split-spoon #6 (Elev. 243.5 m) of Borehole RW1-03 where the measured moisture content was 58 per cent.

The results of grain size analyses carried out on samples of the sandy silty clay to clay with sand to clay till are presented in Figure 6 in Appendix D and are summarized in Table 5.5.

Table 5.5: Grain Size Distribution of Sandy Silty Clay to Clay with Sand to Clay Till

Particle Size	Percentage (%)		
	Sandy Silty Clay Till	Clay with Sand Till	Clay Till
Gravel	5	1 to 2	0 to 3
Sand	33 and 34	22 to 26	5 to 9
Silt	44 and 55	46 to 61	62 to 63
Clay	7 and 17	15 to 27	27 to 31

The result of an Atterberg Limits test carried on a sample of the sandy clay till is presented in Figure 7 in Appendix D and are summarized in Table 5.6. The results indicate that the material is a clay of low plasticity (CL-ML and CL).

Table 5.6: Atterberg Limits of Sandy Silty Clay to Clay with Sand to Clay Till

Parameter	Value		
	Sandy Silty Clay Till	Clay with Sand Till	Clay Till
Liquid Limit	16 and 19	21	29 and 31
Plastic Limit	10 and 13	11 and 12	16 and 17
Plasticity Index	6	9 and 10	13 and 14

5.1.4 Sandy Silt Interlayer

A 1.6 m thick interlayer of sandy silt was encountered within the cohesive till deposit in Borehole RW1-05 at a depth of about 5.6 m (Elev. 244.1 m).

An SPT N-value recorded in the sandy silt interlayer was 13 blows per 0.3 m of penetration, indicating a compact condition.

A natural moisture content measured on a sample of the sandy silt interlayer was 10 per cent.

The results of a grain size analysis carried out on a sample of the sandy silt interlayer are presented in Figure 8 in Appendix D and are summarized in Table 5.7.

Table 5.7: Grain Size Distribution of a Sandy Silt Interlayer

Particle Size	Percentage (%)
Gravel	1
Sand	38
Silt	54
Clay	7

The results of an Atterberg Limits test carried out on the sample of the sandy silt interlayer are

presented in Figure 9 in Appendix D and are summarized in Table 5.8. The results indicate that the material is a silt with a low plasticity (ML).

Table 5.8: Atterberg Limits of Sandy Silt Interlayer

Parameter	Value
Liquid Limit	14
Plastic Limit	11
Plasticity Index	3

5.2 Bradford Bypass to Highway 400 E-S Ramp/8th Line Cemetery Toe Wall

In general, the subsurface conditions at the site consist of a layer of topsoil underlain by a deposit of firm to very stiff clay with sand to clay which in turn is underlain by a till deposit comprised of loose to compact silty sand to sandy silt to silty clayey sand or stiff to very stiff silty clay with sand to clay with sand.

5.2.1 Topsoil

Topsoil was encountered at ground surface in all boreholes, with thicknesses ranging from 380 mm to 500 mm.

The natural moisture content measured on topsoil ranged from 17 per cent to 21 per cent.

The topsoil thickness may vary between and beyond the borehole locations, and the thickness of topsoil encountered in these boreholes are not intended for the purpose of estimating quantities.

5.2.2 Clay with Sand to Clay

A deposit of clay with sand to clay, approximately 2.5 m to 4.4 m thick, was encountered beneath the topsoil in all boreholes. The base of the cohesive deposit was encountered at depths from about 3.0 m to 4.8 m below ground surface (Elev. 249.3 m to Elev. 248.5 m).

SPT N-values recorded in the clay ranged from 5 blows to 20 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

The natural moisture content measured on the clay with sand to clay ranged from 13 per cent to 29 per cent, and on average 21 per cent.

The results of grain size analyses carried out on a sample of the clay with sand and a sample of the clay are presented in Figure 10 in Appendix D and are summarized in Table 5.9.

Table 5.9: Grain Size Distribution of Clay with Sand to Clay

Particle Size	Percentage (%)
Gravel	0 and 4
Sand	6 and 17
Silt	44 and 54
Clay	35 and 40

The results of an Atterberg Limits tests carried out on a sample of the clay with sand and a sample of the clay are presented in Figure 11 in Appendix D and are summarized in Table 5.10. The results indicate that the material is a clay of low plasticity (CL).

Table 5.10: Atterberg Limits of Clay with Sand to Clay

Parameter	Value
Liquid Limit	31 and 34
Plastic Limit	16 and 18
Plasticity Index	15 and 16

5.2.3 Silty Sand to Sandy Silt to Silty Clayey Sand Till

A till deposit comprised of silty sand to sandy silt to silty clayey sand was encountered beneath the clay with sand at depths of about 4.8 m (Elev. 248.5 m) and 3.6 m (Elev. 249.2 m) in Boreholes RW2-01 and RW2-02, respectively. Both boreholes were terminated within the silty sand to sandy silt till at a depth of about 11.3 m (Elev. 242.0 m and Elev. 241.5 m, respectively). Although not encountered at the borehole locations, cobbles and boulders are commonly present within glacially derived soils and should be expected within this deposit.

SPT N-values recorded in the silty sand to sandy silt to silty clayey sand till ranged from 9 blows to 26 blows per 0.3 m of penetration, indicate a loose to compact condition.

The natural moisture content measured on the silty sand to sandy silt to silty clayey sand till ranged from 9 per cent to 13 per cent.

The results of grain size analyses carried out on samples of the silty sand to sandy silt to silty clayey sand till are presented in Figure 12 in Appendix D and are summarized in Table 5.11.

Table 5.11: Grain Size Distribution of Silty Sand to Sandy Silt to Silty Clayey Sand Till

Particle Size	Percentage (%)
Gravel	2 to 10
Sand	40 to 51
Silt	30 to 35
Clay	13 to 17

The results of Atterberg Limits tests carried out on the fine-grained portion of the silty sand to sandy silt to silty clayey sand are presented in Figure 13 in Appendix D and are summarized in Table 5.12. The results indicate that the fines are slightly plasticity.

Table 5.12: Atterberg Limits of Silty Sand to Sandy Silt to Silty Clayey Sand Till

Parameter	Value
Liquid Limit	13 to 16
Plastic Limit	10 to 12
Plasticity Index	2 to 5

5.2.4 Clay with Sand Till

A cohesive till deposit comprised of clay with sand till was encountered beneath the clay in Borehole RW2-03 at a depth of about 3 m (Elev. 249.3 m).. The borehole was terminated within the clay with sand till at a depth of about 11.3 m below ground surface (Elev. 241.0 m). Although not encountered at the borehole locations, cobbles and boulders are commonly present within glacially derived soils and should be expected within this deposit.

SPT N-values recorded in the clay with sand till ranged from 14 blows to 26 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

The natural moisture content measured on the clay with sand till ranged from 9 per cent to 24 per cent, and on average 14 per cent.

The results of grain size analyses carried out on two samples of the clay with sand till are presented in Figure 14 in Appendix D and are summarized in Table 5.13.

Table 5.13: Grain Size Distribution of Clay with Sand Till

Particle Size	Percentage (%)
Gravel	0
Sand	18 and 26
Silt	45 and 57
Clay	25 and 29

The results of an Atterberg Limits tests carried out on two samples of the clay with sand till are presented in Figure 15 in Appendix D and are summarized in Table 5.14. The results indicate that the material is a clay of low plasticity (CL).

Table 5.14: Atterberg Limits of Clay with Sand Till

Parameter	Value
Liquid Limit	22 and 23
Plastic Limit	12 and 14
Plasticity Index	8 and 10

5.3 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. All open boreholes were dry upon completion of drilling. A monitoring well was installed in Borehole RW2-02 to permit monitoring of groundwater levels.

Groundwater levels measured in the monitoring well are presented in Table 5.15 below.

Table 5.15: Groundwater Level Measurements

Location	Borehole	Date	Groundwater Level		Comments
			Depth (m)	Elevation (m)	
West of Highway 400 SBL	RW2-02	August 7, 2025	1.8	250.9	Monitoring well
		August 21, 2025	1.4	251.3	
		September 8, 2025	1.7	251.0	

The groundwater levels measured in the monitoring well are short-term readings where seasonal fluctuations are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation. Seasonal fluctuations of the groundwater levels are to be expected. Perched water within layers of cohesionless fill overlying the cohesive fill and cohesive deposits are also expected.

5.4 Analytical Laboratory Testing

Selected soil samples recovered from boreholes advanced along the alignment of the proposed Highway 400 NBL/McKinstry Road RSS wall and the Bradford Bypass to Highway 400 E-S Ramp/8th Line cemetery toe wall were submitted for analytical testing of corrosivity parameters including sulphate content. The results of available analytical tests are shown in Table 5.16. The laboratory certificates of analysis are presented in Appendix E.

Table 5.16: Analytical Corrosivity Test Results

BH and Sample ID / Soil Description	Sample Depth / Elevation (m)	pH	Soil Redox Potential (mV)	Sulphide (Na ₂ CO ₃) %	Resistivity (ohm-cm)	Electrical Conductivity (µS/cm)	Sulphate (µg/g)	Chloride (µg/g)
RW1-02 SS-4 Clay with sand Till	2.6 / 247.1	7.37	161	0.01	2,360	424	16	110
RW2-03 SS-2B Clay	1.2 / 251.1	8.83	28	<0.01	7,940	126	11	36

6. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to borehole drilling operations.

Boreholes along the proposed RSS wall and toe wall were advanced using a CME 55 truck-mounted drill rig and a CME 55 track-mounted drill rig, respectively, supplied and operated by 3D Drilling Inc. of Uxbridge, Ontario.

The on-site foundation investigation was supervised by Messrs. Smit Patel, E.I.T. and Mr. Abdul Basit, E.I.T. of Thurber. The coordination and management of the field program was carried out by Messrs. Rod de Castro, P.Eng. and Joshua Alexander, P.Eng. of Thurber.

7. CLOSURE

Interpretation of the field data and preparation of the report was carried out by Mr. Tomasz Zalucki, P.Eng., a Senior Geotechnical Engineer. This report was reviewed by Mr. Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Tomasz Zalucki, P.Eng.
Associate, Senior Geotechnical Engineer



Jason Lee, M.Sc.(Eng.), P.Eng.,
Partner, Senior Geotechnical Engineer
Designated MTO Contact

Date: **April 13, 2026**

File: **48856**

PART B: FOUNDATION DESIGN REPORT

8. GENERAL

This report provides an interpretation of the subsurface information obtained from the foundation investigation and provides foundation recommendations for the design of the proposed Highway 400 NBL/McKinstry Road Retained Soil System (RSS) wall and the BBP to Highway 400 E-S Ramp/8th Line Cemetery toe wall in the Town of Bradford West Gwillimbury, Ontario.

The discussions and recommendations presented in this report are intended for the use of the Ministry of Transportation, Ontario and their designers, AECOM, but should not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The contractor undertaking the work must make their own interpretation based on the information presented in the factual sections of the report (Part A of this report). Where comments are made on construction, they are provided to highlight those aspects which could affect the design of the project. The contractor must make their own interpretation of the data provided as it may affect equipment selection, proposed construction methods, scheduling, and the like.

Based on the General Arrangement drawing of the proposed RSS wall (provided by AECOM on January 21, 2026 and included in Appendix F), details of the retaining structure are provided in Table 8.1.

Table 8.1: Highway 400 NBL/McKinstry Road RSS Wall Details

Chainage (From)	Chainage (To)	Length (m)	Top of Levelling Pad Elev. (m)	Top of RSS Wall Elev. (m)	Approx Total Wall Height (m)	Approx Exposed Wall Height (m)
17+220	17+270	50	248.3	252.5 to 252.7	4.2 to 4.4	2.0 to 3.3
17+270	17+400	130	247.2	251.9 to 252.5	4.7 to 5.3	2.5 to 4.1
17+400	17+420	20	248.6	251.8	3.2	1.6 to 2.4

Based on cross-sections of the proposed toe wall (provided by AECOM on January 26, 2026), details associated with the retaining structures are provided in Table 8.2.

Table 8.2: BBP to Highway 400 E-S Ramp/8th Line Cemetery Toe Wall Details

Wall Type	Chainage (From)	Chainage (To)	Length (m)	Base Width (m)	Total Wall Height (m)	Approx. Exposed Wall Height (m)	
						Ramp Side	Cemetery Side
Type III	12+430	12+475	45	1.1	1.21	12+430: 0.76 12+475: 0.76	12+430: 0.15 12+475: 0.76

9. CONSEQUENCE AND SITE UNDERSTANDING CLASSIFICATION

It is assumed that the proposed retaining structures have a “*typical consequence level*” associated with exceeding limits states design in accordance with Clause 6.5 and Table 6.1 of the 2019 *Canadian Highway Bridge Design Code (2019 CHBDC)* and as such, a consequence factor, Ψ , of 1.0 is used for foundation design.

In addition, based on the level of foundation investigation completed, the site understanding is considered to be a “*typical degree of site and prediction model understanding*”. Accordingly, the appropriate ultimate and serviceability geotechnical resistance factors, ϕ_{gu} and ϕ_{gs} , from Tables 6.2 and 6.3 of the *CHBDC (2019)* have been used for foundation design.

10. SEISMIC CONSIDERATIONS

10.1 Seismic Site Classification and Performance Category

In accordance with Clause 4.4.3.2 of the *CHBDC (2019)*, the section of the seismic site classification is based on the soil deposits within the upper 30 m of the stratigraphy. Given that the boreholes advanced along the proposed retaining walls were terminated at a depth of about 11.3 m, information from adjacent seismic Cone Penetration Tests (sCPTs) and deep boreholes advanced in the vicinity as part of the overall project were reviewed to establish the seismic site class. Based on the shear wave velocity test results from sCPTs and the shear strength of the deeper underlying, predominantly cohesive deposits, inferred from SPT N-values, the site classification for the seismic site response is C (i.e., Site Class C) in accordance with Table 4.1, Clause 4.4.3.2 of the *CHBDC (2019)*.

The site-specific peak ground acceleration, *PGA*, for a 2,475-year return period earthquake at this site is 0.103 g as per the 2020 National Building Code of Canada (NBCC) (refer to Appendix G).

10.2 Liquefaction

Liquefaction is a phenomenon whereby seismically induced shaking generates shear stresses within the soil under undrained conditions. These stresses tend to densify the soil which may lead to potentially large surface deformations, and under undrained conditions generate excess pore water pressures that can lead to sudden temporary losses in strength of the soils. Where existing static shear stresses are present, the loss of strength can lead to significant lateral movements (analogous to slope failure) often referred to as “lateral spreading” or under certain conditions even catastrophic failure of slopes often referred to as “flow slides”. Lateral spreading and flow slide often accompany liquefaction along rivers and other shorelines.

Based on the relative density of the fill/native soils and consistency of the native soils as well as

the low site-specific *PGA*, the fills and soils at the sites are considered to have a low potential for liquefaction during a seismic event.

11. FOUNDATION DESIGN FOR RETAINING WALLS

11.1 Highway 400 NBL/McKinstry Road RSS Wall

11.1.1 Geotechnical Resistances

A typical RSS wall has a front facing panel system that is supported on a levelling pad (typically a cast-in-place concrete pad) installed at shallow depth below the ground surface in front of the wall. In accordance with the MTO RSS Design Guidelines (2008), the levelling pad must be placed within a 500 mm thick OPSS.PROV 1010 Granular A pad, placed in accordance with OPSS.PROV 501, such that there is a minimum of 300 mm of Granular A below the levelling pad. The Granular A pad must extend at least 1 m beyond the outside edges of the levelling pad, then slope downward at an inclination of 1H:1V.

Prior to placement of the levelling pad and the reinforced soil mass, the subgrade should be prepared, as described in Section 16.1.

The open boreholes advanced along the proposed RSS wall were dry upon completion of drilling; however, since the soils encountered at the site are predominantly cohesive and have a low hydraulic conductivity, the dry open boreholes are not representative of the groundwater level conditions at the site. The design groundwater level is anticipated to be at the top of cohesive deposit, below the embankment fill. The foundation engineering parameters used in the settlement analysis are presented in Table 11.1, while the foundation engineering parameters for the soil types used in the stability analyses are presented on the stability figures in Appendix H.

Table 11.1: Engineering Parameters for Settlement Analyses

Stratigraphic Unit	Unit Weight, γ (kN/m ³)	Elastic Modulus, E_s (kPa)	Coefficient of Compressibility, m_v (m ² /kN)
Compacted Granular A or B Type II	22.8	75,000	--
Compact Existing Silty Sand with Gravel Fill	20	20,000	--
Stiff Existing Sandy Silty Clay Fill	20	--	6.7×10^{-5}
Firm to Very Stiff Clay with Sand to Clay	19	--	6.7×10^{-5}

Stratigraphic Unit	Unit Weight, γ (kN/m ³)	Elastic Modulus, E_s (kPa)	Coefficient of Compressibility, m_v (m ² /kN)
Stiff to Very Stiff Sandy Silty Clay to Clay with Sand to Clay Till	20	--	2.0×10^{-5}

The founding elevations and the factored geotechnical resistances for the RSS wall are presented in Table 11.2.

Table 11.2: Factored Geotechnical Resistances for RSS Wall

Retained Height, H (m)	Width of Reinforced Soil Mass, B (m)	Founding Elevation (m)	Factored Ultimate Geotechnical Resistance (kPa)	Factored Serviceability Geotechnical Resistance (for 25 mm of Settlement) (kPa)
4.4	3.5	248.3	300	175
5.3	4.2	247.2		
3.2	2.6	248.6		

The geotechnical resistances provided above assume the RSS wall is subjected to vertical and concentric loads. Where eccentric and/or inclined loads are applied, the geotechnical resistances must be reduced in accordance with Clauses 6.10.4 and 6.10.5 of the *CHBDC (2019)*.

The RSS wall must also be designed against various modes of failure, including sliding and overturning. The horizontal resistance against sliding between the levelling pad and the underlying compacted Granular A material can be calculated using an unfactored ultimate friction coefficient, $\tan\phi'$, of 0.6, if cast-in-place concrete is used, or 0.5, if precast concrete is used. A geotechnical resistance factor of 0.8 for cohesionless soils (assuming static analysis – typical degree of understanding), as per Table 6.2 of the *CHBDC (2019)*, should be applied to this value.

11.1.2 Global Stability

Limit equilibrium global slope stability analyses were carried out for the proposed retaining wall using the commercially available program Slide2 (Version 9.031), developed by Rocscience Inc., employing the Morgenstern-Price method of analysis. The Factors of Safety of numerous potential failure surfaces were computed to establish the minimum Factor of Safety. The Factor of Safety is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. The Factor of Safety is equal to the inverse of the product of the consequence factor, Ψ , and the geotechnical resistance factor, ϕ_{gu} (i.e., $FoS = 1/(\Psi \cdot \phi_{gu})$). Accordingly, minimum Factors of Safety of 1.5, 1.3, and 1.1 have been used

for the design of the proposed retaining wall for the permanent (long-term), temporary (short-term), and seismic conditions, respectively.

Stability analyses were carried out on a critical section of the RSS wall corresponding to the greatest wall height. The foundation engineering parameters for the fill and soils used in the stability analyses are presented in the stability figures in Appendix H.

In accordance with the MTO RSS Design Guidelines (2008), the width (B), of the RSS backfill with reinforcing elements (i.e., reinforced soil mass) is assumed to be equal to 80 per cent of the RSS wall height (H).

The results of the stability analyses are presented in Appendix H and are summarized in Table 11.3.

Table 11.3: Results of Stability Analyses

Chainage	Condition	Minimum Factor of Safety	Figure
~ STA 17+340	Temporary (Undrained Condition)	1,7	H1
	Permanent (Drained Condition)	3.3	H2
	Seismic (Pseudo-Static Condition)	2,7	H3

Notes: 1. RSS wall geometry based on a General Arrangement drawing provided by AECOM in February 2026.
2. The site-specific *PGA* is 0.103.

The factors of safety from the stability analyses are greater than the minimum factors of safety for design and therefore instability mitigation measures are not required.

11.1.3 Additional Requirements

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

11.2 Bradford Bypass to Highway 400 E-S Ramp / 8th Line Cemetery Toe Wall

11.2.1 Geotechnical Resistances

The future concrete toe wall is proposed to be about 1.1 m wide and founded at approximately Elev. 252.15 m at STA 12+430 and at approximately Elev. 252.05 m at STA 12+475. Given the soils anticipated to be encountered at these founding elevations, the toe wall must be founded on a 2 m thick granular pad comprised of OPSS.PROV 1010 Granular A or B Type II material compacted to 100% of the material's Standard Proctor Maximum Dry Density (SPMDD) in order

to design the Type III toe wall in accordance with OPSD 3120.100. The granular pad should extend a minimum of 1 m from each end of the base of the toe wall and sloped at an inclination of 1H:1V.

The design groundwater level is assumed to be at Elev. 251.3 m for the assessment of settlement of the toe wall. The foundation engineering parameters used in the settlement analysis are presented in Table 11.4.

Table 11.4: Engineering Parameters for Settlement Analyses

Stratigraphic Unit	Unit Weight, γ (kN/m ³)	Elastic Modulus, E_s (kPa)	Coefficient of Compressibility, m_v (m ² /kN)
Compacted Granular A or B Type II	22.8	75,000	--
Firm to Very Stiff Clay with Sand to Clay	19	--	7.7×10^{-5}
Loose to Compact Silty Sand to Sandy Silt Till	20	15,000	--

The founding elevation and stratum as well as the factored geotechnical resistances for the retaining wall are presented in Table 11.5.

Table 11.5: Factored Geotechnical Resistances for Toe Wall

Founding Elevation (m)	Founding Stratum	Footing Width (m)	Factored Ultimate Geotechnical Resistance (kPa)	Factored Serviceability Geotechnical Resistance (for 25 mm of Settlement) (kPa)
~252.1	2 m thick compacted Granular A or B Type II overlying native soils ⁽¹⁾	1.1	300	300

Note: 1. The granular pad will extend about 1.3 m below the groundwater level. Refer to Section 17 for a discussion regarding dewatering.

The geotechnical resistances provided above assume the toe wall is subjected to vertical and concentric loads. Where eccentric and/or inclined loads are applied, the geotechnical resistances must be reduced in accordance with Clauses 6.10.4 and 6.10.5 of the *CHBDC (2019)*.

The toe wall must also be designed against various modes of failure, including sliding and overturning. The horizontal resistance against sliding between the toe wall and the underlying compacted Granular A or B Type II material can be calculated using an unfactored ultimate friction coefficient of 0.6, if cast-in-place concrete is used, or 0.5, if precast concrete is used. A geotechnical resistance factor of 0.8 for cohesionless soils (assuming static analysis – typical degree of understanding), as per Table 6.2 of the *CHBDC (2019)*, should be applied to this value.

11.2.2 Global Stability

Given that the toe wall will retain less than 0.8 m of fill and will be founded on a 2 m thick granular pad, instability is not anticipated to be an issue and instability mitigation measures are not required.

12. LATERAL EARTH PRESSURES

12.1 Static Lateral Earth Pressures

The lateral earth pressures acting on the RSS wall and toe wall will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls.

Backfill placed behind the walls should consist of free-draining, non-frost susceptible granular materials such as OPSS.PROV 1010 Granular A or B Type II and placed in accordance with OPSS.PROV 902, as amended by Special Provision 109S61. The granular backfill behind the RSS wall and toe wall should be placed to the extents as shown in the MTO RSS Design Guidelines (2008) and OPSD 3120.100, respectively. Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS.PROV 501 (as amended).

Earth pressures acting on the structures may be assumed to impose a triangular distribution governed by the characteristics of the wall backfill. For a fully drained condition, the pressures should be calculated in accordance with *the CHBDC (2019)* but generally are given by the expression:

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

Where:

- p_h = horizontal pressure on the wall at depth h (kPa)
- K = coefficient of lateral earth pressure (see Table 12.1 below)
- γ = unit weight of retained soil (see Table 12.1 below)
- h = depth below top of fill where pressure is calculated (m)
- q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment walls are dependent on the material used as backfill with typical values presented in Table 12.1.

Table 12.1: Static Coefficient of Lateral Earth Pressures

Loading Condition	Granular A ⁽¹⁾ $\phi = 39^\circ, \gamma = 22.9 \text{ kN/m}^3$		Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Backfill	2H:1V Sloping Backfill	Horizontal Backfill	2H:1V Sloping Backfill	Horizontal Backfill	2H:1V Sloping Backfill
Active, K_a ⁽¹⁾ (Unrestrained Wall)	0.23	0.31	0.27	0.39	0.31	0.47
At-rest K_o (Restrained Wall)	0.37	0.54	0.43	0.62	0.47	0.68
Passive, K_p ⁽¹⁾	4.40	15.15	3.69	10.82	3.26	8.61

Note: 1. Friction angle and unit weight of Granular A material area based on the results provided in technical memorandum titled, "Innovation Study – Memo, Determination of Strength Parameters of Granular Materials, Bradford Bypass West Contractor, CMGC 2023-E-0068", dated December 12, 2025.

2. The values of K_a and K_p correspond to full mobilization of active and passive earth pressures and require certain relative movements between the wall and adjacent soil to produce these conditions. Figures C6.27 and Table C6.12 of the Commentary to the *CHBDC (2019)* indicate relative movement required to fully mobilize the active earth pressures.

In accordance with Clause 6.12.3 of the *CHBDC (2019)*, a compaction surcharge should be added to the lateral force caused by compaction.

If lateral movement is not permissible and/or the wall is restrained, the at-rest/non-yielding coefficient of lateral earth pressure should be used. If the wall allows for lateral movement, the active/yielding earth pressures should be used.

A geotechnical resistance factor, ϕ_{gu} , of 0.5 should be applied in static design to the passive coefficient of lateral earth pressure, K_p , in accordance with Table 6.2 of the *CHBDC (2019)* for static analysis and typical understanding (consequence factor, $\Psi = 1.0$). The fills and soils within the depth of frost penetration should be ignored from the passive lateral resistance; however, the equivalent surcharge loading from the weight of the fills and soils above the depth of frost penetration should be incorporated in the fills and soils below.

The design of the retaining walls must incorporate measures that will permit drainage of the backfill and eliminate hydrostatic pressures acting on the back of the walls. Drainage details for the RSS wall and the toe wall should be incorporated in accordance with the MTO RSS Design Guidelines (2008) and OPSD 3120.100, respectively.

12.2 Seismic Lateral Earth Pressures

In accordance with Clause 6.14.7 of the *CHBDC (2019)*, 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 Table 12.2 may be used:

Table 12.2: Seismic Coefficient of Lateral Earth Pressures

Loading Condition ^(1, 2)	Granular A ⁽³⁾ $\phi = 39^\circ, \gamma = 22.9 \text{ kN/m}^3$		Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Backfill	2H:1V Sloping Backfill	Horizontal Backfill	2H:1V Sloping Backfill	Horizontal Backfill	2H:1V Sloping Backfill
Active (K_{AE})	0.26	0.50	0.31	0.55	0.35	0.59
Passive (K_{PE})	4.24	2.68	3.55	2.41	3.12	2.24

Notes: 1. After Mononobe and Okabe (1924).

2. The site-specific PGA is 0.103.

3. Friction angle and unit weight of Granular A material area based on the results provided in technical memorandum titled, "Innovation Study – Memo, Determination of Strength Parameters of Granular Materials, Bradford Bypass West Contractor, CMGC 2023-E-0068", dated December 12, 2025.

For force-based designs, a seismic geotechnical resistance factor, $\phi_{gu(seismic)}$, should be applied to the calculated seismic earth pressure. In accordance with Table 6.3 of the *CHBDC (2019)*, seismic geotechnical resistance factor, $\phi_{gu(static)}$, is equal to the static geotechnical resistance factor plus 0.2 but must not be greater than 1.0 (i.e., $\phi_{gu(seismic)} = \phi_{gu(static)} + 0.2 \leq 1$). For seismic design, the consequence factor, Ψ , is equal to 1.0 as per Section 6.14.4 of the *CHBDC (2019)*.

13. FROST PROTECTION

A minimum 1.5 m of soil cover for frost protection of the retaining structures is required as per OPSD 3090.101, as measured vertically and perpendicular from the face of the ground surface in front of the wall to the underside of the wall. The concrete toe wall will be constructed adjacent to the BBP to Highway 400 E-S Ramp and is proposed to be embedded only 0.45 m below ground surface (minimum embedment in accordance with OPSD 3120.100); however, given that the toe wall will be founded on 2 m thick granular pad, concerns due to frost heave are not anticipated. While the minimum soil cover above the underside of RSS levelling pad is proposed to be 0.8 m (more than 40 per cent of the frost depth for this site) and which is consistent with the MTO RSS Design Guidelines (2008), and therefore, frost heave is not considered a concern.

If adequate soil cover cannot be provided for the retaining structures, rigid Styrofoam insulation could be installed to compensate for the lack of soil cover and provide protection from frost penetration. The insulation must be placed above the high groundwater level.

14. EXCAVATION FOR RETAINING WALLS

Excavations will be required to permit construction of the retaining walls. The temporary excavations are anticipated to extend to depths of up to about 3 m below existing ground surface.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) of Ontario and OPSS.PROV 902, as amended by Special Provision 109S61.

The existing embankment fill and firm to stiff clay with sand to clay and sandy silty clay to clay with sand to clay till deposits are classified as Type 3 soils when they are above the groundwater table, and Type 4 soils when they are below the groundwater table. The very stiff cohesive soils are classified as Type 2 soils when they are above the groundwater table, and Type 4 soils when they are below the groundwater table. In accordance with O.Reg. 213, temporary cut slopes for Type 3 and Type 4 soils should have a minimum gradient of 1H:1V, and 3H:1V, respectively.

As an alternative to temporary cut slopes for the excavation, temporary protection systems may be designed and constructed as described in Section 15.

Excavations should be inspected regularly 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.

15. TEMPORARY PROTECTION SYSTEM

Temporary protection systems, if required, shall be designed and constructed for Performance Level 2 in accordance with OPSS.PROV 539 as amended by Special Provision 105S09. All protection systems shall be designed by a licensed Professional Engineer in Ontario with experience in design of shoring systems with consideration for adjacent traffic loads and placement of new engineered embankment fill.

The following engineering parameters may be used for design of the temporary protection systems with horizontal backfill:

Table 15.1: Engineering Parameters for the Design of Temporary Protection Systems

Stratigraphic Unit	Unit Weight of Material, γ' (kN/m ³)	Angle of Internal Friction, ϕ (kN/m ³)	Coefficient of Static Lateral Earth Pressure	
			Active, K_a	Passive, K_p
New Granular Fill	22.8	35	0.27	3.69
Compact to Dense Existing Silty Sand to Silty Sand with Gravel Fill	20	32	0.31	3.25

Stratigraphic Unit	Unit Weight of Material, γ' (kN/m ³)	Angle of Internal Friction, ϕ (kN/m ³)	Coefficient of Static Lateral Earth Pressure	
			Active, K_a	Passive, K_p
Stiff to Very Stiff Existing Sandy Silty Clay to Clay with Sand Fill	20	32	0.31	3.25
Firm to Very Stiff Clay to Clay with Sand	19	32	0.31	3.25
Firm to Very Stiff Sandy Silty Clay to Clay with Sand to Clay Till	20	32	0.31	3.25
Loose to Compact Silty Sand to Sandy Silt to Silty Clayey Sand Till	20	31	0.32	3.12

Notes: 1. The lateral earth pressure coefficients presented above are based on static loading conditions and level backfill/ground surface behind the protection system. Where there is sloping ground behind the protection system, the coefficient of lateral earth pressure must be adjusted to account for the slope.

2. The total passive resistance below the base of excavation, if required, may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (2019 CHBDC).

In accordance with OPSS.PROV 539, should the temporary protection systems be left in place after completion of construction, the top of the system shall be removed to at least 1.2 m below the finished grade or ground level.

16. SUBGRADE PREPARATION, BACKFILLING, AND SITE GRADING

16.1 Subgrade Preparation

All very loose to loose/very soft to soft fill, topsoil/organic matter, soft/loose soils, and other deleterious materials should be removed from the area of the proposed walls. The exposed subgrade should be proof-rolled and inspected by a qualified geotechnical engineer. Any softened/loosened or disturbed/poorly performing areas of the subgrade should be sub-excavated and replaced with compacted engineered fill as directed by a qualified geotechnical engineer but must be approved by the Contract Administrator.

16.2 Backfill Behind the Walls

Granular backfill behind the walls should meet the specifications of OPSS.PROV 1010 Granular A or Granular B Type II, constructed in accordance with OPSS.PROV 902, as amended by Special Provision 109S61. Compaction equipment to be used adjacent to the retaining structures must be restricted in accordance with OPSS.PROV 501 as amended by Special Provision 105S22.

17. CONTROL OF GROUNDWATER AND SURFACE WATER

Groundwater is expected to be encountered during excavations required to construct the granular pad for the toe wall and the RSS wall. Therefore, dewatering measures will be required for construction in dry conditions. Dewatering operations should be carried out and managed in accordance with OPSS.PROV 517, as amended by Special Provision 517F01.

The design of the dewatering system is the responsibility of the Contractor, and the Contract Documents must alert them to this responsibility. Seasonal fluctuations of the groundwater level are to be expected.

Surface water from runoff and precipitation events should be directed away from any excavations and low-lying areas during construction.

18. CORROSION ASSESSMENT

Analytical testing was carried out to determine the pH, water soluble sulphate, sulphide, chloride concentration, resistivity, and electrical conductivity of selected soil samples. The analytical test results for the soils are presented in Appendix E and summarized in Section 5.10. In accordance with California Department of Transportation's (Caltrans) Corrosion Guideline Version 3.2, dated May 2021, a site is considered corrosive if chloride concentration is 500 ppm or greater, sulphate concentration is 1,500 ppm or greater, and/or pH is 5.5 or less. Given the results of the analytical testing does not meet these conditions, the site is not considered to be corrosive. However, the corrosive effects of road de-icing salts/brine should also be considered for the design of corrosion protection of structural elements.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. In accordance with Table 3 of Concrete Materials and Methods of Concrete Construction (CSA A23.1:24), water soluble sulphate concentrations of less than 0.1% (i.e., 1000 µg/g) in soil samples indicate a low degree of exposure to sulphate attack is expected. The selection for the class of concrete should include consideration of the effects of road de-icing salt/brine.

19. CONSTRUCTION CONCERNS

A qualified geotechnical engineer (Foundation Engineering Specialist) should be retained to observe activities during construction and advise the Contract Administrator on construction issues related to performance of the temporary protection systems and construction of the retaining walls.

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

- Cobbles, boulders, and construction debris may be encountered within the existing embankment fill and glacial till deposits, which may affect excavation to construct the retaining walls, and the installation of temporary protection systems, where required. As such, considerations of such obstructions must be made in the selection of appropriate equipment and procedures for the work. An example of a Notice to Contractor to alert the Contractor is included in Appendix I.
- Groundwater levels at the sites are expected to be near or below the proposed foundation excavations for the retaining/toe walls and associated engineered fill pads (i.e., granular pads). Therefore, groundwater control measures will need to be implemented at the sites to ensure construction activities are carried out in dry conditions. An example of a Notice to Contractor to alert the Contractor is included in Appendix I.

20. CLOSURE

Preparation of the design report and engineering analysis was carried out by Mr. Tomasz Zalucki, P.Eng., a Senior Geotechnical Engineer. This report was reviewed by Mr. Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Tomasz Zalucki, P.Eng.
Associate, Senior Geotechnical Engineer



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Partner, Senior Geotechnical Engineer
Designated MTO Contact

Date: **April 13, 2026**

File: **48856**

REFERENCES

California Department of Transportation. 2021. Corrosion Guidelines (version 3.2). Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Branch.

Canadian Geotechnical Society. 2023. Canadian Foundation Engineering Manual, 5th Edition. The Canadian Geotechnical Society, British Columbia.

Chapman, L.J., & Putnam, D.F. (1984). The Physiography of Southern Ontario (3rd ed.). Ontario Geological Survey.

Ministry of Transportation, Engineering Standards Branch. September 2008. RSS Design Guidelines.

Ministry of Transportation, Ontario. 2022. Guideline for Foundation Engineering Services, Version 3.0.

Mononobe, N. 1924. Considerations into Earthquake and Vibration Theories. Journal of Japan Society of Civil Engineers.

Mononobe, N., and Matsuo, H. 1929. On the Determination of Earth Pressure During Earthquake. In Proceedings of the World Engineering Congress, Tokyo, Japan.

Okabe, S. 1924. General Theory of Earth Pressures and Seismic Stability of Retaining Wall and Dam. Journal of the Japan Society of Civil Engineers.

ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Canadian Standards Association (CSA) Group:

CSA A23.1:24 Concrete Materials and Methods of Concrete Construction

CSA S6:19 Canadian Highway Bridge Design Code

CSA S6.1:19 Commentary on CSA C6:19, Canadian Highway Bridge Design Code

Commercial Software:

Slide2 (Version 9.031) by Rocscience Inc.

Settle3 (Version 5.024) by Rocscience Inc.

Ontario Occupational Health and Safety Act:

Ontario Regulation 213 Construction Projects (as amended)

Ontario Provincial Standard Specifications (OPSS):

OPSS.PROV 501 Construction Specification for Compacting

OPSS.PROV 517 Construction Specification for Dewatering and Temporary Flow Passage Systems

OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 902	Construction Specification for Excavating and Backfilling – Structures
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material

MTO Special Provisions (SP):

SP517F01	Dewatering System – Item No. ; Temporary Flow Passage System – Item No.
----------	---

Ontario Provincial Standard Drawings (OPSD):

OPSD 3090.101	Foundations, Frost Penetration Depths for Southern Ontario
OPSD 3120.100	Walls, Retaining, Concrete Toe Wall
OPSD 3121.150	Walls, Retaining, Backfill, Minimum Granular Requirement

Ontario Regulations:

R.R.O. 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40



STATEMENT FOR USE AND INTERPRETATION OF REPORT

1. STANDARD OF CARE

This Report has been prepared in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under similar circumstances at the same time and in the same or similar locality and in compliance with all applicable laws.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment, including this Statement For Use and Interpretation of Report, are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT, AS DESCRIBED ABOVE. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE OF THE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives, and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client for the development, design objectives, and/or purposes described to Thurber by the Client. **NO OTHER PARTY MAY USE OR RELY ON THE REPORT OR ANY PORTION THEREOF FOR OTHER THAN THE CLIENT'S BENEFIT IN CONNECTION WITH THE PURPOSES DESCRIBED IN THE REPORT.** Any use which a third party makes of the Report is the sole responsibility of such third party and is always subject to this Statement for Use and Interpretation of Report. Thurber accepts no liability or responsibility for damages suffered by any third party resulting from use of the Report for purposes outside the reasonable contemplation of Thurber at the time it was prepared or in any manner unintended by Thurber.

5. INTERPRETATION OF THE REPORT

- a) **Nature and Exactness of Soil and Contaminant Description:** Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors is inherently judgement-based. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other parties making use of such documents or records with or without our express written consent need to be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other parties. Some conditions are subject to change over time and those making use of the Report need to be aware of this possibility and understand that the Report only presents the interpreted conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client must disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) **Reliance on Provided Information:** The evaluation and conclusions contained in the Report have been prepared based on conditions in evidence at the time of site inspections and based on information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report resulting from misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other parties providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) **Design Services:** The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber is recommended to be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design need to be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) **Construction Services:** During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or other parties who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes, but is not limited to, decisions made to develop, purchase, or sell land, unless such decisions expressly form part of the stated purpose of the Report as described in Paragraph 3.



APPENDIX A

Site Photographs



**Photograph #1 – At the intersection of McKinstry Road and 8th Line, east of Highway 400 looking west.
(October 2025)**



**Photograph #2 – At the north end of McKinstry Road, east of Highway 400 looking south.
(October 2025)**



**Photograph #3 –On McKinstry Road, east of Highway 400 looking south.
(October 2025)**



**Photograph #4 – North of 8th Line and west of Highway 400, looking south.
(October 2025)**

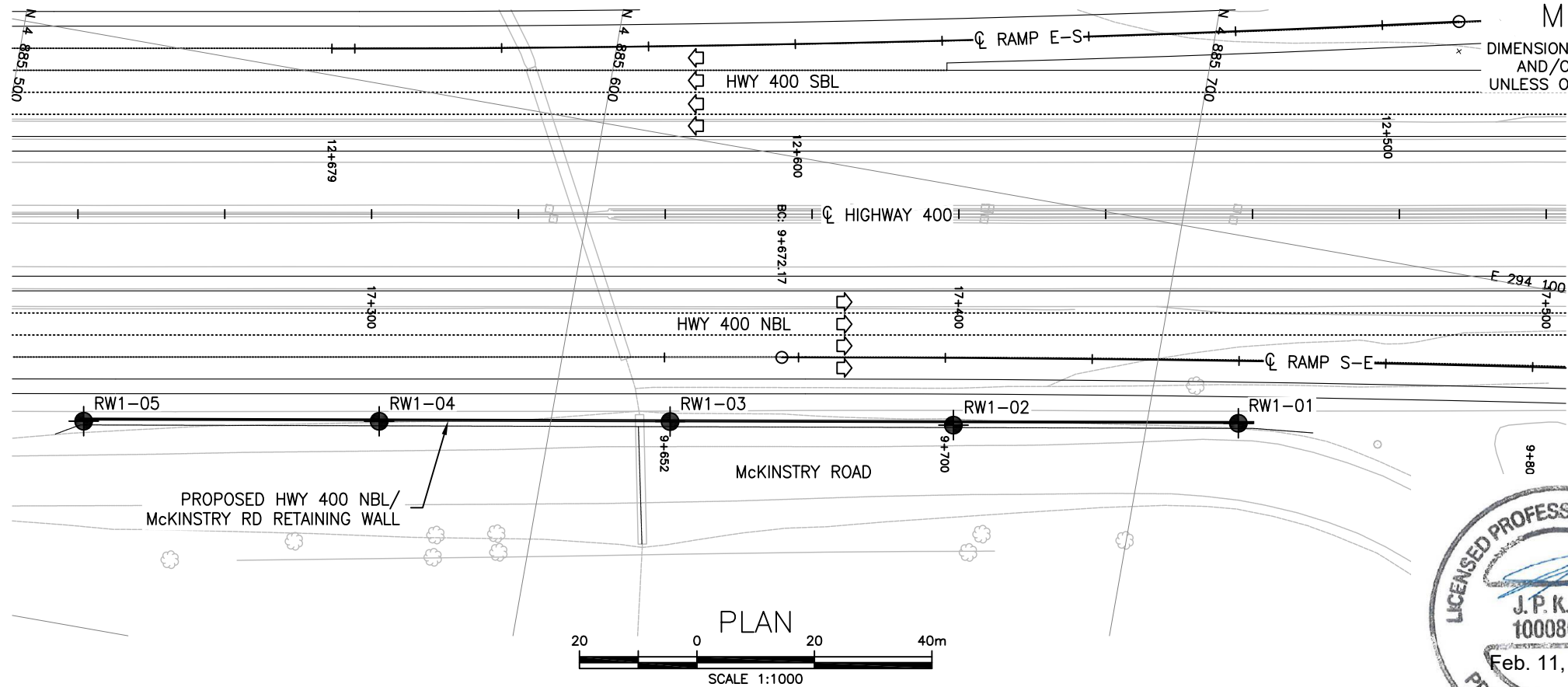


**Photograph #5 – North of 8th Line and west of Highway 400, looking southwest. The 8th Line Cemetery (Rogers United Cemetery) visible west of the trees.
(October 2025)**



APPENDIX B

Borehole Locations Plans and Soil Strata Drawings



METRIC

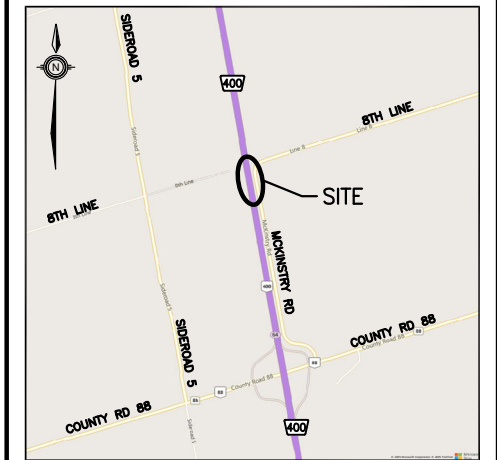
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No

BRADFORD BYPASS
HWY 400 NBL/McKINSTRY RD
RETAINING WALL
BOREHOLE LOCATIONS PLAN & SOIL STARTA

AECOM

THURBER



KEYPLAN

LEGEND

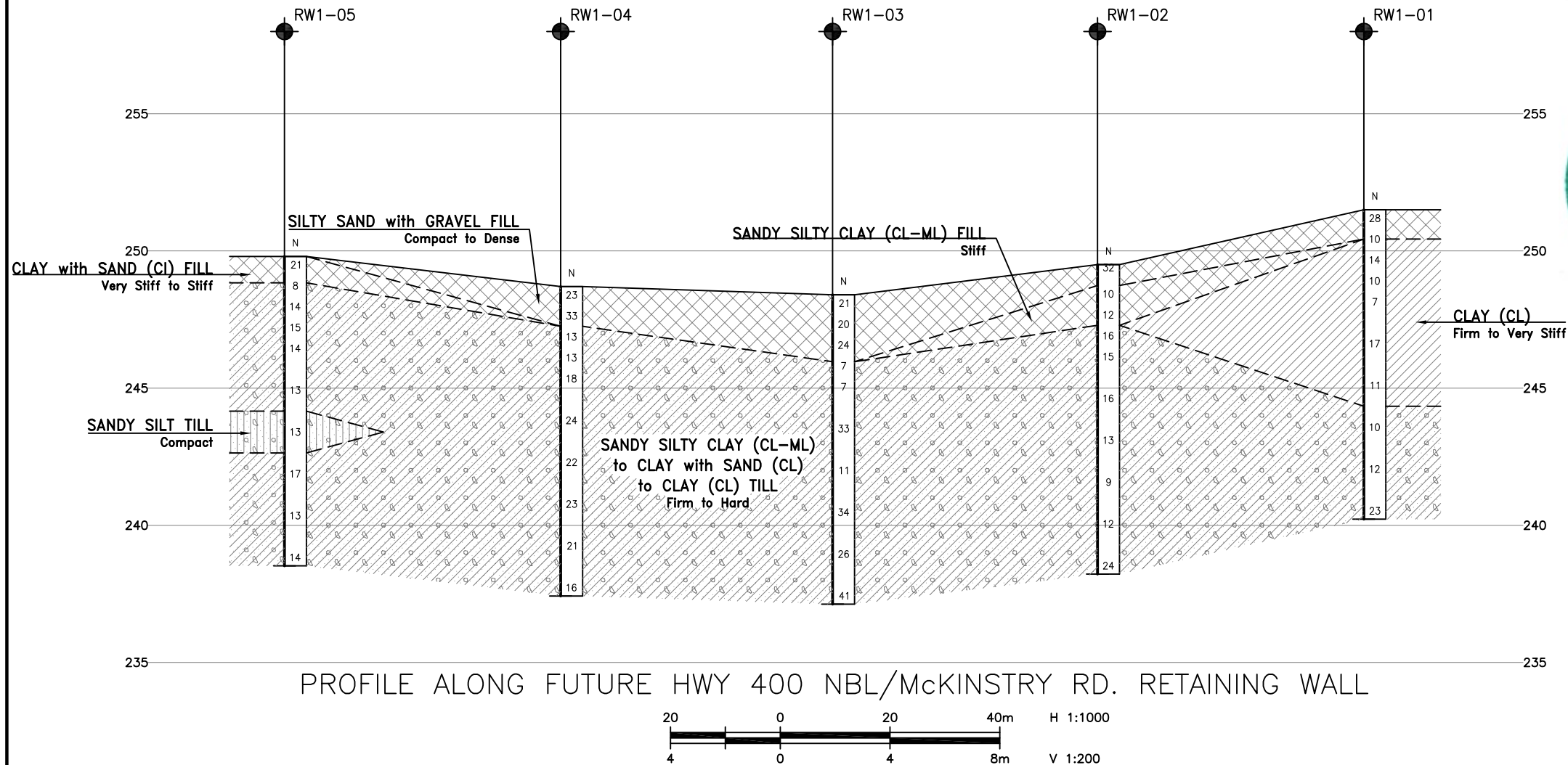
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW1-01	251.5	4 885 715.4	294 131.5
RW1-02	249.5	4 885 667.6	294 140.3
RW1-03	248.4	4 885 620.0	294 148.1
RW1-04	248.7	4 885 571.2	294 156.6
RW1-05	249.8	4 885 521.7	294 165.3

NOTES

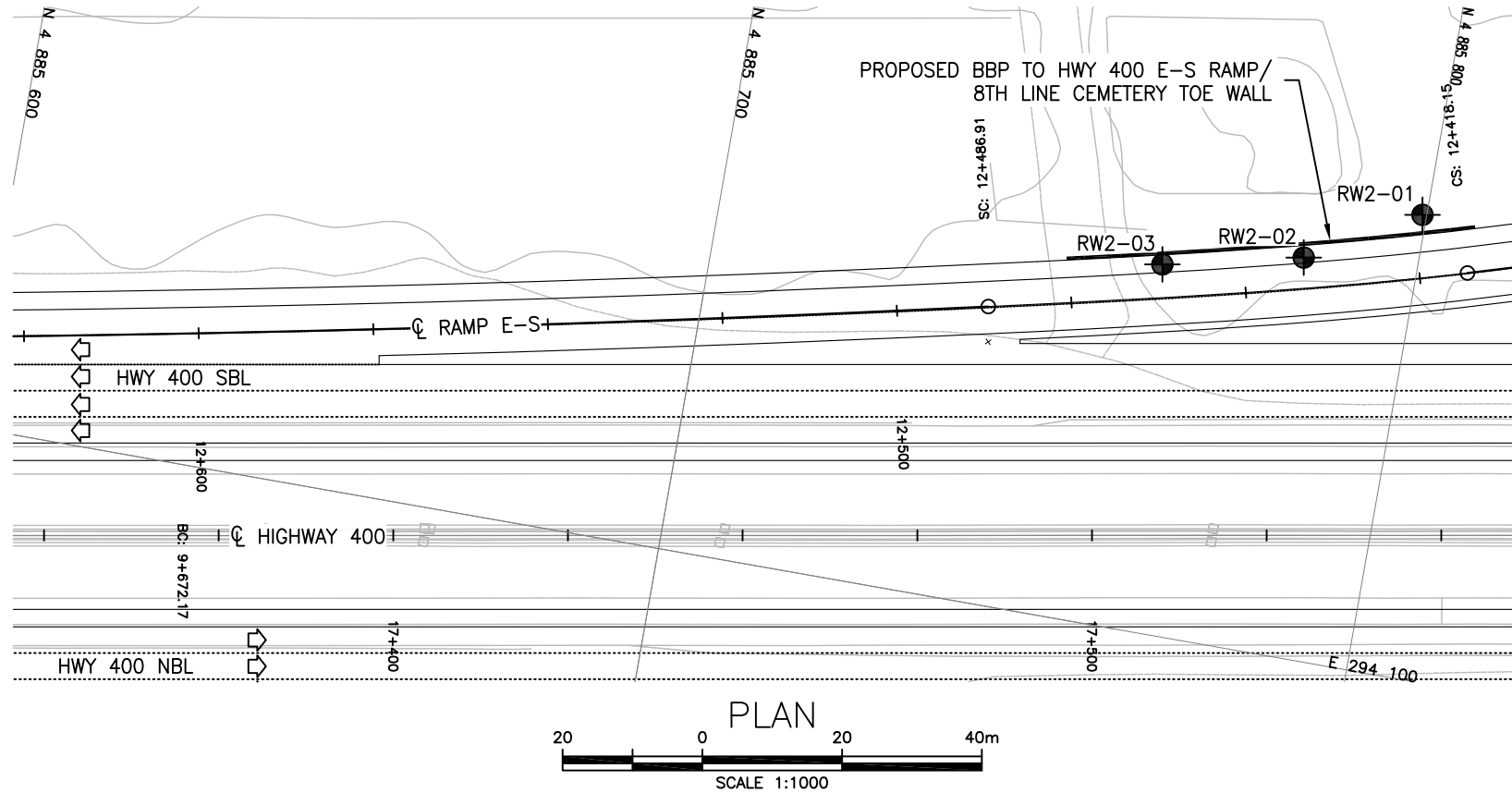
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD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

GEOCRES No. 31D04-019



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	TZ	CHK	JPL	CODE	LOAD	DATE	JAN 2026
DRAWN	AN	CHK	TZ	SITE 30X-0889/NO	STRUCT	DWG	1

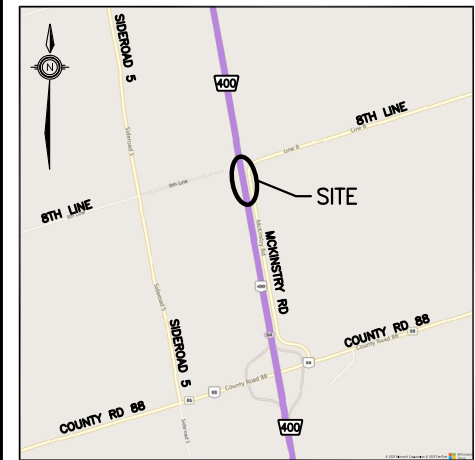


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No
BRADFORD BYPASS
BBP TO HWY 400
E-S RAMP TOE WALL
BOREHOLE LOCATIONS PLAN & SOIL STARTA

AECOM

THURBER



KEYPLAN

LEGEND

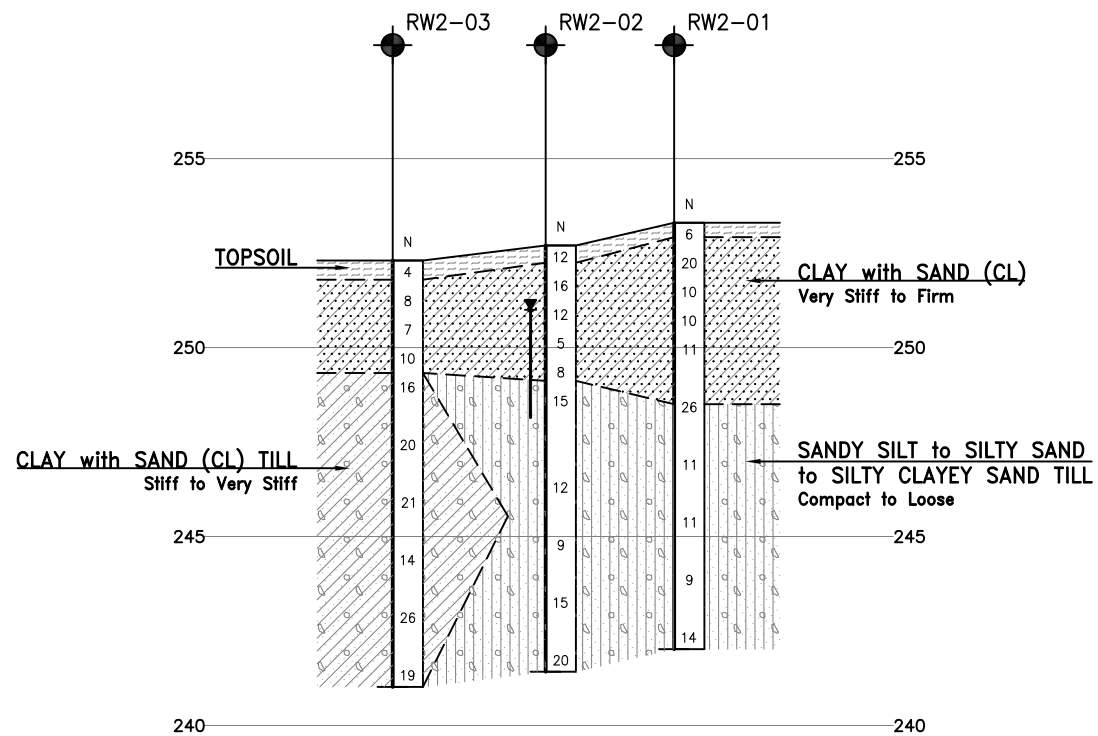
●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⊕	Water Level Upon Completion of Drilling
⊕	Water Level in Monitoring Well/Piezometer
⊕	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW2-01	253.3	4 885 799.4	294 034.0
RW2-02	252.7	4 885 783.7	294 042.9
RW2-03	252.3	4 885 764.0	294 047.4

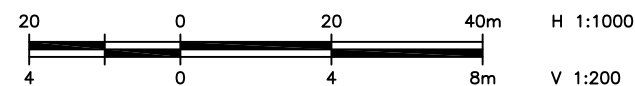
-NOTES-

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

GEOCRES No. 31D04-019



PROFILE ALONG FUTURE BBP TO HWY 400 E-S RAMP/
8TH LINE CEMETERY TOE WALL



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	TZ	CHK JPL	CODE
DRAWN	AN	CHK TZ	SITE
			LOAD
			DATE
			FEB 2026
			STRUCT
			DWG 1

APPENDIX C

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORD OF BOREHOLES

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS:

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in size from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	greater than 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	less than 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. Where insufficient penetration was achieved, the number of blows are reported over the sampler penetration in metres (e.g. 50/0.15).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60-degree apex cone connected to "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

WATER LEVELS:

	Water level upon completion of drilling
	Water level in monitoring well / piezometer
	Monitoring well / piezometer screen

STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravels



Sands



Silts



Clays



Organics



Asphalt



Concrete



Fill



Bedrock

TEXTURING CLASSIFICATION OF SOILS
Classification
Particle Size

Clay	Less than 0.002 mm
Silt	0.002 mm – 0.075 mm
Sand	0.075 mm – 4.75 mm
Gravel	4.75 mm – 75 mm
Cobbles	75 mm – 300 mm
Boulders	Greater than 300 mm

**TERMS DESCRIBING CONSISTENCY
(FINE GRAINED SOILS ONLY)**

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	Less than 12
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split-spoon samples
TW	Thin-wall (Shelby) tube sample
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core sample obtained with the use of standard size diamond coring equipment

**TERMS DESCRIBING DENSITY
(COARSE GRAINED SOILS ONLY)**

Descriptive Term	SPT 'N' Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Division		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS LL < 35	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS 35 ≤ LL < 50	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS LL ≥ 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		PT	Peat and other organic soils.

Note – LL = Liquid Limit

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh, W1 (FR)	No visible signs of weathering.
Slightly Weathered, W2 (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered, W3 (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered, W4 (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered, W5 (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.
Residual Soil, W6 (RS)	Rock is completely changed into a soil, where the rock texture and structures have been completely destroyed.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length.
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

Bedding	Bedding Thickness
Thinly laminated	Less than 6 mm
Laminated	6 mm – 20 mm
Very thinly bedded	20 mm – 60 mm
Thinly bedded	60 mm – 0.2 m
Medium bedded	0.2 m – 0.6 m
Thickly bedded	0.6 m – 2 m
Very thickly bedded	Greater than 2 m

STRENGTH CLASSIFICATION

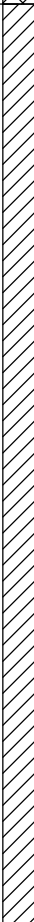
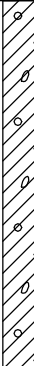
Rock Strength	Uniaxial Compressive Strength (MPa)
Extremely Weak, R0	0.25 – 1
Very Weak, R1	1 – 5
Weak, R2	5 – 25
Medium Strong, R3	25 – 50
Strong, R4	50 – 100
Very Strong, R5	100 – 250
Extremely Strong, R6	Greater than 250

RECORD OF BOREHOLE No RW1-01

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 715.4 E 294 131.5 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.08 - 2024.12.08 LATITUDE 44.111354 LONGITUDE -79.633276 CHECKED BY RR/JA

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						
251.5	GROUND SURFACE							20	40	60	80	100		
0.0	Silty SAND with gravel Compact Brown Moist (FILL)		1	SS	28		251						○	19 54 18 9 Non-plastic
250.4			2	SS	10		250						○	
1.1	CLAY (CL) Firm to Very Stiff Brown to Grey Wet						250						○	
			3	SS	14		249						○	
			4	SS	10		249						○	3 5 62 30
			5	SS	7		248						○	
			6	SS	17		247						○	
			7	SS	11		245						○	
244.3	CLAY with sand (CL) Stiff Grey Wet (TILL)		8	SS	10		244						○	1 26 46 27
7.2			9	SS	12		242						○	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No RW1-02

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 667.6 E 294 140.3 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.08 - 2024.12.08 LATITUDE 44.110925 LONGITUDE -79.633166 CHECKED BY RR/JA

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									WATER CONTENT (%)
249.5	GROUND SURFACE							20	40	60	80	100					
0.0	Silty SAND Dense Brown Moist (FILL)		1	SS	32		249							○			
248.7																	
0.8	Sandy SILTY CLAY (CL-ML) Stiff Brown to Grey Moist (FILL)		2	SS	10		248							○			
			3	SS	12									○H			5 43 38 14
247.3																	
2.2	CLAY with sand (CL) Very Stiff to Firm Grey Wet (TILL)		4	SS	16		247							○			
			5	SS	15		246							○			
			6	SS	16		245							○H			2 25 50 23
							244										
			7	SS	13		243							○			
							242										
			8	SS	9		241							○			
			9	SS	12		240							○			

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+³, ×³: Numbers refer to
Sensitivity

20
15
10

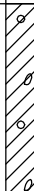
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW1-02

2 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 667.6 E 294 140.3 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.08 - 2024.12.08 LATITUDE 44.110925 LONGITUDE -79.633166 CHECKED BY RR/JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100					w _P w w _L				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
	Continued From Previous Page																
238.2	CLAY with sand (CL) Very Stiff Grey Wet (TILL)		10	SS	24		239								○		
11.3	END OF BOREHOLE AT 11.3m. OPEN BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE CAVED IN TO A DEPTH OF ABOUT 1.8m, THEN BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE. BOREHOLE ELEVATION AND COORDINATES ARE APPROXIMATE. LOCATION COULD NOT BE SURVEYED DUE TO ACCESS RESTRICTIONS.																

RECORD OF BOREHOLE No RW1-03

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 620.0 E 294 148.1 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.08 - 2024.12.08 LATITUDE 44.110497 LONGITUDE -79.633068 CHECKED BY RR/JA

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													w _p	w	w _L
								● QUICK TRIAXIAL × LAB VANE															
248.4	GROUND SURFACE						20	40	60	80	100		20	40	60								
0.0	Silty SAND with gravel Compact Brown Moist (FILL)		1	SS	21								○					18 62 15 5 Non-plastic					
			2	SS	20								○										
			3	SS	24								○										
246.0													○										
2.4	CLAY (CL) Firm to Hard Grey Wet (TILL)		4	SS	7								○	○									
			5	SS	7																		
			6	SS	33										○								
			7	SS	11								○										
			8	SS	34								○										
239.7																							
8.7	Sandy SILTY CLAY (CL-ML) Very Stiff Grey Wet (TILL)		9	SS	26																		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

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

[illegible]

RECORD OF BOREHOLE No RW1-04

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 571.2 E 294 156.6 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.09 - 2024.12.09 LATITUDE 44.110057 LONGITUDE -79.632960 CHECKED BY RR/JA

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				
248.7	GROUND SURFACE						20 40 60 80 100									
0.0	Silty SAND with gravel Compact Brown Moist (FILL)		1	SS	23											
			2	SS	33											
247.3																
1.4	CLAY (CL) Stiff to Very Stiff Brown to Grey Moist (TILL)		3	SS	13											
			4	SS	13											0 6 63 31
			5	SS	18											
			6	SS	24											
			7	SS	22											
241.5																
7.2	CLAY with sand (CL) Very Stiff Brown to Grey Moist to Wet (TILL)		8	SS	23											2 22 61 15
			9	SS	21											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW1-04

2 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 571.2 E 294 156.6 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.09 - 2024.12.09 LATITUDE 44.110057 LONGITUDE -79.632960 CHECKED BY RR/JA

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					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
237.4	Continued From Previous Page		10	SS	16												
11.3	CLAY with sand (CL) Very Stiff Brown to Grey Moist to Wet (TILL)					238											
	END OF BOREHOLE AT 11.3m. OPEN BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE CAVED IN TO A DEPTH OF ABOUT 1.8m, THEN BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE. BOREHOLE ELEVATION AND COORDINATES ARE APPROXIMATE. LOCATION COULD NOT BE SURVEYED DUE TO ACCESS RESTRICTIONS.																

RECORD OF BOREHOLE No RW1-05

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 521.7 E 294 165.3 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.09 - 2024.12.09 LATITUDE 44.109612 LONGITUDE -79.632850 CHECKED BY RR/JA

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	
249.8	GROUND SURFACE																				
0.0	CLAY with sand (CI) Very Stiff to Stiff Brown Moist (FILL)		1	SS	21								○	┌───┐			0	18	64	18	
248.8							249						○								
1.0	Sandy SILTY CLAY (CL-ML) Stiff to Very Stiff Brown to Grey Moist to Wet (TILL)		2	SS	8																
			3	SS	14		248						┌──┐				5	33	55	7	
			4	SS	15								○								
							247						○								
													○								
			5	SS	14								○								
							246														
			6	SS	13		245						○								
244.2																					
5.6	Sandy SILT Compact Grey Wet (TILL)		7	SS	13		244						Φ				1	38	54	7	
							243														
242.6																					
7.2	CLAY with sand (CL) Very Stiff to Stiff Grey Wet (TILL)		8	SS	17		242						○								
							241														
			9	SS	13								○								
							240														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW1-05 2 OF 2 METRIC

W.P. _____ LOCATION HWY 400 NBL/McKinstry Rd. : N 4 885 521.7 E 294 165.3 ORIGINATED BY AB
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2024.12.09 - 2024.12.09 LATITUDE 44.109612 LONGITUDE -79.632850 CHECKED BY RR/JA

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					
	CLAY with sand (CL) Stiff Grey Wet (TILL)																
238.5			10	SS	14		239										
11.3	END OF BOREHOLE AT 11.3m. OPEN BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE CAVED IN TO A DEPTH OF ABOUT 1.5m, THEN BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO GROUND SURFACE. BOREHOLE ELEVATION AND COORDINATES ARE APPROXIMATE. LOCATION COULD NOT BE SURVEYED DUE TO ACCESS RESTRICTIONS.																

RECORD OF BOREHOLE No RW2-01

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 799.4 E 294 034.0 ORIGINATED BY SP
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2025.07.08 - 2025.07.08 LATITUDE 44.112110 LONGITUDE -79.634496 CHECKED BY JA/TZ

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				W _P W W _L WATER CONTENT (%)				GR	SA	SI	CL
253.3	GROUND SURFACE							20	40	60	80	100							
0.0	TOPSOIL: (380mm)		1	SS	6		253							○					
252.9														○					
0.4	CLAY with sand (CL) Very Stiff to Stiff Grey Moist		2	SS	20		252							○					
			3	SS	10		251							○					
			4	SS	10		250							○					
			5	SS	11		249												
248.5														○					
4.8	Sandy SILT to silty SAND Compact to Loose Brown Moist (TILL)		6	SS	26		248							○H				4 45 34 17	
				7	SS	11		247							H			10 40 35 15	
			8	SS	11		246							○					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW2-01

2 OF 2

METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 799.4 E 294 034.0 ORIGINATED BY SP
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2025.07.08 - 2025.07.08 LATITUDE 44.112110 LONGITUDE -79.634496 CHECKED BY JA/TZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p	W	W _L		
							20	40	60	80	100						
	Continued From Previous Page																
242.0	Sandy SILT to silty SAND Compact to Loose Brown Moist (TILL)		10	SS	14		243										
11.3	END OF BOREHOLE AT 11.3m. OPEN BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE CAVED IN TO 10.4m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE.																

RECORD OF BOREHOLE No RW2-02

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 783.7 E 294 042.9 ORIGINATED BY SP
 DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
 DATUM Geodetic DATE 2025.07.08 - 2025.07.08 LATITUDE 44.111969 LONGITUDE -79.634384 CHECKED BY JA/TZ

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										
252.7	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (457mm)		1	SS	12													
252.3																		
0.5	CLAY with sand (CL) Very Stiff to Firm Brown Moist		2	SS	16		252											4 17 44 35
			3	SS	12		251											
			4	SS	5		250											
			5	SS	8													
249.2																		
3.6	Silty clayey SAND Compact Brown Moist (TILL) Field Vane with tip at 4.1 m, 100 ft lbs (refusal)		6	SS	15		249											7 46 32 15
							248											
			7	SS	12		247											
							246											
245.6																		
7.2	Silty SAND Loose to Compact Brown Moist (TILL)		8	SS	9		245											7 50 30 13
							244											
			9	SS	15													
							243											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW2-02

2 OF 2

METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 783.7 E 294 042.9 ORIGINATED BY SP
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2025.07.08 - 2025.07.08 LATITUDE 44.111969 LONGITUDE -79.634384 CHECKED BY JA/TZ

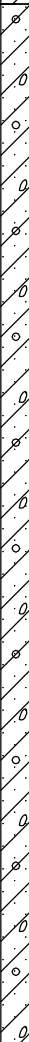
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
241.5	Silty SAND Loose to Compact Brown Moist (TILL)		10	SS	20		242										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED IN TO 9.7m, BACKFILLED WITH BENTONITE HOLEPLUG TO 4.8m, THEN INSTALLED A WELL. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2025.08.08 1.8 250.9 2025.08.21 1.4 251.3 2025.09.08 1.7 251.0																

RECORD OF BOREHOLE No RW2-03

1 OF 2

METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 764.0 E 294 047.4 ORIGINATED BY SP
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2025.07.09 - 2025.07.09 LATITUDE 44.111791 LONGITUDE -79.634328 CHECKED BY JA/TZ

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									
252.3	GROUND SURFACE						20	40	60	80	100	20	40	60			
0.0	TOPSOIL: (500mm)		1	SS	4								○				
251.8													○				
0.5	CLAY (CL) Firm to Stiff Brown Moist		2	SS	8								○				
			3	SS	7								○				
			4	SS	10								○				
249.3																	
3.0	CLAY with sand (CL) Stiff to Very Stiff Grey Moist (TILL)		5	SS	16								○				
													○				
													○				
			6	SS	20								○				
													○				
			7	SS	21								○				
													○				
			8	SS	14												
			9	SS	26								○				

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

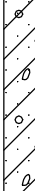
20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW2-03

2 OF 2

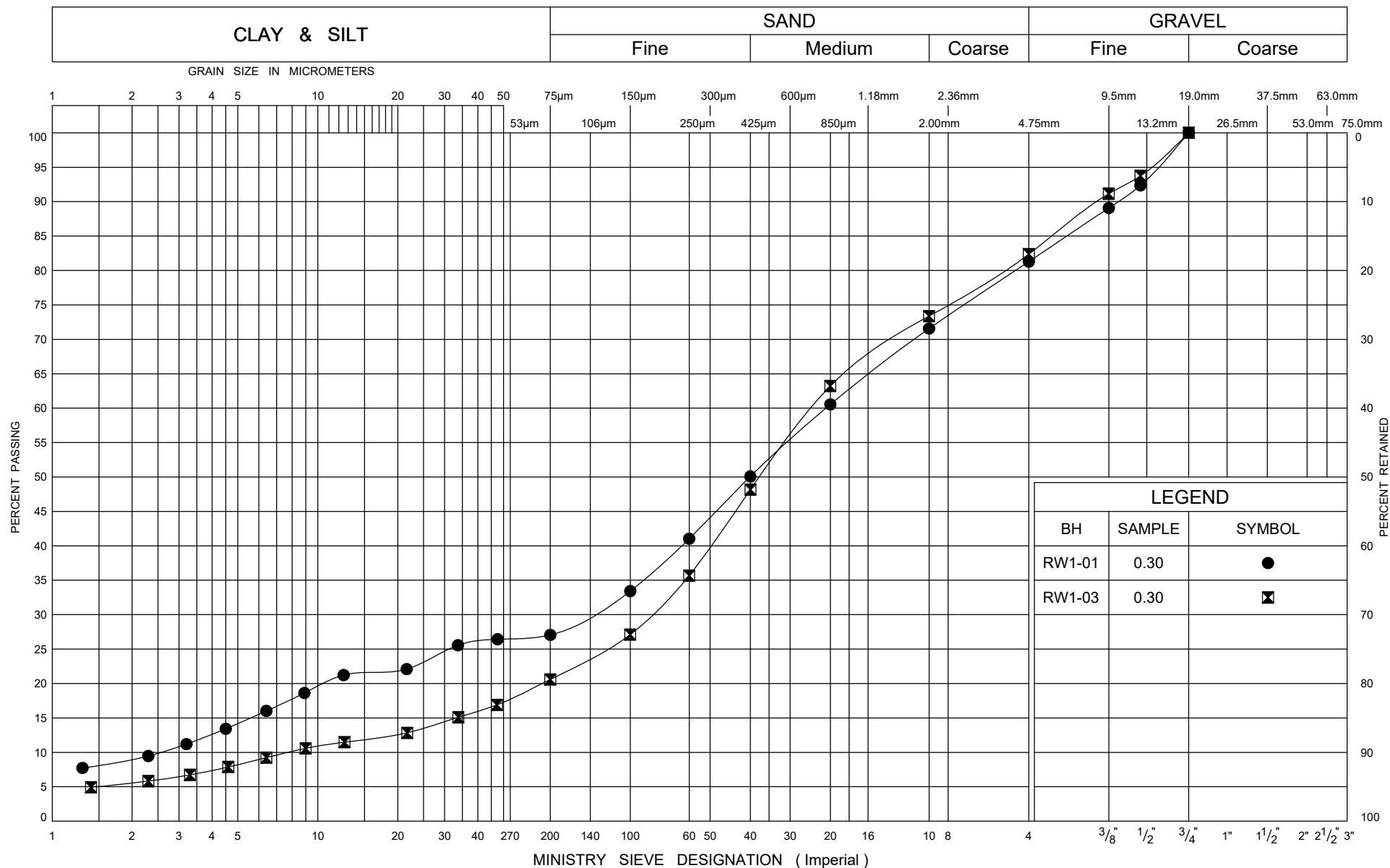
METRIC

W.P. _____ LOCATION HWY 400 SBL/8th Line Cemetery: N 4 885 764.0 E 294 047.4 ORIGINATED BY SP
DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JW
DATUM Geodetic DATE 2025.07.09 - 2025.07.09 LATITUDE 44.111791 LONGITUDE -79.634328 CHECKED BY JA/TZ

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 (%)				
	Continued From Previous Page							20	40	60	80	100	W _p	W	W _L		GR SA SI CL
	CLAY with sand (CL) Very Stiff Grey Moist (TILL)		10	SS	19		242										0 26 45 29
241.0																	
11.3	END OF BOREHOLE AT 11.3m. OPEN BOREHOLE DRY UPON COMPLETION OF DRILLING. BOREHOLE CAVED IN TO 10.1m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE.																

APPENDIX D

Geotechnical Laboratory Test Results



Ministry of
Transportation

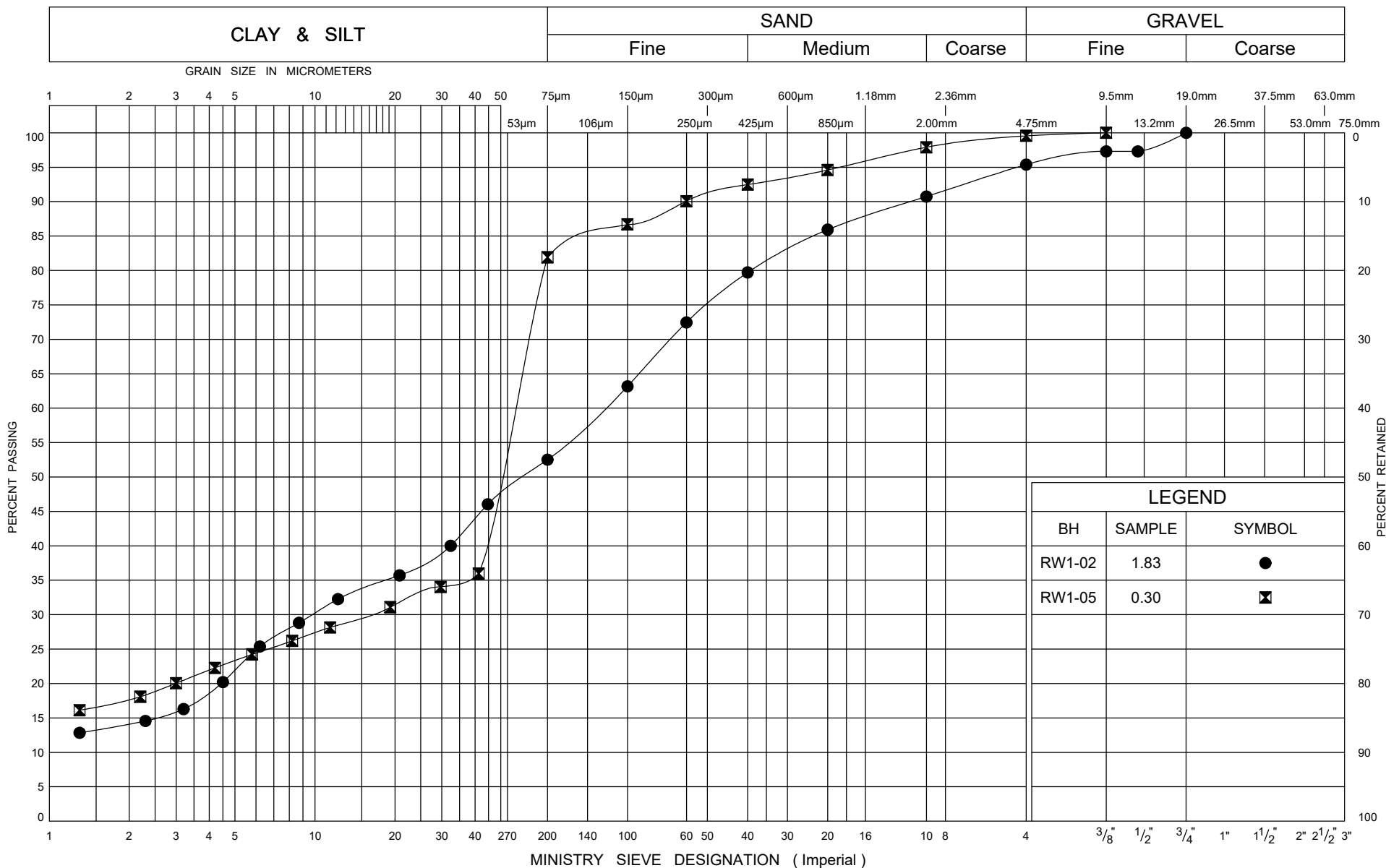
GRAIN SIZE DISTRIBUTION

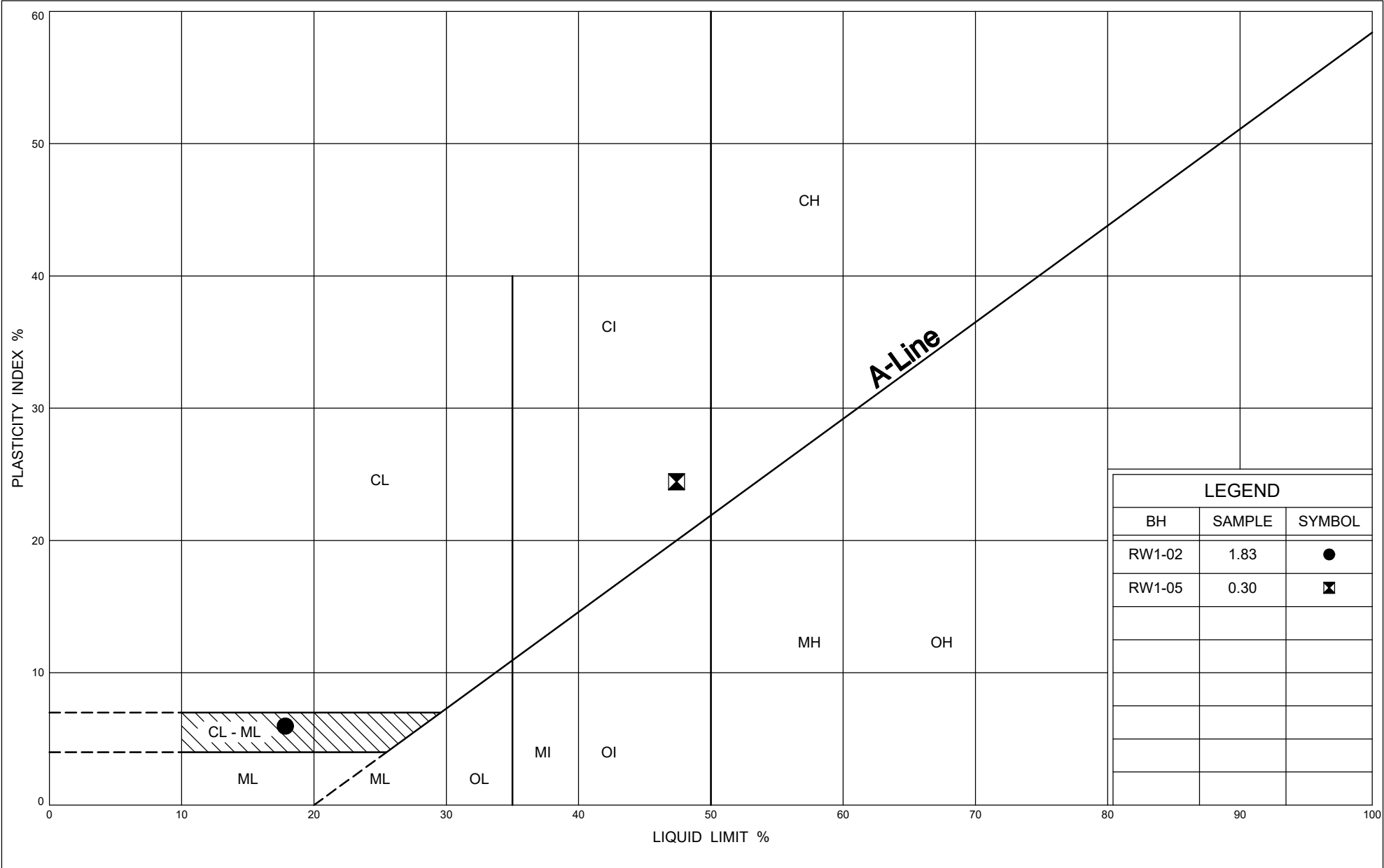
Silty SAND with Gravel FILL

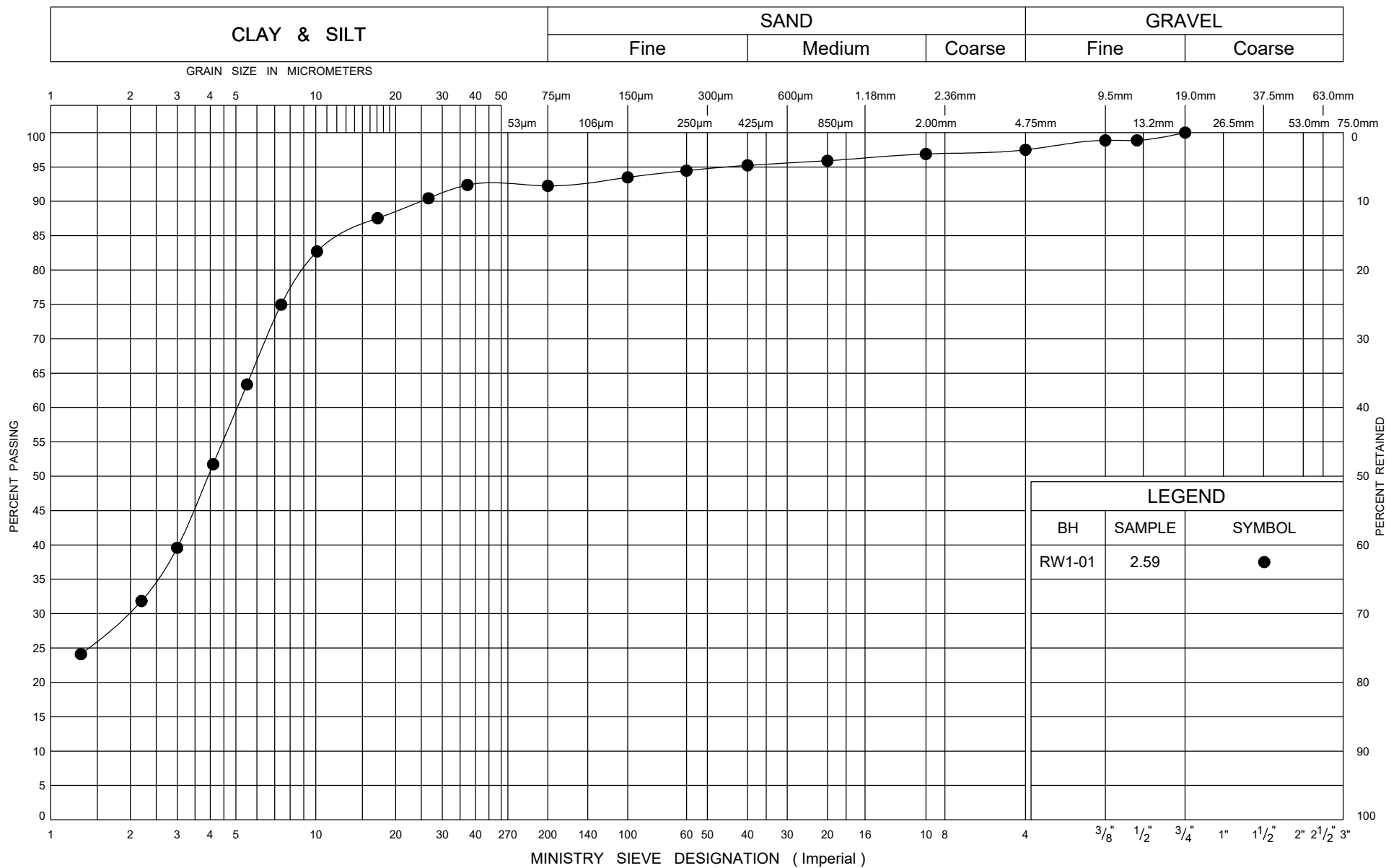
FIG No 1

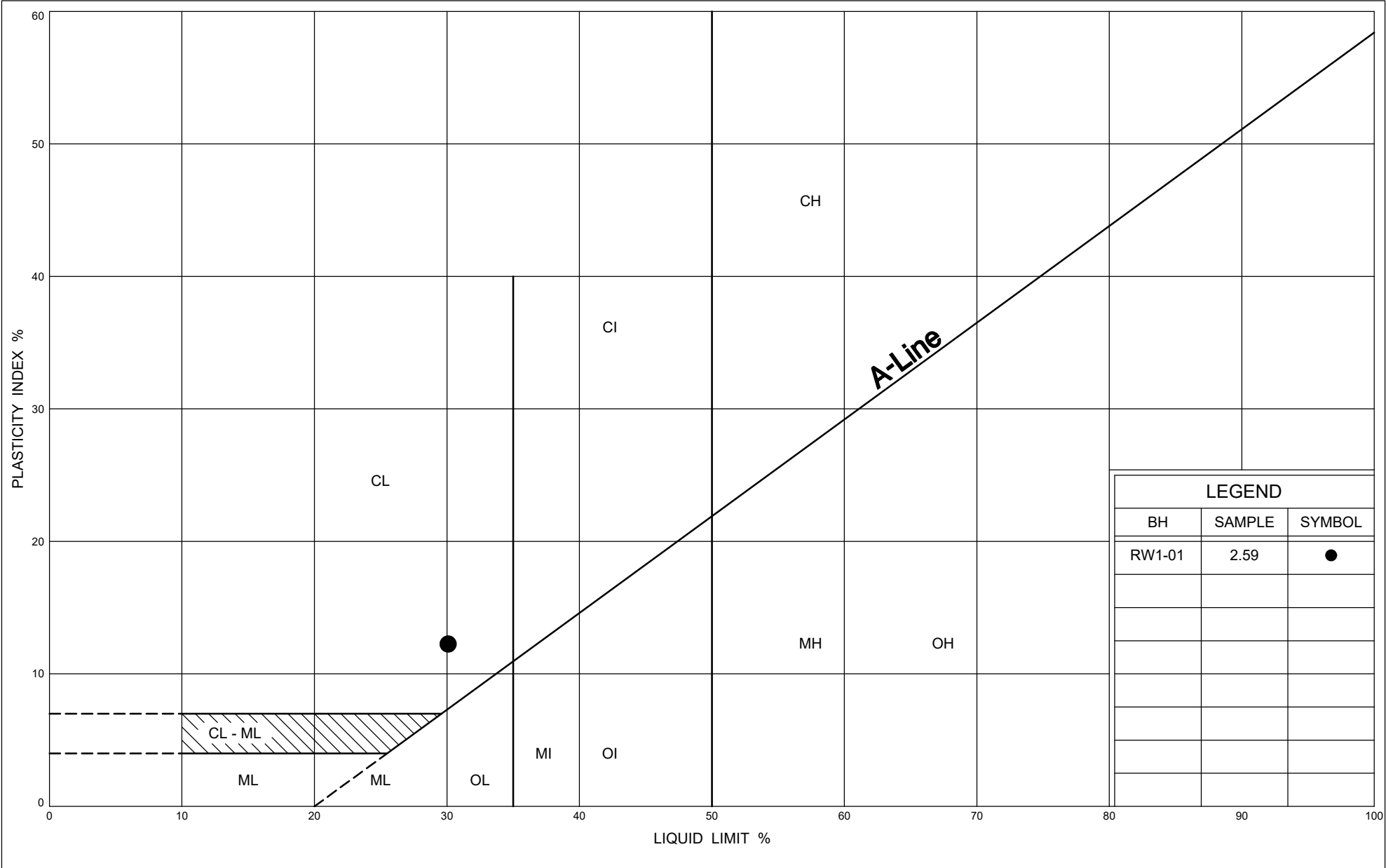
W.P.

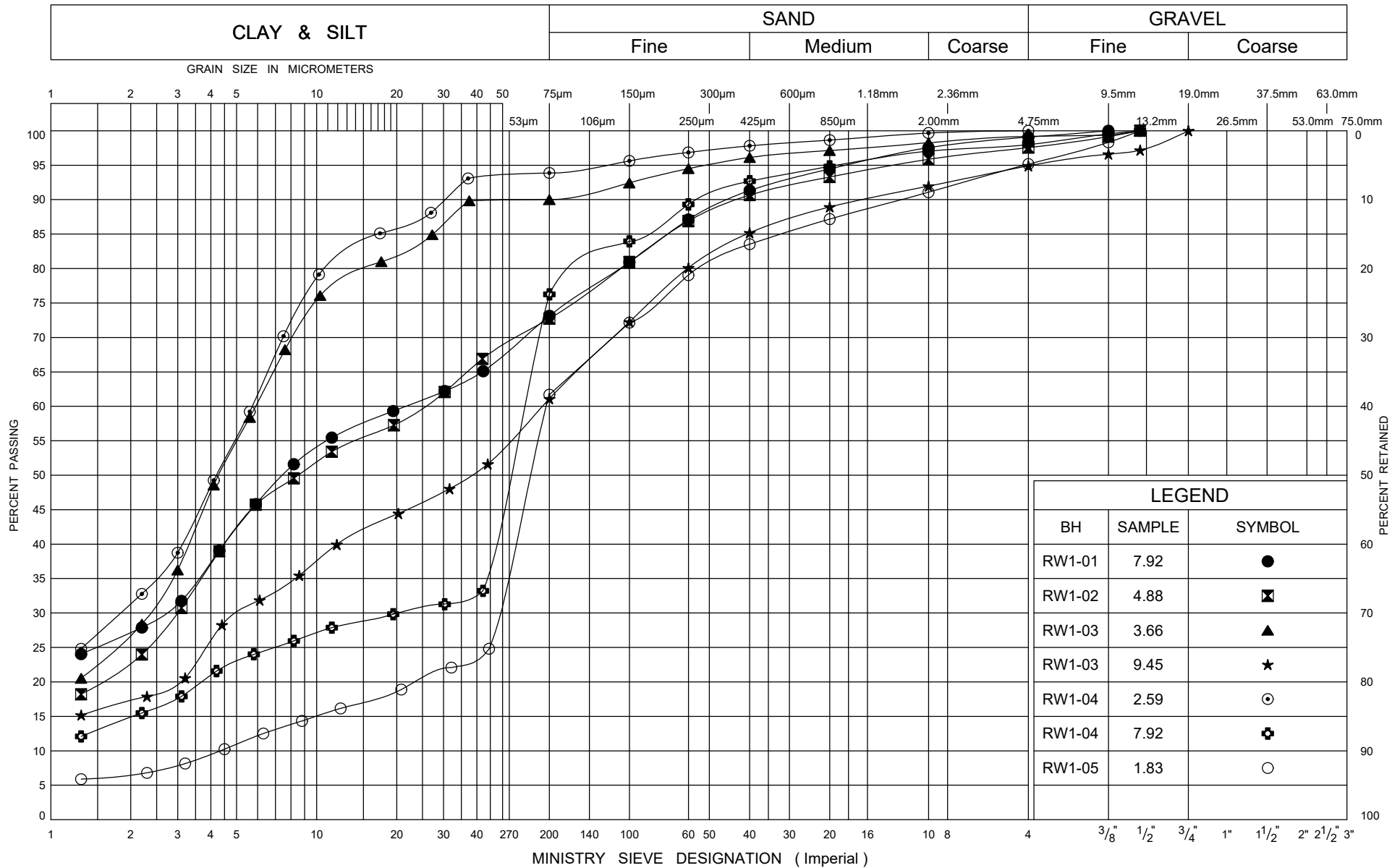
HWY 400 NBL/McKinstry Rd.











Ministry of
Transportation

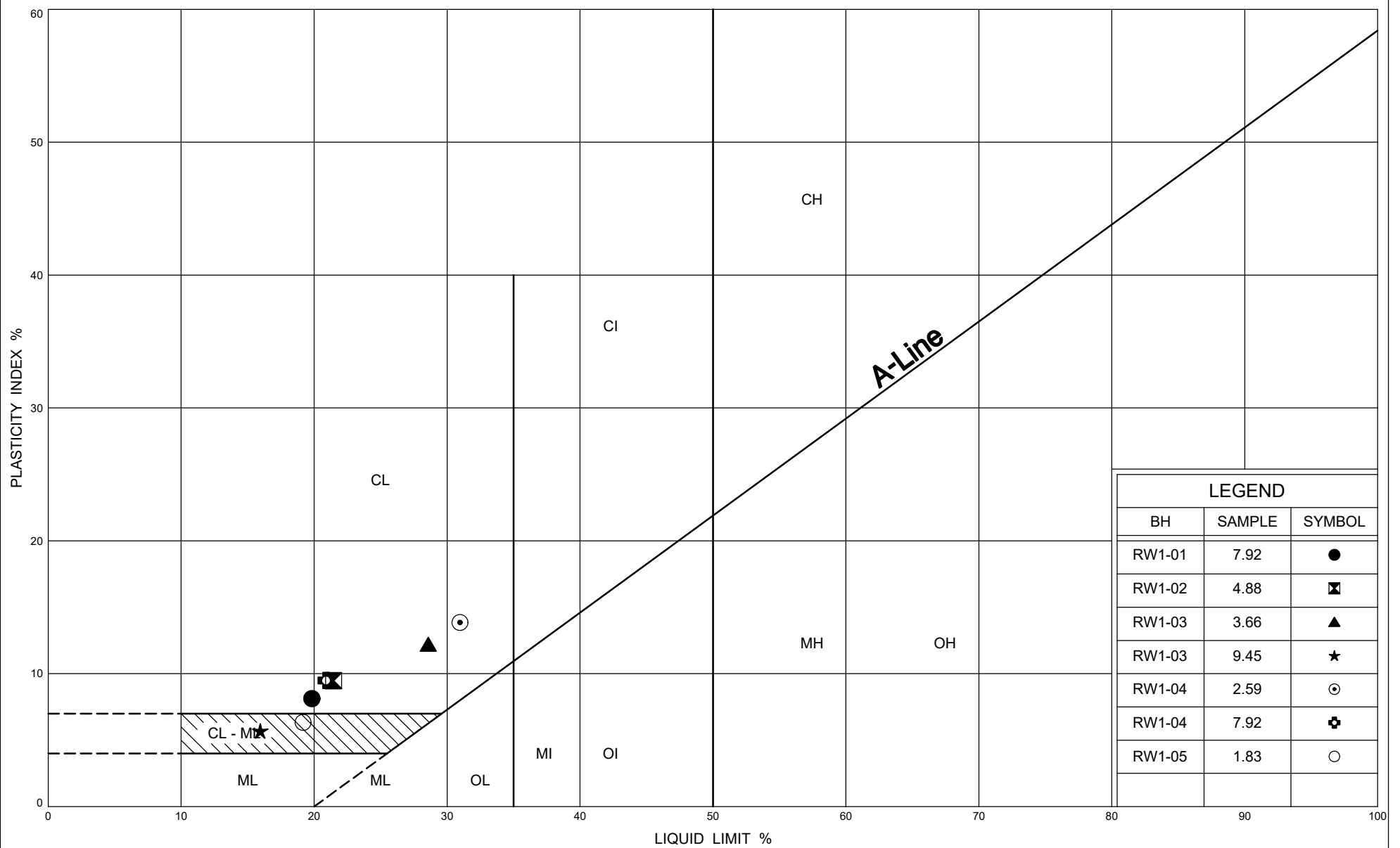
GRAIN SIZE DISTRIBUTION

Sandy SILTY CLAY (CL-ML) to CLAY with Sand (CL) to CLAY (CL) TILL

FIG No 6

W.P.

HWY 400 NBL/McKinstry Rd.



Ministry of
Transportation

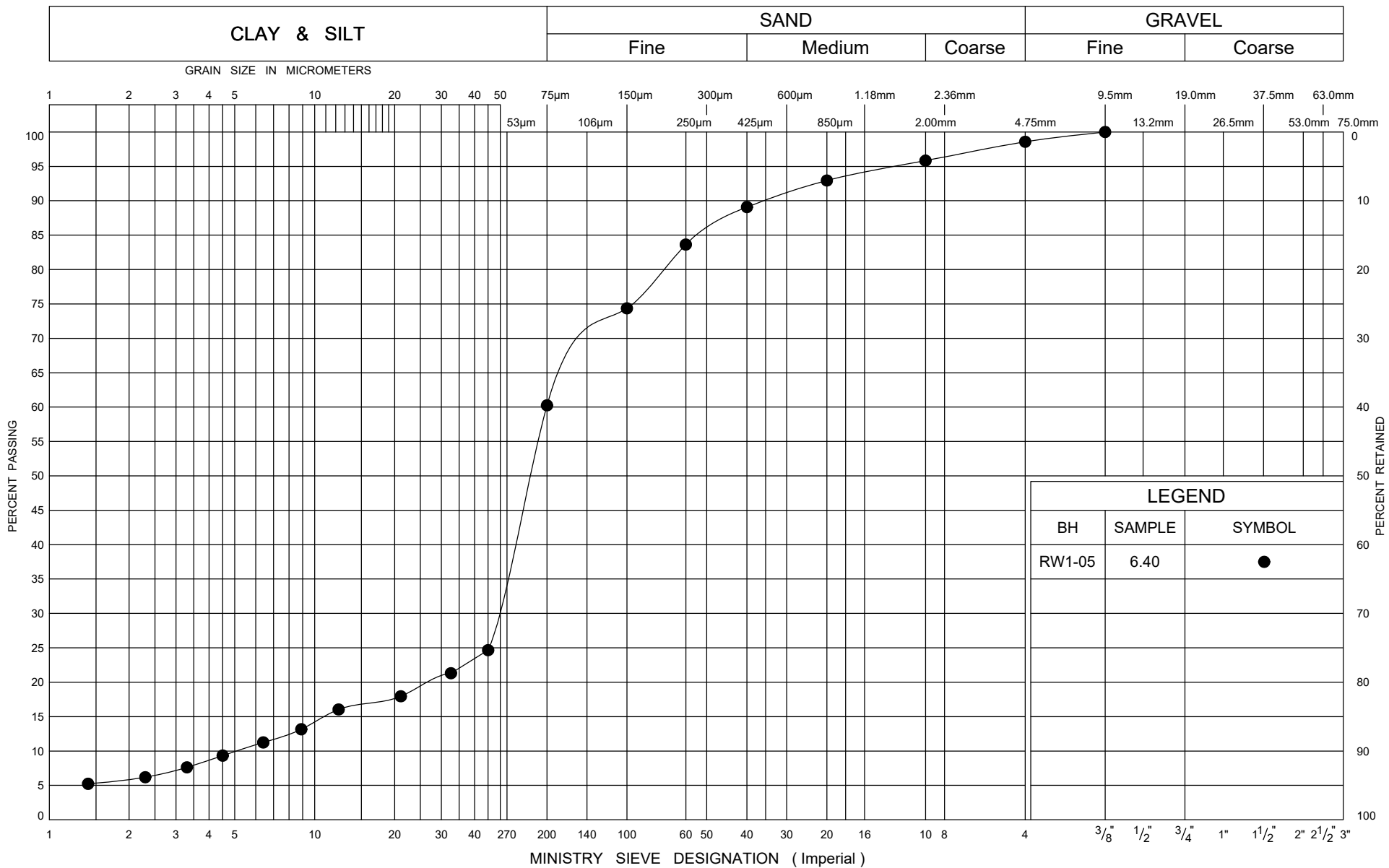
PLASTICITY CHART

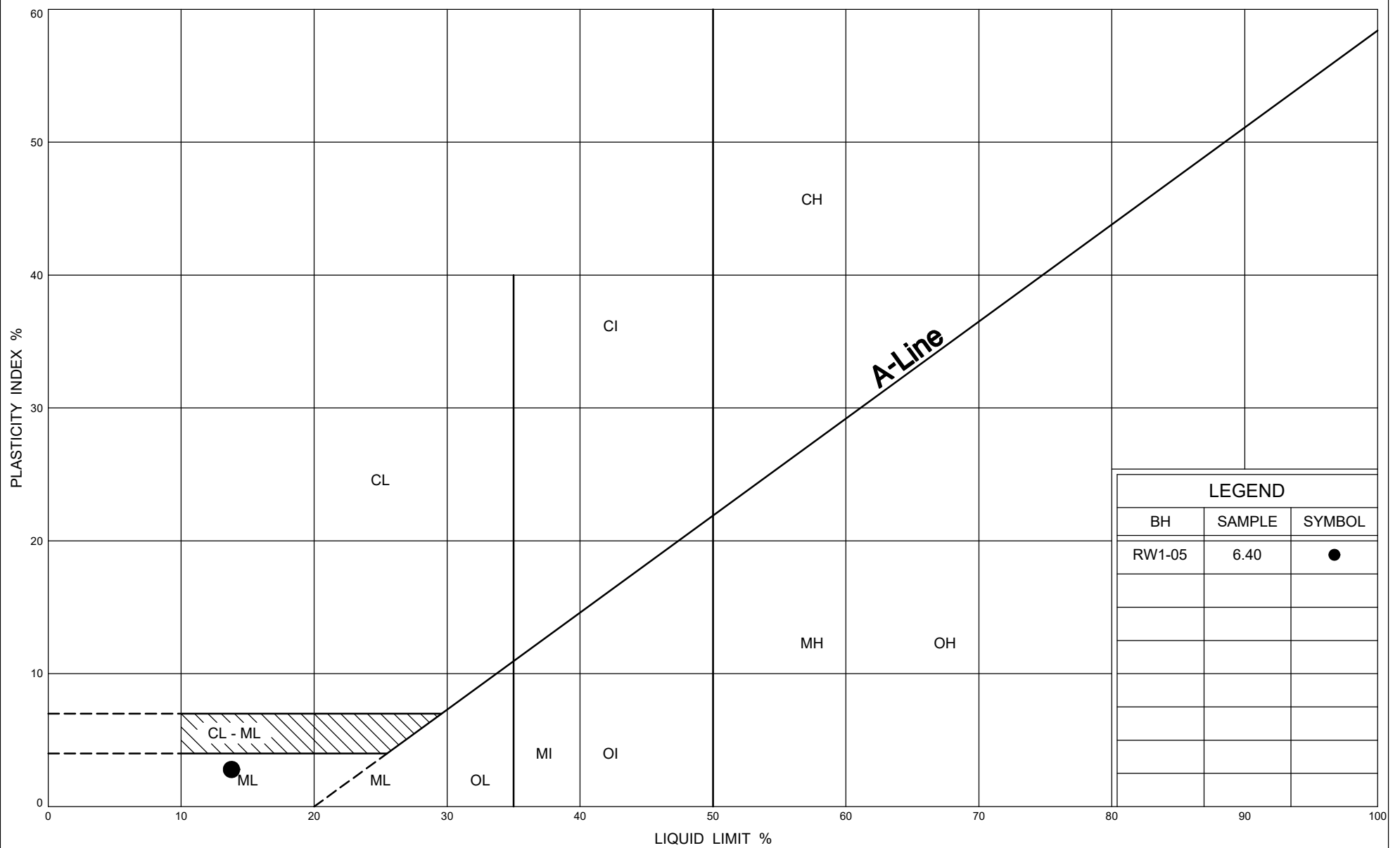
Sandy SILTY CLAY (CL-ML) to CLAY with Sand (CL) to CLAY (CL) TILL

FIG No 7

W.P.

HWY 400 NBL/McKinstry Rd.





Ministry of
Transportation

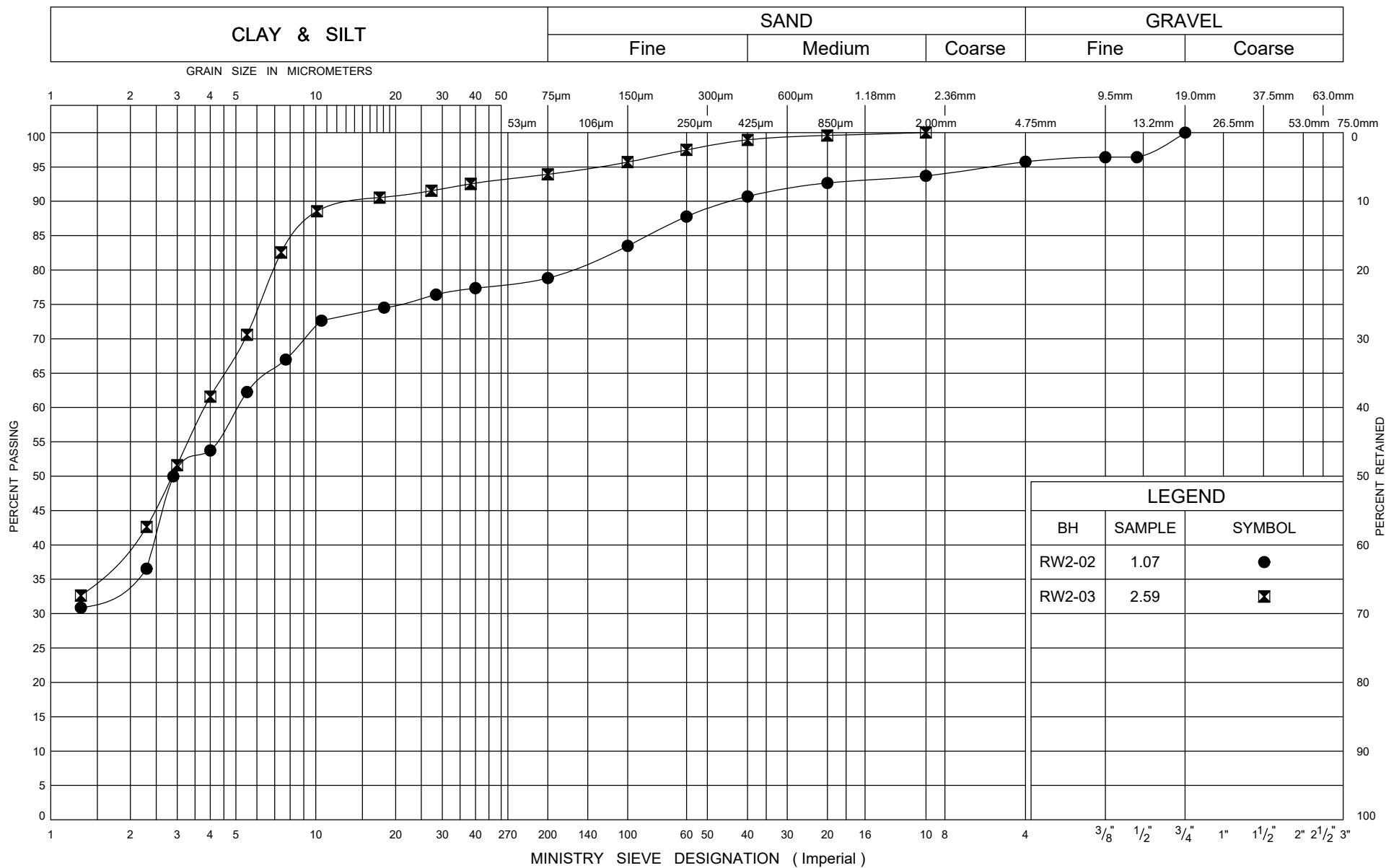
PLASTICITY CHART

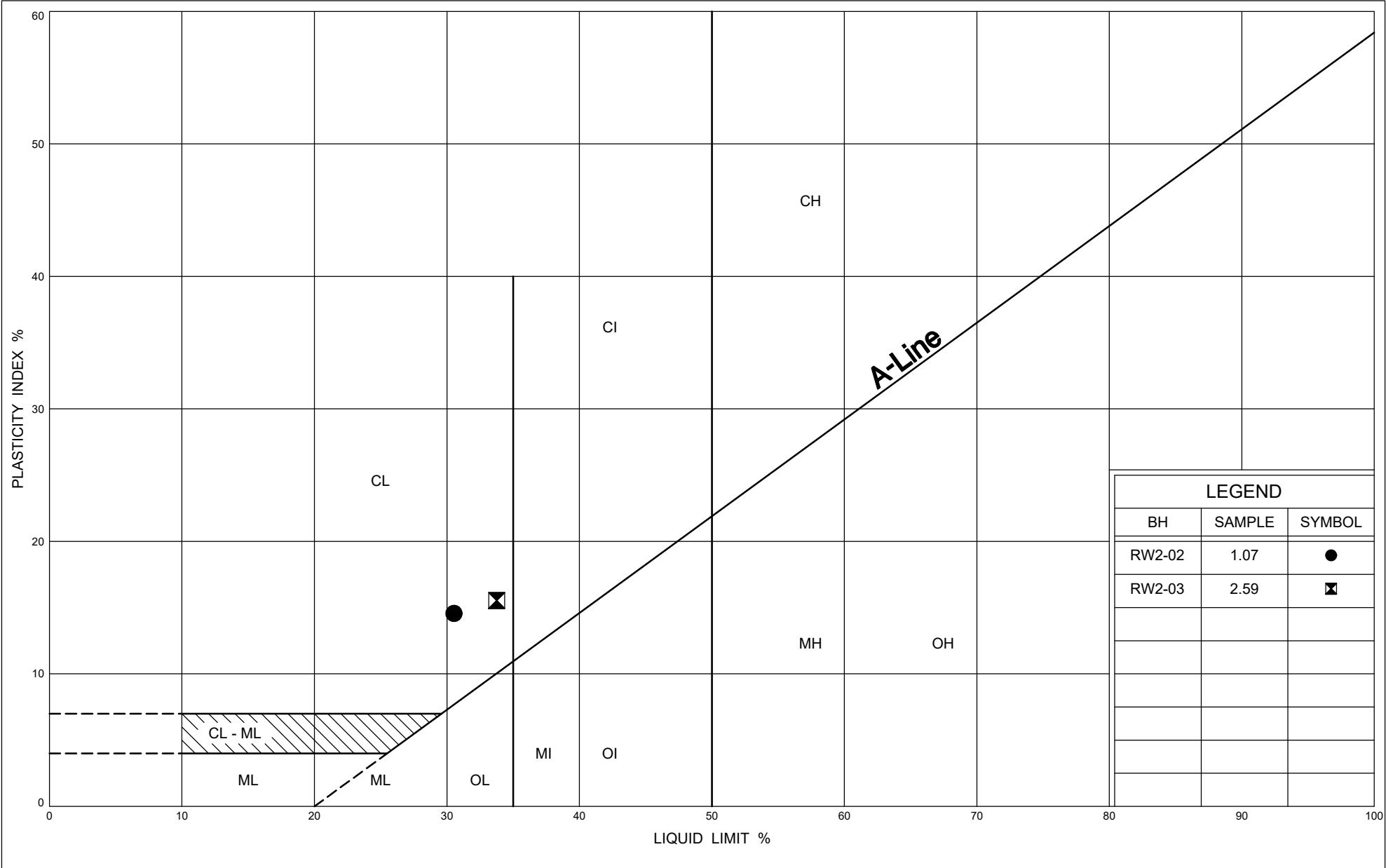
Sandy SILT TILL Interlayer

FIG No 9

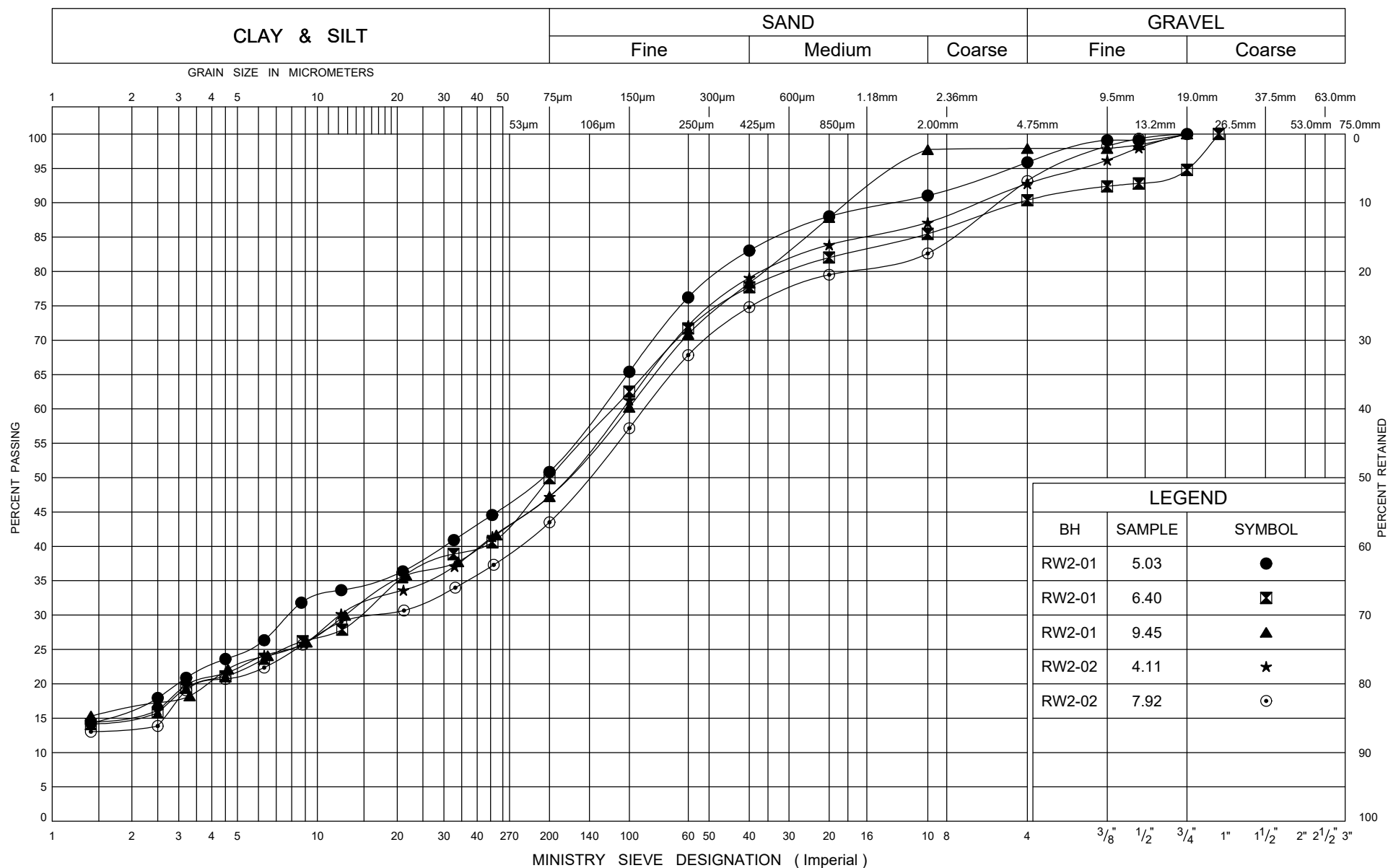
W.P.

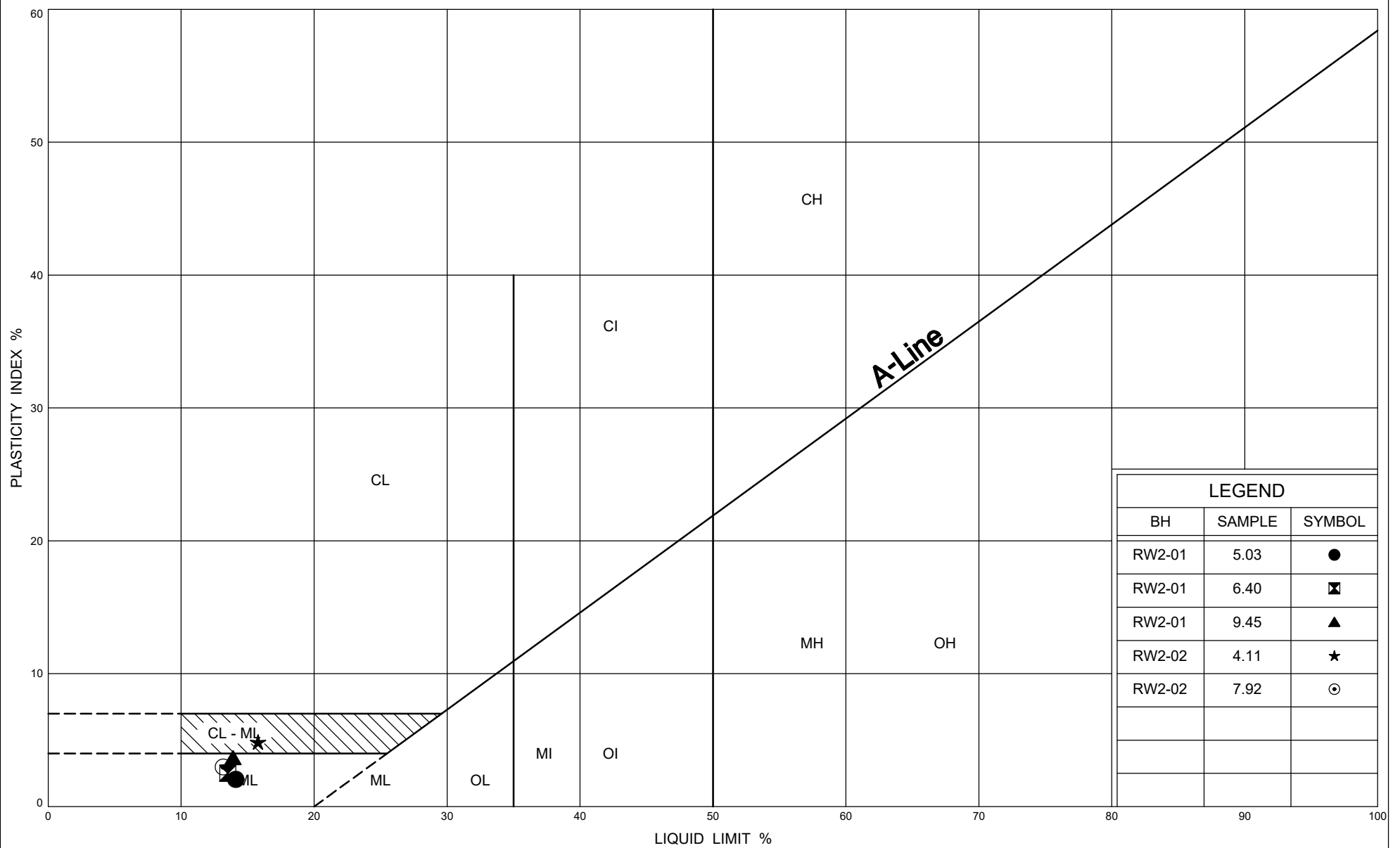
HWY 400 NBL/McKinstry Rd.





LEGEND		
BH	SAMPLE	SYMBOL
RW2-02	1.07	●
RW2-03	2.59	⊠





Ministry of
Transportation

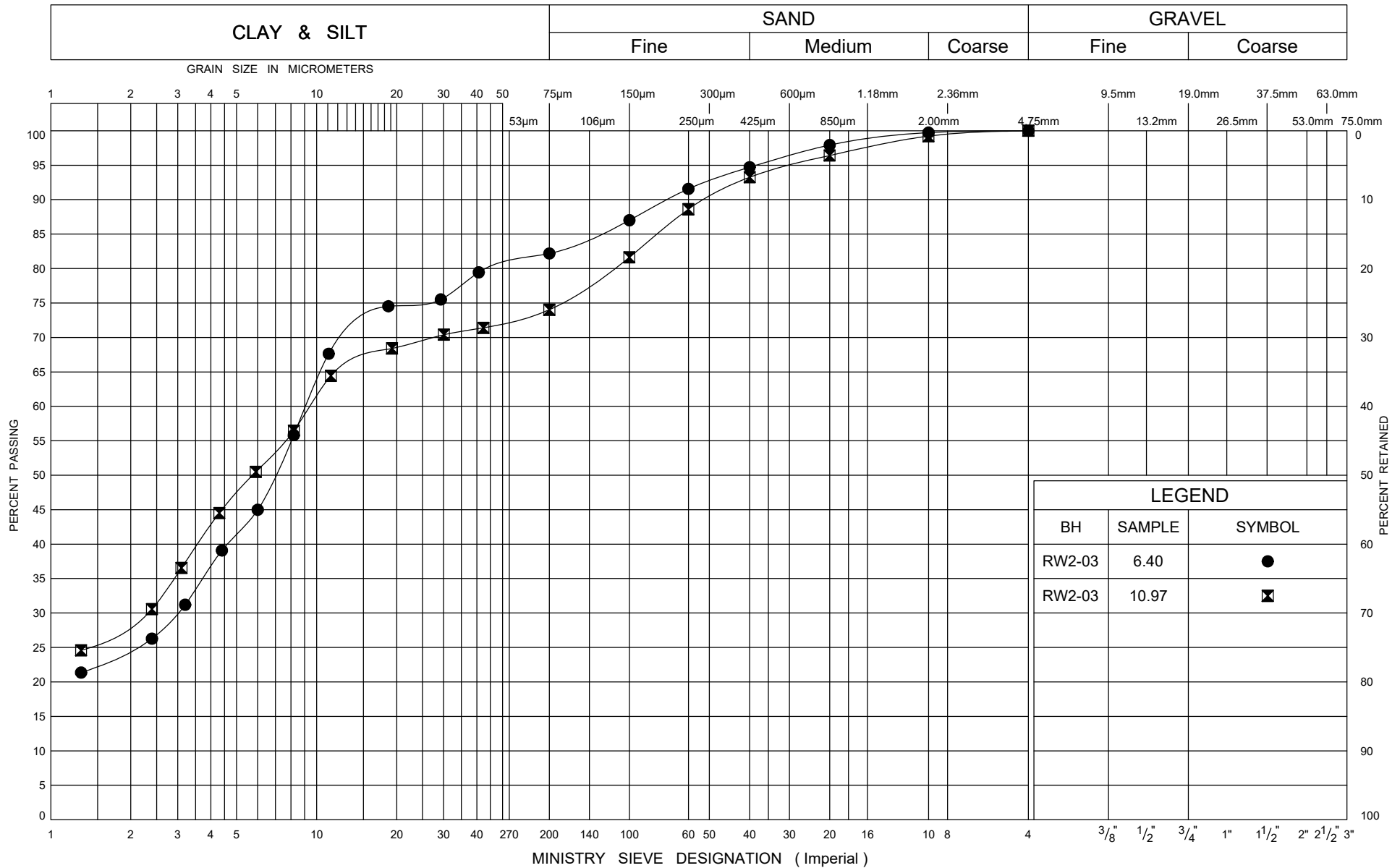
PLASTICITY CHART

Silty SAND to Sandy SILT to Silty CLAYEY SAND TILL

FIG No 13

W.P.

HWY 400 SBL/8th Line Cemetery



Ministry of
Transportation

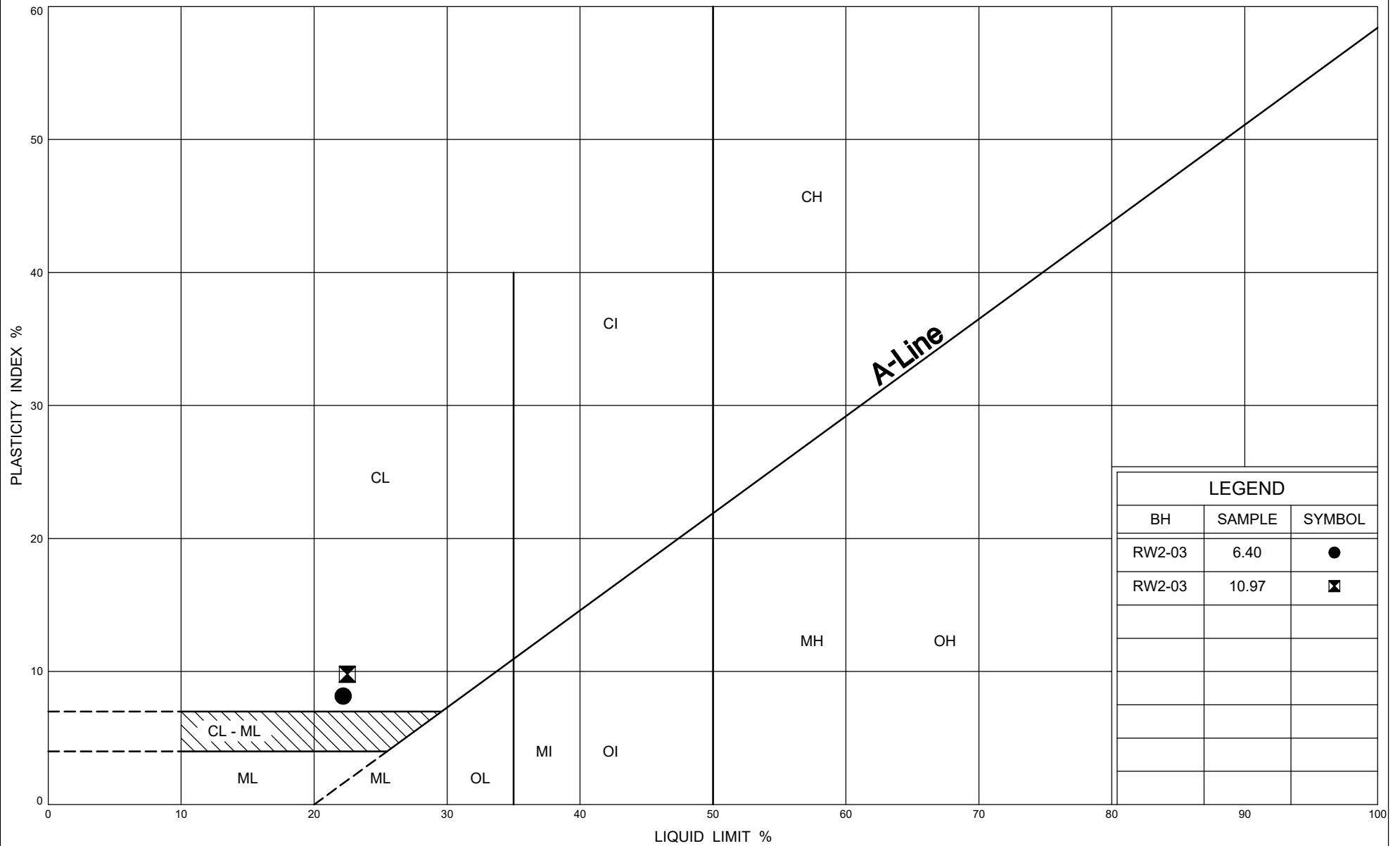
GRAIN SIZE DISTRIBUTION

Silty CLAYEY SAND (CL-ML) to CLAY with Sand (CL) TILL

FIG No 14

W.P.

HWY 400 SBL/8th Line Cemetery



Ministry of
Transportation

PLASTICITY CHART

CLAY with Sand TILL

FIG No 15

W.P.

HWY 400 SBL/8th Line Cemetery



APPENDIX E

Analytical Laboratory Test Results



FINAL REPORT

CA40222-DEC24 R1

48856, Bradford Bypass West Contract

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

Address 1908 Ironoak Way, Suite 202
Oakville, ON
L6H 0N1, Canada

Contact Joshua Alexander

Telephone 613-606-7303

Facsimile

Email jalexander@thurber.ca

Project 48856, Bradford Bypass West Contract

Order Number

Samples Soil (14)

LABORATORY DETAILS

Project Specialist Brad Moore Hon. B.Sc

Laboratory SGS Canada Inc.

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

Telephone 705-652-2143

Facsimile 705-652-6365

Email brad.moore@sgs.com

SGS Reference CA40222-DEC24

Received 12/18/2024

Approved 12/24/2024

Report Number CA40222-DEC24 R1

Date Reported 12/24/2024

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C

Cooling Agent Present: yes

Custody Seal Present: yes

Chain of Custody Number: N/A

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

SIGNATORIES

Brad Moore Hon. B.Sc

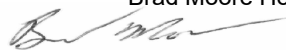




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QC Summary..... 5-7

Legend..... 8

Annexes..... 9-10



FINAL REPORT

CA40222-DEC24 R1

Client: Thurber Engineering Ltd.

Project: 48856, Bradford Bypass West Contract

Project Manager: Joshua Alexander

Samplers: Kamil Feszak/Josh Alexander

MATRIX: SOIL

Sample Number	5	6	7	8	9	10	11	12
Sample Name	RW1-02 SS-4	PEN-01 SS-4	PEN-03 SS-5	HWY400-01 SS-8	HWY400-10 SS-6	HWY400-11 SS-7	HWY400-20 SS-4B	HWY400-22 SS-3
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	08/12/2024	07/11/2024	01/12/2024	17/11/2024	30/10/2024	01/12/2024	07/11/2024	21/11/2024

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

Corrosivity Index

Corrosivity Index	none	1	3	14	12	4	4	14	4	1
pH	pH Units	0.05	7.37	8.62	8.46	7.90	8.36	9.04	8.22	7.90
Soil Redox Potential	mV	no	161	258	288	227	204	294	266	315
Sulphide (Na2CO3)	%	0.01	0.01	0.01	0.02	0.03	0.02	0.01	0.02	< 0.01
Resistivity (calculated)	ohms.cm	-9999	2360	1120	1680	4420	3800	623	3600	7630

General Chemistry

Conductivity	uS/cm	2	424	892	597	226	263	1600	278	131
--------------	-------	---	-----	-----	-----	-----	-----	------	-----	-----

Metals and Inorganics

Sulphate	µg/g	0.4	16	19	19	73	51	50	55	9.1
----------	------	-----	----	----	----	----	----	----	----	-----

Other (ORP)

Chloride	µg/g	0.4	110	380	330	17	42	770	55	5.4
----------	------	-----	-----	-----	-----	----	----	-----	----	-----



FINAL REPORT

CA40222-DEC24 R1

Client: Thurber Engineering Ltd.
Project: 48856, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Kamil Feszak/Josh Alexander

MATRIX: SOIL

				Sample Number	13	14	15	16	17	18
				Sample Name	HWY400-29 SS-3	HWY400-39 SS-7	HWY400-42 SS-2	RCULV-01 SS-4	BBPCULV-01 SS-3	BBPCUULV-07 SS-3
				Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil
				Sample Date	16/10/2024	12/08/2024	22/11/2024	24/10/2024	14/11/2024	11/11/2024
Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result
Corrosivity Index										
Corrosivity Index	none	1		1	1	1	4	1	4	
pH	pH Units	0.05		7.56	8.01	8.48	8.42	8.11	8.15	
Soil Redox Potential	mV	no		324	330	347	256	327	348	
Sulphide (Na2CO3)	%	0.01		< 0.01	0.01	0.01	0.04	0.01	0.02	
Resistivity (calculated)	ohms.cm	-9999		3450	4440	7140	5260	8930	5180	
General Chemistry										
Conductivity	uS/cm	2		290	225	140	190	112	193	
Metals and Inorganics										
Sulphate	µg/g	0.4		3.5	22	14	45	8.2	22	
Other (ORP)										
Chloride	µg/g	0.4		59	54	13	8.8	1.2	9.8	



FINAL REPORT

CA40222-DEC24 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	DIO0460-DEC24	µg/g	0.4	<0.4	2	35	102	80	120	117	75	125
Sulphate	DIO0460-DEC24	µg/g	0.4	<0.4	0	35	101	80	120	102	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 (Na2CO3)	ECS0056-DEC24	%	0.01	< 0.01								



FINAL REPORT

CA40222-DEC24 R1

QC SUMMARY

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-1ENVIEWL-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	EWL0395-DEC24	uS/cm	2	2	5	20	103	90	110	NA		
Conductivity	EWL0419-DEC24	uS/cm	2	2	0	20	101	90	110	NA		

pH

Method: SM 4500 | Internal ref.: ME-CA-1ENVIEWL-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	EWL0395-DEC24	pH Units	0.05	NA	1		99			NA		
pH	EWL0455-DEC24	pH Units	0.05	NA	1		100			NA		



FINAL REPORT

CA40222-DEC24 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

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. 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 and Excess Soil Quality" 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.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

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. Reproduction of this analytical report in full or in part is prohibited.

This report supersedes all previous versions.

-- End of Analytical Report --

Received By: <u>ED</u> Received Date: <u>12/18/24</u> (mm/dd/yy) Received Time: <u>11:35</u> (hr - min)		Received By (signature): <u>ICL</u> Custody Seal Present: Yes ☐ No ☒ Custody Seal Intact: Yes ☐ No ☒ Temperature Upon Receipt (°C): <u>7.3</u>		Quotation #: <u>48856</u> Project #: <u>48856</u> Site Location/ID: <u>Bradford Bypass West Contract</u>		LAB LIMS #: <u>CA10222 Dec 20</u>													
REPORT INFORMATION Company: <u>Thurber Engineering Ltd.</u> Contact: <u>Joshua Alexander</u> Address: <u>202 - 1908 Ironoak Way, Oakville, ON L6H 7G4</u> Phone: <u>613-606-7303</u> Fax: _____ Email: <u>jalexander</u>		INVOICE INFORMATION ☒ (same as Report Information) Company: _____ Contact: _____ Address: _____ Phone: _____ Email: <u>accountingON@thurber.ca</u>		P.O. #: <u>48856</u> 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		NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY													
REGULATIONS Regulation 153/04: Table 1 ☐ Res/Park Soil Texture: ☐ Coarse ☐ Medium ☐ Fine Table 2 ☐ Ind/Com ☐ Agri/Other Table 3 ☐ MSA Table 4 ☐ MSA				ANALYSIS REQUESTED M & I: ☐ Metals & Inorganics (incl. Cu, Ni, Pb, Zn, Cd, Cr, Co, Mn, Fe, Al, Si, Ti, V, U, Se, Ag, Tl, Hg, As, Ba, Bi, B, Br, Ca, Cl, Cs, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AA, AB, AC, AD, AE, AF, AG, AH, AI, AJ, AK, AL, AM, AN, AO, AP, AQ, AR, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BE, BF, BG, BH, BI, BJ, BK, BL, BM, BN, BO, BP, BQ, BR, BS, BT, BU, BV, BW, BX, BY, BZ, CA, CB, CC, CD, CE, CF, CG, CH, CI, CJ, CK, CL, CM, CN, CO, CP, CQ, CR, CS, CT, CU, CV, CW, CX, CY, CZ, DA, DB, DC, DD, DE, DF, DG, DH, DI, DJ, DK, DL, DM, DN, DO, DP, DQ, DR, DS, DT, DU, DV, DW, DX, DY, DZ, EA, EB, EC, ED, EE, EF, EG, EH, EI, EJ, EK, EL, EM, EN, EO, EP, EQ, ER, ES, ET, EU, EV, EW, EX, EY, EZ, FA, FB, FC, FD, FE, FF, FG, FH, FI, FJ, FK, FL, FM, FN, FO, FP, FQ, FR, FS, FT, FU, FV, FW, FX, FY, FZ, GA, GB, GC, GD, GE, GF, GG, GH, GI, GJ, GK, GL, GM, GN, GO, GP, GQ, GR, GS, GT, GU, GV, GW, GX, GY, GZ, HA, HB, HC, HD, HE, HF, HG, HH, HI, HJ, HK, HL, HM, HN, HO, HP, HQ, HR, HS, HT, HU, HV, HW, HX, HY, HZ, IA, IB, IC, ID, IE, IF, IG, IH, II, IJ, IK, IL, IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, JA, JB, JC, JD, JE, JF, JG, JH, JI, JJ, JK, JL, JM, JN, JO, JP, JQ, JR, JS, JT, JU, JV, JW, JX, JY, JZ, KA, KB, KC, KD, KE, KF, KG, KH, KI, KJ, KK, KL, KM, KN, KO, KP, KQ, KR, KS, KT, KU, KV, KW, KX, KY, KZ, LA, LB, LC, LD, LE, LF, LG, LH, LI, LJ, LK, LL, LM, LN, LO, LP, LQ, LR, LS, LT, LU, LV, LW, LX, LY, LZ, MA, MB, MC, MD, ME, MF, MG, MH, MI, MJ, MK, ML, MM, MN, MO, MP, MQ, MR, MS, MT, MU, MV, MW, MX, MY, MZ, NA, NB, NC, ND, NE, NF, NG, NH, NI, NJ, NK, NL, NM, NN, NO, NP, NQ, NR, NS, NT, NU, NV, NW, NX, NY, NZ, OA, OB, OC, OD, OE, OF, OG, OH, OI, OJ, OK, OL, OM, ON, OO, OP, OQ, OR, OS, OT, OU, OV, OW, OX, OY, OZ, PA, PB, PC, PD, PE, PF, PG, PH, PI, PJ, PK, PL, PM, PN, PO, PP, PQ, PR, PS, PT, PU, PV, PW, PX, PY, PZ, QA, QB, QC, QD, QE, QF, QG, QH, QI, QJ, QK, QL, QM, QN, QO, QP, QQ, QR, QS, QT, QU, QV, QW, QX, QY, QZ, RA, RB, RC, RD, RE, RF, RG, RH, RI, RJ, RK, RL, RM, RN, RO, RP, RQ, RR, RS, RT, RU, RV, RW, RX, RY, RZ, SA, SB, SC, SD, SE, SF, SG, SH, SI, SJ, SK, SL, SM, SN, SO, SP, SQ, SR, SS, ST, SU, SV, SW, SX, SY, SZ, TA, TB, TC, TD, TE, TF, TG, TH, TI, TJ, TK, TL, TM, TN, TO, TP, TQ, TR, TS, TT, TU, TV, TW, TX, TY, TZ, UA, UB, UC, UD, UE, UF, UG, UH, UI, UJ, UK, UL, UM, UN, UO, UP, UQ, UR, US, UT, UU, UV, UW, UX, UY, UZ, VA, VB, VC, VD, VE, VF, VG, VH, VI, VJ, VK, VL, VM, VN, VO, VP, VQ, VR, VS, VT, VU, VV, VW, VX, VY, VZ, WA, WB, WC, WD, WE, WF, WG, WH, WI, WJ, WK, WL, WM, WN, WO, WP, WQ, WR, WS, WT, WU, WV, WW, WX, WY, WZ, XA, XB, XC, XD, XE, XF, XG, XH, XI, XJ, XK, XL, XM, XN, XO, XP, XQ, XR, XS, XT, XU, XV, XW, XX, XY, XZ, YA, YB, YC, YD, YE, YF, YG, YH, YI, YJ, YK, YL, YM, YN, YO, YP, YQ, YR, YS, YT, YU, YV, YW, YX, YY, YZ, ZA, ZB, ZC, ZD, ZE, ZF, ZG, ZH, ZI, ZJ, ZK, ZL, ZM, ZN, ZO, ZP, ZQ, ZR, ZS, ZT, ZU, ZV, ZW, ZX, ZY, ZZ)				Sewer By-Law: ☐ Sanitary ☐ Storm ☐ Municipality Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ MMER ☐ CCME ☐ Other: _____											
RECORD OF SITE CONDITION (RSC) ☐ YES ☒ NO				DATE SAMPLED				TIME SAMPLED				# OF BOTTLES				MATRIX			
SAMPLE IDENTIFICATION				DATE SAMPLED				TIME SAMPLED				# OF BOTTLES				MATRIX			
1 RW1-02 SS-4				12/08/24				-				1				soil			
2 PEN-01 SS-4				11/07/24				-				1				soil			
3 PEN-03 SS-5				12/01/24				-				1				soil			
4 HWY400-01 SS-8				11/17/24				-				1				soil			
5 HWY400-10 SS-6				10/30/24				-				1				soil			
6 HWY400-11 SS-7				12/01/24				-				1				soil			
7 HWY400-20 SS-4B				11/07/24				-				1				soil			
8 HWY400-22 SS-3				11/21/24				-				1				soil			
9 HWY400-29 SS-3				10/16/24				-				1				soil			
10 HWY400-39 SS-7				08/12/24				-				1				soil			
11 HWY400-42 SS-2				11/22/24				-				1				soil			
12 RCULV-01 SS-4				10/24/24				-				1				soil			
Observations/Comments/Special Instructions																			
Sampled By (NAME): <u>Kamil Feszak / Josh Alexander</u>				Signature: <u>Joshua Alexander</u>				Date: <u>12 / 16 / 24</u> (mm/dd/yy)				Pink Copy - Client							
Relinquished by (NAME): <u>Kamil Feszak</u>				Signature: <u>Kamil Feszak</u>				Date: <u>12 / 18 / 24</u> (mm/dd/yy)				Yellow & White Copy - SGS							
Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection, handling and transportation of samples. [2] Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). [3] Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm . (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.																			

Laboratory Information Section - Lab use only

Observations/Comments/Special Instructions

Signature: Joshua Alexander

Sampled By (NAME):	Kamil Feszak / Josh Alexander	Signature: 	Date: <u>12</u> / <u>16</u> / <u>24</u> (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME):	Kamil Feszak	Signature: 	Date: <u>12</u> / <u>18</u> / <u>24</u> (mm/dd/yy)	Yellow & White Copy - SGS
Note: Submission of samples to SGS is acknowledgement that you have been provided <u>affidavit</u> on sample collection/handling and transportation of samples. (2) Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). (3) Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.				



FINAL REPORT

CA40011-OCT25 R1

48856, Bradford Bypass West Contract

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

Address 1908 Ironoak Way, Suite 202
Oakville, ON
L6H 0N1, Canada

Contact Joshua Alexander

Telephone 613-606-7303

Facsimile

Email jalexander@thurber.ca

Project 48856, Bradford Bypass West Contract

Order Number

Samples Soil (1)

LABORATORY DETAILS

Project Specialist Jill Campbell, B.Sc.,GISAS

Laboratory SGS Canada Inc.

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

Telephone 2165

Facsimile 705-652-6365

Email jill.campbell@sgs.com

SGS Reference CA40011-OCT25

Received 10/02/2025

Approved 10/09/2025

Report Number CA40011-OCT25 R1

Date Reported 10/09/2025

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C

Cooling Agent Present:Yes

Custody Seal Present:Yes

Chain of Custody Number:1

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

SIGNATORIES

Jill Campbell, B.Sc.,GISAS





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FINAL REPORT

CA40011-OCT25 R1

Client: Thurber Engineering Ltd.
Project: 48856, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Smit Patel

MATRIX: SOIL

Sample Number 5
Sample Name RW2-03 SS-2B
Sample Matrix Soil
Sample Date 07/09/2025

Parameter	Units	RL	Result
Corrosivity Index			
Corrosivity Index	none	1	7
pH	pH Units	0.05	8.83
Soil Redox Potential	mV	no	28
Sulphide (Na2CO3)	%	0.01	< 0.01
Resistivity (calculated)	ohms.cm	-9999	7940
General Chemistry			
Conductivity	uS/cm	2	126
Metals and Inorganics			
Sulphate	µg/g	0.4	11
Other (ORP)			
Chloride	µg/g	0.4	36



FINAL REPORT

CA40011-OCT25 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	DIO0170-OCT25	µg/g	0.4	<0.4	1	35	98	80	120	97	75	125
Sulphate	DIO0170-OCT25	µg/g	0.4	<0.4	6	35	100	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 (Na2CO3)	ECS0024-OCT25	%	0.01	< 0.01								

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	EWL0126-OCT25	uS/cm	2	< 2	1	20	99	90	110	NA		



FINAL REPORT

CA40011-OCT25 R1

QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-1ENVIEWL-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	EWL0126-OCT25	pH Units	0.05	NA	1		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.

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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

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. 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 and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

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This report supersedes all previous versions.

-- End of Analytical Report --

Received By: JPReceived Date: 10/26/16 (mm/dd/yy)Received Time: 10:15 (hr : min)Received By (signature): JPCustody Seal Present: Yes ☒ No ☐Custody Seal Intact: Yes ☒ No ☐Cooling Agent Present: Yes ☐ No ☒Temperature Upon Receipt (°C): 9.3

Type: _____

REPORT INFORMATION

Company: Thurber Engineering Ltd.Contact: Joshua AlexanderAddress: 202 - 1908 Ironoak Way,Oakville, ON L6H 7G4Phone: 613-606-7303

Fax: _____

Email: jalexander@thurber.caEmail: accountingON@thurber.ca

INVOICE INFORMATION

☒ (same as Report Information)

Company: _____

Contact: _____

Address: _____

Phone: _____

Fax: _____

Email: _____

Email: _____

REGULATIONS

Regulation 153/04:

☐ Table 1 ☐ Res/Park ☐ Soil Texture:☐ Table 2 ☐ Ind/Com ☐ Coarse☐ Table 3 ☐ Agri/Other ☐ Medium/☐ Table ☐ Fine

Other Regulations:

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

Sewer By-Law:

☐ Sanitary☐ Storm☐ Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☒ NO

SAMPLE IDENTIFICATION

1 RW2-03 SS-2B

2

3

4

5

6

7

8

9

10

11

12

DATE SAMPLED

07/09/25

TIME SAMPLED

-

OF BOTTLES

1

MATRIX

soil

ANALYSIS REQUESTED

M & I

Full Metals Suite

ICP Metals only

ICP Metals plus Bi(HV-S-soil only) Hg CrVI

ICP Metals only

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FINAL REPORT

CA40011-OCT25 R1

48856, Bradford Bypass West Contract

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

Address 1908 Ironoak Way, Suite 202
Oakville, ON
L6H 0N1, Canada

Contact Joshua Alexander

Telephone 613-606-7303

Facsimile

Email jalexander@thurber.ca

Project 48856, Bradford Bypass West Contract

Order Number

Samples Soil (1)

LABORATORY DETAILS

Project Specialist Jill Campbell, B.Sc.,GISAS

Laboratory SGS Canada Inc.

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

Telephone 2165

Facsimile 705-652-6365

Email jill.campbell@sgs.com

SGS Reference CA40011-OCT25

Received 10/02/2025

Approved 10/09/2025

Report Number CA40011-OCT25 R1

Date Reported 10/09/2025

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C

Cooling Agent Present:Yes

Custody Seal Present:Yes

Chain of Custody Number:1

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

SIGNATORIES

Jill Campbell, B.Sc.,GISAS





TABLE OF CONTENTS

First Page..... 1-2

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Results..... 4

QC Summary..... 5-6

Legend..... 7

Annexes..... 8



FINAL REPORT

CA40011-OCT25 R1

Client: Thurber Engineering Ltd.
Project: 48856, Bradford Bypass West Contract
Project Manager: Joshua Alexander
Samplers: Smit Patel

MATRIX: SOIL

Sample Number 5
Sample Name RW2-03 SS-2B
Sample Matrix Soil
Sample Date 07/09/2025

Parameter	Units	RL	Result
Corrosivity Index			
Corrosivity Index	none	1	7
pH	pH Units	0.05	8.83
Soil Redox Potential	mV	no	28
Sulphide (Na2CO3)	%	0.01	< 0.01
Resistivity (calculated)	ohms.cm	-9999	7940
General Chemistry			
Conductivity	uS/cm	2	126
Metals and Inorganics			
Sulphate	µg/g	0.4	11
Other (ORP)			
Chloride	µg/g	0.4	36



FINAL REPORT

CA40011-OCT25 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	DIO0170-OCT25	µg/g	0.4	<0.4	1	35	98	80	120	97	75	125
Sulphate	DIO0170-OCT25	µg/g	0.4	<0.4	6	35	100	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 (Na2CO3)	ECS0024-OCT25	%	0.01	< 0.01								

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	EWL0126-OCT25	uS/cm	2	< 2	1	20	99	90	110	NA		



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	EWL0126-OCT25	pH Units	0.05	NA	1		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

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. 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 and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

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Type: _____

REPORT INFORMATION

Company: Thurber Engineering Ltd.Contact: Joshua AlexanderAddress: 202 - 1908 Ironoak Way,Oakville, ON L6H 7G4Phone: 613-606-7303

Fax: _____

Email: jalexander@thurber.caEmail: accountingON@thurber.ca

INVOICE INFORMATION

☒ (same as Report Information)

Company: _____

Contact: _____

Address: _____

Phone: _____

Fax: _____

Email: _____

Email: _____

Quotation #: _____

Project #: _____

P.O. #: 48856Site Location/ID: Bradford Bypass West Contract

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

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

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

REGULATIONS

Regulation 153/04:

☐ Table 1 ☐ Res/Park ☐ Soil Texture:☐ Table 2 ☐ Ind/Com ☐ Coarse☐ Table 3 ☐ Agri/Other ☐ Medium/☐ Table _____ ☐ Fine

Other Regulations:

☐ Reg 347/558 (3 Day min TAT)☐ PWOO ☐ 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

Field Filtered (Y/N)

Metals & Inorganics

Full Metals Suite

ICP Metals only

PAHs

SVOCs

PCBs

F1-F4 + BTEX

F1-F4 only

VOCs

BTEX only

Pesticides

Corrosivity Suite

1,4-dioxane

Dioxins and furans

PHC F1

Sewer Use:

Water Characterization Pkg

General

TCLP

Specific

TCLP

tests

M&I

VOC

PCB

Biop

ABN

Ignit

COMMENTS:

Sampled By (NAME): Smit PatelRelinquished by (NAME): Joshua Alexander

Revision # 1.3

Date of Issue: 13 Oct, 2019Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. (2) Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). (3) Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Signature: _____

Signature: _____

Date: 09 / 30 / 25Date: 09 / 30 / 25

(mm/dd/yy)

(mm/dd/yy)

Pink Copy - Client

Yellow & White Copy - SGS

Observations/Comments/Special Instructions



APPENDIX F

General Arrangement Drawing

APPENDIX G

Seismic Hazard Values (2020 National Building Code of Canada)



2020 National Building Code of Canada Seismic Hazard Tool



This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_s	X_C
Latitude (°)	44.111
Longitude (°)	-79.633

Please select one of the tabs below.

NBC 2020 Additional Values Plots API Background Information

The 5%-damped spectral acceleration ($S_a(T, X)$, where T is the period, in s, and X is the site designation) and peak ground acceleration ($PGA(X)$) values are given in units of acceleration due to gravity (g , 9.81 m/s^2). Peak ground velocity ($PGV(X)$) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.221	0.154	0.0877	0.0424	0.0114	0.00397	0.103	0.0995

The log-log interpolated 2%/50 year $S_a(4.0, X_C)$ value is : **0.0157**

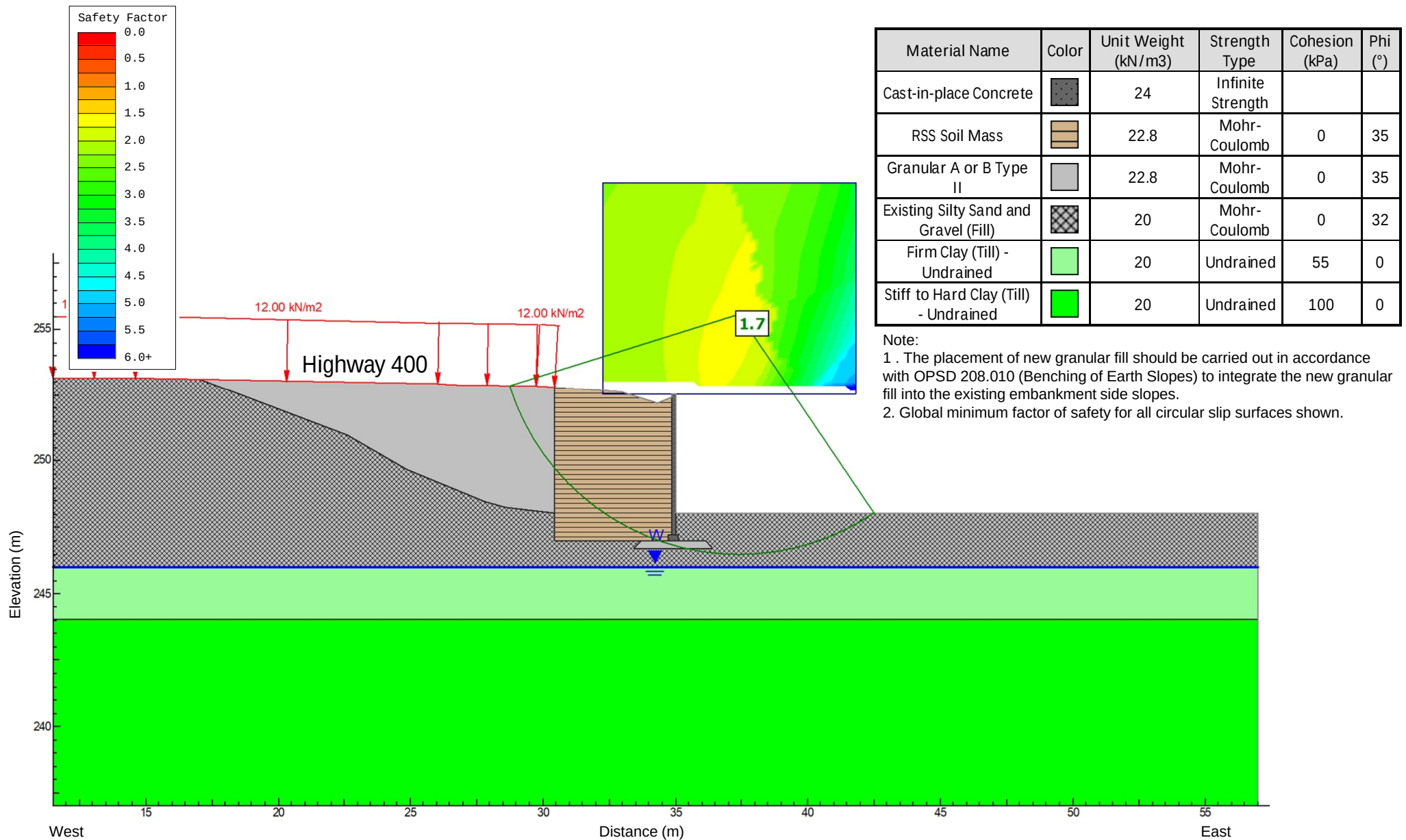
► Tables for 5% and 10% in 50 year values

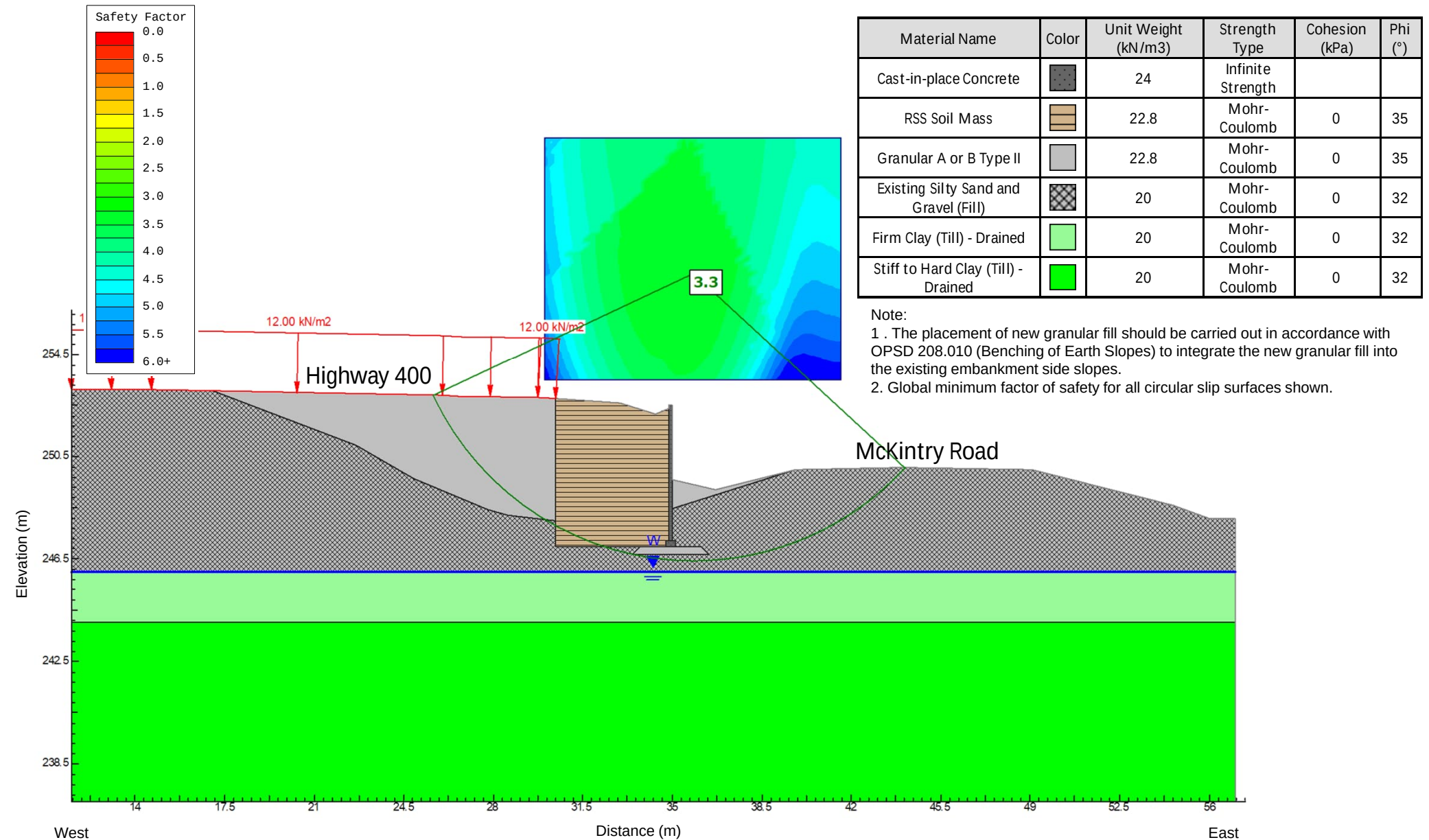
Download CSV

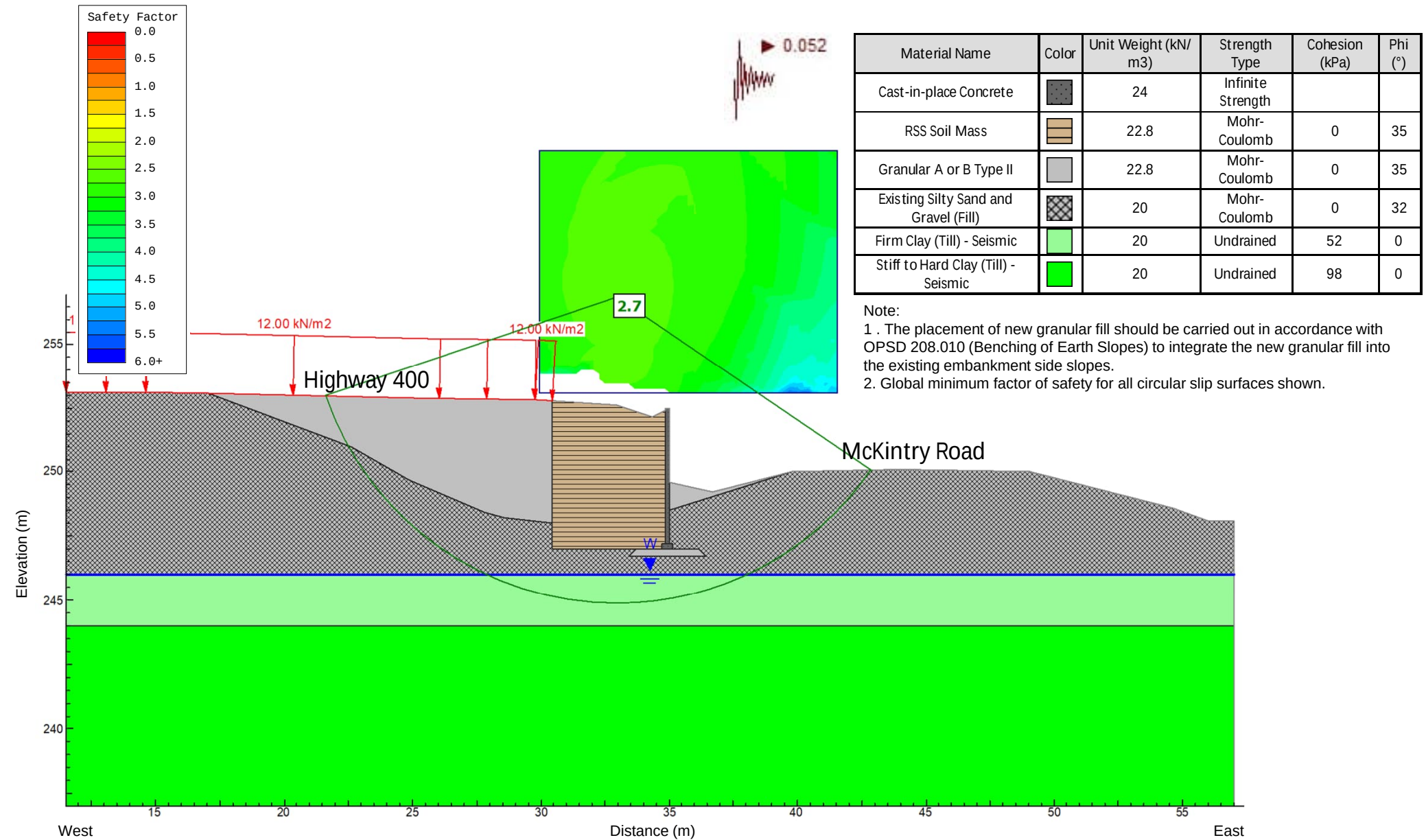
← Go back to the [seismic hazard calculator form](#)

APPENDIX H

Stability Figures









APPENDIX I

Notice to Contractor

PRESENCE OF COBBLES, BOULDERS, AND OTHER OBSTRUCTIONS

Notice to Contractor

The Contractor shall be alerted to the potential presence of cobbles, boulders, and construction debris within the existing embankment fill and/or glacial till deposits. Considerations of the presence of such obstructions must be made in the selection of appropriate equipment and procedures for excavations, and installation of temporary protection systems and retaining walls. The Contractor is responsible for selecting methods and equipment capable of dislodging, removing or otherwise penetrating any such obstructions.

GROUNDWATER CONTROL

Notice to Contractor

The foundation excavations for the retaining/toe walls and associated engineered fill pads (i.e., granular pads) are expected to be near or below the groundwater level. Water inflow/seepage should be anticipated from the embankment fill and underlying native soils, and surface runoff and precipitation which will accumulate within the excavations. Excavations into the native clayey soils below the water level will encounter subgrade softening.

Groundwater control measures such as perimeter ditches and pumping from filtered sumps will need to be employed to remove any accumulation of water from the excavation base prior to placing concrete and constructing engineered fill pads (i.e., granular pads). In addition to effective sump pumping, other measures of groundwater control may be required where the excavations extend below the groundwater table in order to maintain a dry excavation base. Filtered sumps must be designed properly so that construction drainage water containing eroded soil and fines do not flow onto the existing roadways. It is also important to minimize disturbance of the exposed silty sand fill surfaces.