Foundation Investigation Report

Rehabilitation/Replacement of 25 Non-Structural Culverts at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto **- Highway 12 CSPA Culvert Replacement (CV-0204-0012-0001)**

GWP: 2111-19-00
Assignment No. 2020-E-0028
MTO Central Region
Latitude: 44.377620; Longitude: -79.104760
Geocres No. 31D-821

Type of Document:
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Prepared For:
CONSOR Engineers LLC
5090 Explorer Drive, Unit 801
Mississauga, Ontario
L4W 4T9
Attn: Sharm Janaka Talagala, M.Eng., P.Eng.

Prepared By:
EXP Services Inc.
1595 Clark Boulevard
Brampton, ON L6T 4V1
Canada

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CONSOR Engineers LLC

Geotechnical Foundation and Investigation Report

Project Name:

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Issue and Revised Record

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A	April 27, 2023	pdf	S. Fredericks D. Mroz N. Tamrakar	T.C.KIM	S. Gonsalves	Draft Report
B	May 17, 2023	pdf	S. Fredericks D. Mroz N. Tamrakar	T.C. Kim	S. Gonsalves	Final Report

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Appendices

Part I: Foundation Investigation Report

Rehabilitation/Replacement of 25 Non-Structural Culverts at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto **- Highway 12 CSPA Culvert Replacement (CV-0204-0012-0001)**

1.0 Introduction

EXP Services Inc. (EXP) was retained by CONSOR Engineers LLC (CONSOR) on behalf of The Ministry of Transportation (MTO) to provide detailed foundation investigation and engineering services and pavement engineering services for the proposed rehabilitation/replacement of 25 Non-Structural Culverts project at various locations of Highway 9, Highway 12, Highway, 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and City of Toronto. The findings, analyses and recommendations related to foundation scope are presented in a Foundation Investigation Design Report created for each culvert location. The work was undertaken under GWP 2111-19-00, Assignment No. 2020-E-0028. The terms of reference (TOR) and the scope of work for the foundation investigation are outlined in Ministry of Transpiration Ontario's (MTO) Request for Proposal, dated February 2022. The scope of this report is specifically limited to the proposed replacement of the Corrugated Steel Pipe Arch (CSPA) culvert on Highway 12 (CV-0204-0012-0001).

The general design drawings for the proposed culvert replacement were provided to EXP by CONSOR. The purpose of the investigation was to evaluate the subsurface conditions along the existing culvert, and based on this data, to permit detailed design for the culvert replacement and to examine the suitability of open-cut replacement under a full highway closure or open cut-staged replacement with and without temporary protection systems.

The site-specific geotechnical investigation consisted of borings, soil sampling, borehole logging, and field and laboratory testing. The field and laboratory work for this structure was performed by EXP. Based on collected geotechnical data, this report provides an assessment of the geotechnical issues, geotechnical design parameters, and geotechnical foundation design recommendations for the proposed structure. Geotechnical-related construction recommendations are also provided.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

2.0 Structure Description

The contract drawings titled CV-204-0012-0001, prepared by CONSOR, dated March 2023 shows the 30% design configuration of the proposed replacement of the Highway 12 culvert. A summary of the proposed structure is as follows:

- The existing 1260 mm by 620 mm CSPA culvert is proposed to be replaced with a 1200 mm diameter HDPE culvert along the same alignment. Based on the 30% contract drawing the invert level of the new culvert is proposed to be at approximately Elev. 251.8 m and 251.5 m at the inlet and outlet, respectively.
- The existing Highway 12 profile grade is planned to remain unchanged. It is understood that the half and half stage construction approach will be used to replace the existing culvert.

The 30% contract drawings were included as part of this report is used for initial context to address the nature and scope of the investigation. It is understood that some changes might occur as a result of normal refinement or the findings of the geotechnical report.

3.0 Site Description and Geological Setting

3.1 Site Description

The CSPA culvert is located on Highway 12, about 560 m north of the intersection of Highway 12 with Highway 48 in the Durham region, Ontario, in the Ministry of Transportation (MTO) Central Region. Highway 12 generally runs in the north-south direction, however, at the location of Culvert CV-0204-0012-0001, Highway 12 runs in a northeast-southwest direction. At the site, Highway 12 is a two lane roadway, with a speed limit of 80 km/h (unless otherwise posted). Based on the contract drawings, the roadway is about 7.7 m wide from edge of pavement to edge of pavement, with 3.0 m and 1.6 m paved and gravel shoulders at the west side and 0.4 m and 3.5 m paved and gravel shoulders at the east side. In total, the existing roadway with both shoulders included is about 16.2 m wide along the culvert footprint. The existing culvert is positioned approximately perpendicular to the highway central line. The elevation of highway pavement centerline at the site is about 254.4 m. The roadway embankment above the existing ground is about 2.5 m on the west (inlet) side and 2.9 m on the east (outlet) side. The sides of the embankment slope at approximately 3.2H:1V on the west side and 2.6H:1V on the east side.

Based on the information provided in the drawings, the existing culvert is approximately 28.7 m long with a height and width of 1250 mm and 620 mm, respectively, and with up to 2± m of cover. The invert of the culvert is at approximate Elev. 251.9 m, and 251.5 m on west (inlet) and east (outlet) sides, respectively. Selected photographs of the site and existing culvert are presented in Appendix A. The site plan and cross-section profiles for the proposed culvert alignment are shown on the drawings attached in Appendix B.

The general site conditions were assessed during a site reconnaissance on July 27, 2022, and during the field investigation works that took place between January 23 and March 16, 2023. At the time of the field investigation, the approximate top of water elevation at the outlet of the culvert was measured to be about 251.7 m. No riprap to protect against scour or erosion was observed on either side of the culvert. Vegetation at the site consists predominantly of deciduous trees with some coniferous trees, wild bushes and shrubs, and other various species of mature vegetative cover. At the time of investigation, the vegetation immediately adjacent to the culvert openings appears to be light, however the ground was covered in snow. Based on google earth images taken in the late autumn of 2022, the vegetation appears to be relatively heavier just outside the culvert area.

Photographs 1 and 2 (taken by MTO) and Photographs 3 to 9 (taken by EXP between July 2022 and October 2022) in Appendix A show the existing site, culvert, and road conditions. Photographs 1 and 2 show the condition of the inside of the culvert. It can be seen that the culvert barrels are corroded up to the springline; this also provides an indication of the high creek water levels expected through the culvert. It can be seen that the bottom of the culvert is almost completely deteriorated due to corrosion at the inlet side of the culvert. Photographs 3 and 4 shows the outside of the culvert inlet and outlet, respectively, and the side slopes of the embankment surrounding the culvert. Both ends of the culvert are surrounded by light vegetation immediately adjacent to the culvert opening. Photographs 5 and 6 show the existing condition of the NBL and SBL lane of Highway 12 at the culvert location, respectively. The existing pavement appears to be in good condition.

3.2 Geological Setting

Based on a review of geological maps of Southern Ontario (Chapman and Putnam, 1984; 2007), the site is situated within the Peterborough Drumlin Field physiographic region where the predominate landforms are Till Plains

(Drumlinized) and Drumlins. The Peterborough Drumlin Field extends from Hastings County in the east to Simcoe County in the west and includes the drumlins south of the moraine in Northumberland County.

According to the Ministry of Northern Development and Mines, Map 2556 (Quaternary Geology of Ontario, Southern Sheet, 1991) the surface conditions in the vicinity of the project area typically consists of sandy silt to silty sand-textured till, commonly rich in clasts, often high in total matrix carbonate content. In addition, Map 2544 (Bedrock Geology of Ontario, Southern Sheet, 1991), the bedrock geology at the site consists of limestone, dolostone, shale, arkose, and siltstone belonging to the Ottawa Group and Simcoe Group of the Shadow Lake Formation.

4.0 Previous Investigations

There are no available previous geotechnical reports directly at this site in the MTO GEOCRES library. However, one report was available pertaining to a geotechnical investigation for several culvert extensions within the vicinity of Culvert CV-0204-0012-0001. The report is listed below for reference:

> *Geocres No. 31D-399: "Foundation Investigation and Design Report, Proposed Culvert Extensions/Replacements, Hwy 12 Widening from South Junction of Hwy 48 to North Junction of Hwy 48, W.P. 611-89-00, District 7 – Durham, Central Region, Sites 22-411C and 22-412C",* Project: SPT 1024C, Prepared by: Shaheen & Peaker Limited, March 2003.

5.0 Investigation Procedures

5.1 Site Investigation and Field Testing

A site-specific investigation was undertaken by EXP between January 2023 to March 2023, and it included the following:

1. A walkover site assessment was carried out by a Geotechnical Engineer from EXP;
2. Subsequent to the borehole layouts in the field, existing utilities were cleared by public utility companies;
3. Traffic control required to close the driving lanes of Highway 12 during the drilling of on-road boreholes was provided by Barricade Traffic Services.
4. At the time of this report, the program involved the drilling of six (6) boreholes for sampling, consisting of 3 pavement and 3 geotechnical boreholes, numbered PV012-001-01 to PV012-001-03 and BH012-001-01 to BH012-001-03, respectively. Two (2) boreholes were located at each end of the existing culverts, which were PV012-001-01 and BH012-001-03. Additionally, two (2) boreholes were drilled on the west and east shoulders, which were PV012-001-01 and BH012-001-03, respectively. Finally, two (2) boreholes were drilled on the south and north sides of the culvert, which were BH012-001-01 and BH012-001-02, respectively. BH012-001-01 was drilled approximately 13.0 m south of the culvert, and BH012-001-02 was drilled approximately 19.2 m north of the culvert. The locations of the boreholes drilled during this investigation are shown on Drawing 1 in Appendix C. Table 1.1 provides a summary of the boreholes completed by EXP.

5. The boreholes drilled during this fieldwork were advanced using a MARL M5T Rubber Track Drill owned and operated by Drilltech drilling Ltd. The machines are equipped with solid stem augers, and fitted with capability for Standard Penetration Testing (SPT).
6. Soil samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS-split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the N-value, of the soil which is indicative of the compactness of granular (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils);
7. The fieldwork was supervised by a member of EXP's engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification;
8. All spoon samples obtained in the Standard Penetration Tests (SPT, ASTM D-1586) were placed in moisture proof bags after field classification. Samples were allocated from the spoon samples for moisture content testing without delay. They were subsequently re-examined under controlled laboratory conditions prior to assigning other laboratory tests;
9. Selected soil samples for chemical analytical testing were sent to the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. The selected soil samples for the analytical testing were placed in a laboratory prepared glass jar, labelled, and stored in a secure cooler.
10. The borehole locations and their ground surface elevations were surveyed by EXP using a Trimble DA2 GNSS receiver with Trimble Catalyst GNSS positioning, having an accuracy of ±0.10 m horizontal and vertical directions. MTM NAD83 Zone 10 coordinates and the geodetic elevation for the boreholes are listed in Table 1.1 below. It can also be found on the Record of Borehole Sheet (Appendix D); and
11. Upon completion of drilling and field testing, the boreholes were backfilled with a mixture of bentonite and auger cuttings. groundwater level measurements were carried out in boreholes in accordance with MTO guidelines. The recorded groundwater levels after completion of drilling boreholes were presented in the borehole log sheets in Appendix D.
12. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act).

Table 1.1: Summary of boreholes completed

Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
PV012-001-01	Inlet, off-road	4915365.1	336293.8	44.377609	-79.104785	251.9	3.7
PV012-001-02	West shoulder	4915359.7	336302.4	44.377560	-79.104678	254.1	2.1
PV012-001-03	East shoulder	4915359.2	336314.7	44.377555	-79.104523	254.4	2.1

Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
BH012-001-01	On-road – North bound (NB) direction	4915346.2	336307.5	44.377438	-79.104614	254.3	10.4
BH012-001-02	On-road – North bound (NB) direction	4915376.5	336318.5	44.377710	-79.104475	254.6	9.1
BH012-001-03	Outlet, off-road (east ditch)	4915351.6	336322.6	44.377486	-79.104425	251.6	5.2

5.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content on all samples and particle size distribution for approximately 25% of the collected soil samples. In addition, unit weight, Atterberg limits and grain size analysis (sieve and hydrometer) tests were performed on selected soil samples (performed by EXP). Chemical analyses were also carried out on one soil samples selected by EXP. The samples were tested at the Bureau Veritas Laboratories (formerly Maxxam Analytics), a CALA-certified and accredited laboratory in Mississauga, Ontario. All of the laboratory tests were carried out according to MTO and/or ASTM Standards as appropriate. The performed laboratory testing program is listed in Table 1.2.

Table 1.2: List of Laboratory Test Completed by EXP

Borehole No.	Moisture Content	Atterberg Limits	Sieve	Hydrometer	Unit Weight	Corrosivity
PV012-001-01	4	1	1	1	---	---
PV012-001-02	3	---	1	---	---	---
PV012-001-03	3	---	---	---	---	---
BH012-001-01	11	1	3	2	---	---
BH012-001-02	10	1	2	2	---	1
BH012-001-03	4	2	2	2	---	---

The laboratory test results are provided on the attached borehole log sheets in Appendix D as well as graphically in Appendix E.

6.0 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix D. Laboratory test results of grain size analyses and Atterberg limit tests are

provided in Appendix E. The "Explanation of Terms Used in Report" preceding the borehole logs in Appendix D forms an integral part of and should be read in conjunction with this report.

A borehole location plan and cross section subsurface profiles are provided in Appendix C. It should be noted that the stratigraphic boundaries indicated on the borehole log and cross section stratigraphic profiles are inferred from semi-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be regarded as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

In general, the subsoil condition below the roadway consists of non-cohesive fills underlain by native sandy silt till layers or a buried topsoil layer overlaying a layer of clayey silt till which is further underlain by a layer of non-cohesive silt and sand tills. At the inlet side, the subsurface conditions consist of topsoil overlying silt and sand till followed by clayey silt till underlain by sandy silt till. At the outlet side, topsoil overlays clayey silt followed by a layer of sandy silt till.

A detailed description of the subsurface conditions encountered is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by EXP. The lab test results available at the time of writing this draft report are included, while the other results will be added in the next submission of this report.

6.1 Subsoils

6.1.1 Asphalt

A pavement structure consisting of asphalt was encountered at the ground surface in boreholes BH012-001-01, BH012-001-02 and PV012-001-02. The thickness of asphalt ranged from approximately 50 mm to 230 mm.

6.1.2 Topsoil

A topsoil layer was encountered at the ground surface of boreholes PV012-001-01 and BH012-001-03. The thickness of this layer was approximately 100 mm. An additional topsoil layer ranging from 390 mm to 410 mm in thickness was encountered underlaying the silty sand fill in boreholes BH012-001-01 and BH012-001-02. The layer contained rootlets and organics and was generally moist to wet ranging from dark grey to black in color.

6.1.3 Cohesionless Fill

Cohesionless fill layers with trace to some clays were encountered in boreholes BH012-001-01, BH012-001-02, PV012-001-02 and PV012-001-03. The approximate elevations of the surface and base of each fill layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.3 below:

Table 1.3: Summary of Cohesionless Fill Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH012-001-01	254.2	253.6	0.2	0.6	Gravelly Sand	34
	252.8	252.3	1.5	0.5	Silty Sand	19
BH012-001-02	254.4	253.9	0.2	0.5	Gravelly Sand	-
	253.9	252.6	0.8	1.3	Silty Sand	13 – 20
PV012-001-02	254.0	252.5	0.1	1.5	Sand with Gravel	20
PV012-001-03	254.4	252.8	0.0	1.6	Sand with Gravel	17 – 50

The composition of the layers encountered is as presented in Table 1.3 above. The layer was moist with color ranging from grey to brown. The SPT "N" values within this layer ranged from 17 to 50 blows per 300 mm penetration, corresponding to compact to very dense but generally compact in compactness condition.

Moisture Content:

- 3% to 24.9%

Grain Size Distribution:

- 19% to 28% gravel;
- 36% to 63% sand;
- 27% to 29% silt;
- 10% to 18% clay;
- 9% to 21% silt and clay;

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests are also provided on Figure 1 and Figure 2 in Appendix E.

6.1.4 Cohesive Till

A cohesive till layer with traces of gravel was encountered below the topsoil in boreholes BH012-001-01 to BH012-001-03 and below the silt and sand till layer PV012-001-01. The approximate elevations of the surface and base of the till layer, thickness, description and SPT (N Value) encountered in boreholes are summarized in Table 1.4 below:

Table 1.4: Summary of Cohesive Till Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH012-001-01	251.9	249.8	2.4	2.1	Clayey Silt Till	7 – 11
BH012-001-02	252.2	250.0	2.4	2.2	Clayey Silt Till	10 – 13
BH012-001-03	251.5	249.3	0.1	2.2	Clayey Silt Till	5 – 9
PV012-001-01	251.1	249.6	0.8	1.5	Clayey Silt Till	6 – 9

The cohesive till layer consisted of clayey silt which is sandy with trace to some gravel. Trace organics were encountered at the culvert outlet (BH012-001-03). The layer was moist to wet with color ranging from brown to grey. SPT "N" values ranged from 5 to 13 blows per 300 mm penetration corresponding to firm to stiff in consistency.

The results of moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution and Atterberg limit tests are also provided on Figures 3 to 6 in Appendix E.

Moisture Content:

- 7% to 26%

Grain Size Distribution:

- 5% to 13% gravel;
- 28% to 50% sand;
- 36% to 40% silt;
- 11% to 30% clay;

Atterberg Limits:

- Liquid Limit: 17% to 33%
- Plastic Limit: 12% to 16%
- Plasticity Index: 5% to 17%

6.1.5 Cohesionless Till

Cohesionless till layers were encountered in all boreholes. The approximate elevations of the surface and base of each till layer, thickness, description and SPT (N Value) encountered in the boreholes are summarized in Table 1.5 below:

Table 1.5: Summary of Cohesionless Till Layers

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
BH012-001-01	249.8	244.0	4.6	3.1	Silt and Sand Till	13 – 56
BH012-001-02	250.0	245.5	4.6	4.5	Silt and Sand Till	22 – 26
BH012-001-03	249.3	246.4	2.3	2.9	Sandy Silt Till	26 – 38
PV012-001-01	251.8	251.1	0.1	0.7	Silt and Sand Till	3
	249.6	248.2	2.3	1.4	Sandy Silt Till	36 – 40
PV012-001-02	252.5	251.9	1.5	0.6	Sandy Silt Till	10
PV012-001-03	252.8	252.2	1.5	0.6	Sandy Silt Till	11

The cohesionless till layers consisted predominantly of silt and sand with gravel content ranging from some gravel to gravelly, trace to some clay, and occasional cobbles and boulders which were inferred based on the SPT sampler being unable to advance. The layer was moist to wet with color ranging from brown to grey. The SPT "N" values within this layer ranged from 3 to 56 blows per 300 mm penetration corresponding to very loose to very dense but generally compact to dense in compactness condition.

The results of moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution and Atterberg limits tests are also provided on Figure 7 and Figure 8 in Appendix E.

Moisture Content:

- 7% to 18%

Grain Size Distribution:

- 13% to 20% gravel;
- 34% to 41% sand;
- 35% to 36% silt;
- 10% to 11% clay;

Atterberg Limits:

- Liquid Limit: 16% to 18%
- Plastic Limit: 11% to 12%
- Plasticity Index: 5% to 6%

6.2 Groundwater and Surface Water Conditions

The groundwater levels in boreholes were observed during and upon completion of their drilling during EXP's investigation in April 2021. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.6.

Table 1.6: Summary of Observed Groundwater Levels

Borehole	Ground Surface Elevation (m)	Water Level Depth/ Elevation (m)[1]	Date Measured	Comments
BH012-001-01	254.3	-	Jan. 23, 2023	Cave-in at 2.60 m, retrieved samples were fully saturated from 4.6 m below ground surface to end of borehole
BH012-001-02	254.6	4.93 / 249.7	Jan. 24, 2023	Upon completion of drilling
BH012-001-03	251.6	-	Mar. 16, 2023	Cave-in at 0.46 m, *retrieved samples were fully saturated from 0.8 m below ground surface to end of borehole*
PV012-001-01	251.9	-	Mar. 16, 2023	Cave-in at 0.46 m, *retrieved samples were fully saturated from the ground surface to end of borehole*
PV012-001-02	254.1	Dry	Jan. 24, 2023	Upon completion of drilling
PV012-001-03	254.4	Dry	Jan. 24, 2023	Upon completion of drilling

Note:

1. *Depths are relative to ground surface*

The measured elevations of the top of creek water at the existing CSP culvert location on January 23, 2023, were approximately Elev. 251.7 m at the outlet and inlet sides.

Groundwater levels would be expected to reflect levels in the adjacent open water and to fluctuate seasonally. Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods.

6.3 Chemical Analysis

One soil sample was selected for chemical analysis during the current investigations performed by EXP. The soil sample collected by EXP was tested at a CALA-certified and accredited laboratory. The results of the corrosion

potential chemical analysis testing including sulfide, chloride, sulfate, pH, electrical conductivity, resistivity and redox potential are included in Appendix E and summarized in Table 1.7.

Table 1.7. Summary of chemical analysis results

Borehole ID	Sample	Depth (m)	Chloride (ppm)	Sulphate (ppm)	pH	Electrical Conductivity (umho/cm)	Resistivity (ohm-cm)	Redox Potential (mV)
BH012-001-02	SS5	2.64	1900	220	9.05	3880	260	380

7.0 CLOSURE

A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report has been prepared by Daniel Mroz, M.E.Sc., EIT, Stephen Fredericks, M.Eng., P.Eng., and Nimesh Tamrakar, M.Eng., P.Eng. It was reviewed by TaeChul Kim, M.E.Sc., P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Stephen Fredericks, M.Eng., P.Eng.

EXP Services Inc.

Daniel Mroz, M.E.Sc., EIT
Technical Specialist

Nimesh Tamrakar, M.Eng., P.Eng.
Geotechnical Engineer
Project Manager

TaeChul Kim, M.E.Sc., P.Eng.
Senior Geotechnical/Foundation Engineering Specialist

Stan E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
Designated MTO Foundation Contact

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

Ontario Occupational Health and Safety Act (OHSA):

Ontario Regulation 213/91 Construction Projects

9.0 LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of EXP may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by EXP. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and EXP's recommendations. Any reduction in the level of services recommended will result in EXP providing qualified opinions regarding the adequacy of the work. EXP can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to EXP to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client.

EXP has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to EXP by its client ("Client"), communications between EXP and the Client, other reports, proposals or documents prepared by EXP for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. EXP is not responsible for use by any party of portions of the Report.

USE OF 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. No other party may use or rely upon the Report in whole or in part without the written consent of EXP. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. EXP is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

REPORT FORMAT

Where EXP has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by EXP have utilize specific software and hardware systems. EXP makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are EXP's instruments of professional service and shall not be altered without the written consent of EXP.

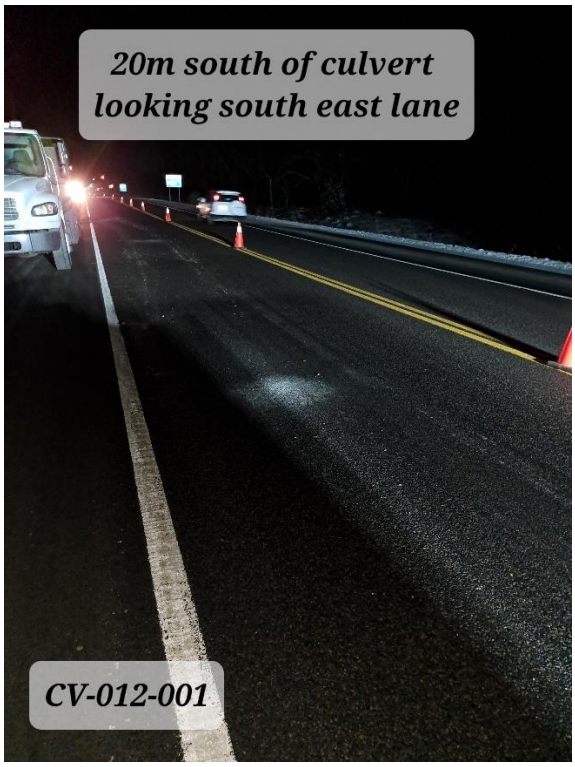
Appendix A –
Site Photographs

Photograph 1. Inside of existing CSPA culvert at inlet side (taken by MTO)

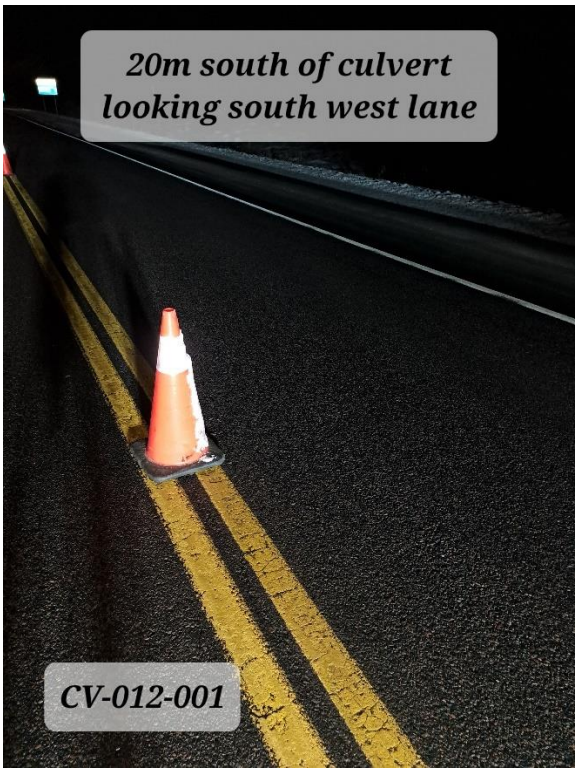
Photograph 2. Inside of existing CSPA culvert at outlet side (taken by MTO)

Photograph 3. Culvert inlet and embankment side slope area (facing east), January 2023 (taken by EXP)

Photograph 4. Culvert outlet and embankment side slope area (facing west), January 2023 (taken by EXP)



Photograph 5. Highway 12 roadway at culvert location, NB lane (facing south), January 2023 (taken by EXP)



Photograph 6. Highway 12 roadway at culvert location, SB lane (facing south), January 2023 (taken by EXP)

Appendix B –
General Arrangement Drawings

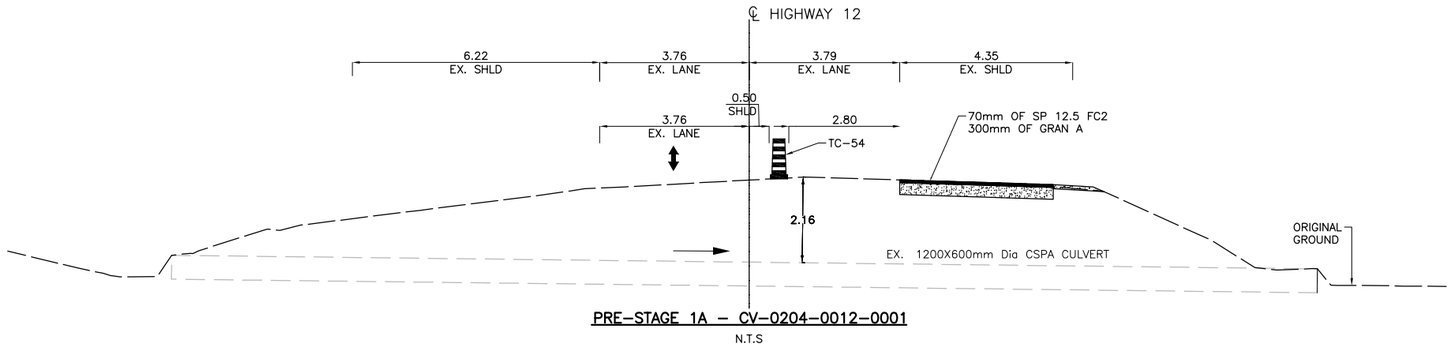
PLATE No

CONT 2023-2024
GWP 2111-19-00

CV-0204-0012-0001
STAGING TYPICAL

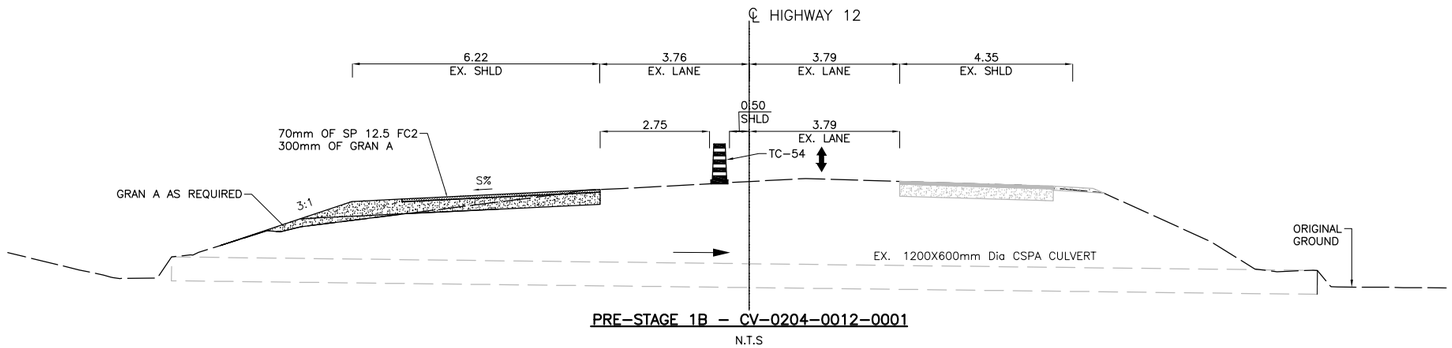
SHEET
10

consor



PRE-STAGE 1A – CV-0204-0012-0001

N.T.S

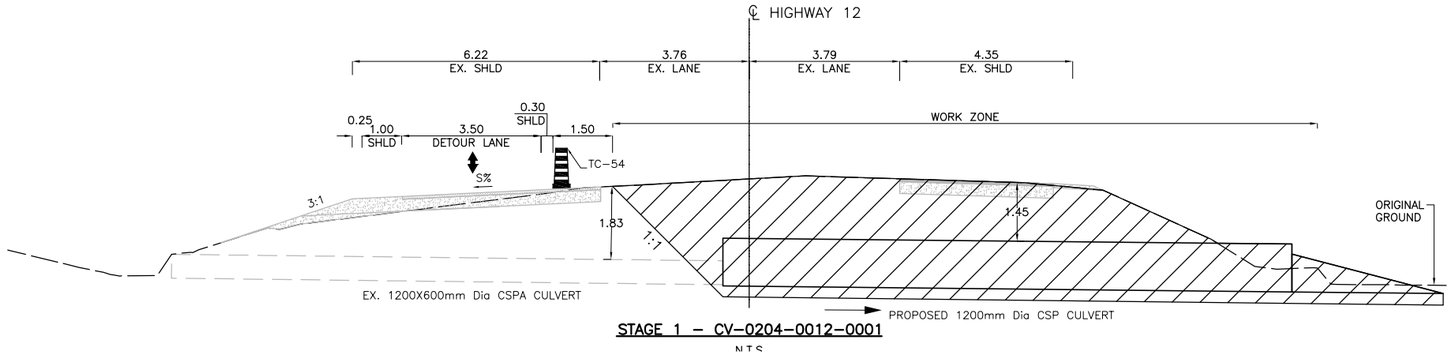


PRE-STAGE 1B – CV-0204-0012-0001

N.T.S

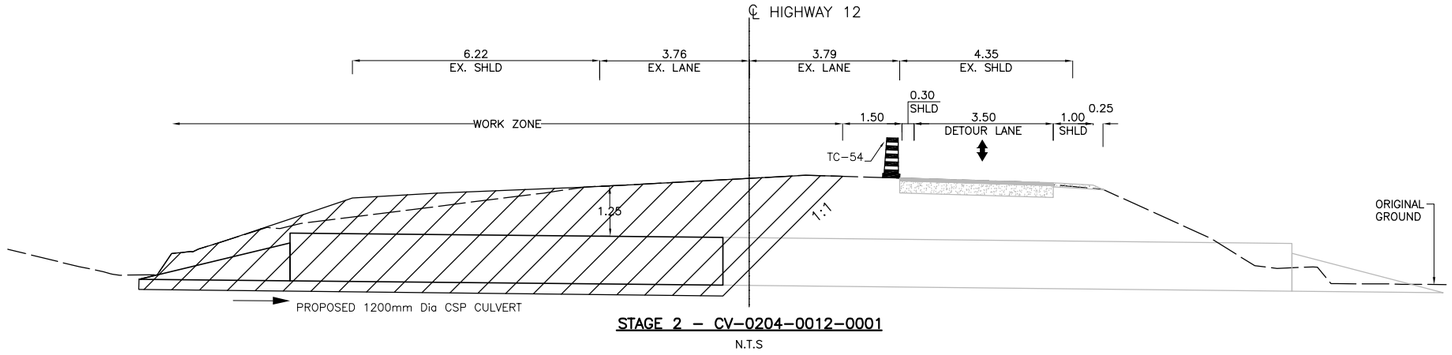
NOTES:

1. SINGLE LANE TRAFFIC TO BE CONTROLLED BY TRAFFIC CONTROL PERSON DURING THE PRE-STAGE AND MAIN STAGES.



STAGE 1 – CV-0204-0012-0001

N.T.S



STAGE 2 – CV-0204-0012-0001

N.T.S

MINISTRY OF TRANSPORTATION, ONTARIO 2016-10 ANSI-D

PLATE No
CONT 2023-2024
GWP 2111-19-00

CV-0204-0012-0001
STAGE 1 AND 2

SHEET
11

consor

LEGEND

- PROPOSED WORK ZONE
- COMPLETED CONSTRUCTION
- SHOULDER STRENGTHENING DONE AT PRE-STAGE
- TEMPORARY WIDENING DONE AT PRE-STAGE
- TRAFFIC FLOW
- TC-54
- MTO RIGHT OF WAY

GENERAL NOTES:

1. CONSTRUCTION STAGING AND TRAFFIC MANAGEMENT SHALL BE IN ACCORDANCE WITH "OTM" BOOK 7 AND ROADSIDE DESIGN MANUAL.
2. TWO CRASH TRUCKS WITH TC-12 BAR SHALL BE PROVIDED TO PROTECT THE OPEN EXCAVATION DURING EACH STAGE.
3. TRAFFIC FROM ACCESSES SHALL BE MAINTAINED AT ALL TIMES.
4. CONSTRUCTION STAGING DRAWINGS ARE PROVIDED TO ILLUSTRATE THE SUGGESTED TRAFFIC MANAGEMENT APPROACH AND GENERAL CONSTRUCTION STAGING WITHIN THE LIMITS OF CONSTRUCTION. THE DETAILED SCHEDULING OF CONSTRUCTION WORK REQUIRED TO ACCOMMODATE THIS APPROACH (INCLUDING ANY PREPARATORY OR FINISHING WORK) SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
5. CONSTRUCTION STAGING DRAWINGS ILLUSTRATE TRAFFIC CONDITIONS TYPICALLY EXPECTED DURING EACH STAGE DURING PERMITTED WORKING HOURS AND HOURS PERMITTED FOR LANE CLOSURES (PER CONTRACT REQUIREMENTS).
6. WORK IN ALL STAGES TO BE COMPLETED AS PER THE GUIDELINES AND DATES SPECIFIED ELSEWHERE IN THE CONTRACT.
7. CONTRACTOR TO MAINTAIN POSITIVE DRAINAGE DURING ALL STAGES.
8. CONTRACTOR SHALL LOCATE AND PROTECT ALL EXISTING UTILITIES.
9. REINSTATE PAVEMENT MARKINGS.

CV-0204-0012-0001
(HWY 12 - DURHAM REGION)
STAGE 1

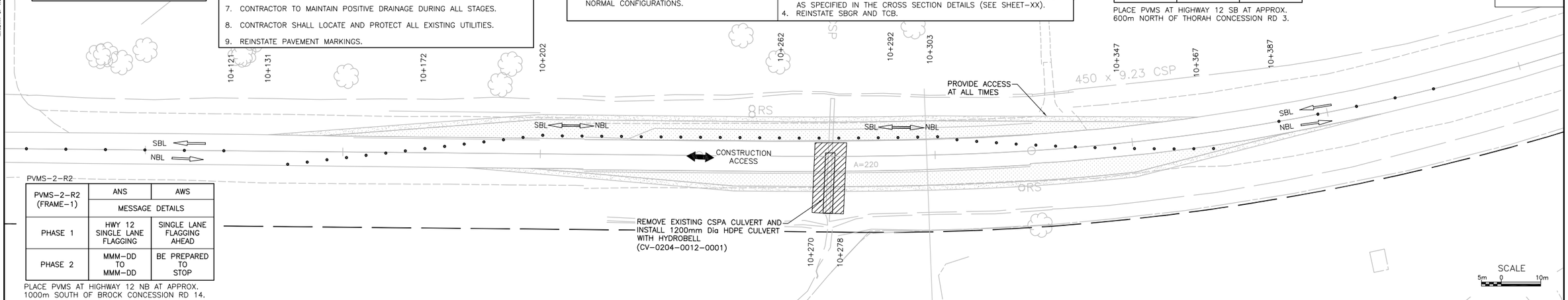
CV-0204-0012-0001 CULVERT REPLACEMENT STAGE 1

TRAFFIC	CONSTRUCTION
PRE-STAGES	**PRE-STAGES**
1. NIGHTTIME LANE CLOSURE WITH TC-54.	1. STRENGTHEN THE EXISTING SHOULDER AND WIDEN ROADWAY AS REQUIRED.
STAGE 1	**STAGE 1**
1. DURING NIGHTTIME, CLOSE ONE LANE AND KEEP ONE LANE OPEN FOR BOTH DIRECTIONS CONTROLLED BY TCP. 2. DURING THE DAYTIME, REINSTATE TRAFFIC TO NORMAL CONFIGURATIONS.	1. REMOVE SBGR AND TCB WITHIN THE EXCAVATION LIMITS. 2. EXCAVATE AND REMOVE THE SOUTH PORTION OF THE EXISTING CSPA CULVERT. 3. PLACE NEW HDPE CULVERT, BACKFILL & PROVIDE ASPHALT PAVEMENT AS SPECIFIED IN THE CROSS SECTION DETAILS (SEE SHEET-XX). 4. REINSTATE SBGR AND TCB.

PVMS-1-R1

PVMS-1-R1 (FRAME-1)	ANS	AWS
	MESSAGE DETAILS	
PHASE 1	HWY 12 SINGLE LANE FLAGGING	SINGLE LANE FLAGGING AHEAD
PHASE 2	MMM-DD TO MMM-DD	BE PREPARED TO STOP

PLACE PVMS AT HIGHWAY 12 SB AT APPROX. 600m NORTH OF THORAH CONCESSION RD 3.



PVMS-2-R2

PVMS-2-R2 (FRAME-1)	ANS	AWS
	MESSAGE DETAILS	
PHASE 1	HWY 12 SINGLE LANE FLAGGING	SINGLE LANE FLAGGING AHEAD
PHASE 2	MMM-DD TO MMM-DD	BE PREPARED TO STOP

PLACE PVMS AT HIGHWAY 12 NB AT APPROX. 1000m SOUTH OF BROCK CONCESSION RD 14.

CV-0204-0012-0001
(HWY 12 - DURHAM REGION)
STAGE 2

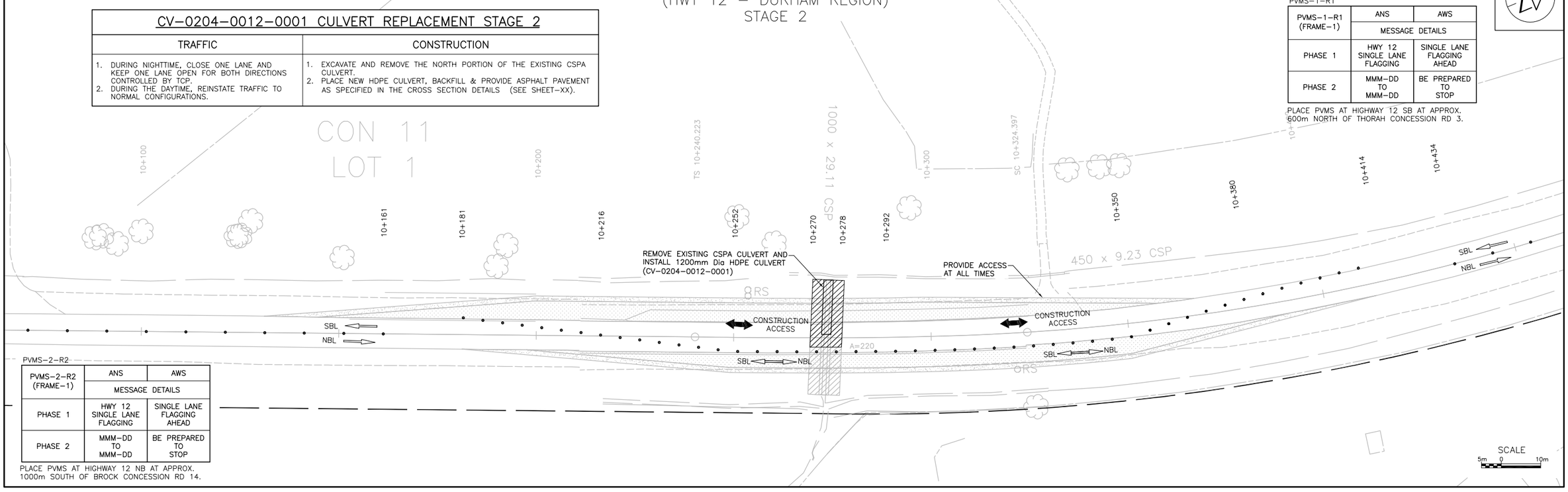
CV-0204-0012-0001 CULVERT REPLACEMENT STAGE 2

TRAFFIC	CONSTRUCTION
1. DURING NIGHTTIME, CLOSE ONE LANE AND KEEP ONE LANE OPEN FOR BOTH DIRECTIONS CONTROLLED BY TCP. 2. DURING THE DAYTIME, REINSTATE TRAFFIC TO NORMAL CONFIGURATIONS.	1. EXCAVATE AND REMOVE THE NORTH PORTION OF THE EXISTING CSPA CULVERT. 2. PLACE NEW HDPE CULVERT, BACKFILL & PROVIDE ASPHALT PAVEMENT AS SPECIFIED IN THE CROSS SECTION DETAILS (SEE SHEET-XX).

PVMS-1-R1

PVMS-1-R1 (FRAME-1)	ANS	AWS
	MESSAGE DETAILS	
PHASE 1	HWY 12 SINGLE LANE FLAGGING	SINGLE LANE FLAGGING AHEAD
PHASE 2	MMM-DD TO MMM-DD	BE PREPARED TO STOP

PLACE PVMS AT HIGHWAY 12 SB AT APPROX. 600m NORTH OF THORAH CONCESSION RD 3.



PVMS-2-R2

PVMS-2-R2 (FRAME-1)	ANS	AWS
	MESSAGE DETAILS	
PHASE 1	HWY 12 SINGLE LANE FLAGGING	SINGLE LANE FLAGGING AHEAD
PHASE 2	MMM-DD TO MMM-DD	BE PREPARED TO STOP

PLACE PVMS AT HIGHWAY 12 NB AT APPROX. 1000m SOUTH OF BROCK CONCESSION RD 14.

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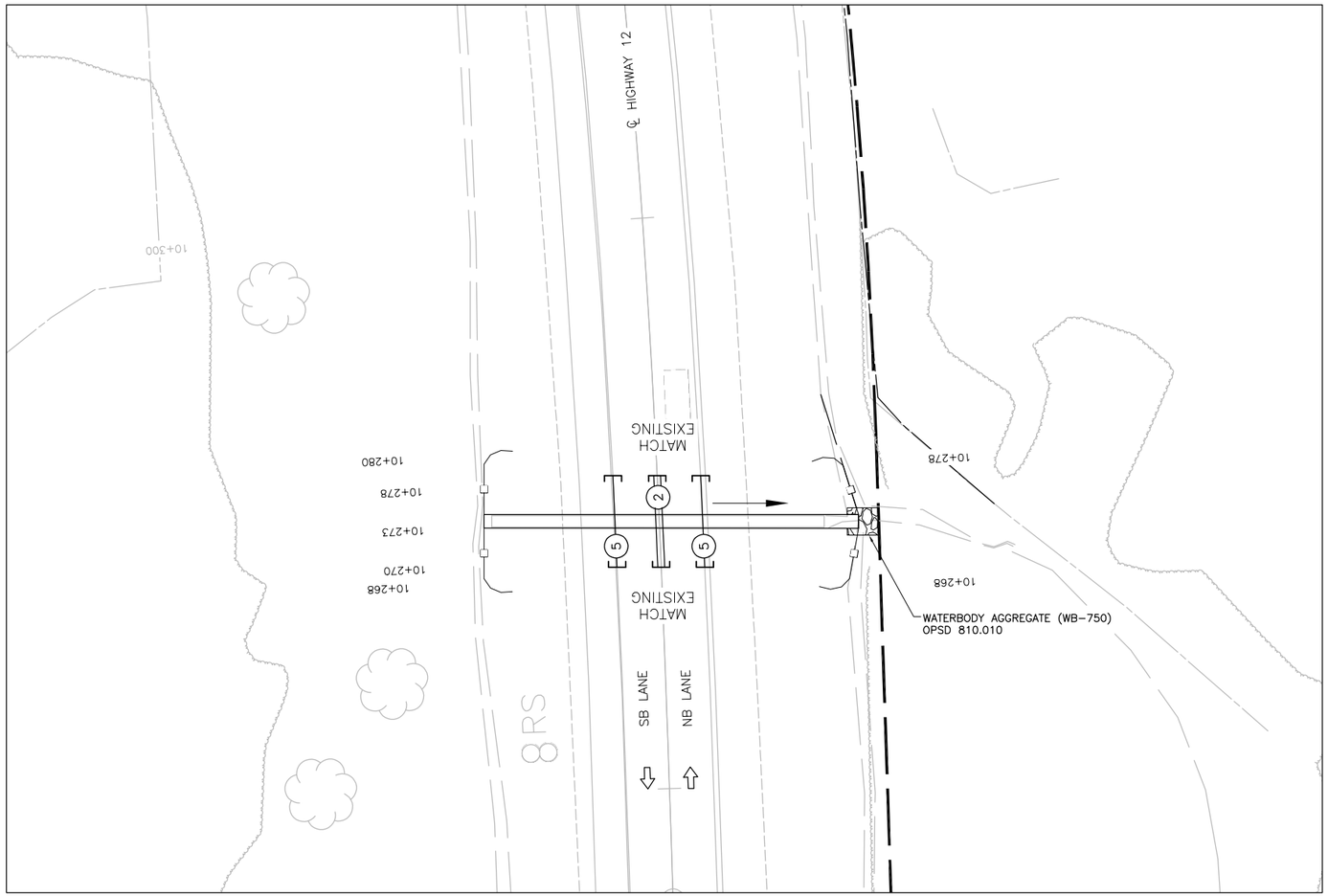
MODIFIED: 5/15/2023 3:49:44 PM BY: RMISTRY
DATE PLOTTED: 5/15/2023 5:05:00 PM BY: RMISTRY

MINISTRY OF TRANSPORTATION, ONTARIO
ANSI-D 2016-10

CV-0204-0012-0001
(HWY 12 – DURHAM REGION)



LEGEND

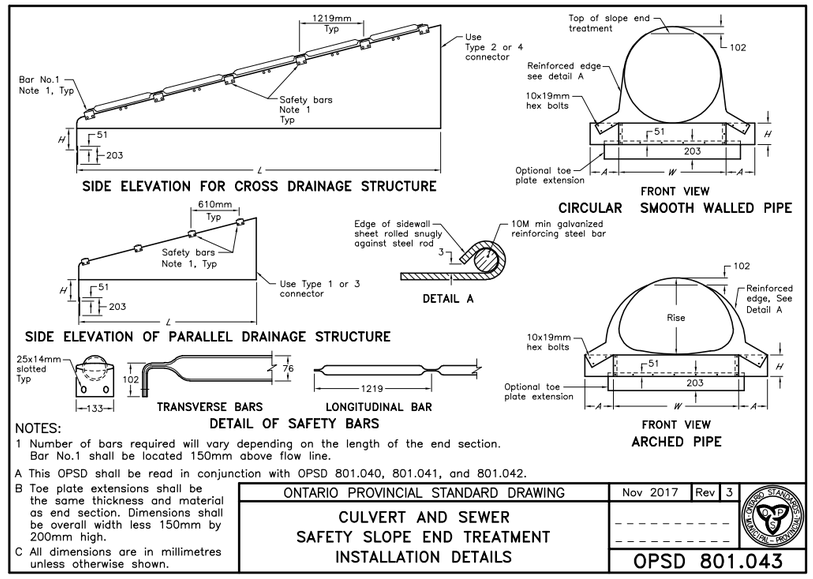
- RIP-RAP/WATERBODY AGGREGATE
- CULVERT REPLACEMENT
- CURB AND GUTTER
- GUIIDERAIL
- LIGHT-DUTY SILT FENCE BARRIER
- FLOW DIRECTION

PLATE No
CONT 2023-2024
GWP 2111-19-00

NEW CONSTRUCTION
CV-0204-0012-0001

consor

SHEET 22



NOTES:

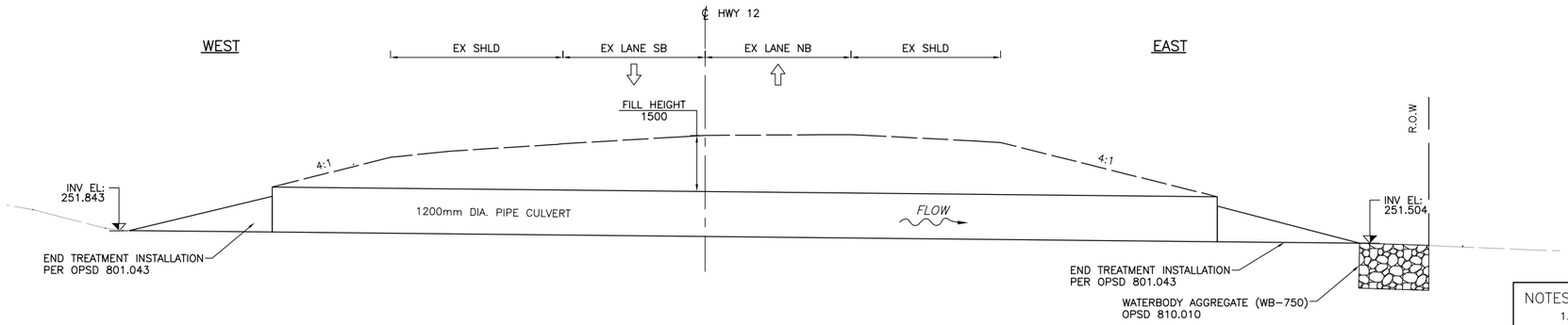
1 Number of bars required will vary depending on the length of the end section. Bar No.1 shall be located 150mm above flow line.

A This OPSD shall be read in conjunction with OPSD 801.040, 801.041, and 801.042.

B Toe plate extensions shall be the same thickness and material as end section. Dimensions shall be overall width less 150mm by 200mm high.

C All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2017	Rev 3
CULVERT AND SEWER SAFETY SLOPE END TREATMENT INSTALLATION DETAILS		OPSD 801.043



1	SOLID YELLOW,10cm
2	SOLID DOUBLE YELLOW,10cm
3	363 BROKEN YELLOW,10cm
4	SOLID YELLOW,20cm
5	SOLID WHITE,10cm
6	333 BROKEN WHITE,10cm
7	363 BROKEN WHITE,10cm
8	393 BROKEN WHITE,10cm
9	SOLID WHITE,20cm
10	111 BROKEN WHITE,20cm
11	333 BROKEN WHITE,20cm
12	333 BROKEN WHITE ,30cm
13	SOLID WHITE,30cm
14	SOLID WHITE,45cm
15	SOLID WHITE,60cm
20	SYMBOLS
] [	LIMITS OF MARKINGS

NOTES:

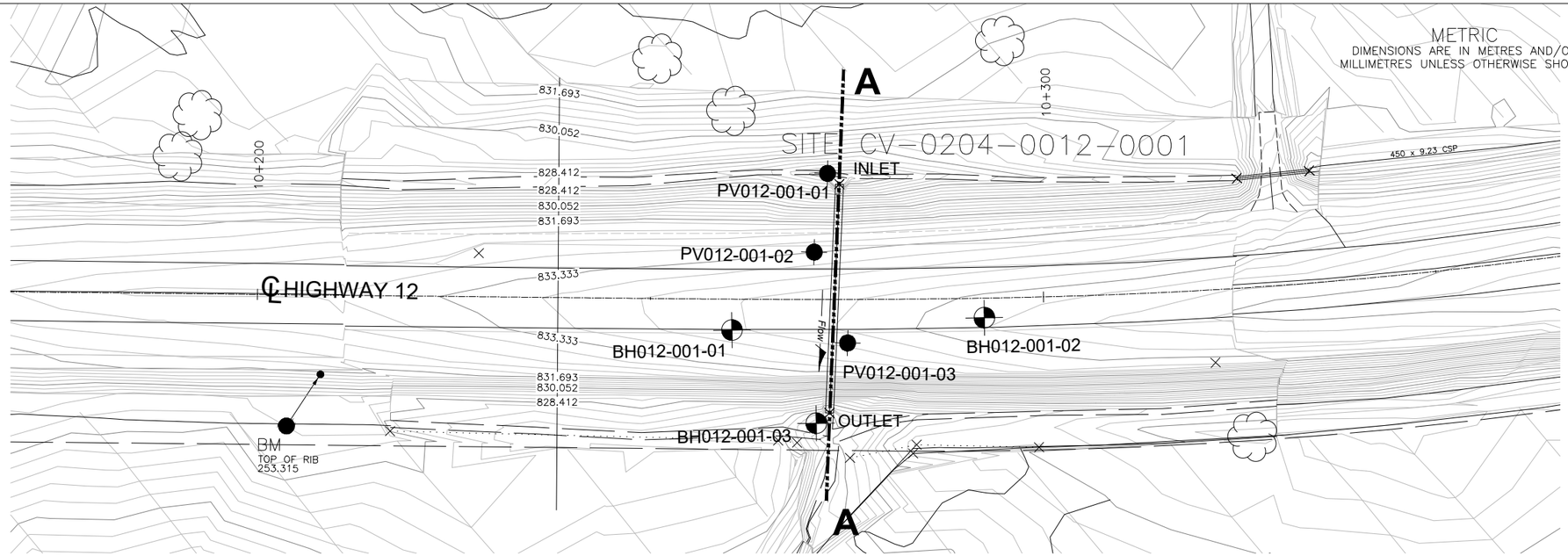
1. 333, 363, 393, DENOTES PAVEMENT MARKING SPACING (ie., 3 m line,3 m gap, 3 m line)
2. Use (1) to Denote PAVEMENT MARKING
3. Use [1] to Denote PAVEMENT MARKING,TEMPORARY
4. Use ⚠1 to Denote PAVEMENT MARKING, TEMPORARY– REMOVABLE
5. Use ⟨1⟩ to Denote PAVEMENT MARKING, DURABLE
6. FROST TAPERS are based on OPSD 803.030, 803.031

SCALE
5m 0 10m

CAD FILE LOCATION AND NAME: P:_V-TPD\Projects\CA\Projects\D220768CN_ 25 Culverts\Drafting\Sheets\Highways\D220768CN_N01.dwg
MODIFIED: 5/15/2023 4:23:16 PM BY: RMISTRY
DATE PLOTTED: 5/15/2023 4:56:14 PM BY: RMISTRY

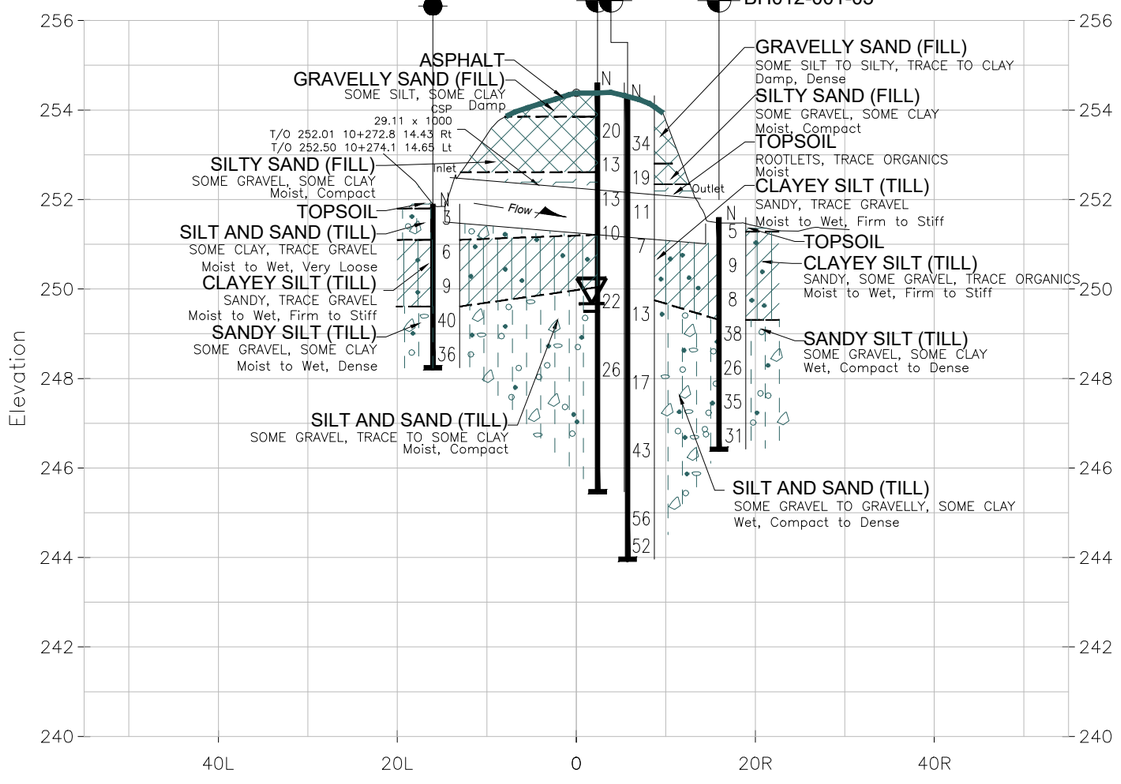
Appendix C –
Borehole Location Plan and Stratigraphic Strata

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



PLAN

PLN 0 10 20m
SEC 0 2 4m



SECTION **A-A** ALONG ℄ CV-0204-0012-0001 CULVERT

LICENSED PROFESSIONAL ENGINEER
N.TAMRAKAR
100169180
MAY 17, 2023
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.E.M. GONSALVES
MAY 17, 2023
PROVINCE OF ONTARIO

FILE NAME: i:\2003-Brampton\Proposals\Projects\International\MTO Projects\MTO 2020-E-0028 25 culverts\working drawings\CAD drafting\CV-0204-0012-0001\CV-0204-0012-0001 - borehole location plan & soil strata.dwg
MODIFIED: 2023-05-16 11:03

ASSIG No. 2020-E-0028
GWP No. 2111-19-00

HIGHWAY 12 CULVERT REPLACEMENT, DURHAM, ON
CV-0204-0012-0001
Latitude: 44.377620° Longitude: -79.104760°
BOREHOLE LOCATION PLAN & SOIL STRATA

SHEET 1

EXP SERVICES INC.

KEY PLAN
N.T.S.

LEGEND

- Borehole Location
- Pavement Borehole
- Water Level Upon Completion of Drilling (W. L. NOT STABILIZED)
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)

SOIL STRATA SYMBOLS

- ASPHALT
- FILL
- TOPSOIL
- CLAYEY SILT (TILL)
- SILT AND SAND (TILL)

BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10

BH No.	ELEV.	NORTHING	EASTING
BH012-001-01	254.3	4915346.2	336307.5
BH012-001-02	254.6	4915376.5	336318.4
BH012-001-03	251.6	4915351.6	336322.6
PV012-001-01	251.9	4915365.1	336293.8
PV012-001-02	254.1	4915359.7	336302.4
PV012-001-03	254.4	4915359.2	336314.7

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

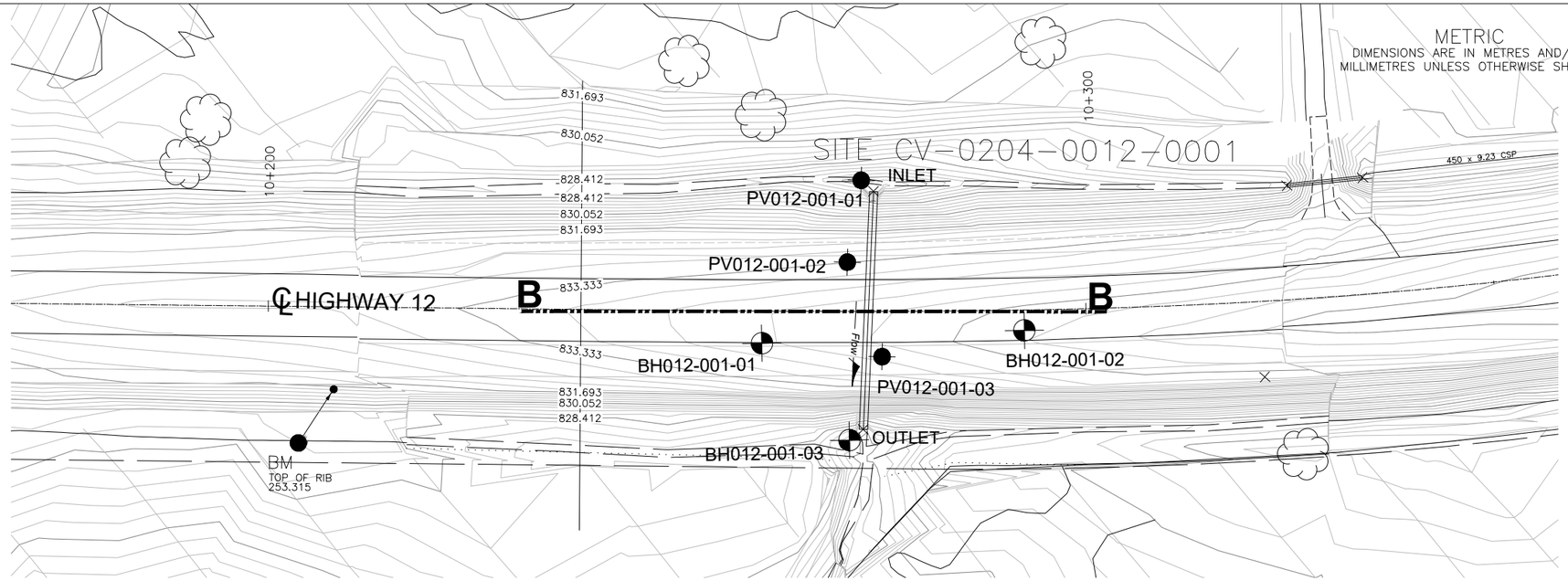
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REVISIONS

NO	DATE	BY	DESCRIPTION
			SUBMISSION FOR MTO REVIEW

PROJECT No.	ADM-22007871-A0	GEOCRES No.	31D-821
SUBM'D SH	CHKD. SM	DATE MAY 17, 2023	SITE-
DRAWN SH	CHKD. TC	APPRD SG	DWG 01

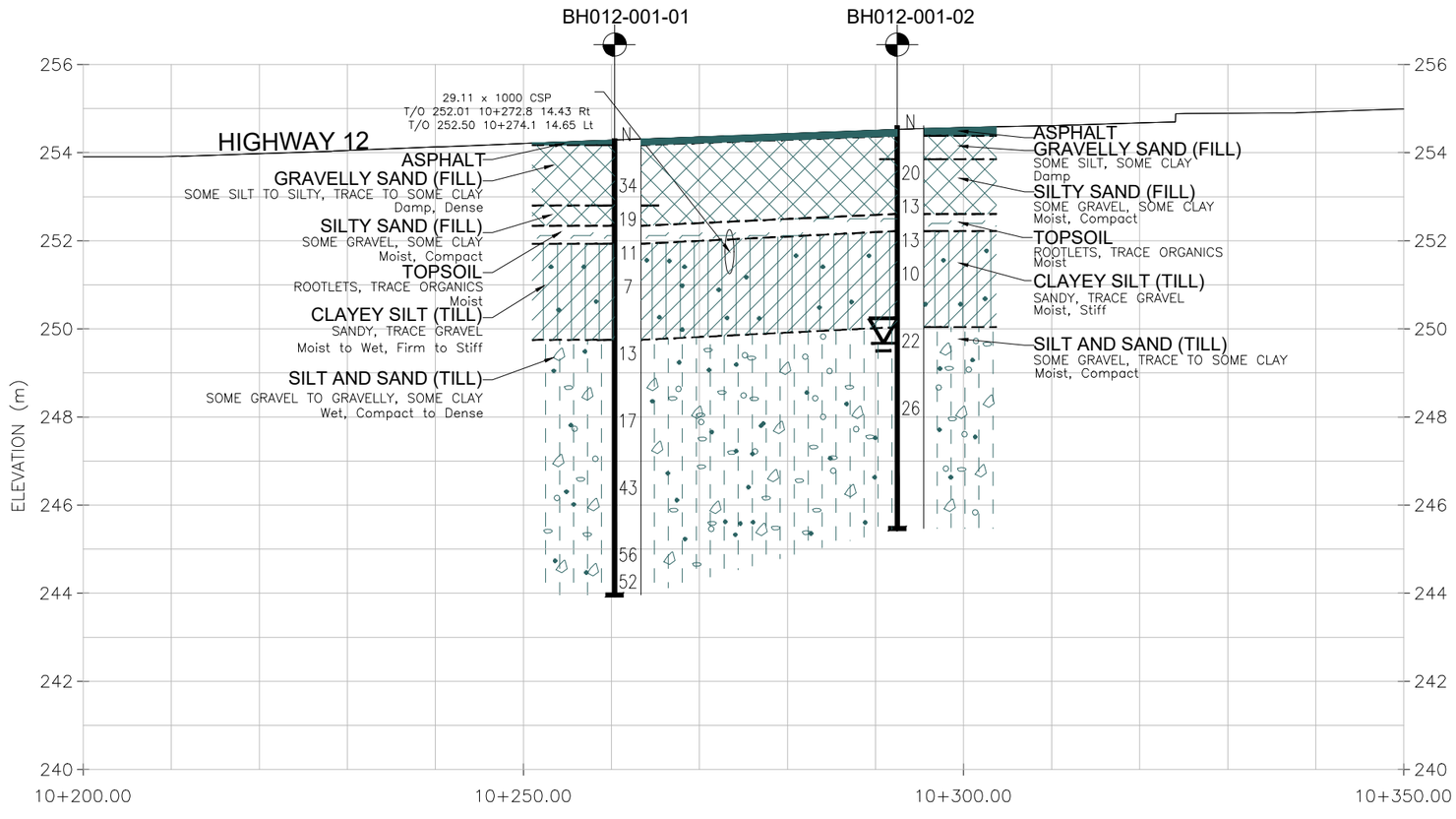
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.



PLAN

PLN 0 10 20m

SEC 0 2 4m



SECTION **B-B** ALONG ℄ HIGHWAY 12

LICENSED PROFESSIONAL ENGINEER
N.TAMRAKAR
100169180
MAY 17, 2023
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.E.M. GONSALVES
MAY 17, 2023
PROVINCE OF ONTARIO

FILE NAME: i:\2003-Brampton\Proposals\Projects\International\MTO Projects\MTO 2020-E-0028 25 culverts\working drawings\CAD drafting\CV-0204-0012-0001\CV-0204-0012-0001 - borehole location plan & soil strata.dwg
MODIFIED: 2023-05-16 11:03

ASSIG No. 2020-E-0028
GWP No. 2111-19-00

HIGHWAY 12 CULVERT REPLACEMENT, DURHAM, ON
CV-0204-0012-0001
Latitude: 44.377620° Longitude: -79.104760°
BOREHOLE LOCATION PLAN & SOIL STRATA

SHEET 2

EXP SERVICES INC.

KEY PLAN
N.T.S.

LEGEND

- Borehole Location
- Pavement Borehole
- Water Level Upon Completion of Drilling (W. L. NOT STABILIZED)
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)

SOIL STRATA SYMBOLS

- ASPHALT
- FILL
- TOPSOIL
- CLAYEY SILT (TILL)
- SILT AND SAND (TILL)

BOREHOLE CO-ORDINATES/ NAD 83/ MTM ON-10

BH No.	ELEV.	NORTHING	EASTING
BH012-001-01	254.3	4915346.2	336307.5
BH012-001-02	254.6	4915376.5	336318.4
BH012-001-03	251.6	4915351.6	336322.6
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PV012-001-02	254.1	4915359.7	336302.4
PV012-001-03	254.4	4915359.2	336314.7

NOTES

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REVISIONS			
			SUBMISSION FOR MTO REVIEW
NO	DATE	BY	DESCRIPTION

PROJECT No.	ADM-22007871-A0	GEOCRES No.	31D-821
SUBM'D SH	CHKD. SM	DATE MAY 17, 2023	SITE -
DRAWN SH	CHKD. TC	APPRD SG	DWG 02

Appendix D –
Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Canadian Foundation Engineering Manual (CFEM):

Table a: Percent or Proportion of Soil

Term	Description	Criteria
“trace”	trace gravel, trace sand, etc.	1% - 10%
“some”	some gravel, some sand, etc.	10% - 20%
Adjective	gravelly, sandy, silty and clayey	20% - 35%
“and”	and gravel, and sand, etc.	>35%
Noun	gravel, sand, silt, clay	>35% and main fraction

The
standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test ‘N’ value:

Table b: Apparent Density of Cohesionless Soil

	‘N’ Value (blows/0.3 m)
Very Loose	N<5
Loose	5≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤N

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

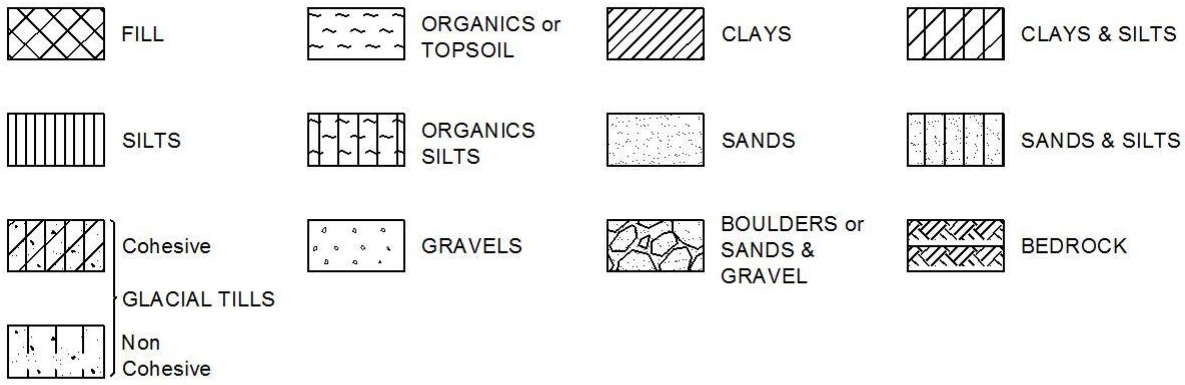
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICALL PROPERIES OF SOIL

m_v	kPa^{-1}	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m^2/s	Coefficient of consolidation
H	m	Drainage path
T_V	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_P	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	–°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	–°	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	Density of solid particles
γ_s	kN/m^3	Unit weight of solid particles
ρ_w	kg/m^3	Density of water
γ_w	kN/m^3	Unit weight of water
ρ	kg/m^3	Density of soil
γ	kN/m^3	Unit weight of soil
ρ_d	kg/m^3	Density of dry soil
γ_d	kN/m^3	Unit weight of dry soil
ρ_{sat}	kg/m^3	Density of saturated soil
γ_{sat}	kN/m^3	Unit weight of saturated soil
ρ'	kg/m^3	Density of submerged soil
γ'	kN/m^3	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_P	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_P$
I_C	%	Consistency index = $(W_L - W)/I_P$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m^3/s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m^3	Seepage force

RECORD OF BOREHOLE No BH012-001-01 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336307.5E 4915346.2N, 3.90 Rt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.01.23 - 2023.01.23 LATITUDE 44.377438 LONGITUDE -79.104614 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × P. PENETROMETER 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.3											
254.2 0.0	**ASPHALT** - (150 mm)		AS1	AS			254				
0.2	**GRAVELLY SAND (FILL)** - some silt, trace to some clay, brown, damp, dense		AS2	AS					○		22 57 (21)
	- becoming silty at depth of 0.8 m		SS3	SS	34		253		○		25 36 29 10
252.8											
1.5	**SILTY SAND (FILL)** - some gravel, some clay, brown with grey inclusions, moist, compact		SS4	SS	19				○		
252.3							252				
2.0	**TOPSOIL** - (410 mm) contains rootlets, trace organics, black, moist										
251.9											
2.4	**CLAYEY SILT (TILL)** - sandy, trace gravel, grey to brown, moist to wet, firm to stiff		SS5	SS	11				○		5 28 37 30
			SS6	SS	7		251		○		
249.8											
4.6	**SILT AND SAND (TILL)** - some gravel, some clay, grey to brown, wet, compact to dense		SS7	SS	13		250		○		
							249				
			SS8	SS	17		248		○		
	- becoming gravelly at a depth of 7.6 m		SS9	SS	43		247		○		
							246				
	- becoming very dense at a depth of 9.1 m		SS10	SS	56		245		○		
			SS11	SS	52				○		
244.0							244				
10.4	**END OF BOREHOLE**										

NOTE:
1) Groundwater level could not be measured due to cave-in at 2.60 m in borehole.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH012-001-02 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336318.4E 4915376.5N, 2.59 Rt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.01.24 - 2023.01.24 LATITUDE 44.37771 LONGITUDE -79.104475 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × P. PENETROMETER 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.6										
0.0 / 254.4	**ASPHALT** - (230 mm)		AS1	AS						
0.2 / 253.9	**GRAVELLY SAND (FILL)** - some silt, some clay, brown, damp		AS2	AS			254			
0.8	**SILTY SAND (FILL)** - some gravel, some clay, grey to brown, moist, compact		SS3	SS	20					19 36 27 18
252.6			SS4	SS	13		253			
2.0 / 252.2	**TOPSOIL** - (390 mm), contains rootlets, trace organics, dark grey to black, moist									
2.4	**CLAYEY SILT (TILL)** - sandy, trace gravel, grey to brown, moist, stiff		SS5	SS	13		252			Corrosivity sample
250.0			SS6	SS	10		251			
4.6	**SILT AND SAND (TILL)** - some gravel, trace to some clay, grey to brown, moist, compact		SS7	SS	22	▽	250			
			SS8	SS	26		249			13 41 36 10
	- inferred cobble/boulder at 7.6 m		AS9	AS			248			
245.5							247			
9.1	- inferred cobble/boulder at 9.1 m						246			

END OF BOREHOLE

NOTE:

1) Sample AS9 was terminated after application of 50 consecutive blows from start and no advancement of split spoon sampler (possibly cobbles). Sample was obtained from auger after drilling for subsequent sample.
2) Borehole terminated at 9.14 m after application of 50 consecutive blows from start and no advancement of split spoon sampler (possibly cobbles).
3) Groundwater level was encountered at a depth of 4.93 m upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0204-0012-0001_BH.GPJ ONTARIO MTO.GDT 5/4/23

RECORD OF BOREHOLE No BH012-001-03 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336322.6E 4915351.6N, 15.71 Rt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.03.16 - 2023.03.16 LATITUDE 44.377486 LONGITUDE -79.104425 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × P. PENETROMETER 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.6											
~~251.6~~ 0.0	**TOPSOIL** - (100 mm)										
0.1	**CLAYEY SILT (TILL)** - sandy, some gravel, trace organics, brown, moist to wet, firm to stiff		SS1	SS	5		251		○		
			SS2	SS	9				⊣		13 39 36 12
			SS3	SS	8		250				
249.3											
2.3	**SANDY SILT (TILL)** - some gravel, some clay, brown, wet, compact to dense		SS4	SS	38		249		⊣		20 34 35 11
			SS5	SS	26		248				
			SS6	SS	35						
			SS7	SS	31		247		○		
246.4											
5.2	**END OF BOREHOLE**										

NOTE:
1) Groundwater level could not be measured due to cave-in at 0.46 m in borehole.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0204-0012-0001_BH.GPJ ONTARIO MTO.GDT 5/4/23

RECORD OF BOREHOLE No PV012-001-01 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336293.8E 4915365.1N, 16.1 Lt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.03.16 - 2023.03.16 LATITUDE 44.377609 LONGITUDE -79.104785 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE, ● QUICK TRIAXIAL × P. PENETROMETER) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.9											
251.8	**TOPSOIL** - (100 mm)										
0.1	**SILT AND SAND (TILL)** - some clay, trace gravel, brown, moist to wet, very loose		SS1	SS	3				○		
251.1											
0.8	**CLAYEY SILT (TILL)** - sandy, trace gravel, brown to grey, moist to wet, firm to stiff		SS2	SS	6		251				
			SS3	SS	9		250		○ H		9 40 40 11
249.6											
2.3	**SANDY SILT (TILL)** - some gravel, some clay, brown to grey, moist to wet, dense		SS4	SS	40		249				
			SS5	SS	36				○		
248.2									○		
3.7	**END OF BOREHOLE**										

NOTE:
1) Groundwater level could not be measured due to cave-in at 0.46 m in borehole.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0204-0012-0001_PV.GPJ ONTARIO MTO.GDT 5/4/23

RECORD OF BOREHOLE No PV012-001-02 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336302.4E 4915359.7N, 6.02 Lt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.01.24 - 2023.01.24 LATITUDE 44.37756 LONGITUDE -79.104678 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × P. PENETROMETER 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.1										
254.0 / 0.1	**ASPHALT** - (50 mm)						254			
253.7 / 0.4	**SAND WITH GRAVEL (BASE COURSE)** - (300 mm), trace silt, brown, damp		AS1	AS					o	28 63 (9)
253.3 / 0.8	**SAND WITH GRAVEL (SUB-BASE)** - (410 mm), trace silt, brown, damp									
252.5 / 1.5	**SAND WITH GRAVEL (FILL)** - some silt, some clay, grey to brown, moist, compact		SS2	SS	20		253		o	
251.9 / 2.1	**SANDY SILT (TILL)** - some gravel, some clay, grey to black, moist, compact		SS3	SS	10		252		o	
	END OF BOREHOLE									

NOTE:
1) Groundwater was not encountered in open borehole upon completion of drilling.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0204-0012-0001_PV.GPJ ONTARIO MTO.GDT 5/4/23

RECORD OF BOREHOLE No PV012-001-03 1 OF 1 METRIC

W.P. CV-0204-0012-0001 LOCATION **CV-0204-0012-0001, Durham, ON, MTM ON-10 336314.7E 4915359.2N, 5.54 Rt** ORIGINATED BY SF

DIST Durham HWY 12 BOREHOLE TYPE Rubber Track Drill - MARL M5T / SSA COMPILED BY SF

DATUM Geodetic DATE 2023.01.24 - 2023.01.24 LATITUDE 44.377555 LONGITUDE -79.104523 CHECKED BY NT/AA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × P. PENETROMETER 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
254.4										
0.0	**SAND WITH GRAVEL (FILL)** - some silt, some clay, brown to grey, moist, compact to very dense		SS1	SS	50		254			
			SS2	SS	17					
252.8							253			
1.5	**SANDY SILT (TILL)** - some gravel, some clay, brown to grey, moist, compact		SS3	SS	11					
252.2										
2.1	**END OF BOREHOLE**									

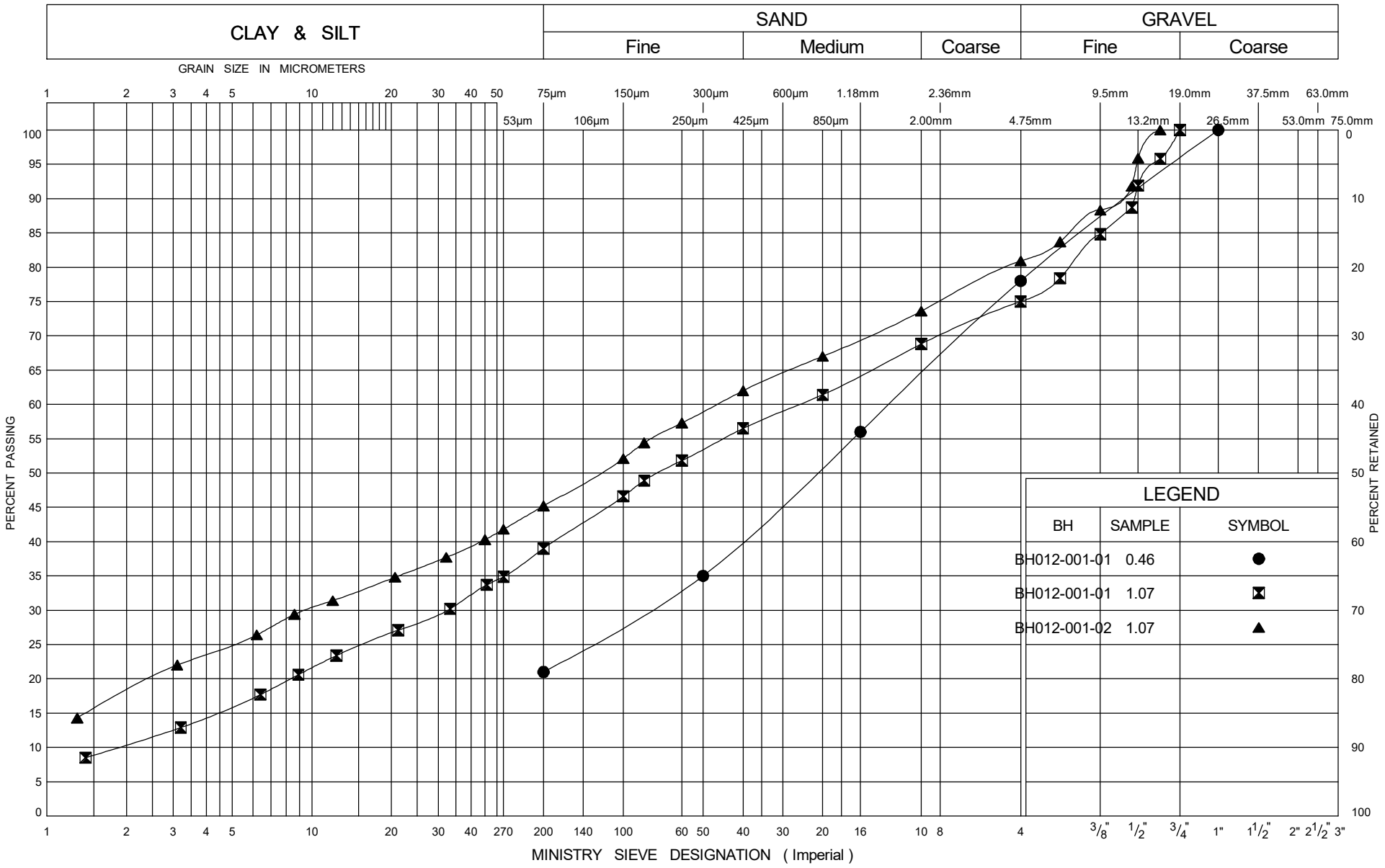
NOTE:
1) Groundwater was not encountered in open borehole upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0204-0012-0001_PV.GPJ ONTARIO MTO.GDT 5/4/23

Appendix E –
Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

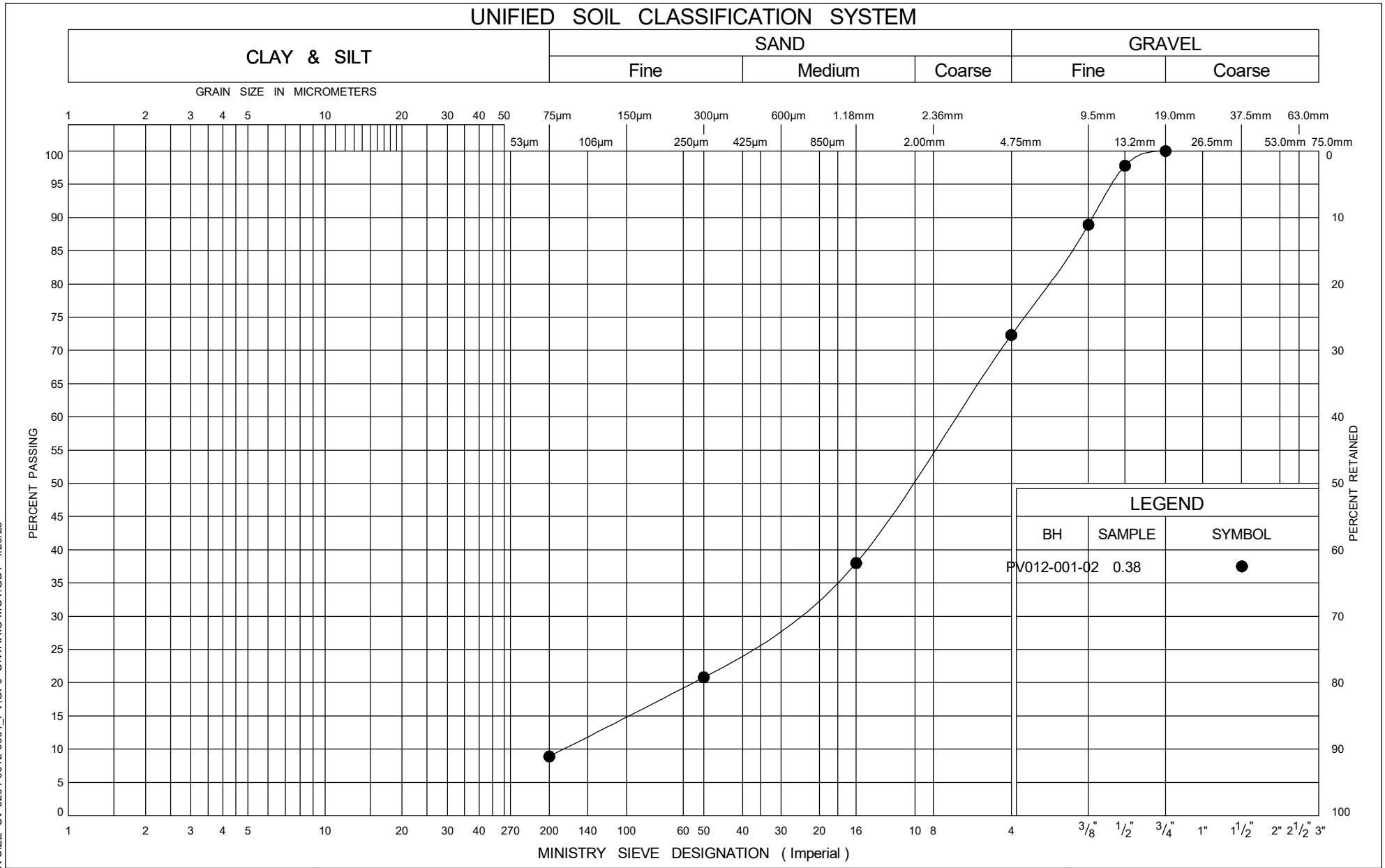
Cohesionless Fill

FIG No 1

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

ONTARIO MOT GRAIN SIZE CV-0204-0012-0001_BH.GPJ ONTARIO MOT.GDT 4/20/23



ONTARIO MOT GRAIN SIZE CV-0204-0012-0001_PV.GPJ ONTARIO MOT.GDT 4/20/23

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

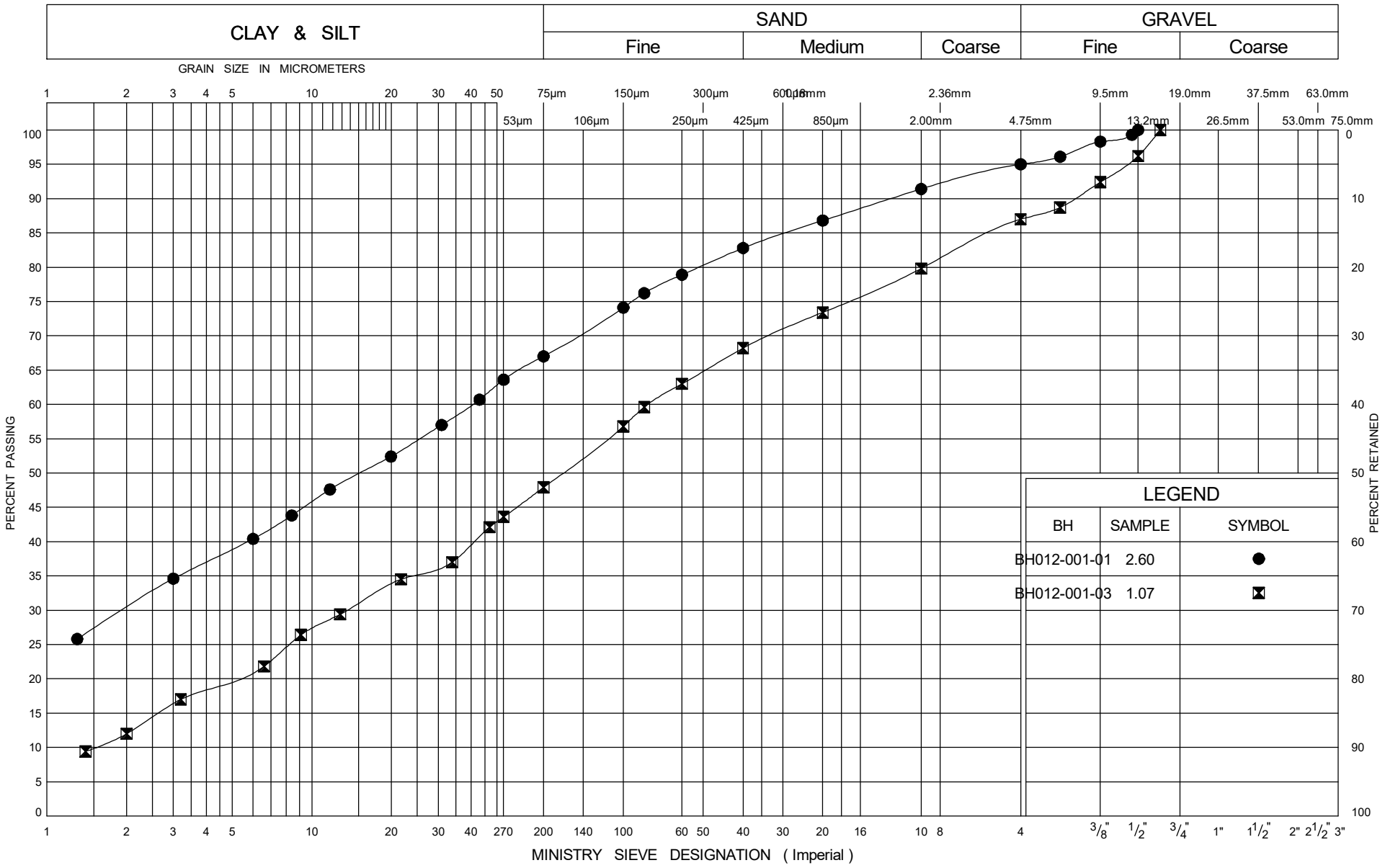
Cohesionless Fill

FIG No 2

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

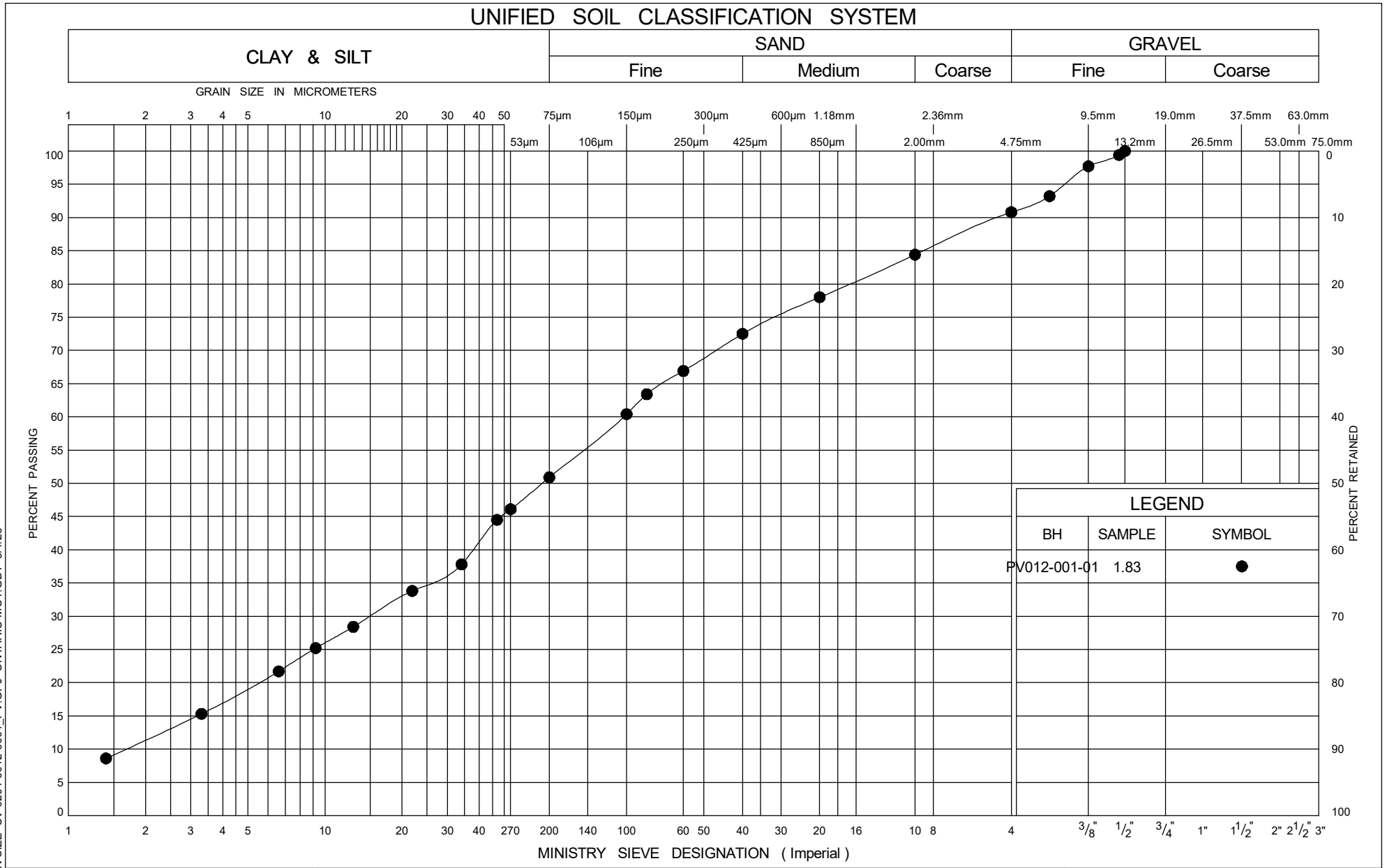
Clayey Silt Till

FIG No 3

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

ONTARIO MOT GRAIN SIZE CV-0204-0012-0001_BH.GPJ ONTARIO MOT.GDT 5/4/23



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

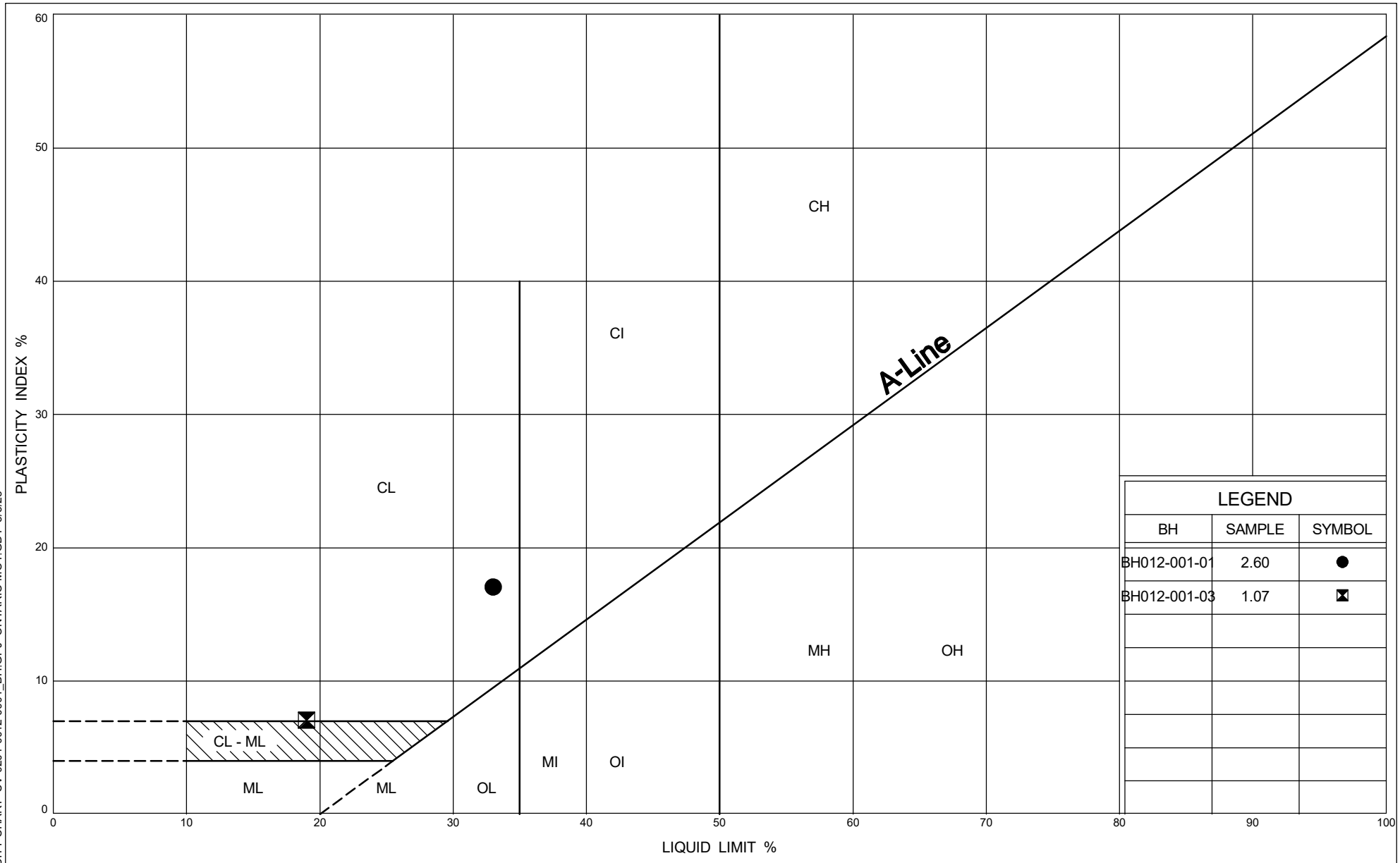
Clayey Silt Till

FIG No 4

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

ONTARIO MOT GRAIN SIZE CV-0204-0012-0001_PV.GPJ ONTARIO MOT.GDT 5/4/23



ONTARIO MOT PLASTICITY CHART CV-0204-0012-0001_BH.GPJ ONTARIO MOT.GDT 5/5/23

Ministry of Transportation
Ontario

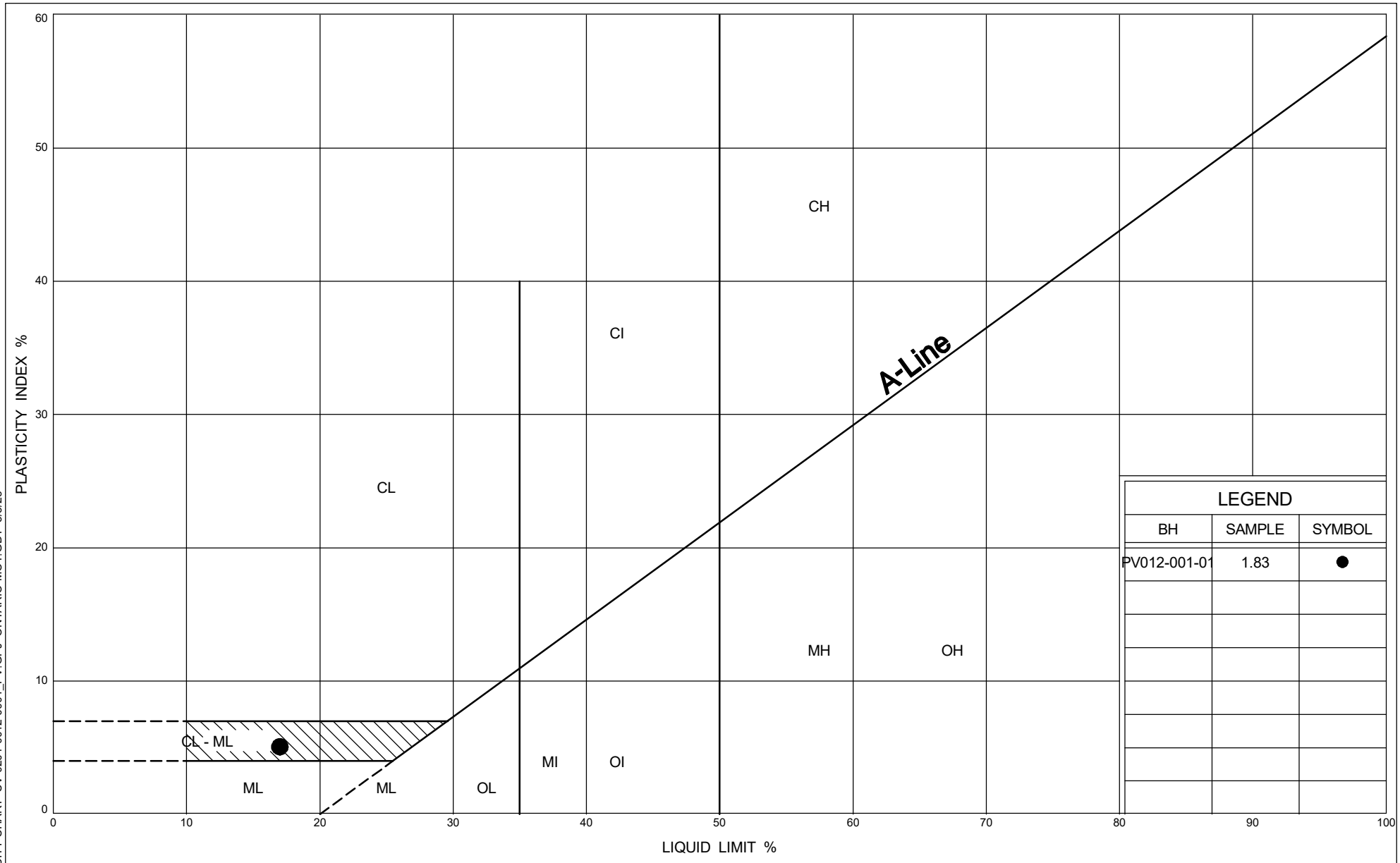
PLASTICITY CHART

Clayey Silt Till

FIG No 5

W P CV-0204-0012-0001

Replacement of 25 Culverts



ONTARIO MOT PLASTICITY CHART CV-0204-0012-0001_PV.GPJ ONTARIO MOT.GDT 5/5/23

Ministry of Transportation
Ontario

PLASTICITY CHART

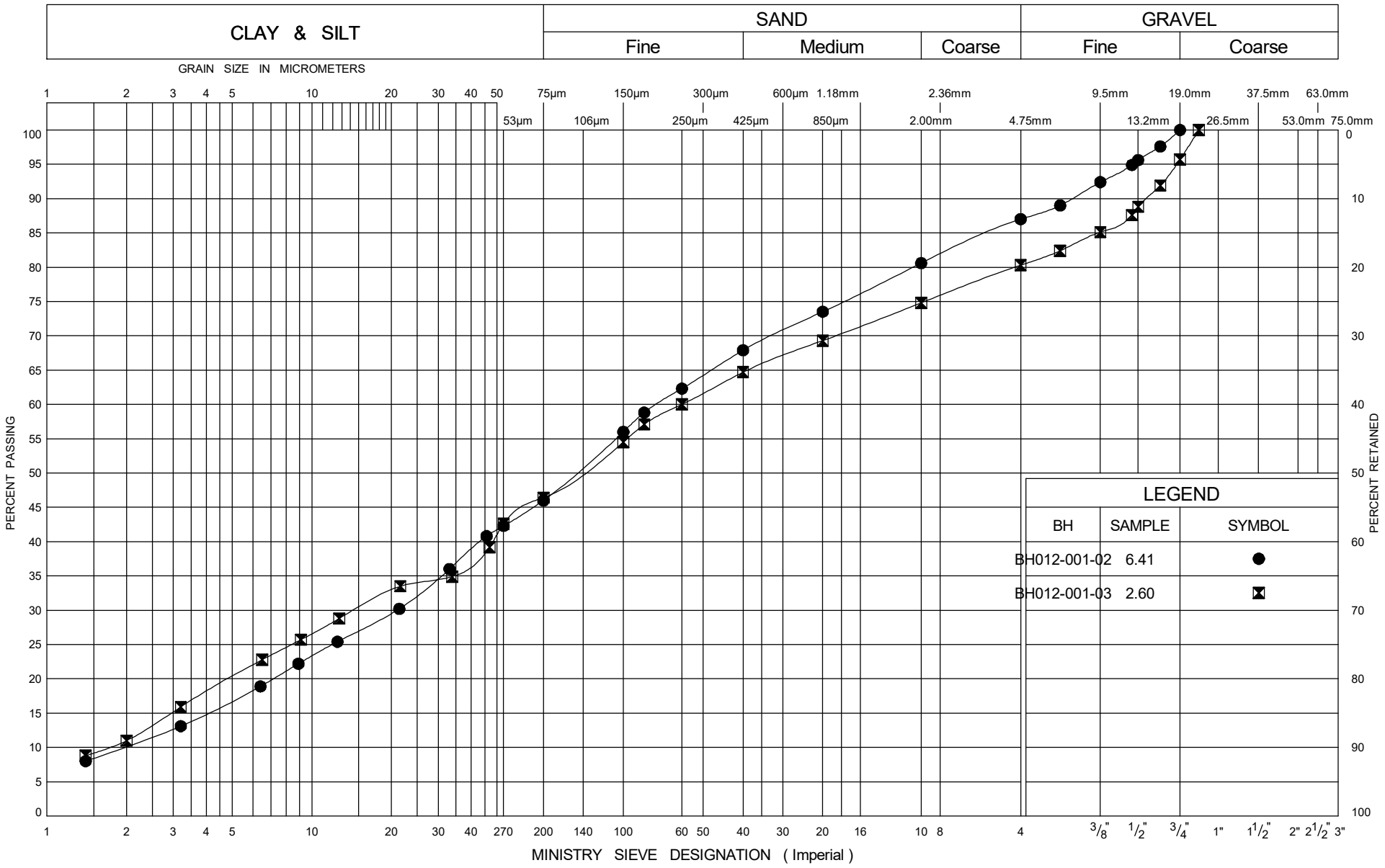
Clayey Silt Till

FIG No 6

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

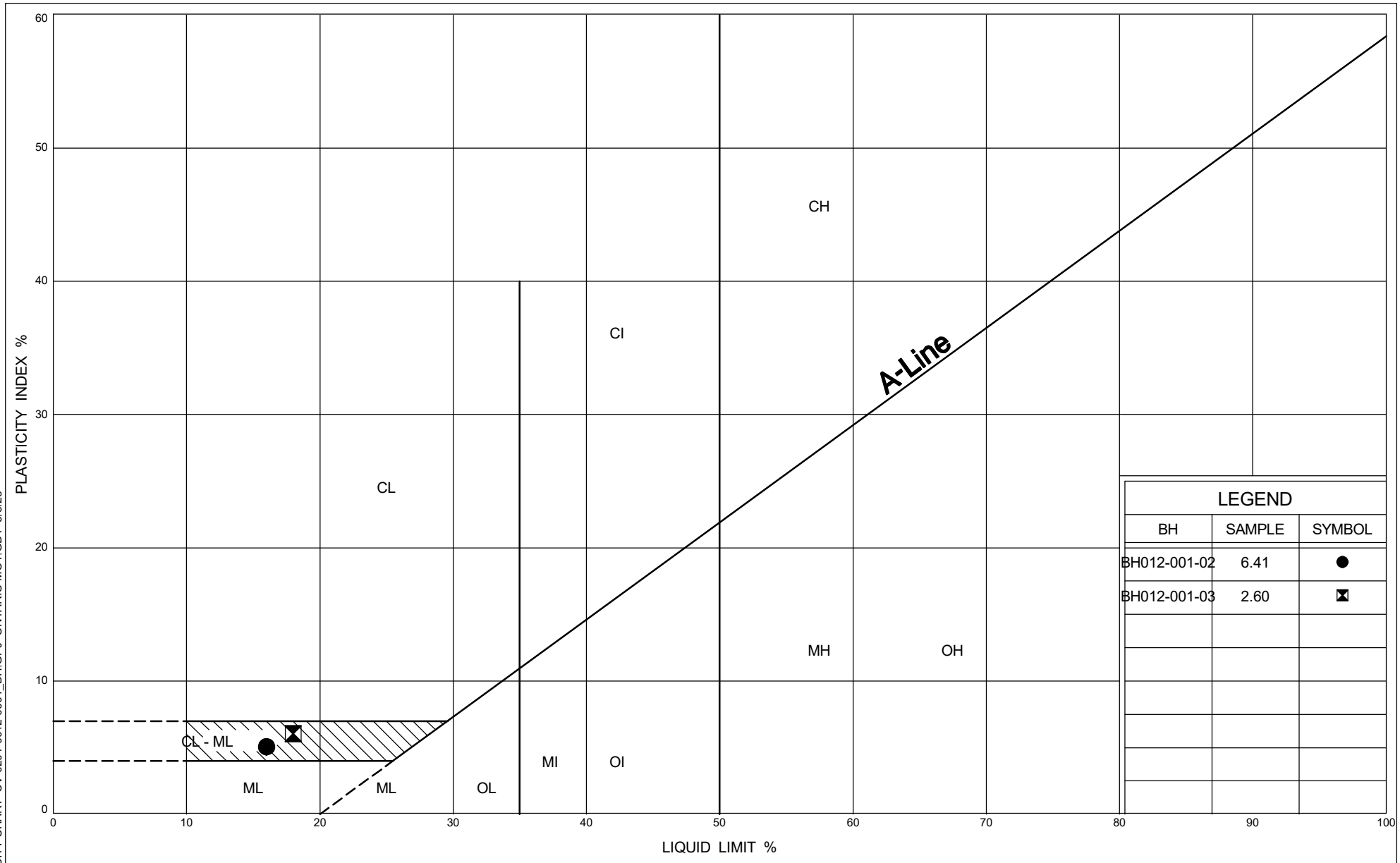
Cohesionless Till

FIG No 7

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

ONTARIO MOT GRAIN SIZE CV-0204-0012-0001_BH.GPJ ONTARIO MOT.GDT 5/5/23



ONTARIO MOT PLASTICITY CHART CV-0204-0012-0001_BH.GPJ ONTARIO MOT.GDT 5/5/23

Ministry of Transportation
Ontario

PLASTICITY CHART

Cohesionless Till

FIG No 8

GWP 2111-19-00

Culvert ID CV-0204-0012-0001

Bureau Veritas Job #: C329405
Report Date: 2023/02/06

exp Services Inc
Client Project #: ADM-22000797-A0
Site Location: HWY 401 FROM VICTORIA TO NELSON AVE, ON
Sampler Initials: IB

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		UYF676			UYF676			UYF677		
Sampling Date		2023/01/25 12:18			2023/01/25 12:18			2023/01/27 10:30		
COC Number		903374-07-01			903374-07-01			903374-07-01		
	UNITS	**BH 12-001-02 SS5**	**RDL**	**QC Batch**	**BH 12-001-02 SS5 Lab-Dup**	**RDL**	**QC Batch**	**BH 400-50-04 SS5**	**RDL**	**QC Batch**
Calculated Parameters										
Resistivity	ohm-cm	260		8481161				1100		8481161
CONVENTIONALS										
Redox Potential	mV	380	N/A	8485160				330	N/A	8485160
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	1900	40	8485316				530	20	8485316
Conductivity	umho/cm	3880	2	8485730				938	2	8485730
Available (CaCl2) pH	pH	9.05		8484048				7.57		8484048
Soluble (20:1) Sulphate (SO4)	ug/g	220	20	8485330				37	20	8485330
Sulphide	mg/kg	4.6 (1)	0.5	8489070	4.0	0.5	8489070	2.4 (1)	0.5	8489070
Physical Testing										
Moisture-Subcontracted	%	9.9	0.30	8489069				20	0.30	8489069

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Sample contained greater than 10% headspace at time of extraction.

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com