



Foundation Investigation and Design 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

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Geotechnical Foundation and Investigation Report

Project Name:

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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 ± 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				
BH007-05-01	146.9	139.4	2.3	7.5	Silt and Sand	9 – 45; 80/51mm
BH007-05-02	146.2	138.7	2.3	7.5	Silty Sand to Sandy Silt	11 – 34; 80/51mm
PV007-05-04	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) ¹	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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7.0 ENGINEERING DISCUSSION & RECOMMENDATIONS

7.1 General

This section of the report provides geotechnical design recommendations on roadway protection systems for partial replacement of the existing non-structural culvert (CV-0003-0007-0005) located at Highway 7 at Coronation Road, about 400 m east of Highway 412 in Whitby, Ontario in the Ministry of Transportation (MTO) Central Region. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current investigation at the site performed by EXP between May 24, 2023. The compiled factual data is presented in **Part I-Foundation Investigation Report** of this report. The interpretation and recommendations provided are intended solely to permit designers to assess temporary protection systems alternatives the partial replacement of the culvert. Comments on construction are only provided to highlight issues that could affect the design. Contractors bidding on the works should make their own assessments of the factual data and how it might affect construction means and methods, scheduling and the like.

It is understood that the full road closure open cut construction approach will be used for partial replacement the existing culvert. It is anticipated that for the replacement of the culvert, excavations up to about 3.5 m depth below the existing grade will be required along the culvert alignment. A roadway protection system may require at some sections of the alignment to facilitate the construction of the manhole and culvert replacement. However, at the time of preparing this report, the potential location of the temporary protection systems was not finalized by the designer. The report has been prepared for report completeness and to provide geotechnical parameters to permit the design of a temporary protection system if any used. The design recommendation on the proposed partial replacement of the non-structural culvert and pavement reinstatement are provided in a Pavement Design Report for the CV-0003-00007-0005 culvert under a separate cover.

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 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. The new culvert is proposed to be at approximately Elev. 145.1 m and 144.6 m at the inlet (manhole) and outlet, respectively. No significant grade change nor widening are expected at the culvert location.

Based on subsoil conditions encountered at the site it is expected that excavation will be carried out through gravelly sand/silty sand fill, clayey silt fill, native sand to gravelly sand, and silty sand to sandy silt till. The excavation to the foundation level for HDPE pipe/ CSP and culverts has to be carried out to approximately Elev. 145 m to 144.5 m from the inlet to the outlet, respectively. The groundwater level at the site was encountered between Elev. 144.8 m and Elev. 143. m at the time of the investigation. However, groundwater levels would be expected to reflect levels in the adjacent open water. At the time of the field investigation (May 24, 2023), the approximate top of water elevation at the outlet was Elev. 144.6 m. Perched groundwater may be present within the granular fill layers at higher levels. It should be noted that fluctuations in the level of the groundwater may occur due to seasonal variations, (precipitation, snowmelt, rainfall), local soil permeability, construction remediation activities, and other related factors.

This part of the report addresses the geotechnical design of the foundation for the roadway protection system by providing geotechnical design parameters that may be required in accordance with the latest edition of the *Canadian Highway Bridge Design Code (CHBDC) (CAN/CSA-S6-19)*, the *Canadian Foundation Engineering Manual (CFEM) (2006)*, *Guideline for MTO Foundation Engineering Services, Version 02 (October 2020)* and generally accepted good practice. Pertinent construction issues from a geotechnical standpoint are examined in general accordance with the Terms of Reference provided to us in the MTO Request for Proposal dated February 2022. The assessment involved review of options temporary protection systems alternatives.

7.2 Temporary Roadway Protection

Temporary roadway protection is anticipated to be a part of the full road closure (Coronation Road) open cut construction approach that may be required to maintain on-site traffic at Highway 7 during the construction. As stated above, at the time of preparing this report, the potential location of the temporary protection systems was not finalized by the designer. Roadway protection systems (if any) shall be design and constructed in accordance with OPSS.PROV 539 and OPSS.PROV 903 as amended by SP109F57. The complete design, construction, monitoring and removal of the installed protection system should be the responsibility of the Contractor. The lateral movement of the temporary shoring system should meet Performance Level 2 as specified in OPSS.PROV 539 provided that the existing, if any, adjacent utilities, or structures can tolerate this magnitude of deformation or be re-routed away from the excavation influence zone.

Based on the geotechnical conditions at the site, a shoring system such as soldier H-pile with lagging, should be a practical option at this location. Subsurface conditions at this site are suitable for this option. An analysis of this system based on advantages and disadvantages, risks, and relative costs is provided in Table 2.1. It should be designed based on the earth pressure coefficients and soil parameters provided in Table 2.2.

Cobbles and/or boulders were noted to be contained within glacial till, therefore care has to be taken during the installation of piles. It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of the possible presence of cobbles and/or boulders within the overburden soils or native till deposits; an example of a NSSP is included in Appendix F.

Vibration caused by soldier pile installation or during backfill compaction may have potential damage to the nearby structures. In view of the close proximity of the existing residential building, a ground vibration monitoring program should be prepared to monitor and manage risks of construction impacts due to soldier pile installation and compaction. The monitoring program has been discussed further in Section 7.6 of this report.

A soldier pile and lagging wall can be used as a vertical temporary shoring system. The piles are installed, and lagging is inserted between installed piles during excavation. Space between the excavation and lagging must be suitably backfilled and drained. Lagging wall material can be selected as wood (timber), steel or concrete.

For the design of the timber lagging, 100 mm thick hardwood lagging can be used for pile spacings up to 2.25 m (soft to medium clays) and 3.0 m (all other soils) center-to-center in accordance with Table 26.8 of the CFEM (2006). Construction of the lagging should follow industry standard practices to ensure full contact of the lagging with the soil and piles. A concern regarding lagging is the potential for poor performance due to frost action during freeze-thaw events. Soldier piles should extend a minimum depth of 3.0 m below the planned excavation depth. The actual depth of embedment should be determined by balancing moments of the pile tip. Excavation can proceed following the installation of the soldier piles. The unshored height of the excavation should not exceed 1.2 m at any given time.

No excavation height should remain unshored for more than 24 hours. Any loose zones from behind the shoring should be prevented during installation of the protection system. If required, backfill Granular A should be placed and compacted behind the shoring wall.

For the relatively shallow depth of excavation anticipated, cantilevered systems may be adequate. However, depending on the actual excavation depths, embedment depth (i.e., an embedded depth of soldier piles can be approximately 2.0 to 2.5 times of its exposed height) and shoring system used, additional bracing, anchorage or tiebacks may be required. This must be confirmed by the shoring designer. Conventional practice is to incorporate either buried deadman anchors, rakers, or grouted soil anchors. Deadman anchors can be designed based on the earth pressure coefficients and soil parameters provided below in Table 2.2. For this project, either continuous or individual concrete block anchors would likely be appropriate. The anchor resistance is provided by a combination of the dead weight and passive resistance. For the full passive resistance to be realized with no load transfer to the wall, the anchor needs to be fully beyond the active wedge acting on the wall. Pressure grouted soil anchors can be designed in a preliminary fashion in accordance with Section 26 of the CFEM (2006). Based on the general conditions at this site being existing fills, compact to dense silty sand to compact to very dense cohesionless till, the estimated factored (0.4) ULS resistance of grouted anchors would be approximately 30 kN/m in existing fill, 100 kN/m in native very dense till. Detailed design should be completed following the conception of the wall and when the associated loads have been established. Normally, such anchors are supplied and installed/tested by specialist vendors/contractors. The selection and design of protection system will be the responsibility of the contractor.

After construction of the new culvert, the protection system could be removed. In that case the details of the procedures associated with the removal of the protection system indicating method, sequence of work, and removal limits are required from the Contractor as per OPSS.PROV 539. However, if the protection system is decided to be left in place the top should be removed to at least 1.2 m below the finished grade or ground level or at least 0.6 m below the streambed. All disturbed areas should be restored to an equivalent or better condition than what existed prior to the commencement of construction.

Table 2.1: Evaluation of Temporary Roadway Protection System Options

Support System	Advantages	Disadvantages	Relative Cost	Risk/Consequences	Rank
Soldier H-Pile and Lagging	<ul style="list-style-type: none"> Appropriate for shallow and deep installation 	<ul style="list-style-type: none"> May require bracing/ tieback anchors depending on depth of excavation into overburden 	<ul style="list-style-type: none"> More expensive 	<ul style="list-style-type: none"> Piles could be long Potential for loss of soil through laggings 	1

7.2.1 Lateral Earth Pressure

The temporary shoring that may be required for excavation should be designed to resist lateral earth pressure.

The expression for calculating lateral earth pressure is given by:

$$P = K(\gamma h + q) \text{ for non-braced cut, or } K(0.65\gamma H + q) \text{ for braced support}$$

where

$$P = \text{earth pressure intensity at depth } h, \text{ kPa}$$

K = earth pressure coefficient

γ = unit weight of retained soil, kN/m³

q = surcharge near wall, kPa

h = depth to point of interest, m

H = total depth of excavation, m

The above expression does not take into account hydrostatic pressure, which must be included for the groundwater levels measured on the site. For the design purposes, the unfactored static earth pressure parameters given in Table 2.2 can be used (assuming wall friction is neglected, the back wall is vertical, and the ground surface is horizontal both on the retained side as well as in front of the toe):

Table 2.2: Material types and unfactored earth pressure properties under static conditions

Material	Friction Angle ϕ' (°)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)	Coefficient of Earth Pressure at Rest (K_o)	Unit Weight g (kN/m ³)
Compacted Granular A and Granular B Type II	35	0.27	3.69	0.43	22
Compacted Granular B Type I	32	0.31	3.25	0.47	21
Existing cohesionless fill (compact to dense)	30	0.33	3.00	0.50	20
Clayey silt fill (firm) ¹	28	0.36	2.77	0.53	18
Silty Sand to Sandy silt till (compact to very dense)	33	0.29	3.39	0.46	21

Notes:

1. Assumes long term conditions. In short term conditions, $K_a = K_p = 1$

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation. Table C6.6 of the CHBDC S6-14 indicate the relative movement between a wall and the adjacent soil that produce the active and passive earth pressure conditions in granular soils. As per Table C6.6, for active earth pressure, a rotation of 0.002 about the base of vertical walls (horizontal displacement divided by wall height) or translation of 0.001 times wall height or combination of these is required. Full passive pressure requires considerably greater movement than active pressure. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

The effect of compaction surcharge should be taken into account in the calculations of active and at-rest earth pressures. The lateral pressure due to compaction should be taken as at least 12 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the depth where the active (or at rest) pressure is equal to 12 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to culvert walls to prevent

overstressing.

It is likely that bracing for the temporary support system (if any) will be required at a maximum interval of 5 m. For multiple support systems refer to Canadian Foundation Engineering Manual (CFEM) for apparent earth pressure distributions (CFEM, Section 26.10.3, Figure 26.8).

7.3 Construction Considerations

7.3.1 Excavation

All excavations at this site must be conducted in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction (O. Reg. 213/91). The gravelly sand to silty sand fill, as well as the native silty sand to sandy silt may be classified as a Type 3 soil above the groundwater table in conformance with the OHSA. These soils below the groundwater table may be classified as a Type 4 soil. It is expected that most of excavations will be above the groundwater levels except those at the invert level.

Temporary excavation side slopes for Type 3 soils should not exceed 1H:1V in accordance with OHSA, while temporary excavation side slopes for Type 4 soils should not exceed 3H:1V where applicable. There is a potential for sloughing to occur if the trench remains open for an extended period of time (i.e. > 24 hours) or during a rainfall event. In addition, some localized surficial sloughing may be experienced in areas of perched groundwater seepage (i.e., within the embankment fill).

Excavated soil should be placed well away from the edge of the excavation and their height should be controlled so they do not surcharge the sides of the excavation. Note that the excavated soils are subject to moisture content increase during wet weather conditions which may render these materials too wet for adequate compaction. Stockpiles should therefore be compacted at the surface or be covered with tarpaulins to help minimize moisture ingress.

7.3.2 Groundwater Control

The groundwater level at the site was encountered between Elev. 144.8 m and Elev. 143 m at the time of investigation. However, groundwater levels would be expected to reflect levels in the adjacent open water. At the time of the field investigation (May 24, 2023), the approximate top of water elevation at the outlet was Elev. 144.6 m. Construction for the replacement of the culvert is recommended during the low water level season.

The excavation to the foundation level for HDPE pipe/ CSP and culverts has to be carried out to approximately Elev. 145 m to 144.5 m from the inlet to outlet, respectively. The soils encountered at the site and within potential excavation depths consist of gravelly sand/silty sand fill, clayey silt fill, native sand to gravelly sand, and silty sand to sandy silt till. Grain size distribution curves are presented in Appendix E. The estimated range of hydraulic conductivity (k) of these materials is 10^{-2} - 10^{-7} m/s.

The soils encountered below the groundwater table and within potential excavation depths consist of sand to sandy silt fill to native materials. Some of these materials are susceptible to disturbance from groundwater and mobilized equipment. The groundwater level needs to be controlled to 0.5 m below the excavation level to avoid disturbance, and any surface or groundwater seepage should be removed from the excavation prior to the culvert bedding material placement of granular backfill in the dry. Granular B Type II or clear stone with non-woven geotextile wrapping, such as Terrafix 270R or approved similar, can be used in wet condition. In general, where the excavation

base is within 0.5 m of the prevailing groundwater level at the time of construction, it is anticipated that control of seepage can be accomplished by using properly filtered sumps.

Surficial water seepage into the excavations should be expected especially during the periods of heavy precipitation. Properly filtered sump pumps at the bottom of excavation may be required to provide groundwater control and the pumping should be located outside of the actual excavation zone for the construction works. Surface water runoff should be controlled and directed away from the excavations during the construction.

Dewatering requirements behind the cofferdams (if any) to keep the construction site dry will be impacted by water levels in the stream at the time of construction activities. 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. Dewatering shall be carried out in accordance with OPSS.PROV 517 and SP517F01. It is the responsibility of the Contractor to propose a suitable dewatering system based on the time of construction, water levels, and flow conditions for prior approval of the MTO. The method used should not undermine the adjacent existing footings, the existing highway embankment or adjacent side slopes. Alternatively, and in accordance with SP 5017F01, the dewatering systems may be completed by a design Engineer and design-checking Engineer with a minimum of 5 years' experience. For this application, this may be a suitable approach, but the owner should make the final decision. Given the conditions and the proposed excavation level, no significant dewatering is expected at this site. However, for completeness, the SP517F01 and Table A are attached in Appendix F

Water takings in excess of 50 m³/day are regulated by the Ministry of the Environment, Conservation and Parks (MECP). Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total less than 400 m³/day qualify for self-registration on the MECP's Environmental Activity and Sector Registry (EASR). Registry on the EASR replaces the need to obtain a PTTW for water taking less than 400 m³/day and a Section 53 approval for discharge of water to the environment. A "Water Taking Plan" and a "Discharge Plan" are required by the MECP if water is taken in accordance with an EASR. In all cases, discharge under the EASR must be in accordance with a Discharge Plan. A Category 3 PTTW would be required for water takings in excess of 400 m³/day. Water seepage into the excavations should be expected and will be heavier during periods of sustained precipitation. The rate and volume required for dewatering will be dependent on the construction methods and staging chosen by the Contractor. Based on the expected excavation depths, groundwater levels, hydraulic conductivity, and subsurface conditions, it is anticipated that a PTTW would not be required at this site.

Erosion and sediment control during culvert construction should be as per the MTO Drainage Manual, Volume 2. Silt fences and other sediment control measures should be included to protect the downstream environment from the construction activities.

7.4 Corrosion Potential and Cement Type

One (1) soil sample was selected for chemical analyses during this investigation. The testing was completed to determine the potential degradation of the concrete in the presence of soluble sulphates and the potential of corrosion of exposed steel used in foundations and buried infrastructure. The analyses results are summarized in Table 1.6 of this report.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil pH value measured at the site was 7.83 which is within the normal range of soil pH of 5.5 to 8.5 and therefore is not considered to be detrimental to culvert durability (AASHTO, 2000/MTO Gravity Pipe Design

Guidelines, April 2014). The chemical data indicates low ($6000 > R > 4500$ ohm-cm) resistivity of the tested soil which suggests low potential for corrosion of buried metallic elements as per Table 3.2 of the MTO Gravity Pipe Design Guideline. The measured chloride content was < 20 ppm ($\mu\text{g/g}$) which also indicates a very low potential for additional corrosion (Molinas and Mommandi, 2009).

These chemical test results may be used to aid in the selection of coatings and corrosion protection systems for buried steel culverts, if selected. If the concrete culvert option is selected, consideration should be given by the designer to designing for a « C » type of exposure class of concrete as defined by CSA A23.1:19 Table 1, since the culvert will be exposed to de-icing salt.

The maximum water-soluble sulphate content of the soils tested is less than 20 ppm ($\mu\text{g/g}$), i.e. 0.0002%, and being less than 0.10% (as per CSA A23.1:19, Table 3) does not require sulphate resistant cement. The data supports our local experience.

7.5 Obstructions during Installation of Temporary Protection Systems

Cobbles and/or boulders were noted to be contained within the fill or native till deposits at the site during site investigation. Therefore, care has to be taken since the presence of these obstructions may affect the excavation for culvert replacement and installation of protection system elements including the temporary roadway protection system and temporary dewatering/unwatering systems (if any). It is recommended that a NSSP be included in the Contract Documents to warn the Contractor of the presence of cobbles and/or boulders within the overburden soils. An example of NSSP for obstructions is provided in Appendix F.

7.6 Monitoring Program

The need for monitoring the effect of the construction of the culvert must be considered. Provided that the shoring and unwatering/dewatering (if any) are carried out in accordance with specifications and good practice, a significant impact on the existing amenities is not anticipated. However, monitoring of vibrations and movements of the shoring systems (if any) during construction is recommended.

7.6.1 Movements of Temporary Protection Systems

The minimum requirements for monitoring of temporary protection system (if any) should include the survey measurements of scaled targets attached to the shoring wall at the elevations specified. The scaled targets should be placed at a maximum spacing of 6 m with targets placed at the extreme ends and the targets distributed between the outer limits. The survey targets shall be monitored for horizontal displacement from the vertical at the frequency specified. The limit for horizontal deformation is 0.1% of the excavated height or a maximum horizontal displacement is 25 mm and maximum angular distortion is 1:200 (as per OPSS.PROV 539 Performance Level 2).

Shoring Limits shall follow OPSS.PROV 539, Performance Level 2:

1. Review Level: If a maximum horizontal displacement value of 15 mm and maximum angular distortion of 1:400 relative to the baseline readings is reached, the method and rate or sequence of construction shall be reviewed or modified to mitigate further ground displacements.
2. Alert Level: If a maximum horizontal displacement of 25 mm and maximum angular distortion of 1:200 relative to the baseline readings is reached, the Contractor shall be required to cease construction

operation and to execute pre-planned measures to secure the site to mitigate further unacceptable settlement and to assure safety of public

7.6.2 Vibration Monitoring During Construction

For structures in good condition, OPSS 120 may be used to provide a limit of peak particle velocity (PPV), (noting that other entities having jurisdiction in particular settings may have more stringent regulations). Experience with monitoring of construction activities such as piling, drilling, and hoe ramming have indicated that the noted threshold limit is not likely to be exceeded. However, it is recommended that site-personnel vibration monitoring takes place only during active construction while soldier pile installation and backfilling compaction at this site. The suggested vibration monitoring plan is described in the following.

- The vibration monitoring should be conducted to verify the vibration levels near the existing private building, structure, and the utilities identified in the area.
- A normal background vibration reading produced by no construction-related activities should be taken one month prior to construction activity.
- Attended vibration monitoring can be conducted by a qualified technician during construction. The vibration monitoring program should include, monitoring with a seismograph near the structure to confirm the magnitude of the vibration produced by construction activity. The seismograph consists of an ISEE geophone and base fitted with an internal battery can be considered. The qualified technician attended during construction activity should take readings from the seismograph and make notes of construction activities that produced the vibration events.
- If excessive vibration levels were to be found, modifications to the construction techniques, potentially utilizing lighter or smaller equipment or less aggressive usage would be required.
- Once construction activity is substantially complete, a final report should be prepared summarizing all vibration measurements made during that phase of construction.

The limits are as follows:

1. Review levels are any PPV of 15 mm/second at a frequency of 40 Hz or less OR a PPV of 40 mm/second at frequencies greater than 40 Hz.
2. Alert levels are any PPV of 20 mm/second at a frequency of 40 Hz or less OR a PPV of 50 mm/second at frequencies greater than 40 Hz

8.0 CLOSURE

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the team responsible for the design of the works described herein.

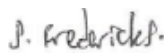



We recommend that we be retained to review our recommendations as the design nears completion to ensure that the final design is in agreement with the assumptions on which our recommendations are based and that our recommendations have been interpreted as intended. If not accorded this review, EXP will assume no responsibility for the interpretation and use of the recommendations in this report.

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.

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9.0 REFERENCES

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- 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
- Molinas, A., and Mommandi, A., 2009. Development of New Corrosion/Abrasion Guidelines for Selection of Culvert Pipe Materials, Report No. CDOT-2009-11. Colorado Department of Transportation, DTD Applied Research and Innovation Branch.

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 314 Construction Specification for Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
- 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 1205 Material Specification for Clay Seal
- OPSS.PROV 1860 Material Specification for Geotextiles

Special Provisions (SP):

*Foundation Investigation and Design Report
Highway 7 at Coronation Rd Partial Culvert Replacement (CV-0003-0007-0005)
GWP 2111-19-00
Assignment No. 2020-E-0028
Date: July 10, 2023*

SP 109F57 Amendment to OPSS 903
SP 517F01 Amendment to OPSS 517
NSP FOUN0003 Amendment to OPSS.PROV 902

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

10.0 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

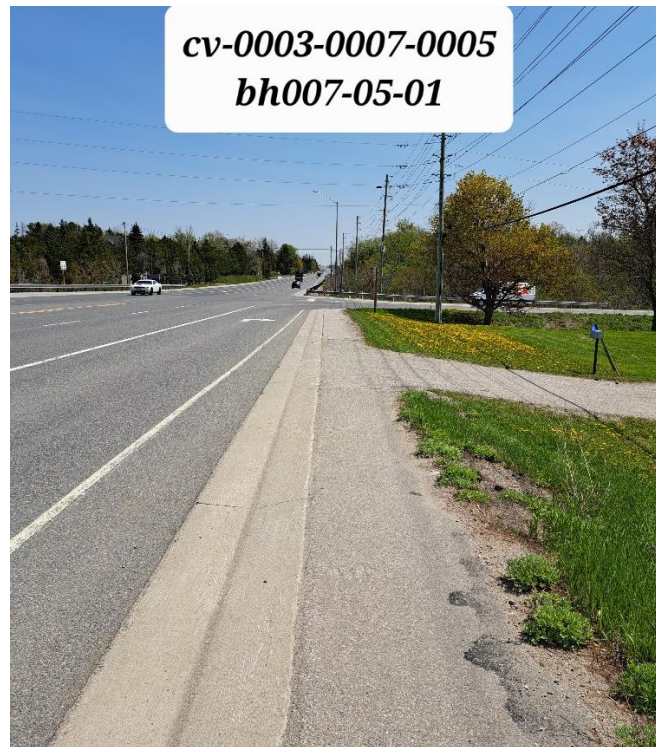


Photo (1): Hwy 7 looking east towards Coronation Road



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

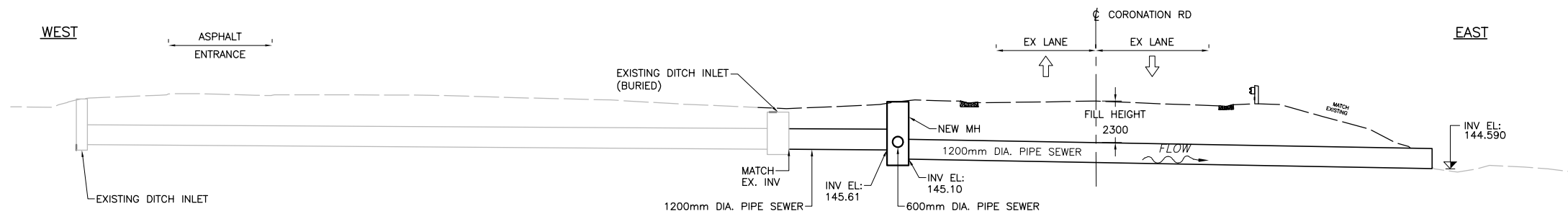
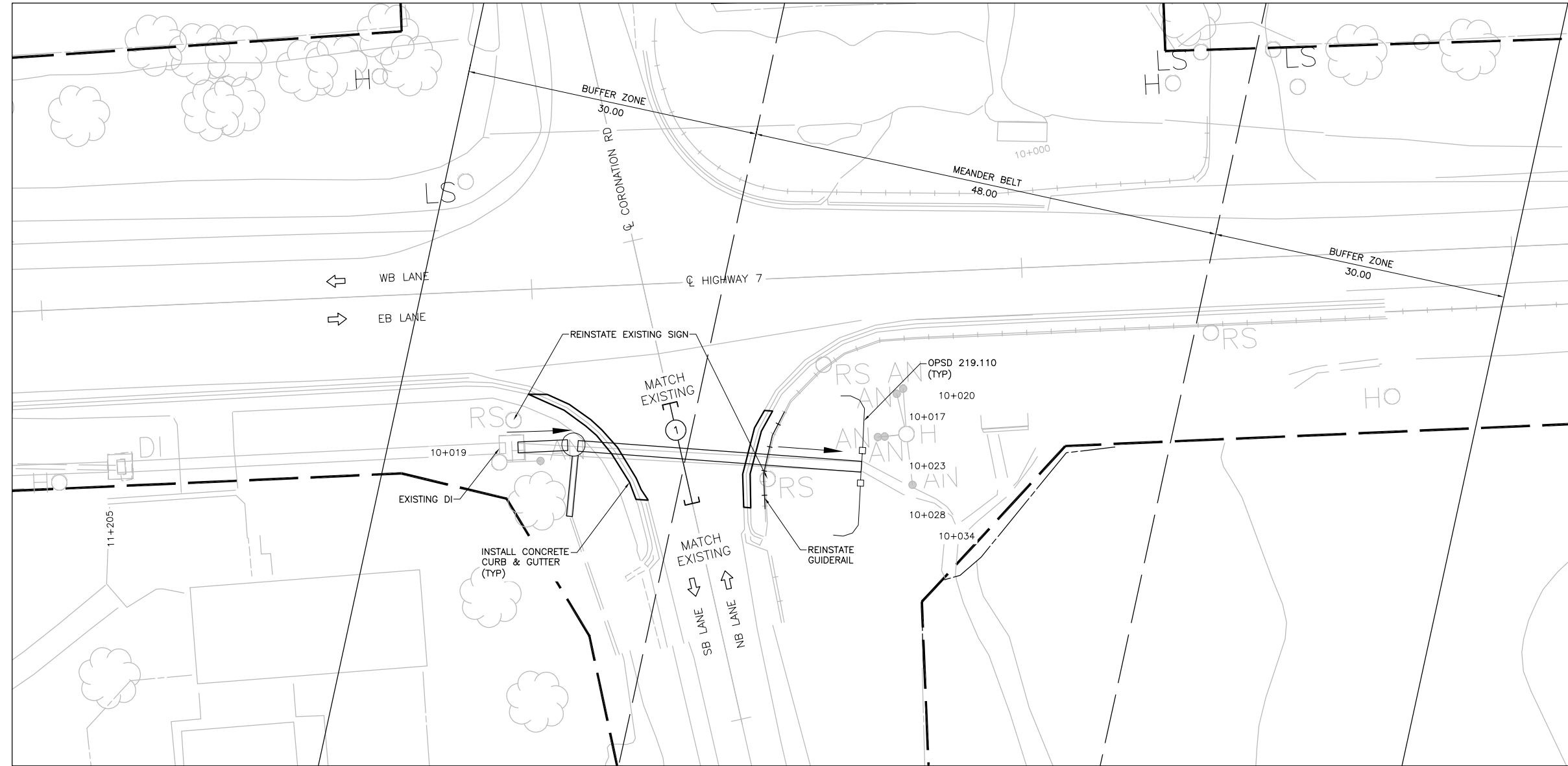
1	SOLID YELLOW,10cm
2	SOLID DOUBLE YELLOW,10cm
3	363 BROKEN YELLOW,10cm
4	SOLID YELLOW,20cm
5	SOLID WHITE,10cm
6	333 BROKEN WHITE,10cm
7	363 BROKEN WHITE,10cm
8	393 BROKEN WHITE,10cm
9	SOLID WHITE,20cm
10	111 BROKEN WHITE,20cm
11	333 BROKEN WHITE,20cm
12	333 BROKEN WHITE ,30cm
13	SOLID WHITE,30cm
14	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 ① to Denote PAVEMENT MARKING, DURABLE
- FROST TAPERS are based on OPSD 803.030, 803.031

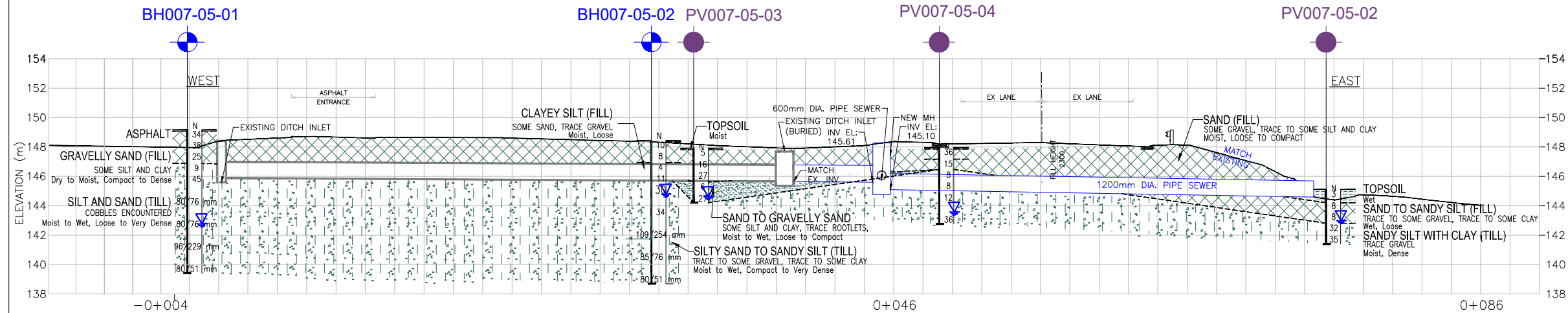
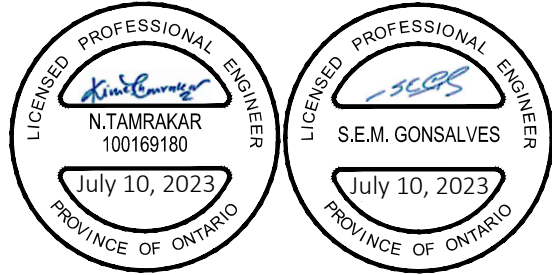
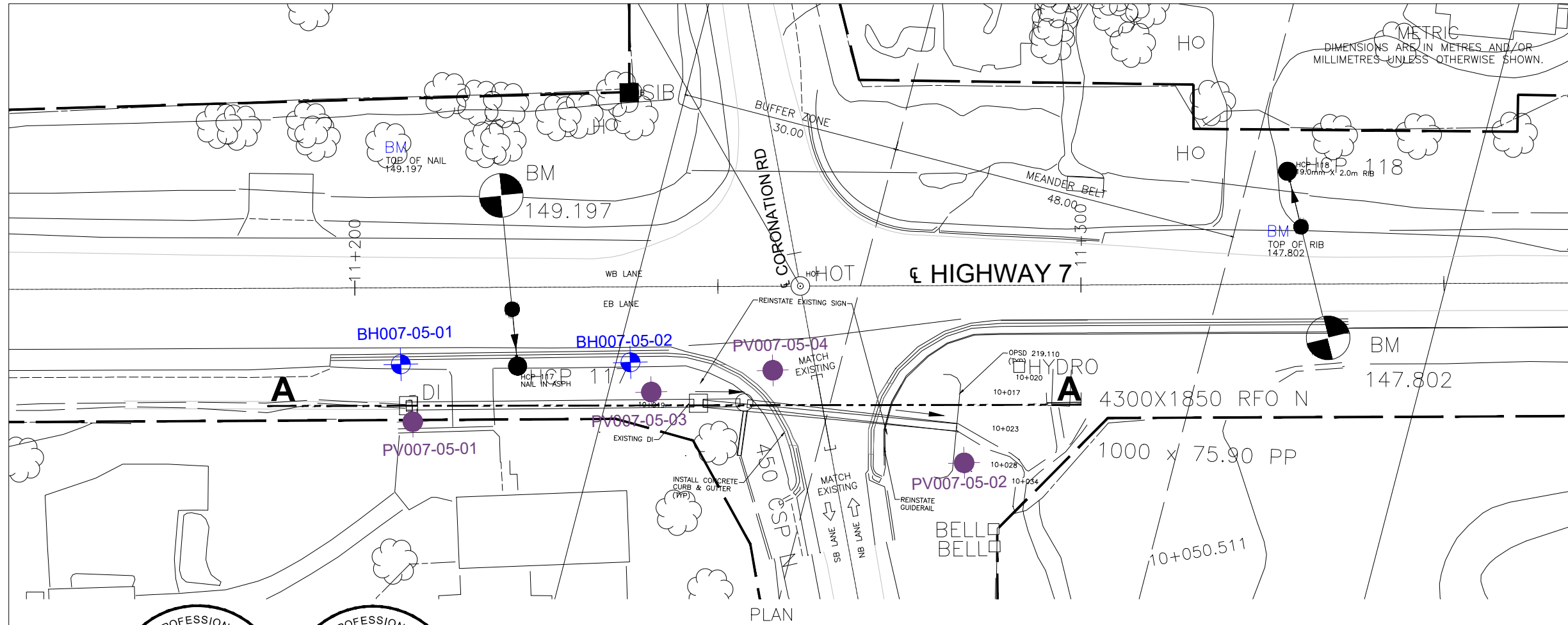


SCALE
5m 0 10m



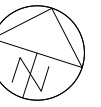
Appendix C – Borehole Location Plan and Stratigraphic Strata

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

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)
- 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.

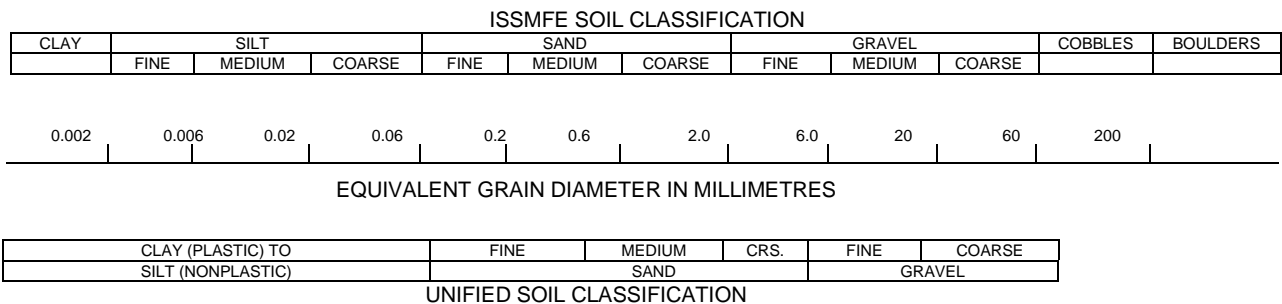
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

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:

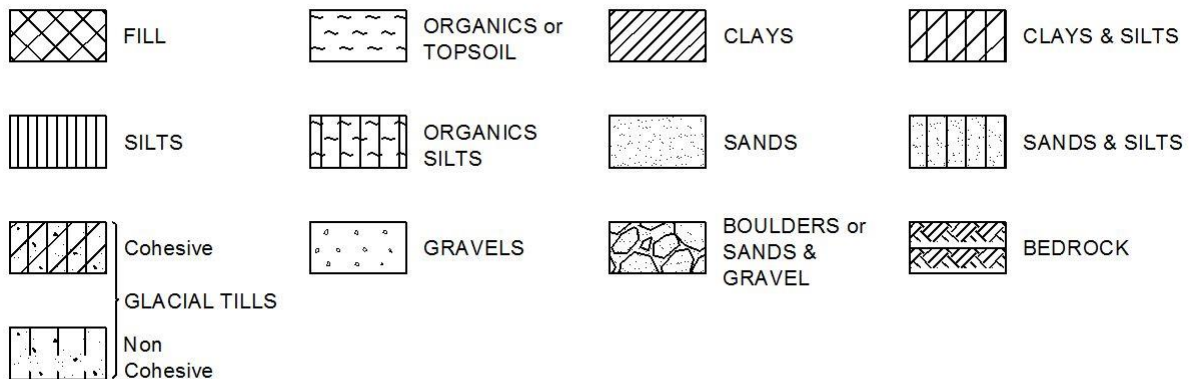
Table c: Consistency of Cohesive Soil

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
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

MECHANICAL PROPERTIES 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

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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
149.2	Asphalt (100 mm) GRAVELLY SAND (FILL) - some silt and clay, grey to blackish grey, dry to moist, compact to dense		SS1	SS	34		149										
140.9			SS2	SS	38		148										
			SS3	SS	25		147										
146.9	SILT AND SAND (TILL) - 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										
2.3			SS5	SS	45		145										
			SS6	SS	80/ 76 mm		144										
			SS7	SS	80/ 76 mm		143										
			SS8	SS	96/ 229 mm		142										
							141										
							140										
			SS9	SS	80/ 51 mm												
139.4	END OF BOREHOLE 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.																
9.8																	

+³, ×³: 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 _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										
148.5							20	40	60	80	100	20	40	60				
148.4	Asphalt - (76 mm)																	
0.1	GRAVELLY SILTY SAND (FILL) - trace gravel, blackish brown to brown, moist, loose to compact		SS1	SS	10							○						
			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													
		</																

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

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

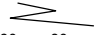
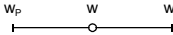






Brampton, Ontario

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 LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
																				
147.9							20	40	60	80	100									
147.9	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.																			

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

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

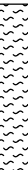



Brampton, Ontario

RECORD OF BOREHOLE No PV007-05-02

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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER					WATER CONTENT (%)							
145.1 0.0	TOPSOIL (914 mm) - blackish brown, wet		SS1	SS	3		145													
144.2 0.9				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.																			

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

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 _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ 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.																	

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

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

1 OF 1

METRIC

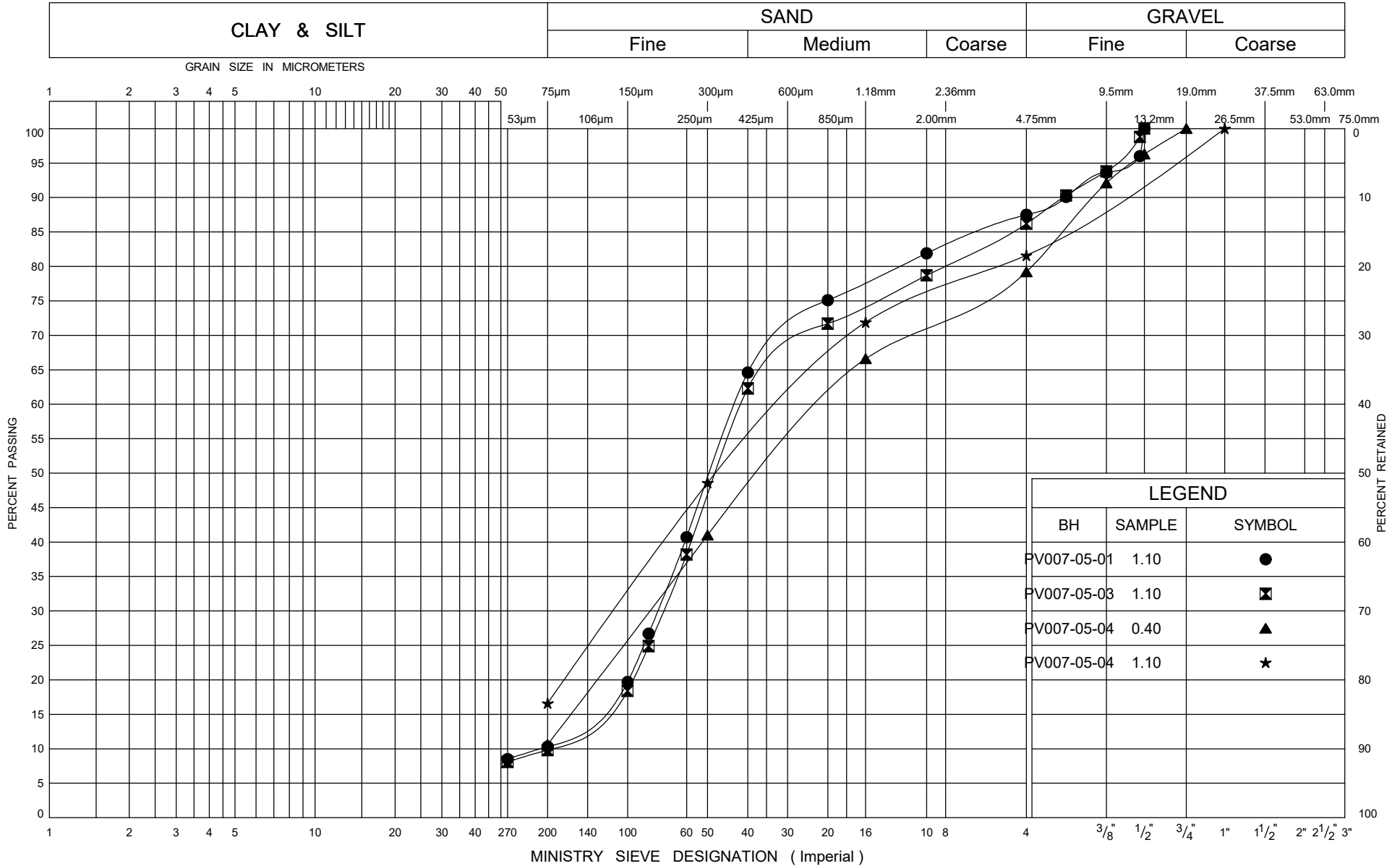
W.P.	2011-19-00	LOCATION	CV-0003-0007-0005, Whitby, ON, MTM ON-10 344772E, 4867197N			ORIGINATED BY	NT
DIST	Durham	HWY	7	BOREHOLE TYPE	Rubber Track Drill (Marl M5T/SSA)	COMPILED BY	NT
DATUM	Geodetic	DATE	2023.05.24 - 2023.05.24	LATITUDE	43.943664	LONGITUDE	-79.002053
						CHECKED BY	AA

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

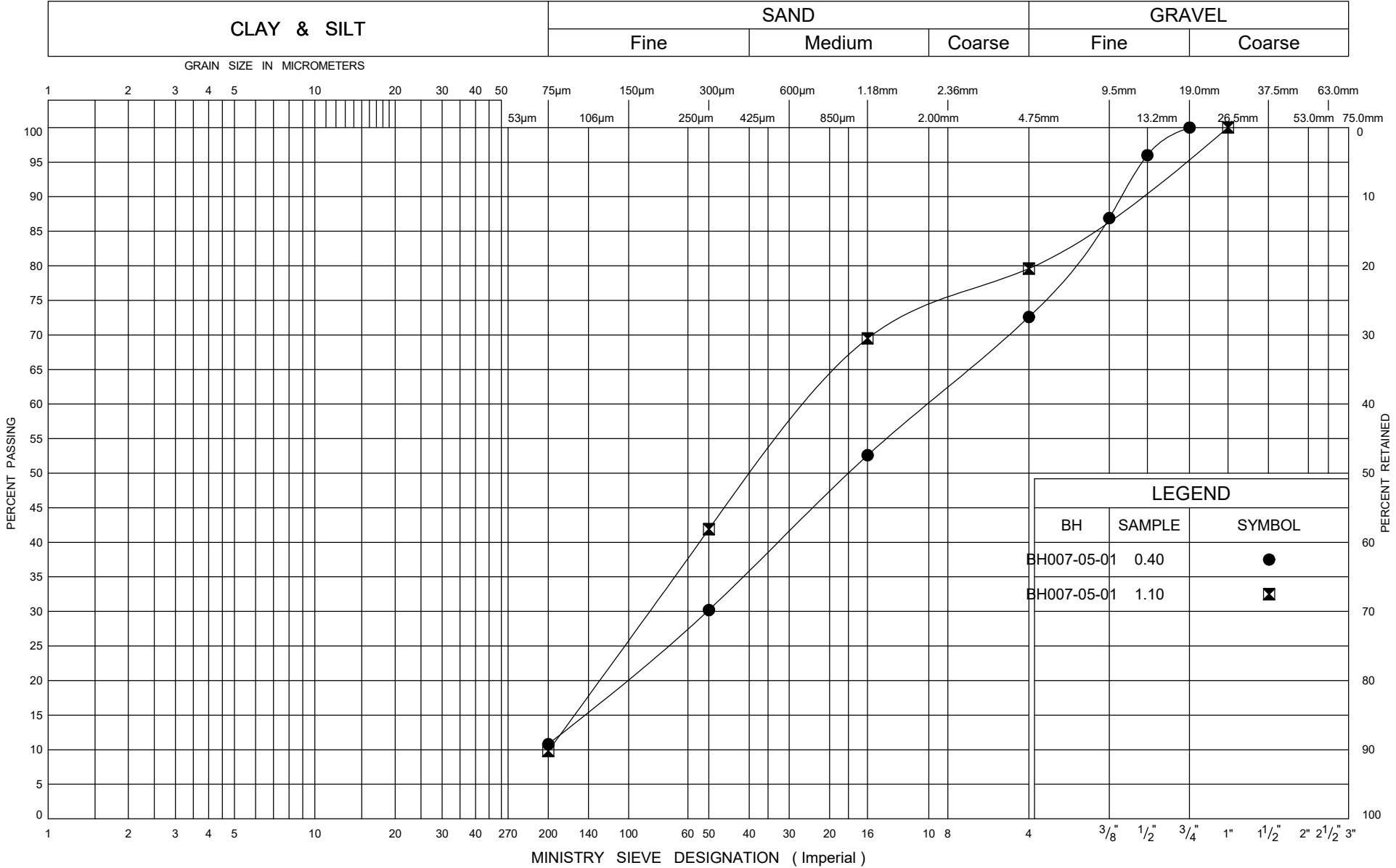
+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

Appendix E – Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

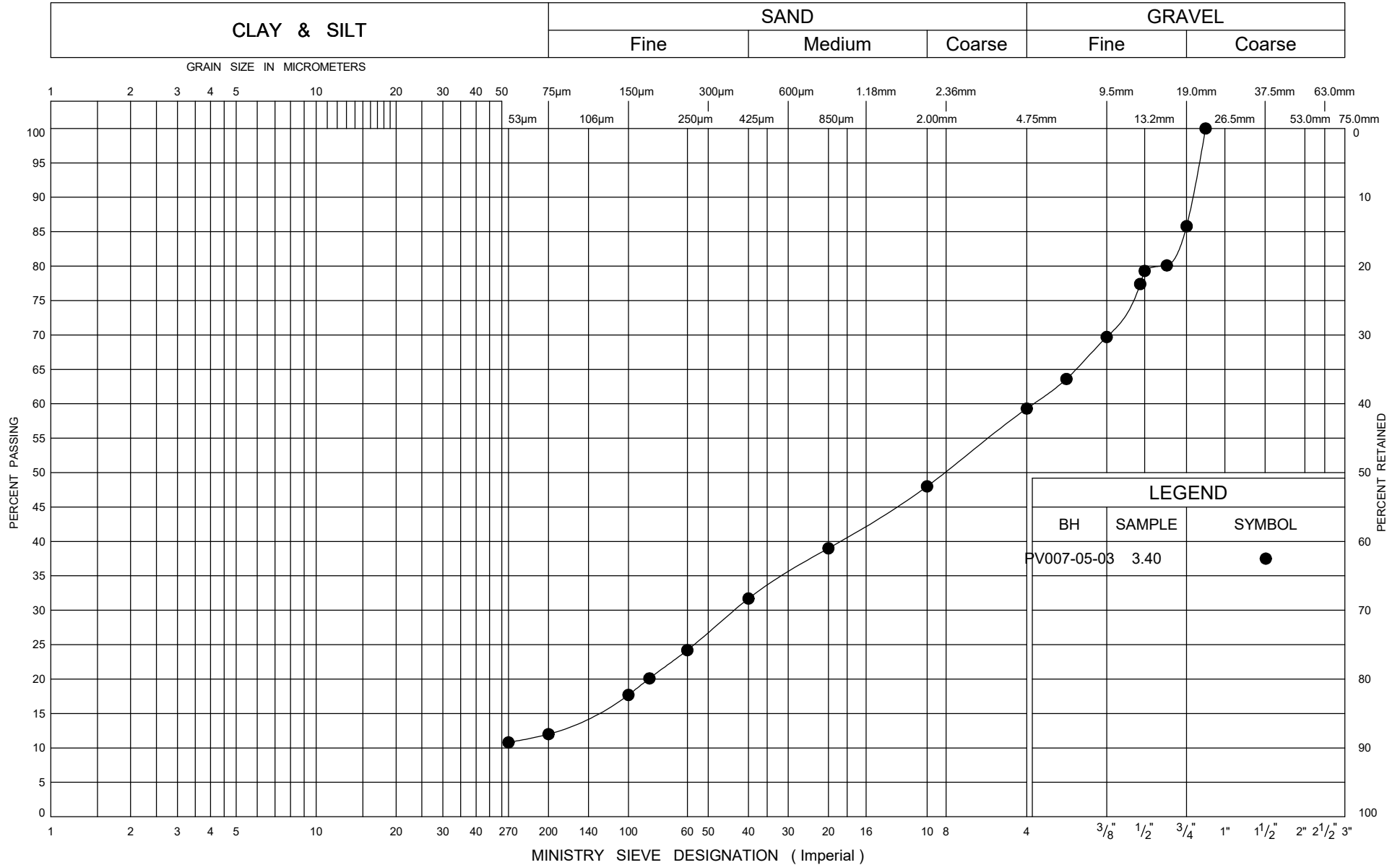
Cohesionless Fill

FIG No 2

W P 2011-19-00

Culvert ID CV-0003-0007-0005

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

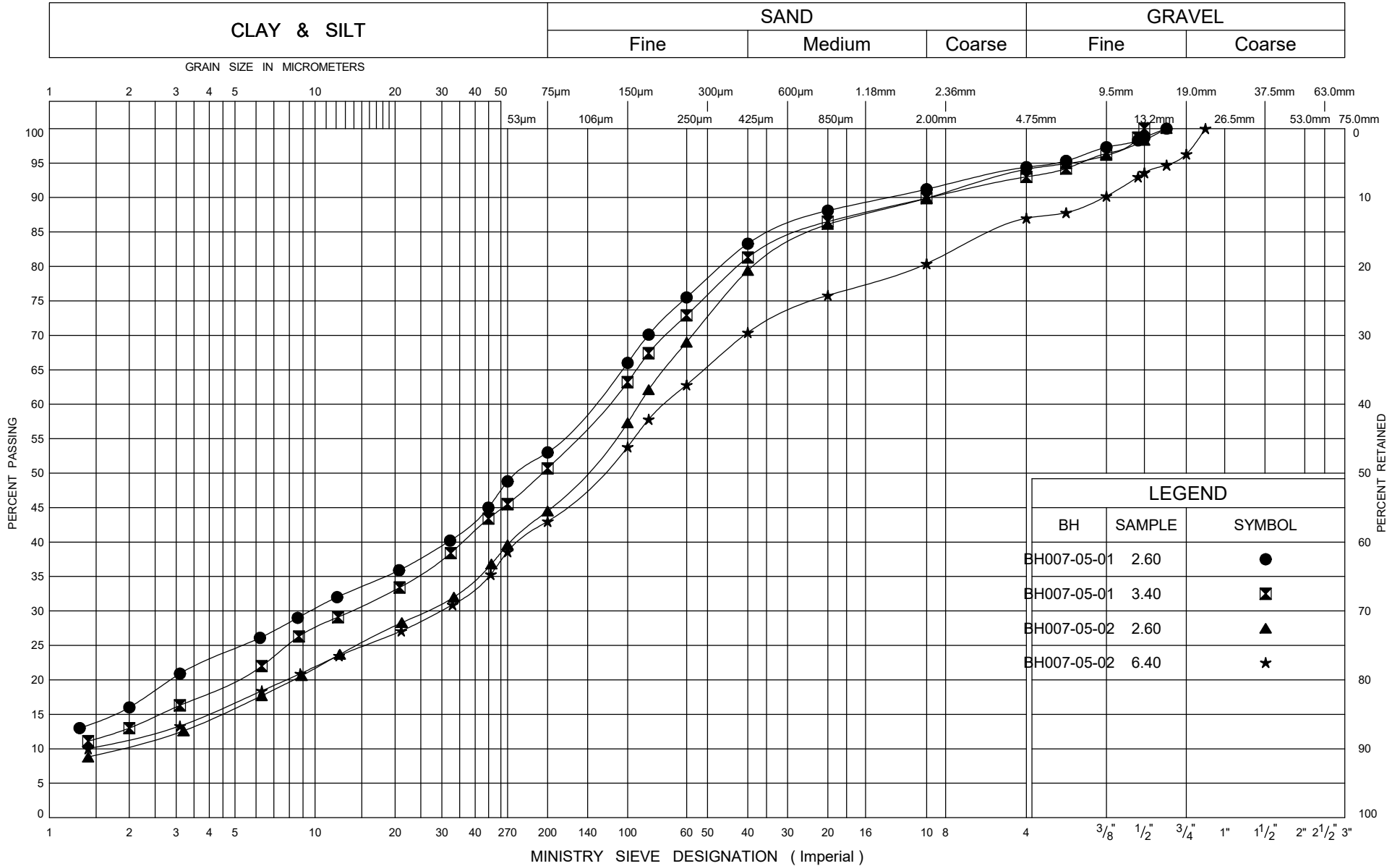
Sand to Gravelly Sand

FIG No 3

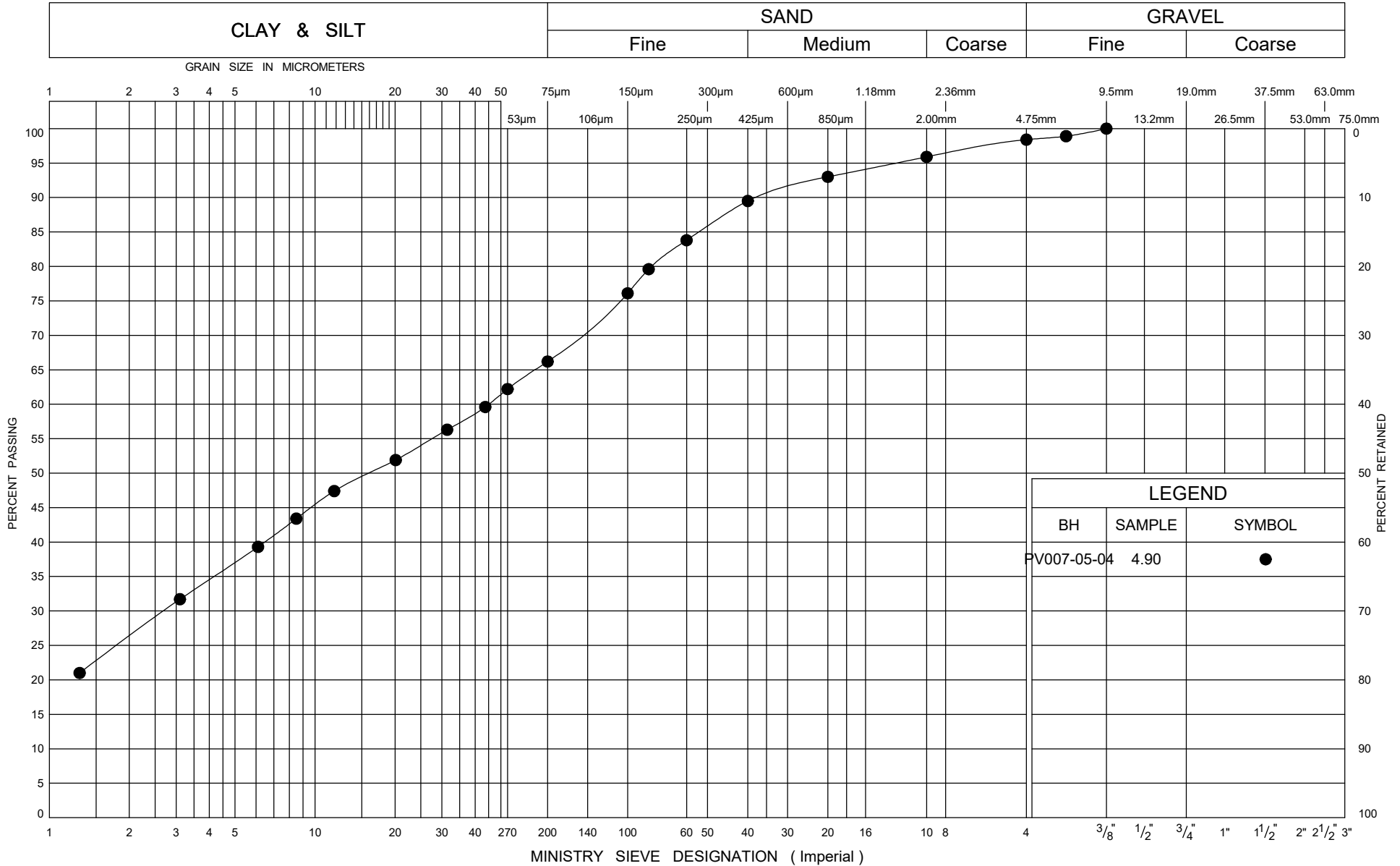
W P 2011-19-00

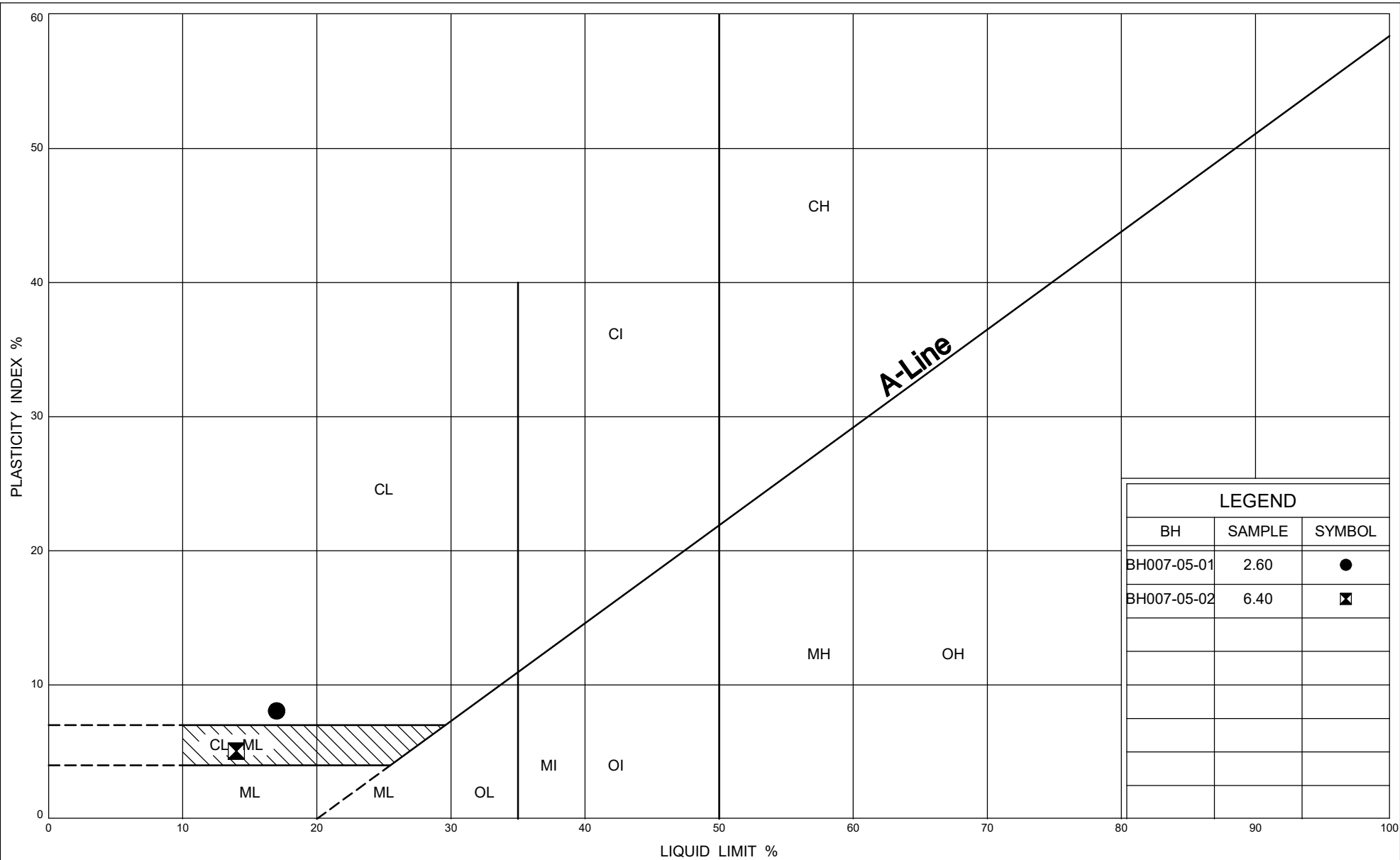
Culvert ID CV-0003-0007-0005

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of
Transportation

PLASTICITY CHART

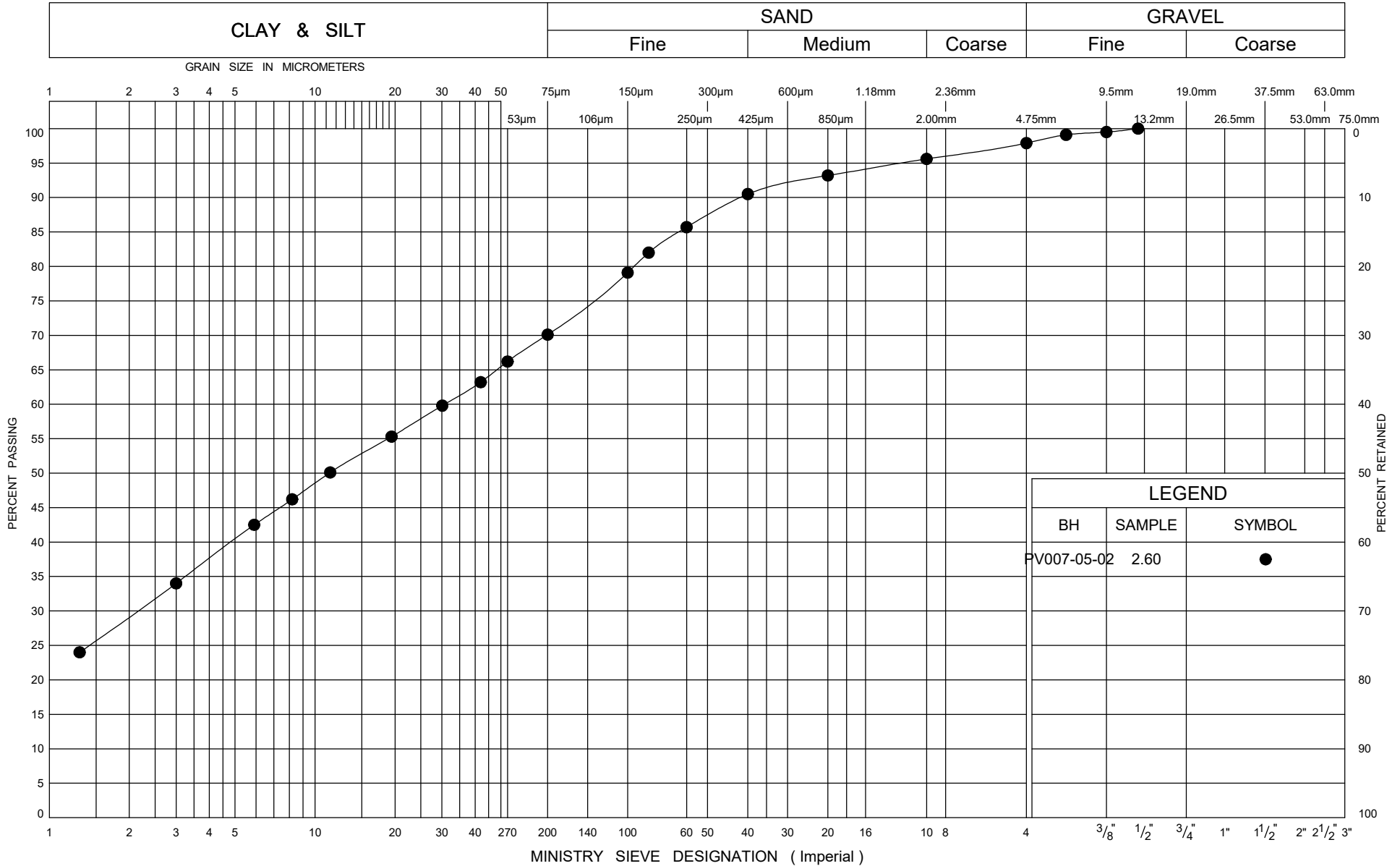
Silty Sand to Sandy Silt Till

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		
	UNITS	PV07-05-04 SS6	RDL	QC Batch	PV07-05-04 SS6 Lab-Dup	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	5000		8688236			
CONVENTIONALS							
Redox Potential	mV	360	N/A	8697565			
Inorganics							
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

IDF Curve Location	Latitude: 43.943453		Longitude: -79.001726			
Temporary Flow Passage Systems						
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
Dewatering Systems						
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>						