



## 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 7 at Coronation Rd Partial Culvert Replacement (CV-0003-0007-0005)**

GWP: 2111-19-00

Assignment No. 2020-E-0028

MTO Central Region

Latitude: 43.943472; Longitude: -79.002288

Geocres No.: 30M15-342

**Type of Document:**

Final Report

**EXP Project Number:**

ADM-22007871-A0

**Prepared For:**

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**Date Submitted:**

July 10, 2023

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### Issue and Revised Record

Rev.	Date	Format	Prepared by	Reviewed by	Approved by	Description
<b>A</b>	June 23, 2023	pdf	S. Fredericks N. Tamrakar	T.C. Kim	S. Gonsalves	Draft Report
<b>B</b>	June 30, 2023	pdf	S. Fredericks N. Tamrakar	T.C. Kim	S. Gonsalves	Final Report
<b>C</b>	July 10, 2023	pdf	S. Fredericks N. Tamrakar	T.C. Kim	S. Gonsalves	Final Report

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*Foundation Investigation Report  
Highway 7 at Coronation Rd Partial Culvert Replacement (CV-0003-0007-0005)  
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Date: July 10, 2023*

## Part I: Foundation Investigation Report

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## 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 on Highway 9, Highway 12, Highway 400, Highway 401, Hwy 404 in Simcoe County, York Region, Durham Region, and the 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 Transportation Ontario's (MTO) Request for proposal, dated February 2022. The scope of this report is specifically limited to the proposed partial replacement of the existing culvert under the Coronation Rd at Highway 7 (CV-0003-0007-0005).

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 potential roadway protection systems (if any), and based on this data, to permit detailed design of roadway protection systems for the full road closure open cut partial replacement of the existing culvert.

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 GWP 2111-19-00, CV-0003-00007-0005, prepared by CONSOR, show the design configuration of the proposed partial replacement of non-structural culvert located at the Highway 7 at Coronation Road. A summary of the proposed structure is as follows:

- It is understood that the full road closure open cut construction approach will be used for partial replacement the existing culvert. A roadway protection system may require at some section of the alignment to facilitate the construction of the manhole and culvert replacement. The design recommendation on the proposed replacement of the non-structural culvert and pavement reinstatement are provided in a Pavement Design Report for CV-0003-00007-0005 culvert under a separate cover.
- The existing culvert was 1100 mm diameter concrete pipe culvert (in front of the private property) with CSP and HDPE extension under the Coronation Road.
- The existing CSP and HDPE pipe under the Coronation Road, between new manhole and outlet which is about 29 m in length, is proposed to be replaced with 1200 mm diameter CSP/HDPE culvert along the same alignment. In addition about 6 m of the existing culvert between new manhole and existing ditch inlet is also proposed to be replaced with 1200 mm diameter CSP/HDPE culvert along the same alignment.

- Based on the contract drawing the invert level of the new culvert is proposed to be at approximately Elev. 145.1 m and 144.6 m at the inlet (manhole) and outlet, respectively.
- The existing coronation road profile grade is planned to remain unchanged. It is understood that the full road closure open cut construction approach will be used for partial replacement the existing culvert.

The 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.

This report presents the results of a geotechnical investigation completed by EXP Services Inc. (EXP) for the roadway protection system (if any) for the construction of manhole/ replacement of the existing culvert under Coronation Road.

## 3.0 Site Description and Geological Setting

### 3.1 Site Description

The culvert is located at Highway 7 at Coronation Road, about 400 m east of Highway 412 in Whitby, Ontario. At the site, Highway 7 is a four lane roadway that runs in an east-west direction, while Coronation road is two lane road runs in north south direction. The elevation of Coronation road pavement centerline at the site is about 148 m.

Based on the information provided, the existing culvert is about 1100 mm in diameter concrete pipe culvert (in front of the private property) with CSP and HDPE extension under the Coronation Road. The total length of the culvert is about 75 m long with about 2.3 m of cover under the Coronation Road. The general site conditions were assessed during the site investigation in May 24, 2023. The culvert flows in west to east direction under the Coronation Road. At the time of this investigation, surficial flow of water through the culvert was observed near the culvert invert level.

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.

### 3.2 Geological Setting

Based on a review of geological maps of Southern Ontario (Chapman and Putnam, 1984; 2007), the site is situated between the south slope and the Iroquois Plain physiographic region. It is understood that the site is located at or near the northern shoreline of glacial lake Iroquois. The overburden in the area is composed of glacial till sheets. Lacustrine clay deposited by lake Iroquois, is often encountered between the till sheets. Where the Lake Iroquois plain transitions into the till plain, the subsurface conditions are complex. Variable soil and ground water conditions occur over relatively short distances.

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 sand, gravelly sand and gravel deposits to silt to silty clay matrix till. In addition, Map 2544 (Bedrock Geology of Ontario, Southern Sheet, 1991), the bedrock geology at the site consists of shale of Blue-Mountain formation. The Blue-Mountain formation belongs to Upper Ordovician period.

## 4.0 Previous Investigations

There are no available previous geotechnical reports directly at this site in the MTO GEOCREs library. However, two reports were available pertaining to a geotechnical investigation for several culvert extensions within the vicinity of Culvert CV-0003-0007-0005. The reports are listed below for reference:

*Geocres No. 30M15-028: "Foundation Investigation Report", Proposed Structure at the Crossing of Stevenson Creek & Highway 7 (Line 'E') Lot 32 – concessions 5&6, W.P. 72-65-1, District 6 – Township of Whitby*

*Geocres No. 30M14-319: "Foundation Investigation and Design Report for Culvert Replacements at Hwy 7 between Brock Road to Hwy 12 Pickering/ Whitby; G.W.P. No. 2075-08-00", Prepared by Thurber Engineering, dated November 6, 2009*

Project reference Geocres No. 30M15-028, is located approximately 45 m east of Highway 7 and Coronation Road intersection. The project entailed subsurface investigations aimed at providing requisite geotechnical design data for the replacement of a structure at the intersection of Stevenson Creek and Highway 7. Issued June 25, 1969, the subsoil at the site was described as composing of a glacial till overlain by approximately 0.9 m of sand to gravelly sand on the western side of the creek and 1.8 m of clayey silt and sand with some gravel and organics on the eastern side of the creek. Some engineered fill was also encountered in some areas at ground surface overlaying the native layers.

Project reference Geocres reference No. 30M14-319 (from the Ministry of Transport Ontario Foundation Library), the culvert replacement sites were located approximately along Highway 7 from Brock Road in the City of Pickering to Highway 12 in the Town of Whitby, Ontario. The project entailed subsurface investigations aimed at providing requisite geotechnical design data for the replacement of several culverts. One of the culvert replacement site (C18), which is close to the current investigation site, is about 45 m east of Highway 7 and Coronation Road intersection. The subsoil at the site was described as composed of organic topsoil of variable thicknesses overlaying native sand and silt layers and sand and silt tills. Where applicable, asphaltic surfaces were underlain by granular fills overlaying native sand and silt layers and sand and silt tills.

## 5.0 Field Investigation and Laboratory Analyses

### 5.1 Site Investigation and Field Testing

A site-specific investigation was undertaken by EXP on May 24, 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 7/Coronation Road during the drilling of on-road boreholes was provided by Barricade Traffic Services.
4. The program involved the drilling of eight (8) boreholes for sampling, consisting of 6 pavement (inclusive of two coring's) and 2 geotechnical boreholes, numbered PV007-05-01 to PV007-001-04, core 1, core 2 and BH007-05-01 and BH007-05-02. The location along with the coordinates, elevations and

depths of each borehole drilled is summarized in Table 1.1 below. The locations of the boreholes drilled by EXP during this investigation are also shown on Drawing 1 in Appendix C.

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  $\pm 0.10$  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.
12. Groundwater level measurements were taken using a water level meter tape upon completion of drilling (or as otherwise stated on the borehole logs) of boreholes in accordance with MTO guidelines. The recorded groundwater levels after the completion of drilling boreholes were presented in the borehole log sheets in Appendix D. No monitoring well was installed for this site.
13. 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				
PV007-05-01	Inlet, off-road	4867175	344727	43.943472	-79.002288	147.9	2.1



Borehole No.	Borehole Location	Location (MTM NAD83 Zone 10)		Latitude	Longitude	Borehole Elevation (m)	Borehole Depth (m)
		Northing	Easting				
PV007-05-02	Outlet, off-road	4867193	344801	43.943631	-79.001696	145.1	3.7
PV007-05-03	Adjacent to manhole off-road	4867189	344757	43.943593	-79.002249	147.9	3.7
PV007-05-04	South-bound Lane Coronation Road	4867197	344772	43.943664	-79.002053	148.0	5.2
BH007-05-01	Asphalt sidewalk south side of Hwy 7	4867182	344723	43.943536	-79.002667	149.2	9.8
BH007-05-02	Asphalt sidewalk south side of Hwy 7	4867192	344753	43.943627	-79.002289	148.5	9.8

## 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 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	Corrosivity
PV007-05-01	2	-	1	-	-
PV007-05-02	3	-	-	1	-
PV007-05-03	3	-	2	-	-
PV007-05-04	4	-	2	2	1
BH007-05-01	5	1	2	2	-
BH007-05-02	6	1	-	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

An asphaltic surface was encountered at the ground surface in boreholes BH007-05-01, BH007-05-02 and PV007-005-04. The thickness of asphalt ranged from approximately 76.2 mm to 127 mm.

#### 6.1.2 Topsoil

A topsoil layer was encountered at the ground surface of boreholes PV007-05-01, PV007-05-02 and PV007-05-03. The thickness of this layer ranged from approximately 152 to 914 mm with a recorded SPT (N Value) of 3 blows per 300 mm penetration encountered in borehole PV007-05-02; corresponding to very loose in consistency. The layer was generally moist to wet ranging from blackish brown to brown in color.

#### 6.1.3 Cohesionless Fill

Cohesionless fill layers with trace to some clays were encountered in all boreholes. 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				
PV007-05-01	147.8	145.8	0.2	2.0	Sand	2-8
PV007-05-02	144.2	142.8	0.9	1.4	Sand to Sandy Silt	8
PV007-05-03	147.8	145.6	0.2	2.2	Sand	5-27
PV007-05-04	147.9	147.2	0.1	0.7	Sand, With Gravel	36
	147.2	146.5	0.8	0.7	Sand to Sandy Silt	15
BH007-05-01	149.1	146.9	0.1	2.2	Gravelly Sand	25-38
BH007-05-02	148.4	146.9	0.1	1.5	Gravelly Silty Sand	8-10

The composition of the layers encountered is as presented in Table 1.3 above. The layer was moist to wet with color ranging from blackish brown to brown to brownish grey to grey to blackish grey. The SPT "N" values within this layer ranged from 2 to 38 blows per 300 mm penetration, corresponding to very loose to dense but generally loose to compact in compactness condition.

Moisture Content:

- 3.6% to 20.5%

Grain Size Distribution:

- 13% to 27% gravel;
- 62% to 77% sand;
- 10% to 11% 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 Fill

A clayey silt cohesive fill layer was encountered underneath the cohesionless gravelly silty sand fill layer in borehole BH007-05-02. The thickness of this layer was 0.8 m extending from an approximate elevation of 146.9 m. The layer was moist and greyish brown in color with a moisture content of 13.3% and a SPT (N Value) of 4 blows per 300 mm penetration, corresponding to firm in consistency.

### 6.1.5 Sand to Gravelly Sand

A sand to gravelly sand native layer with trace rootlets was encountered underneath the cohesionless sand fill layer in borehole PV007-05-03. The thickness of this layer was 1.4 m extending from an approximate elevation of 145.6 m. The layer was brown in color, ranging from moist to wet with a moisture content of 11.4%. The SPT (N Value) within the layer ranged from 6 to 27 blows per 300 mm penetration, corresponding to loose to compact in compactness condition.

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 3 in Appendix E.

### 6.1.6 Cohesionless Till

A cohesionless till layer with trace to some gravel and trace to some clay was encountered below the fill layers in boreholes BH007-05-01, BH007-05-02 and PV007-05-04. 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 Cohesionless Till Layers**

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)	Layer Description	SPT "N" Value Range
	Top	Bottom				
<b>BH007-05-01</b>	146.9	139.4	2.3	7.5	Silt and Sand	9 – 45; 80/51mm
<b>BH007-05-02</b>	146.2	138.7	2.3	7.5	Silty Sand to Sandy Silt	11 – 34; 80/51mm
<b>PV007-05-04</b>	146.5	142.8	1.5	3.7	Sandy Silt	8-36

The composition of the layers encountered is as presented in Table 1.4 above. Trace rootlets were encountered in borehole PV007-05-04. In general, the layer was moist to wet with color ranging from brown to brownish grey to grey to blackish grey to greyish brown. SPT "N" values ranged from 8 to 45 blows per 300 mm penetration, to 80 blows per 51 mm penetration, corresponding to loose to very 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 limit tests are also provided on Figures 4 to 6 in Appendix E.

Moisture Content:

- 7.8% to 15.4%

Grain Size Distribution:

- 2% to 13% gravel;

- 32% to 50% sand;
- 32% to 47% silt;
- 10% to 26% clay;

Atterberg Limits:

- Liquid Limit: 14% to 17%
- Plastic Limit: 9%
- Plasticity Index: 5% to 8%

#### 6.1.7 Cohesive Till

A sandy silt with clay cohesive till layer with trace gravel was encountered below the sand to sandy silt fill layer in boreholes PV007-05-02. The thickness of the layer was 1.4 m extending from an approximate elevation of 142.8 m. The layer was moist and grey in color with SPT (N Value) ranging from 32 to 34 blows per 300 mm penetration, corresponding to hard in consistency.

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 7 in Appendix E.

Moisture Content:

- 9.1%

Grain Size Distribution:

- 2% gravel;
- 28% sand;
- 41% silt;
- 29% clay;

## 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 1.5.

**Table 1.5: Summary of observed Groundwater Levels**

Borehole	Ground Surface Elevation (m)	Water Level Depth/ Elevation (m) <sup>1</sup>	Date Measured	Comments
PV007-05-01	147.9	Dry	May 24, 2023	-
PV007-05-02	145.1	2.1/143.0	May 24, 2023	Measured upon completion of drilling
PV007-05-03	147.9	3.3/144.6	May 24, 2023	Measured upon completion of drilling
PV007-05-04	148.0	4.4/143.6	May 24, 2023	Measured upon completion of drilling
BH007-05-01	149.2	6.4/142.8	May 24, 2023	Measured upon completion of drilling
BH007-05-02	148.5	3.7/144.8	May 24, 2023	Measured upon completion of drilling

Note:

1. Depths are relative to ground surface

At the time of this investigation, surficial flow of water through the culvert was observed near the culvert invert level.

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 1.6.

**Table 1.6. 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)
PV007-05-04	SS6	4.9	<20	20	7.83	200	5000	360

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 Assignment No. 2020-E-0028  
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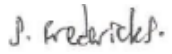



## 7.0 CLOSURE

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 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 Nimesh Tamrakar, M.Eng., P.Eng.

### EXP Services Inc.

 Stephen Fredericks, M.Eng., P.Eng. Geotechnical Engineer	 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



## 8.0 REFERENCES

Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Canadian Standards Association (CSA), 2019. Canadian Highway Bridge Design Code and Commentary on CAN/CSA-S6-19. CSA Special Publication.

Highway Standards Branch, Provincial Memorandum, Material Engineering and Research Office (MERO) #2020-01, March 23, 2020

Ministry of Northern Development and Mines, Map 2556. Quaternary Geology of Ontario, Southern Sheet, 1991

Ministry of Northern Development and Mines Map 2544. Bedrock Geology of Ontario, Southern Sheet, 1991

Ministry of Transportation, April 2014. MTO Gravity Pipe Design Guidelines. Circular Culverts and Storm Sewers.

Ministry of Transportation, October 2020. Guideline for MTO Foundation Engineering Services, Version 02

### **ASTM International:**

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

### **Ontario Provincial Standard Specifications (OPSS):**

OPSS.PROV 501 Construction Specification for Compacting

OPSS.PROV 517 Construction Specification for Dewatering

OPSS.PROV 539 Construction Specification for Temporary Protection Systems

OPSS.PROV 902 Construction Specification for Excavating and Backfilling – Structures

OPSS.PROV 903 Construction Specification for Deep Foundations

OPSS.PROV 1010 Material Specification for Aggregates - Base, Subbase, Select Subgrade, And Backfill Material

OPSS.PROV 1860 Material Specification for Geotextiles

### **Special Provisions (SP):**

SP 109F57 Amendment to OPSS 903

SP 517F01 Amendment to OPSS 517

### **Ontario Water Resources Act:**

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.

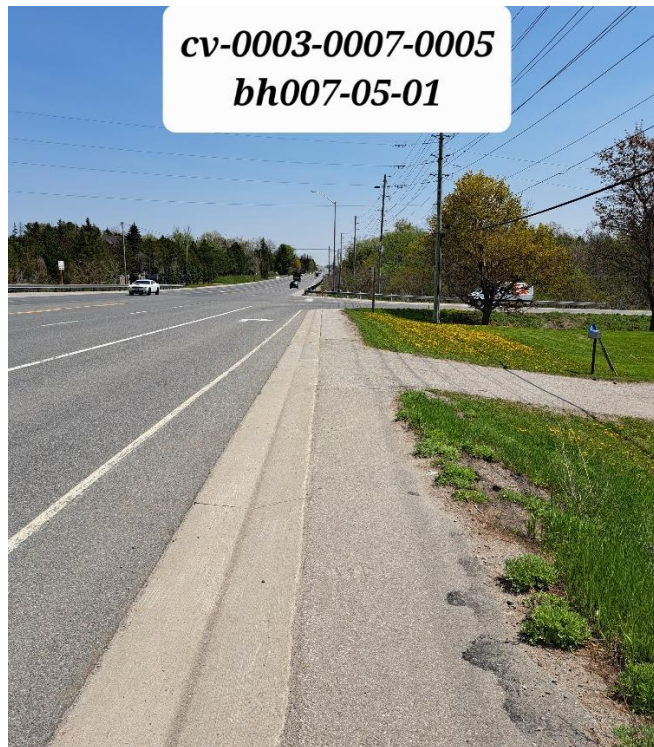
#### **USE OF REPORT**

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.

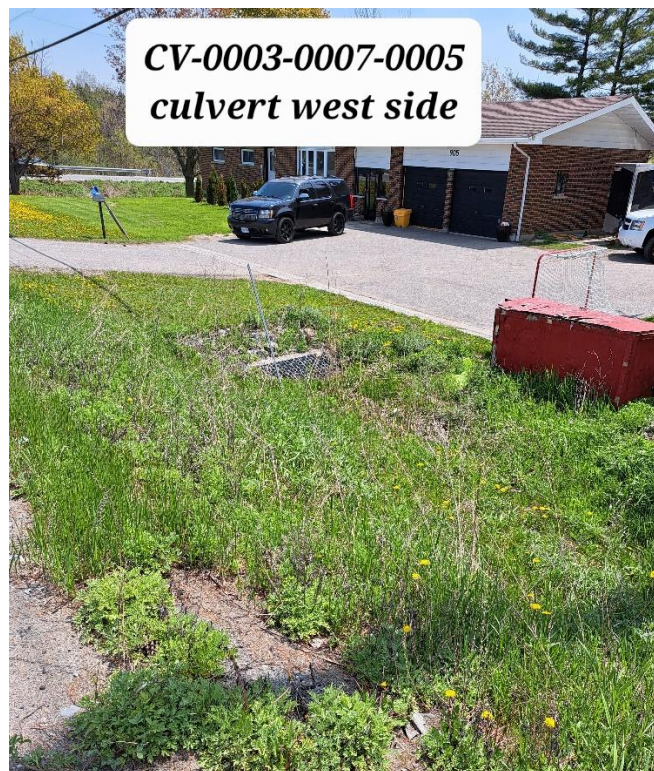
#### **REPORT FORMAT**

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 utilized 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



**Photo (1): Hwy 7 looking east towards Coronation Road**



**Photo (2): Ditch inlet looking east, west of the private driveway**





**Photo (3): Coronation Rd looking north toward Hwy 7**



**Photo (4): Culvert outlet looking west**





**Photo (5): Embankment slope south of Hwy 7 and West of Coronation Road**



**Photo (6): Embankment slope on the outlet side looking north-west**

## Appendix B – General Arrangement Drawings

CV-0003-0007-0005  
(HWY 7/CORONATION RD - DURHAM REGION)

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

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

NEW CONSTRUCTION  
CV-0003-0007-0005

SHEET 22A

NOTES:

- THE CONTRACTOR SHALL VERIFY THE EXISTING CULVERT DIMENSIONS, ELEVATIONS, WATER DEPTH, PROPOSED WORK AND DETAILS AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
- THE CONTRACTOR TO VERIFY ALL UTILITY LOCATIONS PRIOR TO EXCAVATION AND PROVIDE ADEQUATE PROTECTION OF ALL UTILITIES, SERVICES, STRUCTURES, ROADWAYS, ETC. DURING CONSTRUCTION OPERATIONS.

LEGEND

- 
- RIP-RAP/WATERBODY AGGREGATE

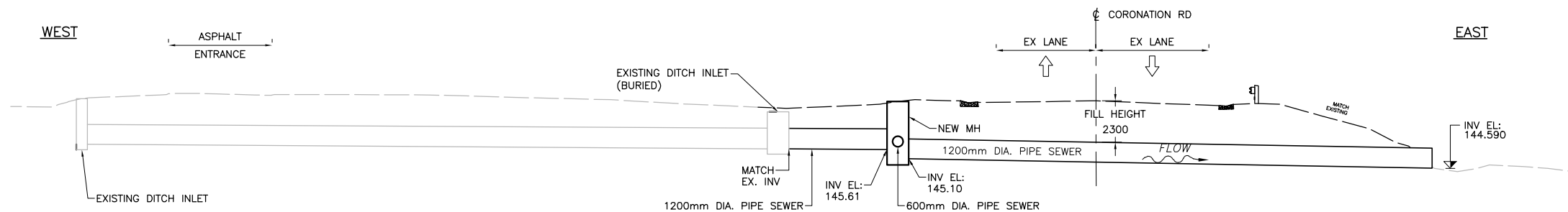
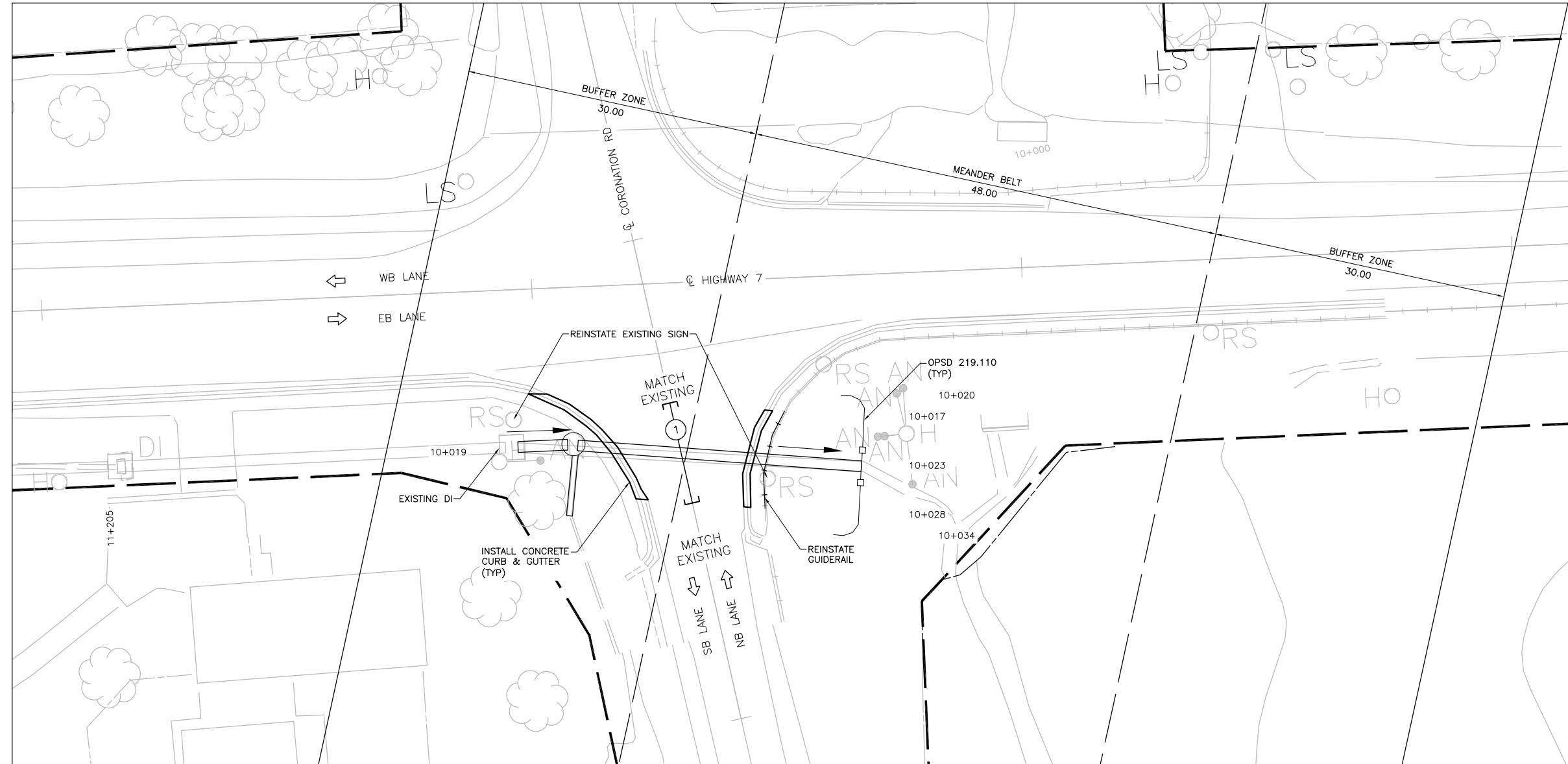
1	SOLID YELLOW,10cm
2	SOLID DOUBLE YELLOW,10cm
3	363 BROKEN YELLOW,10cm
4	SOLID YELLOW,20cm
5	SOLID WHITE,10cm
6	333 BROKEN WHITE,10cm
7	363 BROKEN WHITE,10cm
8	393 BROKEN WHITE,10cm
9	SOLID WHITE,20cm
10	111 BROKEN WHITE,20cm
11	333 BROKEN WHITE,20cm
12	333 BROKEN WHITE ,30cm
13	SOLID WHITE,30cm
14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

NOTES:

- 333, 363, 393, DENOTES PAVEMENT MARKING SPACING (ie., 3 m line,3 m gap, 3 m line)
- Use ① to Denote PAVEMENT MARKING
- Use 1 to Denote PAVEMENT MARKING,TEMPORARY
- Use Δ to Denote PAVEMENT MARKING, TEMPORARY- REMOVABLE
- Use ② to Denote PAVEMENT MARKING, DURABLE
- FROST TAPERS are based on OPSD 803.030, 803.031



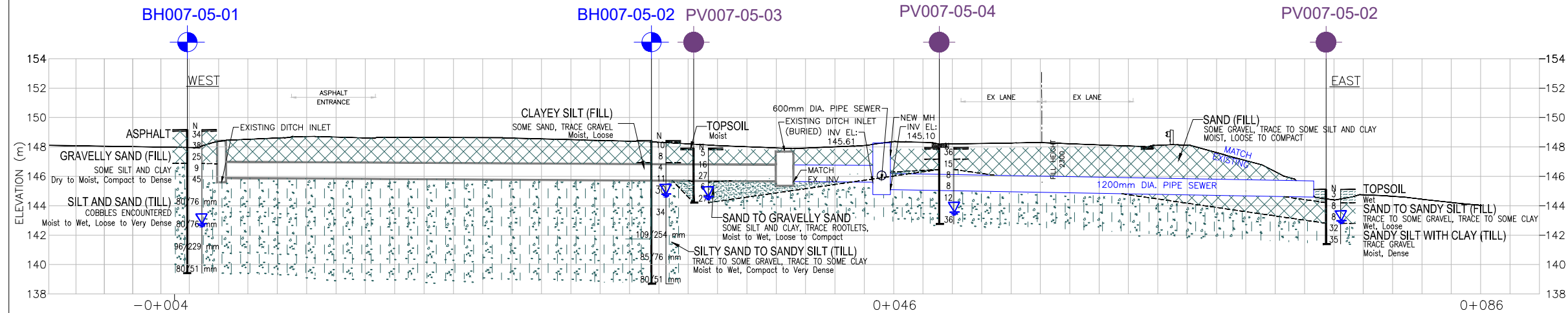
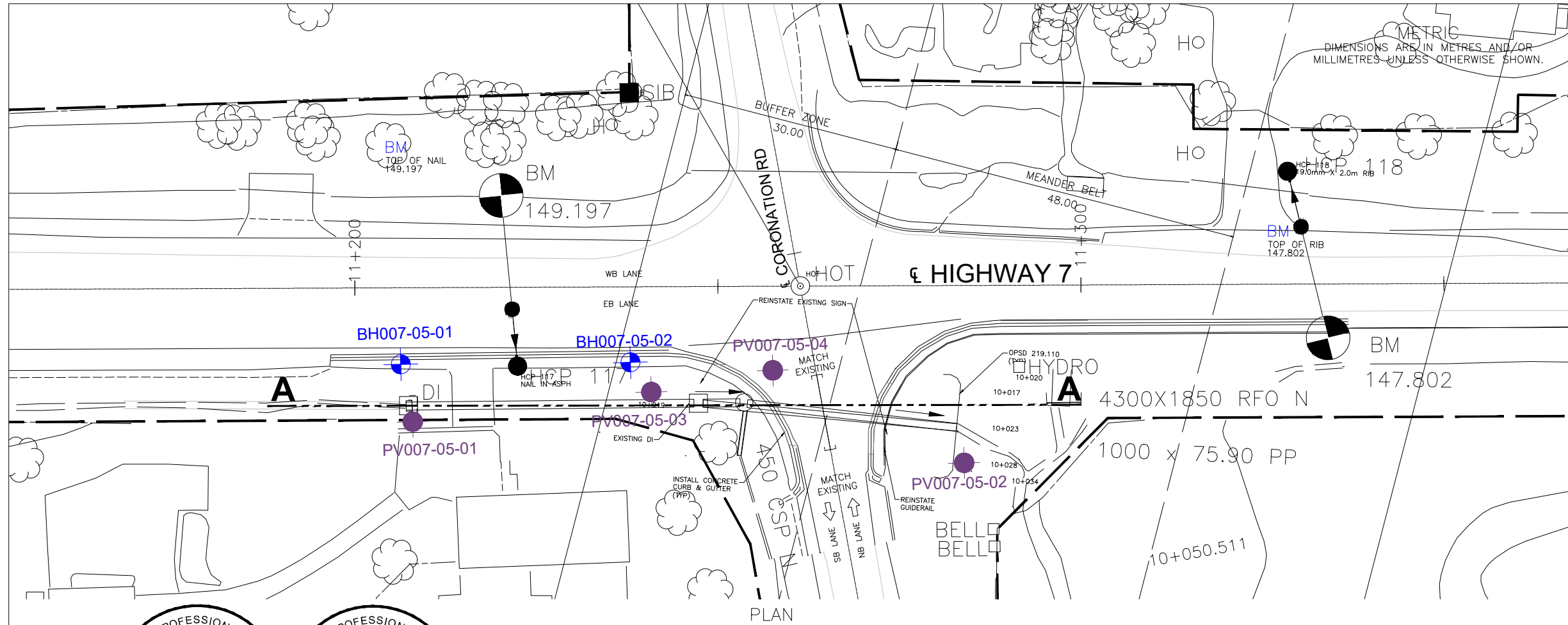
SCALE  
5m 0 10m





## Appendix C – Borehole Location Plan and Stratigraphic Strata

FILE NAME: I:\2003-Brampton\Proposals\Projects\International\WTO Projects\WTO 2020-E-0028 25 culverts\working drawings\CAD drafting\CV-0003-0007-0005\2220768CN\_N01\_borehole location plan & soil strata.dwg  
MODIFIED: 2023-07-04 16:12



SECTION A-A ALONG & CV-0003-0007-0005 CULVERT

ASSIG No. 2020-E-0028

GWP No. 2111-19-00

HIGHWAY 7 CULVERT REPLACEMENT, DURHAM, ON  
CV-0003-0007-0005  
Latitude: 43.943472° Longitude: -79.002288°

BOREHOLE LOCATION PLAN & SOIL STRATA



EXP SERVICES INC.



KEY PLAN  
N.T.S.

LEGEND

- Borehole Location
- Pavement Borehole
- Water Level Upon Completion of Drilling  
(W. L. NOT STABILIZED)
- 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
BH007-05-01	149.2	4867182	344723
BH007-05-02	148.5	4867192	344753
PV007-05-01	147.9	4867175	344727
PV007-05-02	145.1	4867193	344801
PV007-05-03	147.9	4867189	344757
PV007-05-04	148.0	4867197	344772

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.

SUBMISSION FOR MTO REVIEW			
NO	DATE	BY	DESCRIPTION
PROJECT No.	ADM-22007871-A0	GEOCREs No.	30M15-342
SUBM'D SH	CHKD. NT	DATE	JUNE 30, 2023 SITE CV-0003-0007-0005
DRAWN SH	CHKD. TK	APPRD SG	DWG 01

## 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.

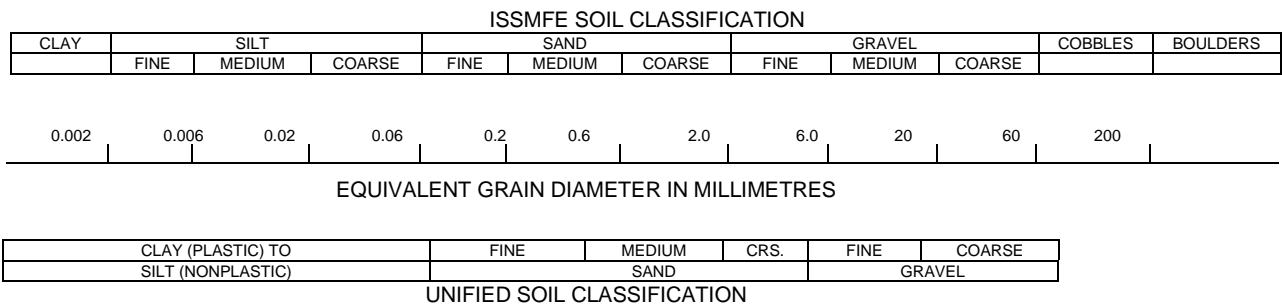
*Seam:* a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

*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.



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:

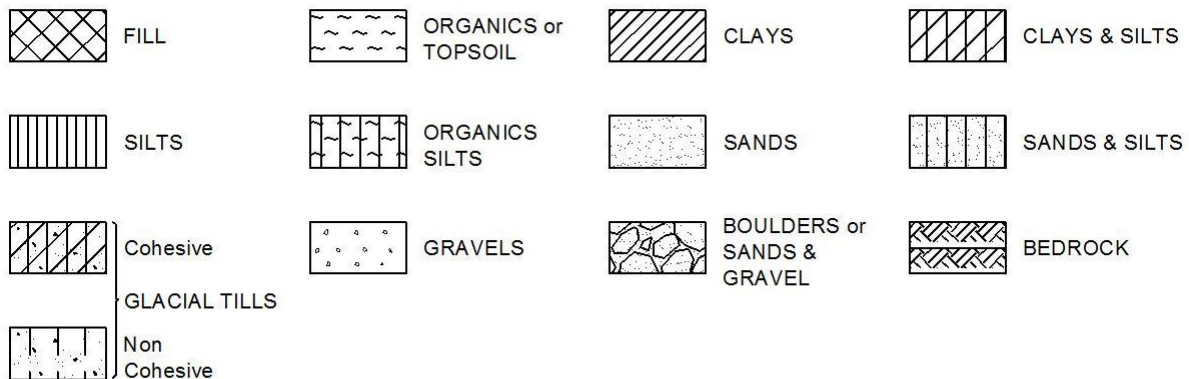
Table c: Consistency of Cohesive Soil

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



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

## 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
$\sigma$	kPa	Total normal stress
$\sigma'$	kPa	Effective normal stress
$\tau$	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
$\varepsilon$	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
$\mu$	1	Coefficient of friction

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	Coefficient of volume change
$c_c$	1	Compression index
$c_s$	1	Swelling index
$c_r$	1	Recompression index
$c_v$	m <sup>2</sup> /s	Coefficient of consolidation
H	m	Drainage path
$T_v$	1	Time factor
U	%	Degree of consolidation
$\sigma'_{v0}$	kPa	Effective overburden pressure
$\sigma'_p$	kPa	Preconsolidation pressure
$\tau_f$	kPa	Shear strength
$c'$	kPa	Effective cohesion intercept
$\phi'$	—°	Effective angle of internal friction
$c_u$	kPa	Apparent cohesion intercept
$\phi_u$	—°	Apparent angle of internal friction
$\tau_R$	kPa	Residual shear strength
$\tau_r$	kPa	Remoulded shear strength
$S_t$	1	Sensitivity = $c_u/\tau_r$

### PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	Density of solid particles
$\gamma_s$	kN/m <sup>3</sup>	Unit weight of solid particles
$\rho_w$	kg/m <sup>3</sup>	Density of water
$\gamma_w$	kN/m <sup>3</sup>	Unit weight of water
$\rho$	kg/m <sup>3</sup>	Density of soil
$\gamma$	kN/m <sup>3</sup>	Unit weight of soil
$\rho_d$	kg/m <sup>3</sup>	Density of dry soil
$\gamma_d$	kN/m <sup>3</sup>	Unit weight of dry soil
$\rho_{sat}$	kg/m <sup>3</sup>	Density of saturated soil
$\gamma_{sat}$	kN/m <sup>3</sup>	Unit weight of saturated soil
$\rho'$	kg/m <sup>3</sup>	Density of submerged soil
$\gamma'$	kN/m <sup>3</sup>	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 <sup>3</sup> /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m <sup>3</sup>	Seepage force



Brampton, Ontario

## RECORD OF BOREHOLE No BH007-05-01

1 OF 1

METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Durham, ON, MTM ON-10 344723E, 4867182N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY SF  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943536 LONGITUDE -79.002667 CHECKED BY NT/AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
149.2	<b>Asphalt (100 mm)</b> <b>GRAVELLY SAND (FILL)</b> - some silt and clay, grey to blackish grey, dry to moist, compact to dense		SS1	SS	34		149							27 62 (11)
140.9			SS2	SS	38		148							
			SS3	SS	25		147							
146.9	<b>SILT AND SAND (TILL)</b> - trace to some gravel, trace to some clay, greyish brown to brownish grey, moist to wet, loose to very dense  - cobbles encountered at 5.03 m		SS4	SS	9		146							6 41 37 16
2.3			SS5	SS	45		145							
			SS6	SS	80/ 76 mm		144							
			SS7	SS	80/ 76 mm		143							
			SS8	SS	96/ 229 mm		142							
			SS9	SS	80/ 51 mm		141							
							140							
139.4	<b>END OF BOREHOLE</b>  NOTE: 1) Borehole open upon completion to 6.71 m. 2) Groundwater level measured at 6.40 m in open borehole upon completion of drilling.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0003-0007-0005-BH.GPJ ONTARIO MTO.GDT 6/26/23



Brampton, Ontario

## RECORD OF BOREHOLE No BH007-05-02

1 OF 1

METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Durham, ON, MTM ON-10 344753E, 4867192N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY SF  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943627 LONGITUDE -79.002289 CHECKED BY NT/AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										
148.5							20	40	60	80	100	20	40	60				
148.4	Asphalt - (76 mm)		SS1	SS	10							○						
0.1	GRAVELLY SILTY SAND (FILL) - trace gravel, blackish brown to brown, moist, loose to compact																	
			SS2	SS	8													
146.9																		
1.5	CLAYEY SILT (FILL) - some sand, trace gravel, greyish brown, moist, loose		SS3	SS	4							○						
146.2																		
2.3	SILTY SAND TO SANDY SILT (TILL) - trace to some gravel, trace to some clay, brown to grey, moist to wet, compact to very dense		SS4	SS	11							○						
			SS5	SS	30							○						
			SS6	SS	34							○						
			SS7	SS	109/ 254 mm							○						
			SS8	SS	85/ 76 mm													
			SS9	SS	80/ 51 mm													
138.7																		
9.8	END OF BOREHOLE																	
	NOTE: 1) Borehole open upon completion to 6.71 m. 2) Groundwater level measured at 3.66 m in open borehole upon completion of drilling.																	

ONTARIO MTO CV-0003-0007-0005-BH.GPJ ONTARIO MTO.GDT 6/26/23

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Brampton, Ontario

RECORD OF BOREHOLE No PV007-05-01 1 OF 1 METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Whitby, ON, MTM ON-10 344727E, 4867175N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY NT  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943472 LONGITUDE -79.002288 CHECKED BY AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER				w <sub>p</sub> w      w <sub>L</sub>								
147.9								20	40	60	80	100		20	40	60	GR	SA	SI	CL
147.8	TOPSOIL (152 mm) - brown, moist																			
0.1	SAND (FILL) - some gravel, trace to some silt and clay, brown to brownish grey, moist to wet, very loose to loose		SS1	SS	8									○						
			SS2	SS	4															
			SS3	SS	2									○						
145.8	END OF BOREHOLE																			
2.1	NOTE: 1) No groundwater was encountered in open borehole upon completion of drilling.																			

ONTARIO MTO CV-0003-0007-0005-PVS.GPJ ONTARIO MTO.GDT 6/23/23

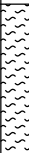



Brampton, Ontario

## RECORD OF BOREHOLE No PV007-05-02

1 OF 1

METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Whitby, ON, MTM ON-10 344801E, 4867193N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY NT  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943631 LONGITUDE -79.001696 CHECKED BY AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W <sub>P</sub> W                      W <sub>L</sub>				GR	SA	SI	CL
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIALX P. PENETROMETER				WATER CONTENT (%)							
145.1 0.0	TOPSOIL (914 mm) - blackish brown, wet		SS1	SS	3		145												
144.2 0.9	SAND TO SANDY SILT (FILL) - trace to some gravel, trace to some clay, blackish brown to brown, wet, loose		SS2	SS	8		144												
			SS3	SS	8		143												
142.8 2.3	SANDY SILT WITH CLAY (TILL) - trace gravel, grey, moist, dense		SS4	SS	32		142												
			SS5	SS	35														
141.4 3.7	END OF BOREHOLE  NOTE: 1) Borehole open to depth about 2.1 m below ground surface upon withdrawal of drilling auger. 2) Groundwater level measured at 2.1 m in open borehole upon completion of drilling.																		

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0003-0007-0005-PVS.GPJ ONTARIO MTO.GDT 6/23/23

Brampton, Ontario

## RECORD OF BOREHOLE No PV007-05-03

1 OF 1

METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Whitby, ON, MTM ON-10 344757E, 4867189N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY NT  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943593 LONGITUDE -79.002249 CHECKED BY AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIALX P. PENETROMETER								
147.9							20	40	60	80	100					
147.8	TOPSOIL (152 mm) - blackish brown, moist															
0.1	SAND (FILL) - some gravel, trace to some silt and clay, blackish brown to brown, moist, loose to compact		SS1	SS	5											
			SS2	SS	16											
			SS3	SS	27											
145.6	SAND TO GRAVELLY SAND - some silt and clay, trace rootlets, brown, moist to wet, loose to compact		SS4	SS	6											
2.3																
	-becoming gravelly sand															
			SS5	SS	27											
144.2	END OF BOREHOLE															
3.7	NOTE: 1) Borehole open to depth about 3.6 m below ground surface upon withdrawal of drilling auger. 2) Groundwater level measured at 3.3 m in open borehole upon completion of drilling.															

+ <sup>3</sup>, × <sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO CV-0003-0007-0005-PVS.GPJ ONTARIO MTO.GDT 6/23/23

Brampton, Ontario

## RECORD OF BOREHOLE No PV007-05-04

1 OF 1

METRIC

W.P. 2011-19-00 LOCATION CV-0003-0007-0005, Whitby, ON, MTM ON-10 344772E, 4867197N ORIGINATED BY NT  
 DIST Durham HWY 7 BOREHOLE TYPE Rubber Track Drill (Marl M5T/SSA) COMPILED BY NT  
 DATUM Geodetic DATE 2023.05.24 - 2023.05.24 LATITUDE 43.943664 LONGITUDE -79.002053 CHECKED BY AA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER												
148.0								20	40	60	80	100								
149.9	ASPHALT (127 mm)																			
0.1	SAND, WITH GRAVEL (FILL) - some silt and clay, brown, moist, dense		SS1	SS	36														21 69 (11)	
147.2																				
0.8	SAND TO SANDY SILT (FILL) - some gravel, some silt and clay, brown, moist, compact		SS2	SS	15		147												18 65 (17)	
146.5																				
1.5	SANDY SILT (TILL) - some clay, trace gravel, trace rootlets, blackish grey to grey, moist to wet, loose to dense		SS3	SS	8		146												2 37 47 14	
			SS4	SS	8		145													
			SS5	SS	12		144													
							144													
	-becoming sandy silt with clay																			
			SS6	SS	36		143												2 32 40 26 Corrosivity Sample	
142.8																				
5.2	END OF BOREHOLE																			
	NOTE: 1) Borehole open to depth about 4.6 m below ground surface upon withdrawal of drilling auger. 2) Groundwater level measured at 4.4 m in open borehole upon completion of drilling.																			

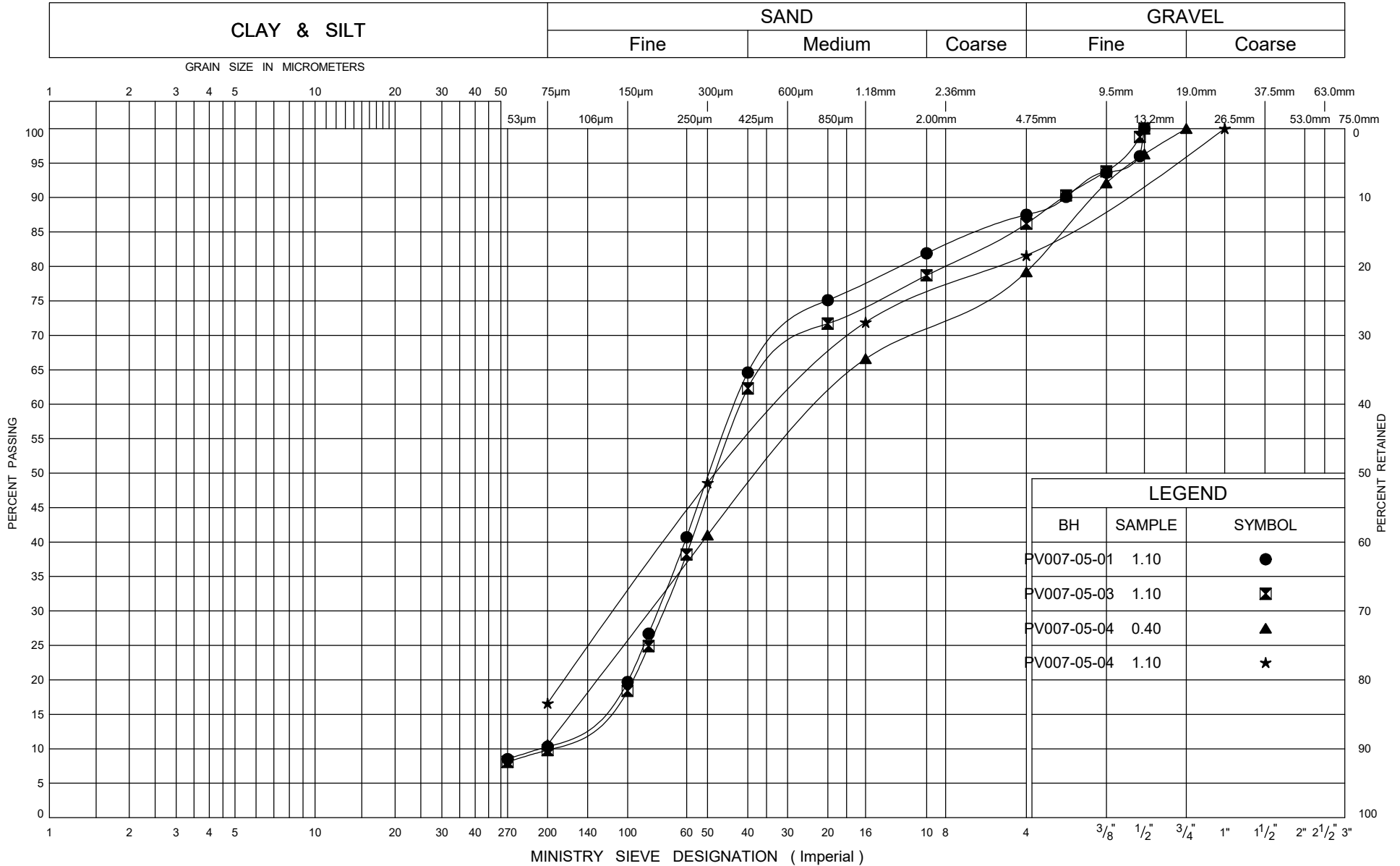
+ 3, X 3: Numbers refer to Sensitivity

O 3% STRAIN AT FAILURE

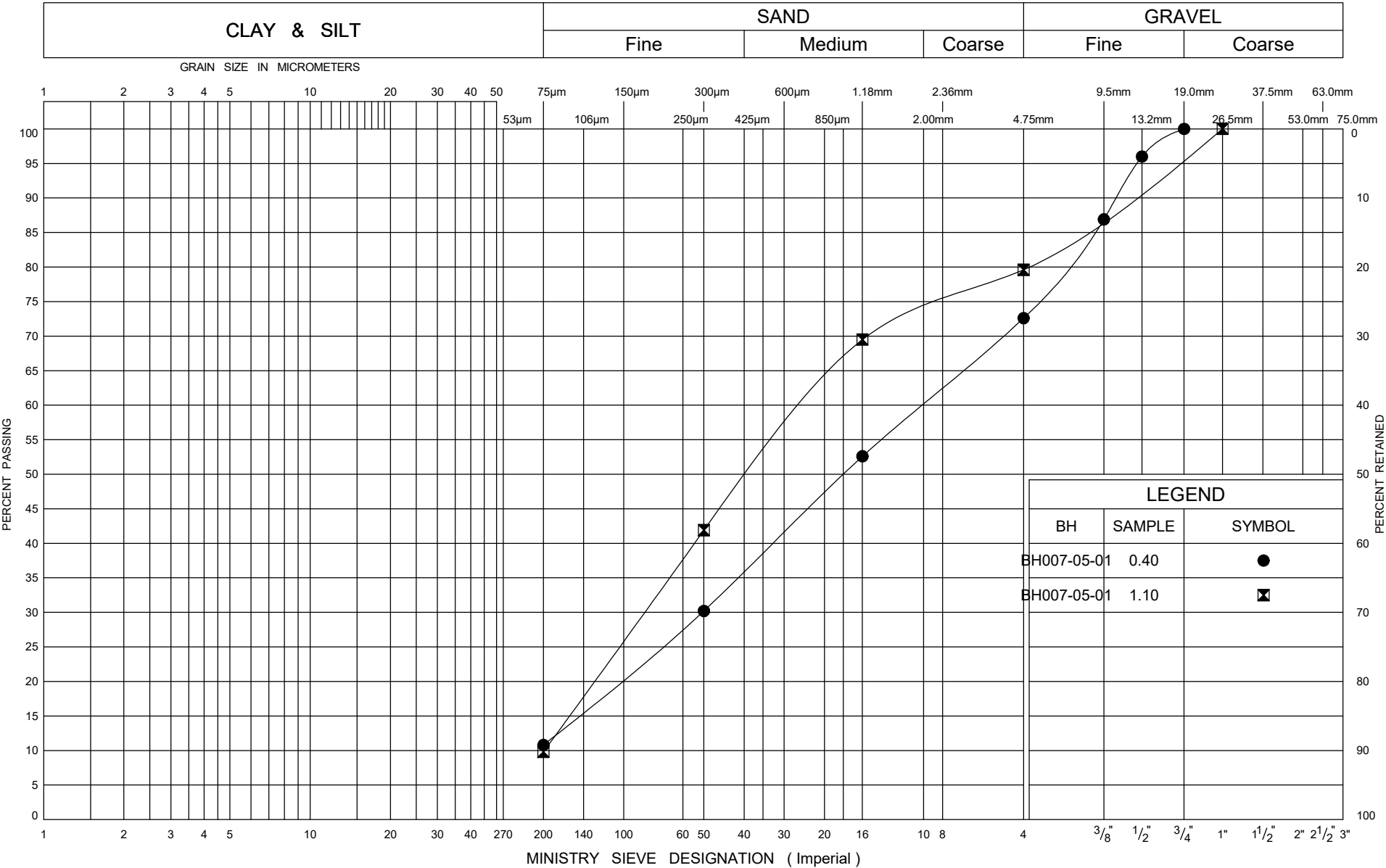
ONTARIO MTO CV-0003-0007-0005-PVS.GPJ ONTARIO MTO.GDT 6/23/23

## Appendix E – Laboratory Data

# UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

Cohesionless Fill

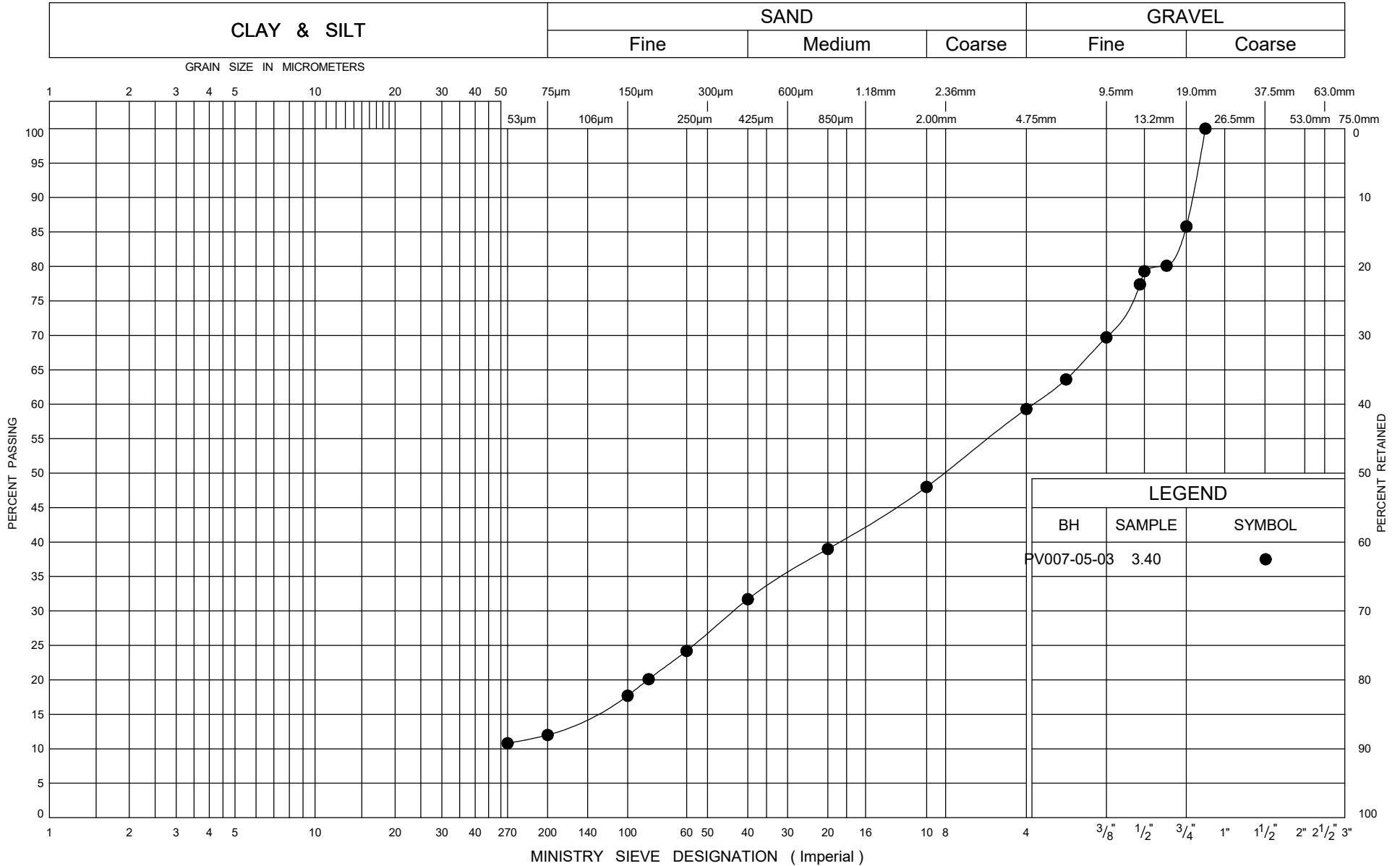
FIG No 2

W P 2011-19-00

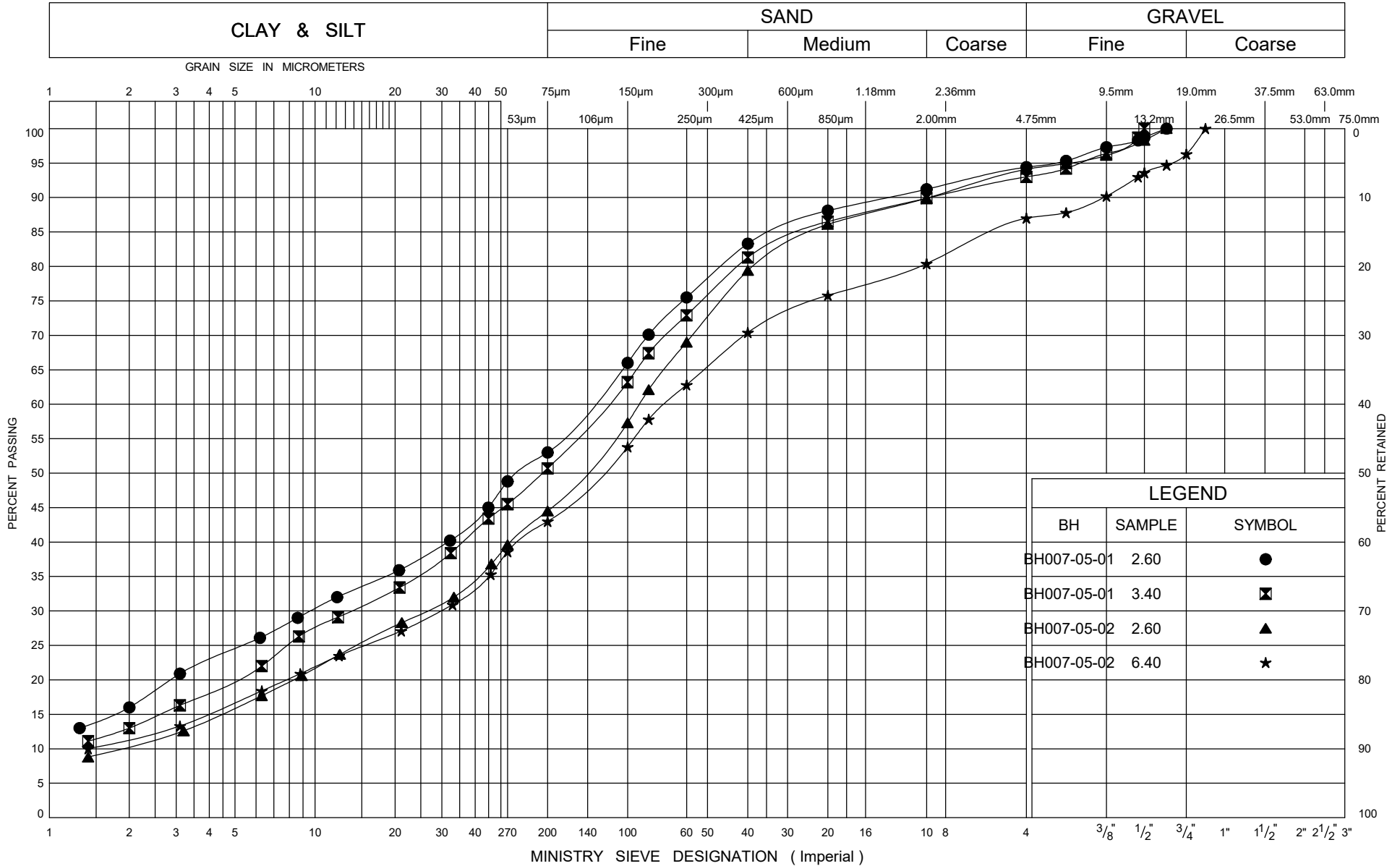
Culvert ID CV-0003-0007-0005



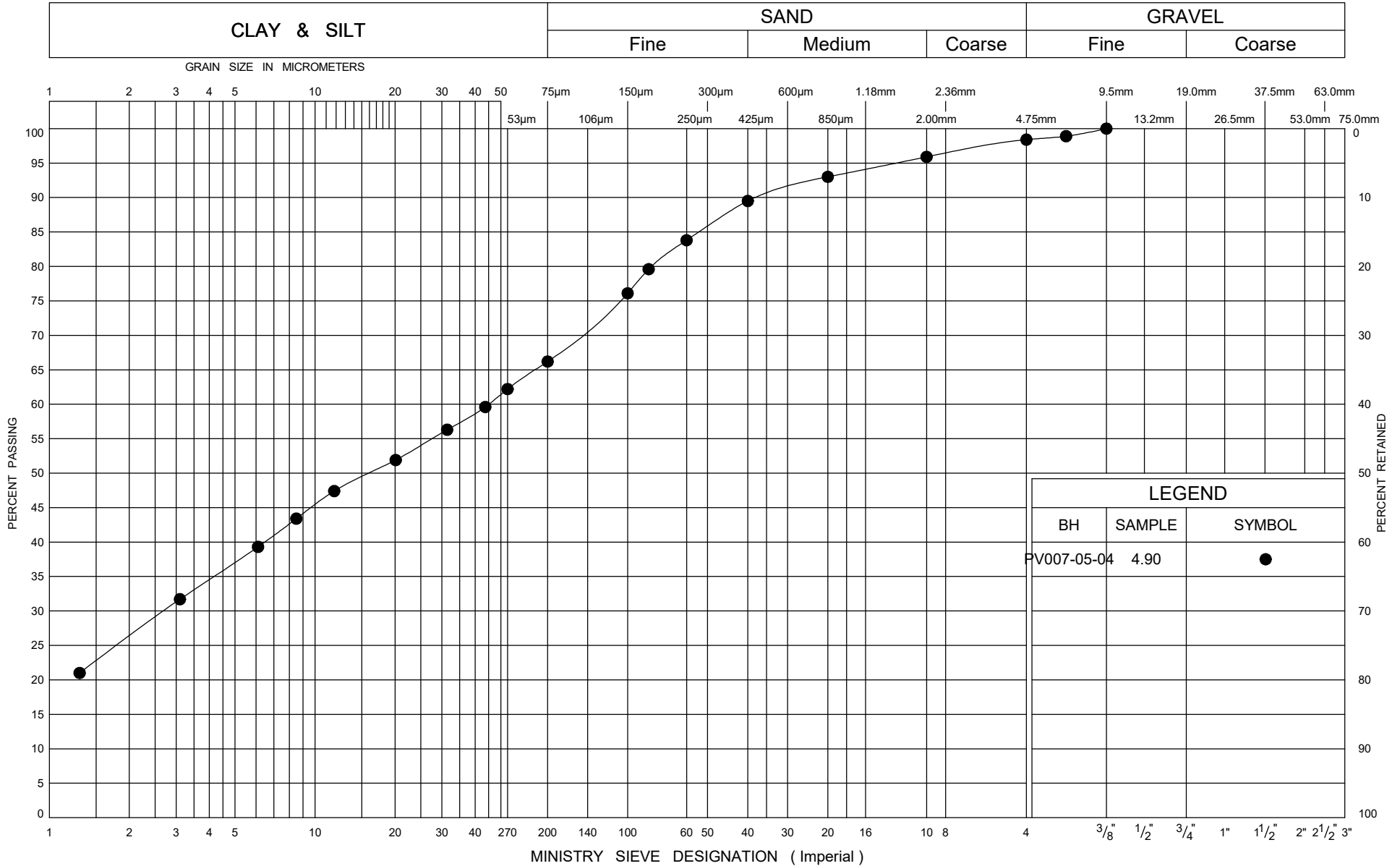
# UNIFIED SOIL CLASSIFICATION SYSTEM

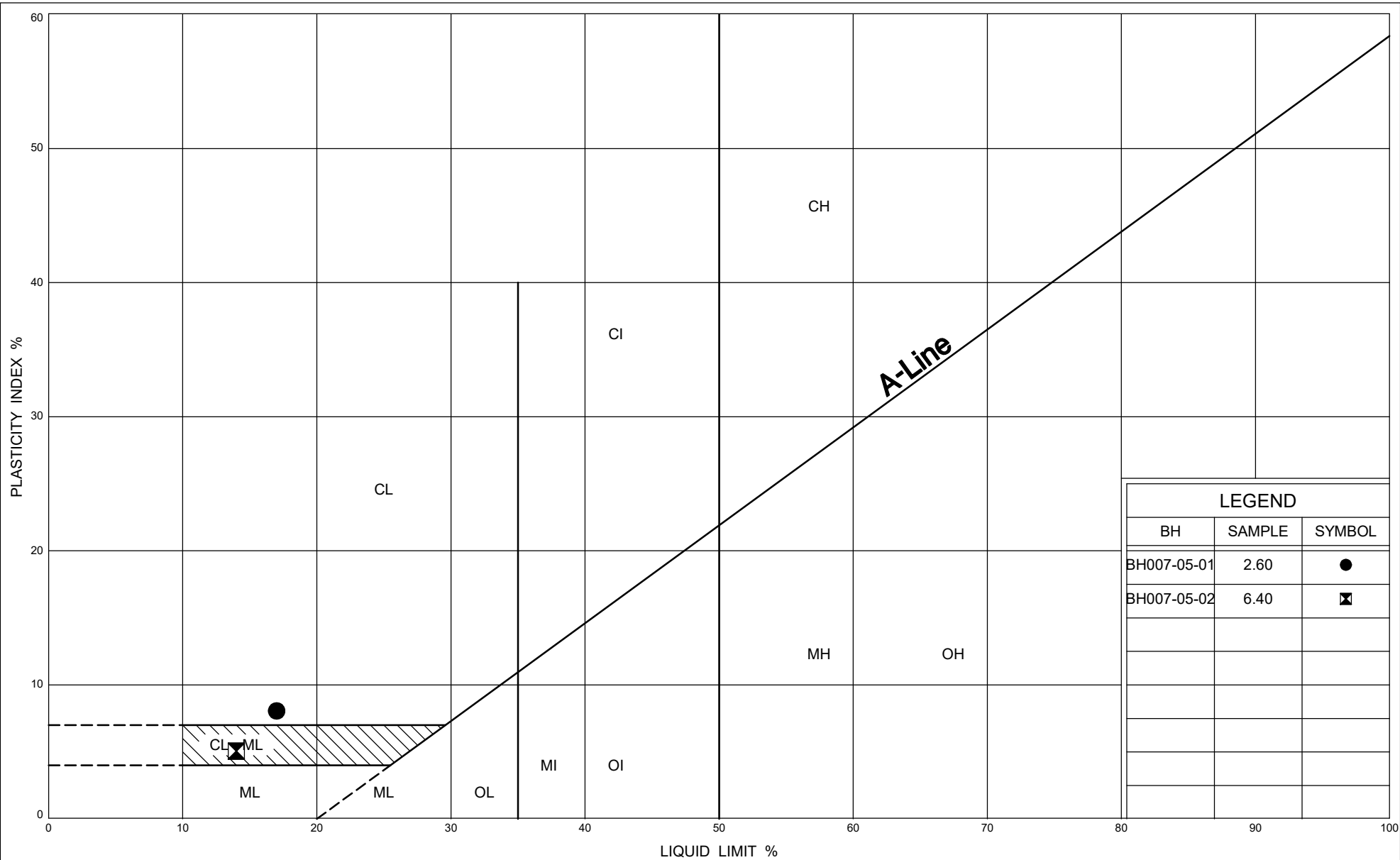


# UNIFIED SOIL CLASSIFICATION SYSTEM



# UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of  
Transportation

## PLASTICITY CHART

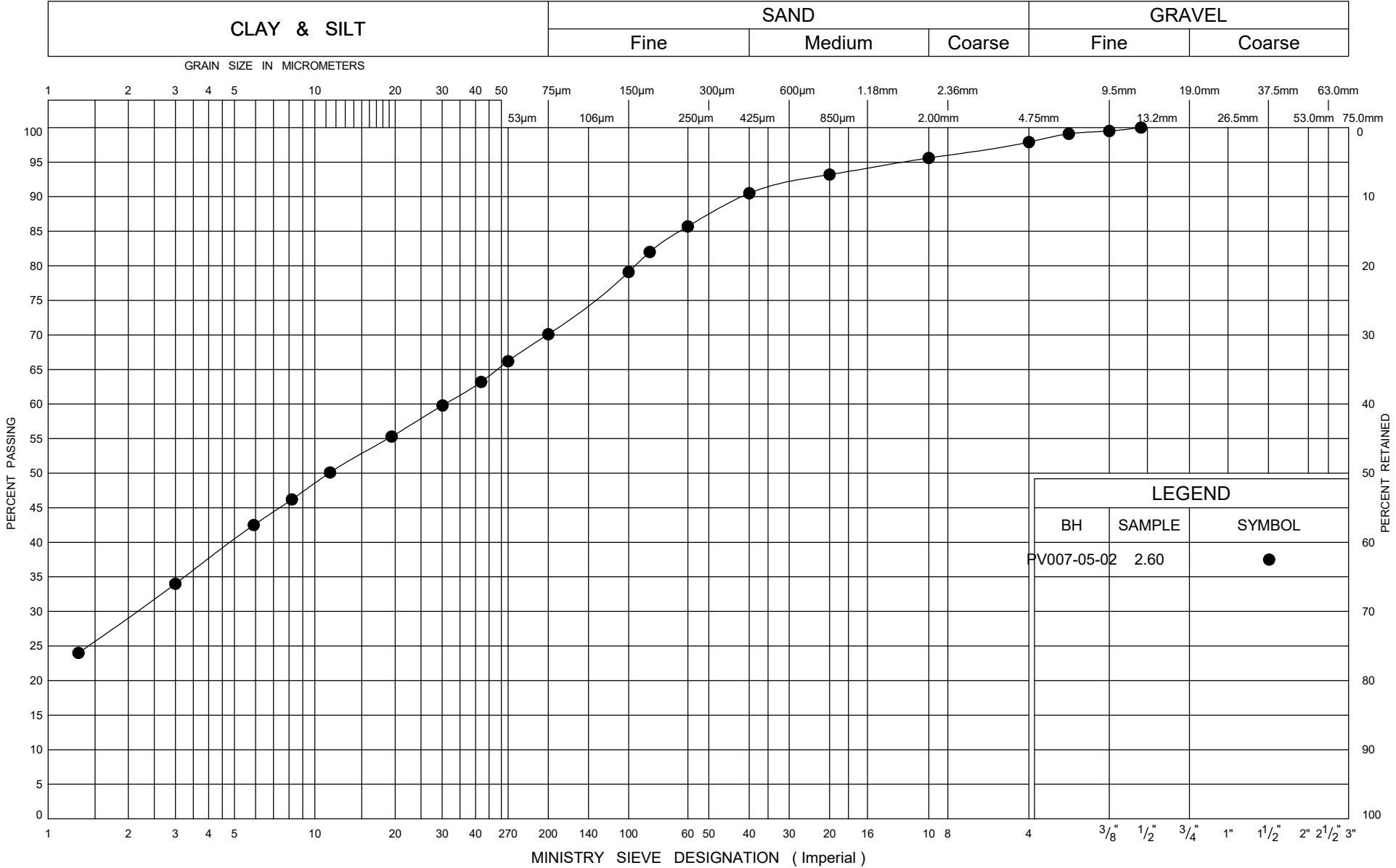
Silty Sand to Sandy Silt Till

FIG No 6

W P 2011-19-00

Culvert ID CV-0003-0007-0005

UNIFIED SOIL CLASSIFICATION SYSTEM





### SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		VXR545			VXR545		
Sampling Date		2023/05/24 14:17			2023/05/24 14:17		
COC Number		903374-14-01			903374-14-01		
	<b>UNITS</b>	<b>PV07-05-04 SS6</b>	<b>RDL</b>	<b>QC Batch</b>	<b>PV07-05-04 SS6 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

<b>Calculated Parameters</b>							
Resistivity	ohm-cm	5000		8688236			
<b>CONVENTIONALS</b>							
Redox Potential	mV	360	N/A	8697565			
<b>Inorganics</b>							
Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	8694934			
Conductivity	umho/cm	200	2	8697823	204	2	8697823
Available (CaCl2) pH	pH	7.83		8697296			
Soluble (20:1) Sulphate (SO4)	ug/g	20	20	8694938			
Sulphide	mg/kg	2.6 (1)	0.5	8699182	2.5	0.5	8699182
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Matrix spike exceeds acceptance limits due to matrix interference. Sample contained greater than 10% headspace at time of extraction.							

## Appendix F – NSSPs

## **NSSP FOR OBSTRUCTIONS**

### **Scope of Work**

The Contractor shall be alerted to the potential presence of cobbles and boulders in the fill and/or native soils encountered in few boreholes advanced at the site. Therefore, appropriate equipment and procedures will be required for open cut excavation and installation of roadway protection systems and temporary dewatering/unwatering systems.

### **Basis of Payment**

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment, and materials for completion of the work.



**Table A**

<b>IDF Curve Location</b>	Latitude: 43.943453		Longitude: -79.001726			
<b>Temporary Flow Passage Systems</b>						
Site Name/ Station Reference	Minimum Return Period (Years)	Return Period Flow Estimates (m3/s)				Design Engineer Requirements (Note 1)
		2 Year	5 Year	10 Year	25 Year	
CV-0003-0007-0005 culvert, Coronation Rd at Hwy 7, Whitby	2	0.19	0.25	0.29	0.34	No
<b>Dewatering Systems</b>						
Site Name/ Station Reference	Preconstruction Survey Distance (Note 2) (m)					Design Engineer Requirements (Note 1)
CV-0003-0007-0005 culvert, Coronation Rd at Hwy 7, Whitby	N/A					No
<p>Note:</p> <p>1. "Yes means he design Engineer and design-checking Engineer shall have a minimum of 5 years of experience in designing systems of similar nature and scope to the required work. "No" means a minimum experience level is not required for the design Engineer and design-checking Engineer.</p> <p>2. "N/A" indicates a preconstruction survey is not required.</p>						