FINAL REPORT

Foundation Investigation and Design Report

High Fill Embankments and Deep Cuts
Highway 6/Hanlon Expressway Mid-Block Interchange
County of Wellington, Ontario
MTO DB 2021-3004

Submitted to:

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Distribution List

1 PDF Copy - MTO West Region

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COUNTY OF WELLINGTON, ONTARIO
MTO DB 2021-3004

1.0 INTRODUCTION

The Ministry of Transportation Ontario (MTO) has engaged Dufferin Construction Company, A Division of CRH Canada Group Inc. (Dufferin) as the Design-Builder for the Highway 6/Hanlon Expressway Mid-Block Interchange Improvements south of Guelph in the County of Wellington, Ontario, as part of MTO's Design-Build Major Contract DB 2021-3004. WSP Canada Inc. (WSP) is the lead designer and is also providing geotechnical/foundation engineering services in support of this contract.

This report addresses the high fill embankments and deep cuts, including excavations for the stormwater management ponds, associated with the Highway 6/Hanlon Expressway Mid-Block Interchange Improvements contract. Other foundation engineering elements of this project, including the Highway 6/Mid-Block Connection Road underpass, Highway 6/Wellington Road 34 underpass and sign supports along Highway 6 are addressed in separate Foundation Investigation and Design Reports.

2.0 PROJECT AND SITE DESCRIPTION

The Mid-Block Interchange (MBI) project limits extend along Highway 6/Hanlon Expressway from approximately 300 metres (m) south of Wellington Road 34 to 150 m north of Maltby Road/Concession Road 4, as well as along Wellington Road 34 and Concession Road 7, as shown on Figure 1. A new Mid-Block Connection Road will be constructed, extending from Wellington Road 34 and crossing Highway 6 to connect to Concession Road 7, with the new Mid-Block Connection Road underpass located approximately 2 kilometres (km) north of Highway 401 and approximately 900 m north of the Highway 6/Wellington Road 34 intersection.

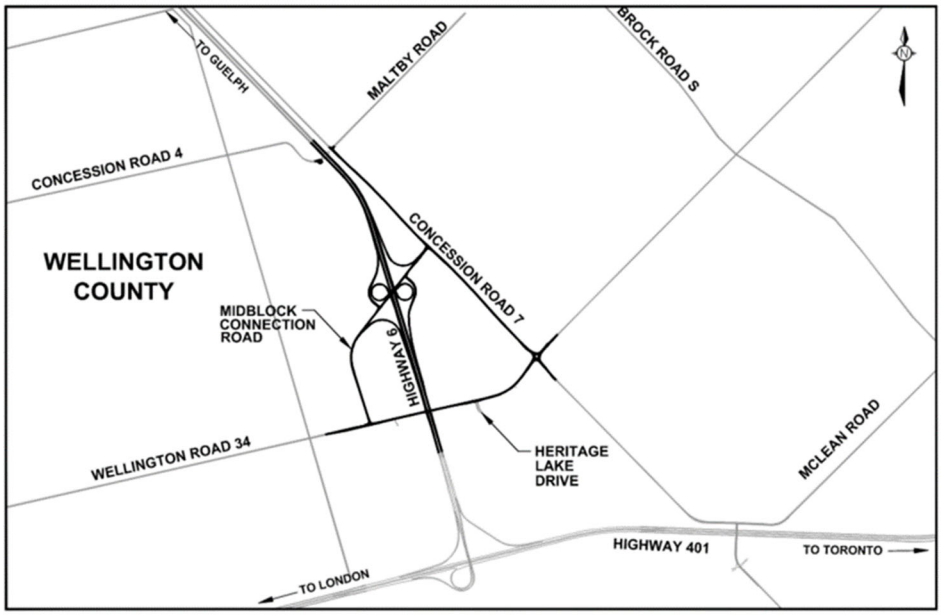

Figure 1: Highway 6/Hanlon Expressway Mid-Block Interchange project limits

The project area includes a low-lying wetland surrounding the intersection of Highway 6/Wellington Road 34, with the ground surface generally rising northward throughout the project limits. Highway 6 and Wellington Road 34 within the limits of the wetland have been built on low embankments, while further north Highway 6 has been constructed in a cut. Irregular hummocky and undulating topography is present along Concession Road 7.

3.0 HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS

Table 1 provides a summary of the high fill and deep cut sections with heights or depths greater than 4.5 m. For consistency, the nomenclature for the high fill and deep cut areas has been maintained consistent with that used in the Design-Build-Ready Foundation Investigation and Design Report prepared by Peto MacCallum Ltd. (PML) for the high fill embankments and deep cuts associated with the Mid-Block Interchange project. The locations of these high fill and deep cut sections are shown on Drawings 1 to 5 following the text of this report.

Table 1: Summary of High Fill Embankments and Deep Cut Sections

Label	Road Section	Approximate Station	Approximate Maximum Height or Depth (m)
HIGH FILL EMBANKMENTS			
HF-1	Concession Road 7	10+960 – 11+110	7.5
HF-2	Mid-Block Connection Road	10+355 – 10+375 Rt	5.5
HF-3		9+850 – 9+890	5.5
		9+925 – 9+940 Rt	5.5
HF-4	Wellington Road 34	9+820 – 9+970	9
HF-5		10+030 – 10+180	9
HF-6	Highway 6 S-EW Ramp	10+290 – 10+420	4.5
DEEP CUTS			
DC-1	Concession Road 7	10+730 – 10+800	10
DC-2	Mid-Block Connection Road	9+050 – 9+085	5.5
DC-3	Highway 6 SBL	11+790 – 11+770	5.2
DC-4	Highway 6 E-N Ramp	9+780 – 10+000	7
	Highway 6 NBL	12+030 – 12+100	7
		12+180 – 12+520	7
DC-5	Highway 6 E-S Ramp	9+980 – 10+000	7
DC-6	Highway 6 SBL	12+540 – 12+240	10.5
	Highway 6 N-EW Ramp	10+000 – 10+280	10.5
--	Infiltration Ponds	SE Quadrant (W-N Ramp)	6
		NW Quadrant (E-S Ramp)	6.5

As indicated in Table 1 and shown on Drawing 1, the high fill embankment sections include areas around the Concession Road 7 and Mid-Block Connection Road intersection, along the Mid-Block Connection Road within the interchange area, and along Wellington Road 34 west and east of the new underpass. The deep cut sections include localized areas along Concession Road 7 and Mid-Block Connection Road, along the Highway 6 mainline north and south of Mid-Block Connection Road where existing cut slopes will be widened associated with

construction of the new speed change lanes, and along portions of the new interchange ramps including the infiltration ponds within the new loop ramps.

4.0 INVESTIGATION PROCEDURES

4.1 Design-Build Ready Investigations by Peto McCallum Limited

Site-specific investigations relevant to the high fill embankment and deep cut sections, including borehole drilling and geotechnical and analytical laboratory testing, have been completed by PML between 2017 and 2021 as part of Design-Build Ready studies, as documented in the following reports:

- **MTO GEOCRES No. 40P8-291:** "Preliminary Foundation Investigation and Design Report for Design-Build Ready Alternative Bid Package for Wellington Road 34 Connector Underpass, Site No. 35X-0618/B0, Station 10+000, Mid-Block Interchange (MBI) Area, Highway 6 and Highway 401 Improvements from Hamilton North Limits to Guelph South Limits, City of Guelph, Ontario, GWP 3059-20-00", dated October 2021.
- **MTO GEOCRES No. 40P8-292:** "Preliminary Foundation Investigation and Design Report for Design-Build Ready Alternative Bid Package for Wellington County Road 34 Underpass, Site No. 35X-0617/B0, Mid-Block Interchange (MBI) Area, Highway 6 and Highway 401 Improvements from Hamilton North Limits to Guelph South Limits, City of Guelph, Ontario, GWP 3059-20-00", dated October 2021.
- **MTO GEOCRES No. 40P8-293:** "Preliminary Foundation Investigation and Design Report for Design-Build Ready Alternative Bid Package, Mid-Block Interchange Area High Fill and Deep Cut Sections, Highway 6 and Highway 401 Improvements from Hamilton North Limits to Guelph South Limits, City of Guelph, Ontario, GWP 3059-20-00", dated October 2021.

The following boreholes advanced by PML have been included in this Foundation Investigation Report:

- Forty-six boreholes within the high fill embankment and deep cut areas (GEOCRES No. 40P8-293)
- Seven boreholes (35-617-series) at the abutments and approaches for the Highway 6/Wellington Road 34 underpass (GEOCRES No. 40P8-291)

A summary of the PML borehole locations is provided in Table 2, including MTM NAD83 (Zone 10) northing and easting coordinates and ground surface elevations referenced to geodetic datum, as surveyed by J.D. Barnes Limited and Callon Dietz for the 2017 and 2021 boreholes, respectively. The borehole locations are shown on Drawings 1 to 5 following the text of this report, and the borehole records are contained in Appendix A.

Table 2: Borehole Coordinates and Ground Surface Elevations – PML 2017 to 2021 Investigations

Area	Roadway	Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Depth (m)
			Northing (m)	Easting (m)		
HF-1	Concession Road 7	21-36	4,814,435.7	249720.9	325.1	3.6
		21-37	4,814,416.7	249749.6	321.1	9.2
		21-38	4,814,365.8	249790.9	319.7	9.7
		21-39	4,814,284.1	249889.9	318.0	10.5
		21-40	4,814,292.3	249854.9	318.5	9.8

Area	Roadway	Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Depth (m)
			Northing (m)	Easting (m)		
HF-2	Mid-Block Connection Road	21-34	4,814,370.6	249707.8	321.5	4.4
		21-35	4,814,396.6	249722.2	321.7	10.5
HF-3		21-32	4,814,013.2	249379.2	325.6	7.7
		21-33	4,813,935.1	249354.5	326.9	10.4
HF-4	Wellington Road 34 West of Highway 6	21-04	4,813,263.5	249663.1	308.9	6.6
		21-05	4,813,253.2	249634.1	310.6	11.3
		21-06	4,813,246.5	249588.8	309.1	5.2
		21-07	4,813,223.9	249574.4	309.4	10.1
		21-07A	4,813,242.3	249643.2	310.3	3.1
		21-08	4,813,221.3	249538.8	310.8	10.4
		35-617-01	4,813,256.6	249692.1	310.3	9.8
		35-617-02	4,813,273.5	249,693.4	309.0	19.8
		35-617-03 35-617-03A[1]	4,813,252.4 4,813,254.4	249,699.1 249,700.0	309.1 309.1	13.4 9.1
HF-5	Wellington Road 34 East of Highway 6	21-01	4,813,308.7	249977.7	309.1	10.5
		21-02	4,813,317.5	249888.4	308.9	10.4
		21-03	4,813,299.2	249837.9	309.7	15.3
		35-617-06	4,813,287.4	249,756.7	308.7	17.4
		35-617-07	4,813,255.2	249,765.1	308.8	11.6
		35-617-08	4,813,273.1	249,774.5	309.5	9.8
		35-617-10	4,813,257.5	249,767.4	309.3	14.6
HF-6	Midblock Interchange	21-26	4,814,192.4	249610.9	329.9	10.5
		21-27	4,814,102.5	249623.5	324.0	10.4
		21-28	4,813,971.7	249606.3	320.5	8.2
DC-1	Concession Road 7	21-41	4,814,246.8	249895.5	319.2	3.7
		21-42	4,814,206.7	249950.0	321.1	10.0
		21-43	4,814,120.8	250017.4	312.4	7.0
DC-2	Proposed Connector Route	21-09	4,813,274.1	249319.2	315.6	5.9
		21-10	4,813,309.7	249266.4	316.6	10.5
		21-11	4,813,364.8	249271.1	313.0	9.1

Area	Roadway	Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Depth (m)
			Northing (m)	Easting (m)		
DC-3	Highway 6	21-29	4,813,886.7	249519.8	316.5	10.4
		21-30	4,813,948.9	249478.3	321.9	10.5
		21-31	4,814,028.5	249474.5	320.2	10.4
DC-4		21-17	4,814,216.1	249484.3	330.6	9.8
		21-18	4,814,385.2	249433.1	336.8	5.4
		21-20	4,814,472.4	249424.5	338.6	9.8
		21-22	4,814,552.0	249380.8	339.2	9.8
		21-24	4,814,618.2	249342.6	335.8	10.4
DC-5	Proposed Midblock Interchange	21-12	4,814,135.0	249363.0	329.1	9.8
		21-13	4,814,150.3	249412.1	330.5	9.3
		21-14	4,814,060.5	249385.1	328.9	10.2
DC-6		21-15	4,814,162.2	249327.3	334.4	6.6
		21-16	4,814,238.0	249369.2	331.4	10.1
		21-19	4,814,358.6	249353.7	336.9	10.1
		21-21	4,814,451.1	249347.6	333.4	7.9
		21-23	4,814,519.6	249299.5	342.6	10.1
		21-25	4,814,637.2	249288.2	335.3	8.2
Infiltration Ponds	W-N Ramp	21-50	4,814100.9	249556.1	324.6	7.7
	E-S Ramp	21-51	4,814111.5	249385.4	325.5	11.3

1. Borehole 35-617-03A was drilled without sampling for installation of a monitoring well adjacent to Borehole 35-617-03.

The boreholes were generally advanced using Geoprobe 7822DT and CME75 drill rigs with continuous flight hollow or solid stem augers; at some locations, particularly within the wetland area, wash boring (mud rotary) techniques were used. Portable drilling was completed at Boreholes 21-04, 21-06, 21-34, 21-36, 21-18), and these boreholes terminated upon refusal between 3.6 m and 6.6 m depth owing to the nature of the portable/manual drilling. Soil samples were obtained at regular intervals using a split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 – Standard Test Method for Standard Penetration Test).

Groundwater levels in open boreholes were observed throughout the drilling operations by visual examination of recovered soil samples, the sampler and drill rods, and by measurement of the water level in the open boreholes. Some boreholes were advanced using water and wash boring techniques and, as such, direct observation or measurement of the water level after completion of drilling could not be established in these boreholes. Monitoring wells were installed in selected boreholes to measure groundwater levels; the monitoring wells consisted of 50 mm outside diameter rigid PVC pipe with a 1.5 m or 3.0 m long screen surrounded by a sand pack and sealed at a selected depth within the boreholes. Boreholes were backfilled with soil cuttings and in accordance with the

requirements of Ministry of Environment, Conservation and Parks (MECP) Ontario Regulation 903 (as amended by Ontario Regulation 372); artesian conditions as encountered in some boreholes in the wetland area near the Highway 6/Wellington Road 34 intersection were decommissioned in accordance with MTO guidelines and the requirements of O.Reg. 903 (as amended). In the case of wells, the annular space between the borehole wall and the well pipe above the filter pack was backfilled to ground surface using bentonite pellets. The groundwater data, details of the artesian conditions, and the sealing operations, where applicable, are provided in the borehole records in Appendix A.

Geotechnical classification testing, consisting of water contents, grain size distributions and Atterberg limits determinations on soil samples and uniaxial compressive strength testing on bedrock core specimens, was conducted at PML's laboratory in Toronto, Ontario. The results of the geotechnical laboratory testing on boreholes from the high fill embankment and deep cut sections are provided in Appendix B.

4.2 2022 Borehole Investigation by WSP

Additional investigation was completed by WSP at the Mid-Block Connection Road interchange in June 2022 to supplement the PML investigations in the infiltration pond areas and along the Mid-Block Connection Road. The locations of Boreholes GBH-28, GBH-30 and GBH-32 are shown on Drawings 1 and 3 following the text of this report and summarized in Table 3 including MTM NAD83 (Zone 10) northing and easting coordinates and ground surface elevations referenced to geodetic datum. The borehole records are contained in Appendix C.

Table 3: Borehole Coordinates and Ground Surface Elevations – 2022 Investigation

Borehole No.	MTM NAD 83 Coordinates (MTM Zone ON10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
GBH-28	4,814,073.6	249,553.8	323.7	9.8
GBH-30	4,814,194.5	249,565.1	329.9	6.7
GBH-32	4,814,087.0	249,396.0	326.9	9.8

The boreholes were advanced using 150 mm and 200 mm diameter hollow stem augers, with soil samples obtained at 0.75 m and 1.5 m intervals of depth using a split-spoon sampler in accordance with SPT procedures.

The groundwater conditions were observed in the open boreholes and a monitoring well was installed in Borehole GBH-32 to monitor the groundwater level within the infiltration pond area. The boreholes were backfilled in accordance with O.Reg. 903 (as amended).

4.3 2023 Test Holes Adjacent in Wetland Area Adjacent to Wellington Road 34

Test holes were advanced by WSP in May 2023 in the wetland area adjacent to Wellington Road 34 to assess the thickness and properties of the peat/organic soils and underlying materials. The test holes were advanced by nominally clearing the surface area of roots using an excavator, then using a 75 mm diameter manual auger to

continuously sample the test hole through the peat/organic stratum and into the underlying soils. In situ vane shear testing was completed within the organic soils, where possible, using an MTO N-size vane pushed in a separate hole adjacent to the initial test hole.

The test hole locations are shown on Drawings 1 and 4 following the text of this report and summarized in Table 4 including MTM NAD83 (Zone 10) northing and easting coordinates and ground surface elevations referenced to geodetic datum.

Table 4: Test Hole Locations and Approximate Ground Surface Elevations – 2023 Investigation

Test Hole No.	MTM NAD 83 Coordinates (MTM Zone ON10)		Approximate Ground Surface Elevation[1] (m)	Test Hole Depth (m)
	Northing (m)	Easting (m)		
TP-03	4,813,216	249,548	310.0	0.8
TP-04	4,813,239	249,543	309.8	0.9
TP-07	`4,813,230	249,604	309.0	0.9
TP-08	4,813,250	249,598	308.9	1.0
TP-11	4,813,247	249,678	308.7	1.6
TP-12	4,813,267	249,669	308.7	1.5
TP-15	4,813,282	249,841	308.4	2.0
TP-16	4,813,306	249,837	308.6	1.5
TP-19	4,813,294	249,891	308.2	1.2
TP-24	4,813,321	249,911	308.6	1.2

1. This represents the approximate ground surface elevation following clearing of the surficial root mat to enable sampling.

The test hole records including in situ field vane shear strengths and geotechnical laboratory testing are contained in Appendix D.

5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Physiography and Regional Geology

The Mid-Block Interchange area is located within the western flank of the northeast-to-southwest trending Paris Moraine, which is characterized by a broad band of high-relief hummocky topography with hilly irregular slopes and enclosed basins, as demonstrated by the presence of frequent small ponds and marshy areas such as the wetland surrounding the Highway 6/Wellington Road 34 intersection. The Paris Moraine is composed of an extensive network of coarsely stratified sand and gravel deposits on adjacent outwash plains.

The Quaternary Geology map published by the Ontario Ministry of Northern Development and Mines (MNDM) indicates that the subsurface conditions in the area consist predominantly of silty sand to sandy silt associated with the Wentworth Till. The bedrock in the area belongs to the Lower Silurian sandstone, shale, dolostone and siltstone of the Guelph Formation. The Guelph Formation is identified as an important aquifer in City of Guelph and surrounding areas.

5.2 Subsurface Conditions

The detailed subsurface conditions encountered during the 2017- 2021 foundation investigations by PML are shown on the borehole records in Appendix A and the geotechnical test results from PML's investigations are contained in Appendix B. The results of WSP's borehole investigation in the infiltration pond area are provided in Appendix C and the records of test holes to assess the peat/organic thicknesses and properties adjacent to Wellington Road 34 are provided in Appendix D. The results of the in situ field tests (i.e., Standard Penetration Test "N" values and field vane shear strength) as presented on the borehole records and described in the following sub-sections are uncorrected.

Interpreted stratigraphic profiles in the high fill embankment and deep cut areas are included in Appendix E, based on the sections prepared by PML; while some adjustments to the horizontal and vertical profiles have been made in detail design, these stratigraphic profiles remain illustrative of the subsurface conditions in the various high fill and deep cut sections. Moreover, the findings of the 2022 and 2023 investigations by WSP are consistent with those of the Design-Build Ready investigations for the high fill embankment and deep cut areas. The stratigraphic boundaries or variations shown on the borehole records and on the stratigraphic profiles are inferred from non-continuous sampling, observations of drilling progress and SPT results. Such boundaries or variations therefore represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the boreholes. It should be noted that the interpreted stratigraphic profiles represent a simplification of the subsurface conditions.

Throughout the Mid-Block interchange area and along Concession Road 7, the subsurface conditions consist of limited thicknesses of topsoil and fill (typically reworked native soils associated with agricultural activities), underlain by an extensive, compact to very dense silty sand to sandy silt till deposit that contains occasional thin interlayers and varying proportions of gravel and cobbles. Dolostone bedrock is present at depth beneath the till deposit; bedrock will not be encountered within the cut depths associated with this contract.

Within the wetland along Wellington Road 34, and in the localized area in which Concession 7 crosses this wetland feature, the subsurface conditions consist of peat/organic soils overlying a generally compact to very dense silty sand to sandy silt till deposit that extends to dolostone bedrock, which was encountered at a depth of approximately 11.5 m to 17 m below the existing Wellington Road 34 surface in the vicinity of the future underpass. Based on the borehole results, the peat/organic soils have generally been removed below the Highway 6 and Wellington Road 34 footprints and replaced with the pavement structure and silty sand to sandy silt fill.

The following sub-sections provide brief summaries of the subsurface conditions encountered within the high fill embankment and deep cut sections.

5.2.1 High Fill Area 1 (HF-1) – Concession Road 7

This high fill area extends from approximately Station 10+960 to 11+110 on Concession Road 7, with the existing ground surface varying from approximately Elevation 318 m to 326 m, generally rising northward. Five boreholes (21-36 to 21-40 – see Drawing 5) were drilled in this area and the interpreted stratigraphic profile is shown on Drawing MBI-9 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 600 mm of topsoil was encountered in all boreholes.

- **Silty Sand to Sandy Silt Fill:** Approximately 1.5 m of silty sand to sandy silt fill associated with Concession 7 was encountered below the topsoil in Borehole 21-39. This fill is compact to very dense based on SPT "N" values of 29 and 74 blows per 0.3 m of penetration.
- **Silty Sand to Sandy Silt Till:** Till was encountered in all boreholes below the topsoil or fill (where present), extending to the full depth of investigation (up to approximately 9.7 m below existing ground surface). This till generally consists of silty sand to sandy silt with occasional zones of gravel, sandy gravel and silt; sandy gravel till was encountered in the lower portions of Boreholes 21-39 and 21-40. The till is generally compact to very dense based on SPT "N" values ranging from about 11 to greater than 100 blows per 0.3 m of penetration; however, localized very loose to loose zones with SPT "N" values of less than 10 blows per 0.3 m of penetration were encountered in the upper 1 m to 4 m of this deposit. The results of grain size distribution testing on selected samples of the till are provided on Figures HF1-GS-1A and 618-GS-1B in Appendix B. The water contents measured on selected samples range from approximately 2% to 27%.
- **Groundwater Conditions:** Boreholes 21-36 (only 3.6 m deep) and 21-37 were dry upon completion of drilling. Groundwater was observed at depths of approximately 2.7 m to 6.8 m, between approximately Elevation 311.7 m and 317.0 m, in Boreholes 21-38, 21-39 and 21-40 during or upon completion of drilling.

5.2.2 High Fill Area 2 (HF-2) – Mid-Block Connection Road East of Highway 6

A short section of high fill embankment extends from approximately Station 10+355 to 10+375 approaching Concession Road 7 with the existing ground surface at approximately Elevation 321.5 m to 322 m. Boreholes 21-34 and 21-35 (see Drawing 3) were drilled in this area and the interpreted stratigraphic profile is shown on Drawing MBI-9 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm and 800 mm of topsoil were encountered in the boreholes.
- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in both boreholes, and both boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers. The till is generally compact to dense based on SPT "N" values of 12 to 48 blows per 0.3 m of penetration; lower SPT "N" values of 2 to 7 blows per 0.3 m of penetration were encountered in the upper 1 m to 3 m of the deposit, and one SPT "N" value of 6 blows per 0.3 m of penetration measured at the base of Borehole 21-35 is attributed to disturbance by groundwater inflow to the borehole during sampling. One SPT "N" value of 50 blows per 0.10 m of penetration suggests the presence of gravel and/or cobbles. The results of the grain size distribution analyses conducted on representative samples of the till are provided in Figure HF2-GS-1 in Appendix B. The water contents measured on selected samples range from approximately 6% to 24%.
- **Groundwater Conditions:** The groundwater level was observed in the open boreholes to be between 1.7 m and 4.2 m depth, at about Elevation 319.8 m to 317.5 m.

5.2.3 High Fill Area 3 (HF-3) – Mid-Block Connection Road West of Highway 6

High fill embankment areas extend along the Mid-Block Connection Road west of Highway 6 from approximately Station 9+850 to 9+890 and 9+925 to 9+940 with the existing ground surface in the area between approximately Elevation 324 m and 327 m. Boreholes 21-32 and 21-33 were drilled in this area (see Drawing 3) and the interpreted stratigraphic profile is shown on Drawing MBI-9 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 800 mm of topsoil was encountered in the boreholes.

- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in both boreholes, and both boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers. The till is generally compact to dense based on SPT "N" values of 14 to 43 blows per 0.3 m of penetration; one SPT "N" value of 50 blows per 0.08 m of penetration suggests the presence of gravel and/or cobbles. The results of the grain size distribution analyses conducted on representative samples of the till are provided in Figure HF3-GS-1 in Appendix B. The water contents measured on selected samples range from approximately 5% to 9%.
- **Groundwater Conditions:** Boreholes 21-32 and 21-33 were dry during and on completion of drilling, suggesting that the groundwater level is below the base of these boreholes (i.e., below approximately Elevation 317.9 m and 316.5 m, respectively).

5.2.4 High Fill Area 4 (HF-4) – Wellington Road 34 West of Highway 6

This section of high fill embankment extends from approximately Station 9+820 to 9+970 along Wellington Road 34, west of the proposed Wellington Road 34 underpass. The existing Wellington Road 34 grade is at approximately Elevation 310.5 m and the natural ground surface in the wetland surrounding the local roadway is at approximately Elevation 309 m. Nine boreholes (21-04 to 21-08, 21-07A, 35-617-01 to 35-617-03) and six test holes (TP-03, TP-04, TP-07, TP-08, TP-11 and TP-12) were advanced in this area (see Drawing 4). The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-10 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Pavement Structure and Fill:** Approximately 100 mm and 50 mm of asphalt was encountered in Boreholes 21-05 and 21-08, overlying an approximately 600 mm thick granular layer. Beneath the pavement structure in these two boreholes, below the topsoil in Borehole 21-07A, from ground surface in Borehole 35-617-01 advanced through the shoulder, and from ground surface in Boreholes 35-617-02 and 35-617-03 advanced near the embankment toe, the Wellington Road 34 embankment fill consists of approximately 0.7 m to 3.0 m of silty sand to sandy silt, some gravel to gravelly, which extends to a maximum depth of approximately 3.8 m (Elevation 306.8 m) as measured at the borehole locations. The SPT "N" values within the fill range from weight of hammer to 80 blows per 0.3 m of penetration, with one SPT "N" value of 50 blows per 0.13 m of penetration, indicating a variable, very loose to very dense relative density. The results of grain size distribution testing are provided in Figure HF4-GS-1A in Appendix B. The moisture contents of the samples tested from this fill material ranged from about 5% to 10%.
- **Topsoil:** Approximately 300 mm to 900 mm of topsoil was encountered at ground surface in the majority of the test holes advanced within the wetland area (excluding TP-11).
- **Peat/Organics:** Peat/organic soil was encountered immediately below ground surface in Boreholes 21-04, 21-06, 21-07 and TP-11, and below the topsoil in test holes TP-07, TP-9 and TP-12. This material is between 0.6 m and 1.8 m in thickness as encountered in these boreholes and test holes, with its base between approximately Elevation 307.1 m and 308.3 m; the thickness and depth of this peat will vary between and beyond the exploration locations. This layer varies in composition from fibrous peat containing undecomposed pieces of wood and roots mixed with trace to some sand and gravel; to amorphous peat, to organic clayey silt to silty clay containing trace to some sand and gravel. The SPT "N" values within this layer ranged from weight of hammer to 2 blows per 0.3 m of penetration. In situ vane shear testing was completed in the peat and organic clayey silt in TP-11 and TP-12 and measured undrained shear strengths ranging from 6 kPa to 24 kPa, indicating a very soft to soft consistency. The measured water contents range from approximately 23% to 499%.

- **Silty Sand to Sandy Silt Till:** Till was encountered below the Wellington Road 34 embankment fill or below the peat/organic deposit outside of the roadway platform, with its surface at approximately Elevation 306.8 m to 308.3 m; the till surface will vary between and beyond the boreholes and test holes. The till deposit is on the order of 14 m in thickness as proven in Borehole 35-617-02 near the proposed west abutment of the Wellington Road 34 underpass. The till varies in composition from silty sand to sandy silt containing zones of gravel and sandy gravel. The SPT 'N' values within the till deposit ranged from 1 to 50 blows per 0.3 m of penetration with sampler refusal noted on gravel or cobbles at several locations; some of the lower SPT "N" values are attributed to disturbance by groundwater pressures during sampling. The deposit is therefore interpreted to have a generally loose to dense relative density. The results of grain size distribution tests conducted on selected samples of the till are provided on Figure HF4-GS-1A and -1B in Appendix B. The measured water contents range from about 2% to 32%.

- **Groundwater Conditions:** The groundwater level in the open boreholes and test holes in this area was between Elevation 307.3 m and 308.8 m, while that in the monitoring well in Borehole 35-617-03A has been measured as high as Elevation 308.4. In general, the water level within the wetland is at or slightly below the ground surface, although this level is expected to fluctuate seasonally and may be higher in the spring following snow melt or following periods of heavy precipitation.

5.2.5 High Fill Area 5 (HF-5) – Wellington Road 34 East of Highway 6

This section of high fill embankment extends from approximately Station 10+030 to 10+180 along Wellington Road 34, east of the proposed Wellington Road 34 underpass. The existing Wellington Road 34 grade is at approximately Elevation 310 m to 310.5 m, and the natural ground surface in the wetland surrounding the local roadway is at approximately Elevation 309 m. Seven boreholes (21-01 to 21-03, 35-617-06, 35-617-07, 35-617-08 and 35-617-10) and four test holes (TP-15, TP-16, TP-19 and TP-24) were advanced in this area (see Drawing 4). The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-11 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Fill:** Approximately 2.3 m of granular and silty sand fill was encountered immediately below ground surface in Borehole 21-03, which was drilled through the north shoulder of Wellington Road 34, and approximately 0.4 m to 2.1 m of silty sand to clayey silt fill was encountered below a thin topsoil layer in Boreholes 21-01, 35-617-06, 35-617-07 and 35-617-08, with the base of the fill extending to between Elevation 306.8 m and 308.1 m. The SPT "N" values within the fill ranged from 6 to 74 blows per 0.3 m of penetration indicating a variable, loose to very dense relative density. The results of a grain size distribution test conducted on a sample taken from a gravelly zone of this fill in Borehole 21-03 are provided in Figure HF5-GS-1A in Appendix B. The measured water contents range from about 7% to 19%.

- **Topsoil:** Approximately 100 mm to 500 mm of topsoil was encountered immediately below ground surface in Boreholes 21-01, 35-617-06, 35-617-07, 35-617-08, and all four test holes (TP-15, TP-16, TP-19 and TP-24) in this section.

- **Peat/Organics:** Peat/organic soil was encountered immediately below ground surface in Boreholes 21-02 and 35-617-10, below the surficial topsoil in all four test holes, and below approximately 2.3 m of fill in Borehole 21-03 which was drilled through the north shoulder of Wellington Road 34. The peat/organic layer is approximately 0.9 m to 2.3 m thick as encountered in these boreholes and test holes, with the base of this layer extending to between Elevation 305.9 m and 307.4 m (i.e., approximately 1.5 m to 4 m below the natural ground surface in the wetland area. The thickness and depth/base elevation of this peat will vary between and beyond the borehole locations and, indeed, test excavations by Dufferin Construction suggest that the

peat/organic soils may be more than 4 m thick in portions of this area. This layer varies in composition from fibrous peat containing undecomposed pieces of wood and roots mixed with trace to some sand and gravel; to amorphous peat, to organic clayey silt to silty clay containing trace to some sand and gravel. The SPT "N" values within this layer ranged from weight of hammer to 4 blows per 0.3 m of penetration. In situ vane shear testing was completed in the peat and organic clayey silt in TP-15 and TP-16 and measured undrained shear strengths ranging from 14 kPa to 24 kPa, indicating a very soft to soft consistency. An Atterberg limits test was completed on the organic silty clay from Borehole 21-03 and the result is shown on Figure HF5-PC-1 in Appendix B. The measured water contents on samples of the peat/organic layer range from approximately 35% to 477%.

- **Silty Sand to Sandy Silt Till:** Till was encountered below the Wellington Road 34 embankment fill or below the peat/organic deposit outside of the roadway platform, with its surface between approximately Elevation 305.9 m and 308.1 m; the till surface will vary between and beyond the boreholes and test holes. The till deposit is on the order of 13 m to 14 m thick as proven in Borehole 35-617-02 near the proposed east abutment of the Wellington Road 34 underpass. The till varies in composition from silty sand to sandy silt containing zones of gravel and sandy gravel. The SPT 'N' values within the till deposit ranged from 3 to 48 blows per 0.3 m of penetration with sampler refusal noted on gravel or cobbles at several locations; some of the lower SPT "N" values are attributed to disturbance by groundwater pressures during sampling. The deposit is therefore interpreted to have a generally loose to dense relative density. The results of grain size distribution tests conducted on selected samples of the till are provided on Figure HF5-GS-1B in Appendix B. The measured water contents range from about 9% to 20%.

- **Clayey Silt Till:** In the eastern portion of this high fill section, in Boreholes 21-01 and 21-02, the lower portion of the till below Elevation 304.5 m and 303.6 m grades to clayey silt containing trace sand and gravel. The measured SPT "N" values range from 14 to 61 blows per 0.3 m of penetration suggesting a stiff to hard consistency, with one SPT "N" value of 73 blows per 0.28 m of penetration suggesting the presence of gravel or cobbles. The results of grain size distribution tests conducted on selected samples of the cohesive till are provided on Figure HF5-GS-1C in Appendix B. The results of Atterberg limit tests on the cohesive till confirm it is a clayey silt of low plasticity (see Figure HF5-PC-3 in Appendix B). The measured water contents range from about 11% to 19%.

- **Groundwater Conditions:** The groundwater level in the open boreholes and test holes in this area was between Elevation 307.1 m and 308.8 m; artesian groundwater pressures were measured in Boreholes 35-617-06 and 35-617-10 associated with the till deposit just above the bedrock surface, with the piezometric head rising to approximately Elevation 310.7 m. In general, the water level within the wetland is at or slightly below the ground surface, although this level is expected to fluctuate seasonally and may be higher in the spring following snow melt or following periods of heavy precipitation.

5.2.6 High Fill Area 6 (HF-6) – S-EW Ramp

This section of high fill embankment extends from approximately Station 10+290 to 10+420 along the Highway 6 S-EW Ramp, where the existing grade is at approximately Elevation 321 m to 326 m. Three boreholes (21-26 to 21-28 – see Drawing 3) were advanced in this area. The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-12 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 600 mm to 800 mm of topsoil was encountered at ground surface in the boreholes.

- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in all boreholes, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers, and a zone within Borehole 21-27 that grades to low plasticity clayey silt. The till is generally compact to very dense based on SPT "N" values of 14 to 61 blows per 0.3 m of penetration; one SPT "N" value of 100 blows per 0.3 m of penetration may be indicative of the presence of gravel and/or cobbles. The results of the grain size distribution tests conducted on representative samples of the till are provided in Figure HF6-GS-1 in Appendix B. The results of the Atterberg limits test on a sample of the cohesive zone from Borehole 21-27 are shown on Figure HF6-PC-1 in Appendix B, confirming that the till grades locally to clayey silt of low plasticity. The water contents measured on selected samples range from approximately 1% to 17%.
- **Groundwater Conditions:** Boreholes 21-26 and 21-28 were dry during and following drilling. The water level measured in the monitoring well in Borehole 21-27 was at approximately 8.1 m depth (Elevation 315.9 m).

5.2.7 Deep Cut Area 1 (DC-1) – Concession Road 7

This section of deep cut extends from approximately Station 10+730 to 10+800 along Concession Road 7, where the existing grade is at approximately Elevation 317 m to 321 m. Three boreholes (21-41 to 21-43 – see Drawing 5) were advanced in this area. The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-13 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 400 mm of topsoil was encountered at ground surface in the boreholes.
- **Sandy Silt Fill:** Fill consisting of sandy silt, trace gravel and trace clay was encountered below the topsoil in Boreholes 21-41 and 21-43. The fill is 1.2 m to 1.3 m thick as encountered in these boreholes, extending to approximately Elevation 310.9 m to 317.8 m (rising northward). The SPT "N" values range from 3 to 7 blows per 0.3 m of penetration, indicating that this fill is very loose to loose. The results of a grain size distribution test conducted on a sample of are provided in Figure DC1-GS-1 in Appendix B. The measured water contents range from about 8% to 18%.
- **Silty Sand to Sandy Silt to Sandy Gravel Till:** Till was encountered below the topsoil and fill (where present) in all boreholes, and all boreholes terminated within this deposit. The till generally consists of silty sand to sandy silt, trace gravel to gravelly, although the till encountered in Borehole 21-43 grades to sandy gravel. The till is compact to very dense based on SPT "N" values of 12 to 85 blows per 0.3 m of penetration; with several SPT "N" value of 50 blows for less than 0.3 m of penetration which may be indicative of the presence of gravel and/or cobbles. The results of grain size distribution tests conducted on representative samples of the till are provided in Figures DC1-GS-2 and DC1-GS-3 in Appendix B. The water contents measured on selected samples range from approximately 6% to 20%.
- **Groundwater Conditions:** The groundwater level has been measured at approximately Elevation 310.6 m in the monitoring well in Borehole 21-43 near the south (lower) portion of this deep cut section.

5.2.8 Deep Cut Area 2 (DC-2) – Mid-Block Connection Road North of Wellington Road 34

This section of deep cut extends from approximately Station 9+050 to 9+085 along the Mid-Block Connection Road, just north of Wellington Road 34, where the existing grade is at approximately Elevation 315.5 m to 316 m. Three boreholes (21-09 to 21-11) were advanced in this general area (see Drawing 2). The interpreted

stratigraphic profile based on the borehole information is shown on Drawing MBI-13 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 600 mm of topsoil was encountered at ground surface in the boreholes.
- **Silty Sand to Sandy Silt to Sandy Gravel Till:** Till was encountered below the topsoil in all boreholes in this area, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers. The till is generally compact to very dense based on SPT "N" values of 11 to 55 blows per 0.3 m of penetration; several instances of higher SPT "N" values for less than 0.3 m of penetration are considered indicative of the presence of gravel and/or cobbles. The results of the grain size distribution tests conducted on representative samples of the till are provided in Figure DC2-GS-1 in Appendix B. The water contents measured on selected samples range from approximately 2% to 13%.
- **Groundwater Conditions:** The groundwater level in the monitoring wells in Boreholes 21-09 and Borehole 21-11 was measured as high as Elevation 311.3 m in August 2021.

5.2.9 Deep Cut Area 3 (DC-3) – Highway 6 SBL South of Mid-Block Connection Road

This section of deep cut extends from approximately Station 11+790 to 11+770 along the Highway 6 southbound lanes, south of the Mid-Block Connection Road underpass, where the existing grade is at approximately Elevation 320 m. Three boreholes (21-29 to 21-31) were advanced in this general area (see Drawing 3). The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-14 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 500 mm of topsoil was encountered at ground surface in the boreholes.
- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in all boreholes in this area, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers. The till is generally compact to very dense based on SPT "N" values of 13 to 89 blows per 0.3 m of penetration; several instances of higher SPT "N" values for less than 0.3 m of penetration are considered indicative of the presence of gravel and/or cobbles. The results of the grain size distribution tests conducted on representative samples of the till are provided in Figure DC3-GS-1 in Appendix B. The water contents measured on selected samples range from approximately 5% to 23%.
- **Groundwater Conditions:** The groundwater level in the monitoring well in Boreholes 21-29 was measured as high as Elevation 311.5 m in August 2021 and Elevation 311.7 m in August 2022. The groundwater level in Boreholes 21-30 and 21-31 was observed at approximately Elevation 312.5 m to 313 m in the open boreholes during and following completion of drilling.

5.2.10 Deep Cut Area 4 (DC-4) – Highway 6 NBL and E-N Ramp

This section of deep cut extends from approximately Station 12+030 to 12+100 and 12+180 to 12+520 along the Highway 6 NBL and Station 9+780 to 10+000 along the E-N Ramp, with the existing grade outside of the current Highway 6 cut at approximately Elevation 330 m to 339 m. Five boreholes (21-17, 21-18, 21-20, 21-22 and 21-24) were advanced in this general area (see Drawing 3). The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-15 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 400 mm of topsoil was encountered at ground surface in the boreholes.

- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in all boreholes in this area, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and sand or silt layers; a thin zone of clayey silt was encountered within the till in Borehole 21-24. The till is generally compact to very dense based on SPT "N" values that are generally between 10 blows and 75 blows per 0.3 m of penetration; the uppermost sample in the majority of the boreholes has a lower SPT "N" value indicating loose material, and an instance of higher SPT "N" values for less than 0.3 m of penetration is considered indicative of the presence of gravel and/or cobbles. The results of grain size distribution tests conducted on representative samples of the till are provided in Figure DC4-GS-1 in Appendix B. An Atterberg limits test on the cohesive layer in Borehole 21-24 is plotted on Figure DC4-PC-1 in Appendix B, confirming the till grades to clayey silt of low plasticity in this local zone. The water contents measured on selected samples of the till range from approximately 2% to 22%.
- **Groundwater Conditions:** The groundwater level in the monitoring well in Boreholes 21-24 was measured as high as Elevation 327.2 m (8.6 m depth) in August 2021. Boreholes 21-17, 21-18, 21-20 and 21-22 were dry on completion of drilling suggesting the water level is below the base of these boreholes, although this may not represent the stabilized groundwater level at these locations.

5.2.11 Deep Cut Area 5 (DC-5) – E-S Ramp and Infiltration Pond

This section of deep cut extends from approximately Station 9+980 to 10+000 along the Highway 6 E-S Ramp. Five boreholes (21-12 to 21-14, 21-51 and GBH-32) were advanced in this general area (see Drawing 3). The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-14 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 400 mm of topsoil was encountered at ground surface in Boreholes 21-12 to 21-14. Boreholes 21-51 and GBH-32 in the footprint of the infiltration pond encountered approximately 1.5 m and 1.8 m of topsoil, respectively.
- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in all boreholes in this area, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravelly sand and sand layers. The till is generally compact to very dense based on SPT "N" values of 10 to 92 blows per 0.3 m of penetration; one instance of "weight of hammer" suggests a localized very loose zone, and two instances of 50 blows for 0.15 m of penetration are considered indicative of the presence of gravel and/or cobbles. The results of the grain size distribution tests conducted on representative samples of the till are provided in Figure DC5-GS-1 in Appendix B. The water contents measured on selected samples range from approximately 2% to 11%.
- **Groundwater Conditions:** A monitoring well was installed in Boreholes 21-12 and 21-51, and these were reported dry on PML's borehole records, indicating the water level was below approximately Elevation 320.7 m and 314.7 m, respectively, in August 2021. The water level in Monitoring Well 21-12 was measured at approximately 321.0 m in November 2022, while that in Monitoring Well 21-51 was measured at approximately Elevation 314.7 m in November 2022. The monitoring well installed in Borehole GBH-32 was dry (water level below Elevation 319 m) between August and December 2022.

5.2.12 Deep Cut Area 6 (DC-6) – Highway 6 SBL and N-EW Ramp

This section of deep cut extends from approximately Station 12+240 to 12+540 along the Highway 6 southbound lanes and 10+000 to 10+280 along the N-EW Ramp, north of the Mid-Block Connection Road underpass. Six boreholes (21-15, 21-16, 21-19, 21-21, 21-23 and 21-25) were advanced in this general area (see Drawing 3).

The interpreted stratigraphic profile based on the borehole information is shown on Drawing MBI-15 in Appendix E. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 200 mm to 500 mm of topsoil was encountered at ground surface in the boreholes (excluding Borehole 21-25).
- **Silty Sand to Sandy Gravel Fill:** Approximately 1.3 m of silty sand fill was encountered below the topsoil in Borehole 21-21, and about 3.4 m of sandy gravel fill was encountered immediately below the ground surface in Borehole 21-25; these boreholes were drilled along the existing ditch adjacent to Highway 6 southbound lanes. The fill has a loose to dense density based on SPT "N" values ranging from 5 to 44 blows per 0.3 m of penetration. The results of grain size distribution tests on samples of the fill are provided in Figure DC6-GS-1A and DC6-GS-1B in Appendix B. The measured water contents range from 4% to 17%.
- **Silty Sand to Sandy Silt Till:** Till was encountered below the topsoil in all boreholes in this area, and all boreholes were terminated within this deposit. The till generally consists of silty sand to sandy silt with occasional zones of gravel and silt layers; a think zone of clayey silt was encountered within the till in Borehole 21-21. The till is generally compact to very dense based on SPT "N" values of 11 to 53 blows per 0.3 m of penetration; two instances of higher SPT "N" values for less than 0.3 m of penetration are considered indicative of the presence of gravel and/or cobbles. The results of the grain size distribution tests conducted on representative samples of the till are provided in Figure DC6-GS-2 in Appendix B. The result of an Atterberg Limits test on the cohesive sample from Borehole 21-21 is plotted on Figure DC6-PC-1 and confirms that the material is clayey silt of low plasticity. The water contents measured on selected samples range from approximately 1% to 18%.
- **Groundwater Conditions:** The groundwater level was measured at a depth of 5.0 m (Elevation 328.4 m) in the monitoring well in Borehole 21-21 in August 2021, and at a depth of 4.8 m (Elevation 328.6 m) in August 2022. While Boreholes 21-15 and 21-23 were dry on completion of drilling, groundwater was observed during drilling in Boreholes 21-16 (7.6 m depth, Elevation 323.8 m), 21-19 (7.6 m depth, Elevation 329.3 m) and 21-25 (2.4 m depth, Elevation 332.9 m).

5.2.13 Infiltration Pond in W-N Ramp Loop

This infiltration pond is located in the southeast quadrant of the Mid-Block Connection Road interchange, within the W-N Ramp loop. The existing ground surface at this location is at approximately Elevation 324 m. Boreholes 21-50 and GBH-28 were advanced in this area. The encountered subsurface conditions are summarized as follows:

- **Topsoil:** Approximately 400 mm and 800 mm of topsoil was encountered at ground surface in the boreholes.
- **Silty Sand, Gravelly Silty Sand and Sandy Silt to Silt Till:** Non-cohesive soils varying in composition from silty sand, to gravelly silty sand, to sandy silt to silt were encountered below the topsoil layer, and the borehole was terminated within this deposit. The deposit is compact to very dense based on SPT "N" values of 13 blows to greater than 100 blows per 0.3 m of penetration.
- **Groundwater Conditions:** Boreholes 21-50 and GBH-28 were dry during and on completion of drilling, and recovered soil samples were moist, suggesting the groundwater level is below approximately Elevation Elevation 314 m in the vicinity of Borehole GBH-28.

6.0 CLOSURE

This Foundation Investigation Report was prepared and reviewed by Michael Beadle, P.Eng., Senior Principal and Lisa Coyne, P.Eng., Fellow and MTO Principal Foundations Contact.

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PART B

FOUNDATION DESIGN REPORT

HIGH FILL EMBANKMENTS AND DEEP CUTS
HIGHWAY 6/HANLON EXPRESSWAY MID-BLOCK INTERCHANGE
COUNTY OF WELLINGTON, ONTARIO
MTO DB 2021-3004

7.0 DISCUSSION AND FOUNDATION ENGINEERING RECOMMENDATIONS

7.1 General

This section of the report provides detailed geotechnical/foundation engineering recommendations for design of the high fill embankment and deep cut sections associated with the Highway 6/Hanlon Expressway Mid-Block Interchange Improvements contract in the County of Wellington, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during 2017 and 2021 investigations by PML associated with the procurement-ready design for the site, supplemented with additional investigation by WSP in 2022 and 2023 as presented in Part A of this report.

The discussion and recommendations presented herein are intended to provide the designers with sufficient information to complete the detail design of the high fill embankment and deep cut sections. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required for construction.

The recommendations in this report are in accordance with the *Canadian Highway Bridge Design Code* (CHBDC 2019, CAN/CSA-S6-19) and its *Commentary*, the *Canadian Foundation Engineering Manual* (CFEM, 2006), Ontario Provincial Standard Specifications (OPSS), Design-Build Special Provisions (DBSP) and Ontario Provincial Standard Drawings (OPSD).

7.2 High Fill Embankments

High fill embankments, greater than 4.5 m in height, are located along Concession 7, Mid-Block Connection Road, Wellington Road 34 and Highway 6 at the approximate locations summarized in Table 5.

Table 5: Summary of High Fill Embankments Areas

Label	Road Section	Approximate Station	Approximate Maximum Height (m)
HF-1	Concession Road 7	10+960 – 11+110	7.5
HF-2	Mid-Block Connection Road	10+355 – 10+375 Rt	5.5
HF-3		9+850 – 9+890	5.5
		9+925 – 9+940 Rt	5.5
HF-4	Wellington Road 34	9+820 – 9+970	9
HF-5		10+030 – 10+180	9
HF-6	Highway 6 S-EW Ramp	10+290 – 10+420	4.5

In addition to the above-noted high fill embankments, permanent berms are proposed east of the S-EW Ramp to accommodate soils excavated from cut sections on this contract.

7.2.1 Subgrade Preparation for Embankment Construction

7.2.1.1 All High Fill Sections Except Wellington Road 34

Prior to construction of the high fill embankment sections on Concession 7, the Mid-Block Connection Road and the S-EW Ramp, it is recommended that existing topsoil be stripped from the proposed embankment footprint.

For permanent berms, from a geotechnical/foundation perspective, it is not strictly necessary to strip existing topsoil from within the footprint of the proposed berms.

7.2.1.2 Peat/Organic Subexcavation Along Wellington Road 34

Subexcavation of existing peat and organic soils is required within the footprint of the proposed high fill embankments along Wellington Road 34, beyond the existing roadway embankment, to obtain the required minimum factor of safety for global stability and permit the new embankments to meet MTO's post-construction settlement criteria.

This subexcavation is estimated to extend to a depth of approximately 1 m to 4 m below the existing ground surface outside of the existing roadway platform, to approximately Elevation 308 m to 305 m, to remove the existing peat/organic material. In general, based on borehole and test hole investigation results, the subexcavation depth is expected to be as much as approximately 2 m to 2.5 m deep outside of the existing Wellington Road 34 platform west of Highway 6, and locally as much as 3 m to 4 m deep outside of the existing Wellington Road 34 platform east of Highway 6.

The subexcavation works will be completed subaqueously without dewatering, with the excavation completed in relatively narrow strips or zones which are backfilled immediately to minimize sloughing of excavation sidewalls. The narrow strips or zones are required in particular adjacent to the existing Wellington Road 34 or Highway 6 platforms to avoid undermining these existing roadways during the peat/organic subexcavation operation. The subexcavation may be backfilled with the native silty sand to sandy silt till materials excavated from elsewhere on the Highway 6/Mid-Block Connection Interchange contract, or with imported granular materials such as OPSS.PROV 1010 Granular B Type II. An Operational Constraint for subaqueous subexcavation and backfilling is provided in Appendix G.

Further details regarding the limits of subexcavation are provided in Section 7.2.3.2 below, based on global stability analyses for the embankment height at given sections.

7.2.2 Embankment Construction

7.2.2.1 High Fill Embankment Construction

Fill for construction of the high fill embankments may consist of OPSS.PROV 1010 Granular A or Granular B Type I, Type II or Type III, or alternatively earth fill or select subgrade material (SSM). Excavated native material (excluding topsoil) from the cuts at the Mid-Block Interchange area are geotechnically suitable for reuse as embankment fill on the project. Fill should be placed and compacted in accordance with OPSS.PROV 501 (Compacting) and OPSS.PROV 206 (Grading) to at least 95% of the material's standard Proctor maximum dry density (SPMDD).

Where earth fill or select subgrade material is used for embankment construction, exposed unvegetated materials will be susceptible to erosion and shallow ravelling. To reduce surface water erosion and ravelling on the embankment side slopes or cut slopes, treatment per OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover) must be provided. If slope protection is not in place prior to winter or

periods of excessive precipitation, repair of embankment side slopes or use of alternate protection measures such as gravel sheeting per OPSS 511 (Rip-Rap, Rock Protection and Granular Sheeting) and OPSS.PROV 1004 (Aggregates – Miscellaneous) may be required to reduce the potential for erosion and associated requirements for remedial works on the slope faces prior to topsoil dressing and seeding.

7.2.2.2 Permanent Berm Construction

Excess fill or native soils from the Project Area are geotechnically suitable for placement and compaction within the permanent berms. Berm fill materials should be placed in general accordance with OPSS.PROV 206 (Grading) and OPSS.PROV 501 (Compacting).

As the permanent berms will not support highway or structural loading, it is not strictly required to measure and meet a given compaction level; however, selection of appropriate lift thicknesses, wetting or drying of materials to appropriate water contents for compaction and selection of equipment and procedures to meet approximately 90% of standard Proctor maximum dry density for the materials will promote global and surficial stability of these materials on the berm slopes.

Excess organic soils may be incorporated into lifts within the permanent berms. However, where organic soils are incorporated within the body of the permanent berms, it is recommended that they be maintained within the "central" portion of the berm, and that the outside limits of any excess organic soils incorporated into the permanent berms be maintained a minimum distance of 1.5X from the finished toe or face of the berm, where X is the finished height of the berm.

The outer "shell" of the berms may consist of excess organic soil that meets requirements for topsoil, benched into the 2 horizontal to 1 vertical (2H:1V) berm side slopes with a maximum thickness (measured perpendicular to the berm side slope) of 500 mm. Appropriate treatment of the berm surfaces must be provided in the interim and final conditions to mitigate surficial erosion and sloughing, in accordance with OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover).

To incorporate greater volumes of organic material within a permanent berm to optimize on-site reuse of materials throughout construction, a thicker zone of organic material may also be placed horizontally in the upper portion of the berms to the maximum height achievable within the footprint available. The outside slope through any such thicker topsoil zone(s) should be inclined at a maximum of 3H:1V to promote surficial stability in the topsoil materials. As above, the berm side slopes should be treated in accordance with OPSS.PROV 804 and OPSS.PROV 803.

7.2.3 Global Stability

7.2.3.1 All High Fill Embankment Sections Excluding Wellington Road 34

It is recommended that all high fill embankments and permanent berms be constructed with side slopes no steeper than 2H:1V. Where high fill embankments exceed 8 m in height, a minimum 2 m wide mid-height bench is to be incorporated to minimize erosion and promote surficial stability.

Limit equilibrium slope stability analyses have been performed for selected high fill embankment sections using the commercially available program Slide2 produced by Rocscience Inc., using the Morgenstern-Price method of analysis, to examine numerous potential failure surfaces to assess the minimum factor of safety. A minimum factor of safety of 1.5 has been targeted for long-term (effective stress) conditions for the slopes on this project, in accordance with CHBDC (2019).

For the predominantly non-cohesive soils present at the site, the effective stress parameters employed in the analyses were estimated from empirical correlations based on the results of the in-situ Standard Penetration Tests (SPT). The correlations proposed by Peck et al (1974) and U.S. Navy (1986) were employed and the results were adjusted by engineering judgment based on precedent experience in similar soil conditions. The parameters used in these global stability analyses are summarized in Table 6.

Table 6: Geotechnical Parameters for Global Stability Analysis of High Fill Embankment Areas

Soil	Bulk Unit Weight (kN/m^3)	Effective Friction Angle (ϕ') (degrees)	Cohesion (c') (kPa)
Embankment fill (assuming reuse of site soils as compacted earth fill)	20	30	-
Compact to very dense silty sand to sandy silt till	19	28-34	-

The results of the global stability analyses for the following representative "critical conditions" (representing the highest or deepest sections in combination with conservative geotechnical parameters) are shown on Figures F-1 to F-3 in Appendix F, as summarized below. For these analyses, shallow slippages in the silty material have been neglected, and treatment of the slope surfaces will be required to minimize such erosion and ravelling as discussed in Section 7.2.2.

- Figure F-1 illustrates an approximately 5.5 m high embankment on compact till with an effective friction angle of only 28 degrees, demonstrating a minimum factor of safety of 1.5; this represents areas where the upper portion of the till deposit has a loose to compact relative density. The majority of the native till deposit will have an effective friction angle of greater than 28 degrees yielding higher factors of safety for global stability. This is demonstrated in Figure F-2, where a 5.5 m high embankment is shown on compact to dense silty sand till with an effective friction angle of 32 degrees. These analyses demonstrate that the high fill embankments along the Mid-Block Connection Road (HF-2 and HF-3, up to approximately 5.5 m in height), and along the S-EW Ramp (HF-6, up to approximately 4.5 m in height) meet the required minimum factor of safety for global stability.
- Figure F-3 illustrates an approximately 7.5 m high embankment as applicable to High Fill Area 1 (HF-1) along Concession 7, using an effective friction angle of 28 degrees to represent an upper 2 m thick loose zone, over compact to dense till with an effective friction angle of 32 degrees. This analysis demonstrates that a 7.5 m high embankment along Concession 7 meets the required minimum factor of safety for global stability.
- The above-noted analyses also demonstrate an adequate factor of safety for global stability of permanent berms up to 7.5 m in height.

7.2.3.2 Global Stability – High Fill Embankments Along Wellington Road 34

As guiderail is proposed along Wellington Road 34, the high fill embankment side slopes may be oriented as steep as 2H:1V. The key recommendations associated with global stability are summarized as follows, and details regarding the global stability analyses are provided below.

- Provided the peat and organic soils are subexcavated from within the required portion of the footprint of the high fill embankments as described in Section 7.2.1.2 and the Operational Constraint, factors of safety of greater than 1.3 and 1.5 are achieved for global stability in short-term (undrained) and long-term (effective

stress) conditions for embankment heights between 4.5 m and 9 m with side slopes oriented at 2H:1V. These minimum factors of safety meet the requirements of CHBDC (2019) for a typical degree of site understanding.

- As discussed further below, the limits of peat/organic subexcavation have been optimized based on the height of the embankment. The peat/organic soil must be removed outside of the existing roadway platform under the full footprint where the embankments are greater than 8.5 m in height. Where the embankments are less than 8 m in height, some peat/organics may be maintained under the outer toe of the embankments while still achieving the minimum required factors of safety and settlement performance criteria.
- Where embankments with 2H:1V side slopes are equal to or greater than 8 m in height, a mid-height bench with a minimum width of 2 m should be incorporated to aid in mitigating surficial erosion associated with precipitation and run-off. If and where flatter side slopes are adopted, a mid-height bench may not be required, depending on the space available within the right-of-way.

To support the above conclusions regarding global stability, limit equilibrium slope stability analyses were completed using Slide2 produced by Rocscience Inc.; the analyses generally used the Morgenstern-Price method although the more conservative Janbu and Bishop models were also checked. For the predominantly non-cohesive soils present at the site, the effective stress parameters used in the analyses were estimated from empirical correlations based on SPT results (Peck et al (1974) and U.S. Navy (1986)), while estimates of properties for the peat are based on the Muskeg Engineering Handbook and Mesri and Ajlouni (2007), together with engineering judgment based on precedent experience in similar conditions. The ranges of parameters used in the analyses are summarized in Table 7; the properties for the peat are being reviewed as part of the current investigations and will be updated if and as applicable in the final report submission. The groundwater level was modelled at the existing ground surface in the swamp area.

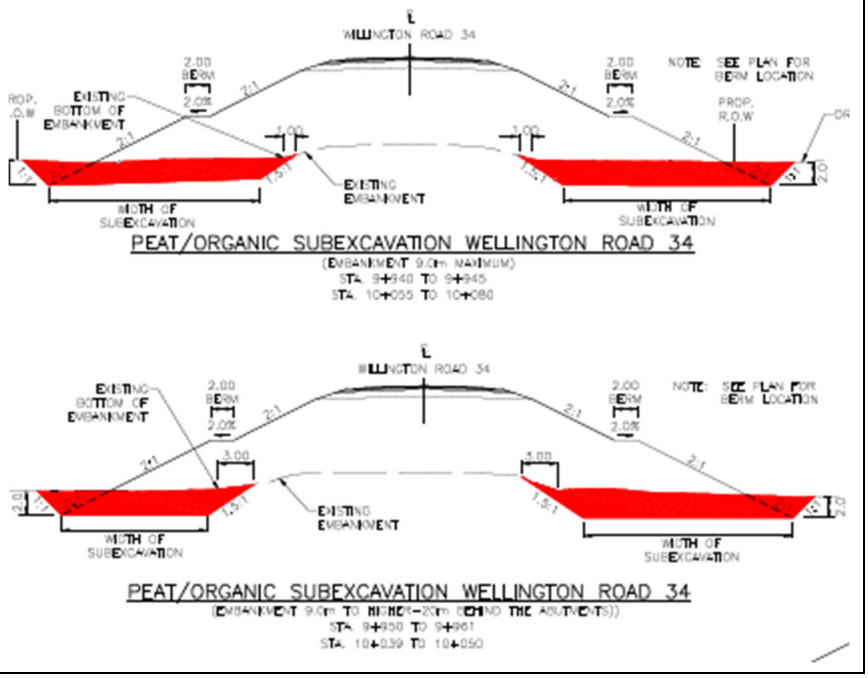
Table 7: Geotechnical Parameters for Global Stability Analyses – Wellington Road 34 Embankments

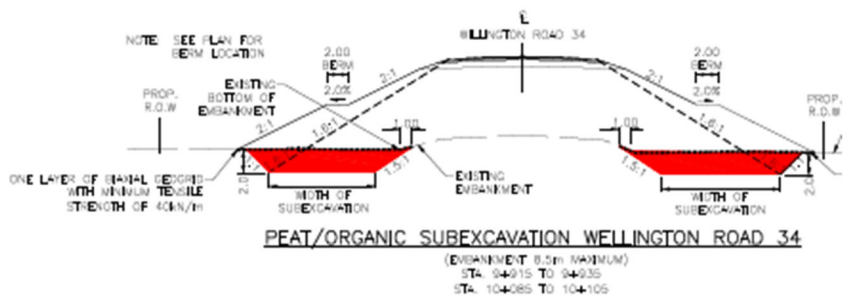
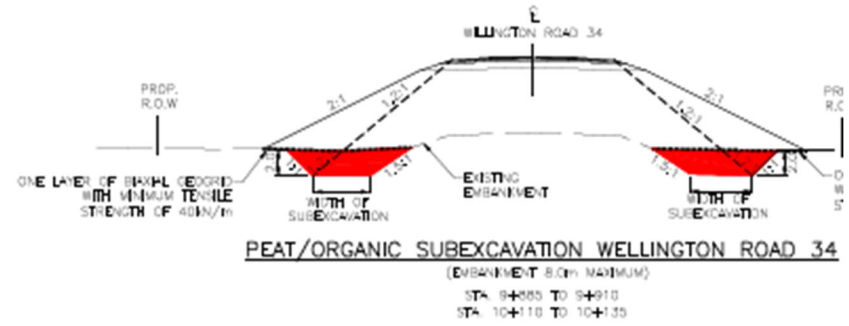
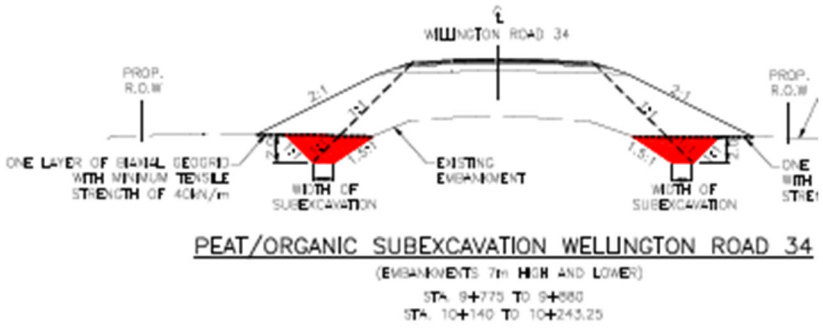
Material or Deposit	Bulk Unit Weight (kN/m^3)	Effective Stress Conditions		Undrained Conditions
		Effective Friction Angle, ϕ' (degrees)	Cohesion (c') (kPa)	Undrained Shear Strength (kPa)
New embankment fill (assuming reuse of silty sand till from Mid-Block interchange area)	20	35	-	-
Existing embankment fill	21	33	-	-
Backfill following subexcavation of peat/organic materials	20	31	-	-
Peat/organic soil remaining beyond embankment toe	12	24	-	12
Peat/organic soil remaining below and immediately adjacent to embankment toe, following subexcavation	17	27	-	25
Generally compact to dense silty sand to sandy silt till	21	34	-	-

To achieve a minimum factor of safety of 1.3 in short-term (undrained) conditions and 1.5 in long-term (effective stress) conditions, peat/organic subexcavation as summarized in Table 8 is required. The projection lines for peat/organic subexcavation described in Table 8 are to extend from the crest of the Wellington Road 34 embankment, downward and outward to the base of the peat layer as illustrated in the sketches in Table 8. For embankment heights between the values given in Table 8, the projected lines and peat/organic subexcavation limits may be interpolated.

It is noted that where there is sufficient property within the right-of-way, excess materials may be placed over the lower portion of the embankment slope as part of excess soil management, and this will have a beneficial impact on the factor of safety for global stability of the embankments as it increases the resisting forces. This will also contribute to localized management of materials removed as part of the peat/organic subexcavation.

Table 8: Summary of Peat/Organic Subexcavation to Achieve Minimum FOS for Global Stability

Embankment Height	Projection Line for Subexcavation (from Crest of Embankment to Base of Peat)	Conceptual Sketch Showing Peat/Organic Subexcavation Requirements
Equal to or greater than 9.0 m	Peat to be subexcavated and replaced under full footprint of the embankment, with the subexcavation line projected downward and outward at 2H:1V to the base of the peat. Where such projection extends beyond the MTO ROW, the subexcavation limit shall extend to 0.5 m inside the MTO ROW. See Figures F4 to F-7 in Appendix F for undrained and effective stress analyses with 2 m and 3 m of peat subexcavation.	

Embankment Height	Projection Line for Subexcavation (from Crest of Embankment to Base of Peat)	Conceptual Sketch Showing Peat/Organic Subexcavation Requirements
Equal to or greater than 8.5 m	Peat to be subexcavated and replaced within the zone defined by lines projected at 1.6H:1V from crest of embankment, downward and outward to base of peat/organic layer – See Figures F-8 to F-11 in Appendix F for undrained and effective stress analyses with 2 m and 3 m of peat subexcavation.	
Equal to or greater than 8.0 m	Peat to be subexcavated and replaced within the zone defined by lines projected at 1.2H:1V from crest of embankment, downward and outward to base of peat/organic layer – See Figures F-12 to F-15 in Appendix F for undrained and effective stress analyses with 2 m and 3 m of peat subexcavation	
Equal to or less than 7.0 m	Peat to be subexcavated and replaced within the zone defined by lines projected at 1H:1V from crest of embankment to base of peat/organic layer – See Figures F-16 and F-17 in Appendix F for undrained and effective stress analyses with 2 m of peat subexcavation (it is estimated that peat thickness will be less than approximately 2 m where embankment is less than 7 m high)	

For the above-noted subexcavation lines in which peat/organic materials remain beneath the embankment toe, one layer of biaxial geogrid with a minimum allowable tensile strength of 40 kN/m is required for embankments 8.5 m in height or less for constructability and to enhance the factor of safety for global stability.

7.2.4 Settlement

MTO's applicable "Embankment Settlement Criteria for Design" (July 2010) are summarized in Table 9. For Highway 6 and associated ramps ("Freeways"), the maximum post-paving settlement is set at 100 mm with a differential settlement of 200:1. For Wellington Road 34, the Mid-Block Connection Road and Concession Road 7 ("Non-Freeways"), the total post-paving settlement is limited to 200 mm and differential settlement is 100:1.

Table 9: MTO Settlement Criteria for Embankments

Roadway Type and Subgrade Condition	SETTLEMENT LIMITS	
	Total Settlement (mm)	Differential Settlement (mm)
Embankments on non-compressible soils	50	200:1
Freeways on compressible soils	100	200:1
Non-Freeways on Compressible Soils	200	100:1

7.2.4.1 All High Fill Embankment Sections Except Wellington Road 34

The loading from the proposed high fill embankments along Concession Road 7 (HF- 1), Mid-Block Connection Road (HF-2 and HF-3) and the S-E/W Ramp (HF-6), which are between approximately 4.5 m and 7.5 m high, will induce compression of the underlying loose to very dense non-cohesive till deposit. The estimated total settlement under the 4.5 m to 7.5 m high embankments ranges from less than 25 mm to less than 50 mm, with higher magnitudes corresponding to areas with thicker zones of loose till, and to higher embankment sections. This settlement will occur during the embankment construction and quickly following completion of embankment construction, such that post-paving settlement in all of these areas is less than 25 mm.

This magnitude of settlement meet's MTO's settlement criteria, and there is no requirement for preloading or other settlement mitigation treatment prior to paving.

7.2.4.2 Settlement – High Fill Embankments Along Wellington Road 34

The loading from the proposed high fill embankments along Wellington Road 34, which will be up to approximately 7.5 m high relative to the existing Wellington Road 34 grade and up to approximately 9 m high relative to the surrounding ground surface, will induce settlement in the underlying soils.

The peat/organic subexcavation and backfilling operation will result in an initially loose backfill layer outside of the existing Wellington Road 34 embankment that will range from less than approximately 1 m to approximately 4 m in thickness. To minimize the total volume of subexcavation of peat/organic materials, it is planned that some peat/organic materials will remain in place under the outer portions of the embankment toes for embankments less than 8.5 m in height (see Section 7.2.3.2). These materials are underlain by generally compact to dense silty sand to sandy silt till.

The total settlement of the foundation soils under the Wellington Road 34 high fill embankment loading is estimated to be up to approximately 75 mm to 125 mm, the majority of which will be associated with the upper 1 m to 4 m thick layer of fill that is placed subaqueously following peat subexcavation. This settlement will be elastic and will occur during and quickly following placement and compaction of the approach embankment fills and prior to construction of the pavement structure and final paving. Where peat/organic material remains under the outside toe of the new embankments, some post-construction settlement will occur under the outer portions of the embankment side slopes; however, these areas have been designed for both stability and settlement (i.e., to remain beyond the loading/settlement zone of influence for the pavements) and the post-paving settlements on Wellington Road 34 and its shoulders will meet MTO's embankment settlement criteria for non-freeways on compressible soil.

It is expected that some localized pockets or zones of peat/organic materials will remain below the existing Wellington Road 34 shoulder, as the presence of such localized pockets/zones cannot be fully delineated, and full removal of the existing Wellington Road 34 platform is not planned. In these cases, it is estimated that a zone of peat/organic soil on the order of 1 m to 1.5 m thick could remain below the loading zone of influence of the finished pavements. The presence of such materials is estimated to result in between 50 mm and 125 mm of settlement of these localized layers, beyond the settlement of the subaqueous backfill and the non-cohesive till deposit. While the settlement in the subaqueous backfill and non-cohesive till will be completed relatively quickly during and following fill placement, settlement of any localized zones of peat/organic soil below the existing Wellington Road 34 embankment will be time-dependent and it is estimated that the majority will be completed within approximately three months following embankment construction.

To address the presence of localized zones of peat/organic soil that may be present below the existing Wellington Road 34 platform, it is recommended that the high fill embankments be constructed to the pavement subgrade level and that final paving on Wellington Road 34 be delayed as long as feasible within the construction schedule, ideally for three months. It is recognized that a shorter duration may be available within the construction schedule following fill placement and prior to final paving in the immediate approach embankments behind the Wellington Road 34 underpass abutments. However, even in this area, the "staged" construction of the Wellington Road 34 high fill embankments (namely subexcavation and backfilling of the peat/organics, initial embankment fill placement above the backfill level, engineered fill placement to pavement subgrade level, then construction of the pavement structure and final paving) represents a form of preloading and will benefit the settlement performance of the high fill embankments.

An Operational Constraint to address the preloading period on Wellington Road 34 is included in Appendix G, for inclusion in the specifications.

7.3 Deep Cut Sections

Deep cut sections, greater than 4.5 m in depth, are required along Concession 7, the Mid-Block Connection Road, Wellington Road 34 and Highway 6 at the approximate locations summarized in Table 10.

Table 10: Summary of Deep Cut Sections

Label	Road Section	Approximate Station	Approximate Maximum Depth (m)
DC-1	Concession Road 7	10+730 – 10+800	10
DC-2	Mid-Block Connection Road	9+050 – 9+085	5.5

Label	Road Section	Approximate Station	Approximate Maximum Depth (m)
DC-3	Highway 6 SBL	11+790 – 11+770	5.2
DC-4	Highway 6 E-N Ramp	9+780 – 10+000	7
	Highway 6 NBL	12+030 – 12+100	7
		12+180 – 12+520	7
DC-5	Highway 6 E-S Ramp	9+980 – 10+000	7
DC-6	Highway 6 SBL	12+540 – 12+240	10.5
	Highway 6 N-EW Ramp	10+000 – 10+280	10.5
--	Infiltration Ponds	SE Quadrant (W-N Ramp)	6
		NW Quadrant (E-S Ramp)	6.5

7.3.1 Summary of Groundwater Conditions at Deep Cut Sections

The groundwater levels in the deep cut areas are summarized in Table 11 relative to the proposed cut grades. In general, all cut areas remain above the stabilized groundwater level in the Mid-Block Interchange area, except for a localized area at the southwest limit of the Connection Road (DC-2) near the tie-in to the Wellington Road 34 grading.

Table 11: Summary of Groundwater Levels in Deep Cut Sections

Location	Approximate Cut Elevation	Approximate Groundwater Elevation	Comments
DC-1	314 to 318 m (rising northward)	310.5 m at the south end, rising northward	Cut section is above the groundwater level
DC-2	311 to 314 m (rising northward)	311 to 311.5 m	Localized area of this cut near west limit of Connection Road, at approximately Station 9+050, will extend near/below groundwater level. Ditch grading must be designed to drain southward to Wellington Road 34 such that the groundwater level in this cut section is lowered to or below the ditch level.
DC-3	318 to 321 m (rising northward	311 to 313 m	Cut section is above groundwater level
DC-4	329 to 336 (rising northward)	Below 320 m (south limit) to 330 m (north limit)	Cut section is above groundwater level
DC-5	324 m to 327 m	Below 322 m	Cut section is above groundwater level

Location	Approximate Cut Elevation	Approximate Groundwater Elevation	Comments
DC-6	329 to 336 (rising northward)	324 m (south limit) to 332 m (north limit)	Cut section is above groundwater level
Pond in SE Quadrant	319 m	Below 318 m	Finished pond base is above groundwater level
Pond in NW Quadrant	321 m	Below 315 m	Finished pond base is above groundwater level

The water levels may be higher during wet periods of the year, such as following winter snow melt and/or periods of heavy precipitation. In addition, localized zones of perched groundwater may be encountered above these elevations.

7.3.2 Cut Slope Construction and Surficial Treatment

For all deep cut sections, the soils exposed in the cut slopes will generally consist of silty sand to sandy silt till, and these soils will be susceptible to erosion and shallow ravelling. To reduce surface water erosion and ravelling on the cut slopes, treatment per OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover) must be provided.

If slope protection is not in place prior to winter or periods of excessive precipitation, or if localized zones of seepage are encountered in cut slopes associated with localized zones of perched water, alternate protection measures such as gravel sheeting per OPSS 511 (Rip-Rap, Rock Protection and Granular Sheeting) and OPSS.PROV 1004 (Aggregates – Miscellaneous) will be required to reduce the potential for erosion and associated requirements for remedial works on the slope faces prior to topsoil dressing and seeding.

For the infiltration ponds, it is recommended that a granular layer be constructed over the pond base to maintain a clean base that minimizes growth of vegetation that could slow infiltration. This granular layer is recommended to consist of a minimum 600 mm thickness of 50 mm clear stone; a non-woven geotextile separator is recommended between the base of this granular fill and the underlying native soils to reduce the potential for movement of finer soil particles into voids in the clear stone.

7.3.3 Global Stability

The cut slopes along Concession 7, the Mid-Block Connection Road and Highway 6 should be constructed with side slopes no steeper than 2H:1V. The infiltration pond side slopes are recommended to be constructed no steeper than 2.5 horizontal to 1 vertical (2.5H:1V) from a global stability perspective; however, flatter side slopes of 3H:1V are recommended to maintain surficial stability with influx and lowering of water during stormwater management events. Where cut slopes exceed 6 m in height, the slope must incorporate a bench with a minimum width of 2 m such that the uninterrupted cut slope height does not exceed 6 m.

Limit equilibrium slope stability analyses were performed for the selected critical deep cut sections using the commercially available program Slide2 produced by Rocscience Inc., employing the Morgenstern-Price method of analysis, to examine numerous potential failure surfaces to assess the minimum factor of safety. A minimum factor of safety of 1.5 has been targeted for long-term (effective stress) conditions for the slopes on this project, in accordance with CHBDC (2019).

For the predominantly non-cohesive soils present throughout the cut sections at this site, the effective stress parameters employed in the analysis were estimated from empirical correlations based on the results of the in-situ Standard Penetration Tests (SPT). The correlations proposed by Peck et al (1974) and U.S. Navy (1986) were employed and the results were adjusted by engineering judgment based on precedent experience in similar soil conditions. The parameters used in this global stability analysis are summarized in Table 12.

Table 12: Geotechnical Parameters for Global Stability Analysis of Cut Sections

Soil	Bulk Unit Weight (kN/m^3)	Effective Friction Angle (ϕ') (degrees)	Cohesion (c') (kPa)
Pavement structure (beyond toe of cut slopes)	21	32	-
Compact to very dense silty sand to sandy silt till	19	28-34	-

The results of the global stability analyses for the following representative “critical conditions” (representing the highest or deepest sections in combination with conservative geotechnical parameters) are shown on Figures F-20 to F-23 in Appendix F, as summarized below. For these analyses, shallow slippages in the silty material have been neglected, and treatment of the slope surfaces will be required to minimize such erosion and ravelling as discussed in Section 7.2.2.1.

- Figures F-18 and F-19 illustrate a deep cut section of approximately 8 m to represent typical conditions at Deep Cut Sections DC-2, DC-3, DC-4 and DC-5, in compact to dense till soils with an effective friction angle of 28 to 30 degrees (Figure F-18) and 28 to 34 degrees (Figure F-19) above the groundwater level; these configurations are intended to represent soil variability for the maximum cut depth demonstrate a minimum factor of safety above 1.5. For Deep Cut Section 2 along the Mid-Block Connection Road just north of Wellington Road 34, appropriate grading and drainage will be required to maintain the groundwater level at or below the ditch level to achieve this factor of safety.
- Localized areas in DC-1 and DC-6 will have deeper cut slopes approaching 10.5 m in height, and this condition is illustrated on Figure F-20, also demonstrating that the factor of safety for global stability is greater than 1.5.
- Figure F-21 illustrates an approximately 6.5 m deep pond side slope oriented at 2.5H:1V above the groundwater table in compact till with effective friction angle conservatively represented at 28 degrees, demonstrating a minimum factor of safety above 1.5. The pond side slopes have been designed to be flatter at 3H:1V which will satisfy the minimum factor of safety for global stability.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Embankment Subgrade Preparation

As described in Section 7.2.1.1, it is recommended that all topsoil and any loosened/softened fill be removed from the footprint of the approach embankments prior to construction of high fill embankments. Topsoil stripping is not strictly required below the footprint of permanent berms.

8.2 Peat/Organic Soil Subexcavation and Backfilling

As described in Section 7.2.1.2, subexcavation of existing peat and organic soils will be required beyond the footprint of the existing Wellington Road 34 embankment toes to obtain an adequate factor of safety for global stability and allow the new embankments to meet MTO's post-construction settlement criteria.

This subexcavation within the approach embankment areas is anticipated to extend to approximately 1 m to 4 m depth below the existing ground surface outside of the existing roadway platform, to approximately Elevation 308 m to 305 m, to remove the existing peat/organic material. These works are planned to be completed subaqueously without dewatering, with the excavation completed in relatively narrow strips or zones which are backfilled immediately. An Operational Constraint has been developed for subexcavation in the vicinity of any utilities and the Highway 6 platform as may be applicable (see Appendix G).

The subexcavation may be backfilled with the native silty sand to sandy silt till materials excavated from elsewhere on the Highway 6/Mid-Block Connection Interchange contract, or with imported granular materials.

8.3 Embankment Side Slope and Cut Slope Treatment

As described in Section 7.2.2, where earth fill or select subgrade material is used for embankment construction, and for cuts within the native soils, the exposed materials will be susceptible to erosion and shallow ravelling. To reduce surface water erosion and ravelling on the embankment side slopes or cut slopes, treatment per OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover) must be provided as soon as possible after completion of the cut or fill slopes.

If slope protection is not in place prior to winter or periods of excessive precipitation, or where localized zones of seepage are encountered in cut slopes, alternate protection measures such as gravel sheeting per OPSS 511 (Rip-Rap, Rock Protection and Granular Sheeting) and OPSS.PROV 1004 (Aggregates – Miscellaneous) will be required to reduce the potential for erosion and associated requires for remedial works on the slope faces prior to topsoil dressing and seeding.

8.4 Incorporation of Excess Organic Soils in Permanent Berms

Excess fill or native soils from the Project Area are geotechnically suitable for placement and compaction within the permanent berms. Berm fill materials should be placed in general accordance with OPSS.PROV 206 (Grading) and OPSS.PROV 501 (Compacting).

As discussed in Section 7.2.2.2, as the permanent berms will not support highway or structural loading, it is not strictly required to measure and meet a given compaction level; however, selection of appropriate lift thicknesses, wetting or drying materials to appropriate water contents for compaction and selection of equipment and procedures to meet approximately 90% of standard Proctor maximum dry density for the materials will promote global and surficial stability of these materials on the berm slopes.

Excess organic soils may be incorporated into lifts within the permanent berms as follows:

- Where organic soils are incorporated within the body of the permanent berms, it is recommended that they be maintained within the "central" portion of the berm, and that the outside limits of any excess organic soils incorporated into the permanent berms be maintained a minimum distance of 1.5X from the finished toe or face of the berm, where X is the finished height of the berm.

- The outer “shell” of the berms may consist of excess organic soil that meets requirements for topsoil, benched into the 2H:1V berm side slopes with a maximum thickness (measured perpendicular to the berm side slope) of 500 mm. Appropriate treatment of the berm surfaces must be provided in the interim and final conditions to mitigate surficial erosion and sloughing, in accordance with OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover).
- To incorporate greater volumes of organic material within a permanent berm to optimize on-site reuse of materials throughout construction, a thicker zone of organic material may also be placed horizontally in the upper portion of the berms to the maximum height achievable within the footprint available. The outside slope through any such thicker topsoil zone(s) should be inclined at a maximum of 3H:1V to promote surficial stability in the topsoil materials. As above, the berm side slope should be treated in accordance with OPSS.PROV 804 and OPSS.PROV 803.

An Operational Constraint to address the incorporation of excess organic soils in the permanent berms has been included in the contract documents; a copy is provided in Appendix G.

8.5 Timing for Final Paving on Wellington Road 34

As discussed in Section 7.2.4.2, the subaqueous peat subexcavation and backfilling operation will result in an initially loose backfill layer that will range from 1 m up to approximately 2.5 m to 3 m thick, outside of the existing Wellington Road 34 embankment. In addition, it is planned that zones of peat/organic material will remain in place under the embankment toe where the embankment is less than 8.5 m in height, as discussed in Section 7.2.3.2. Further, it is expected that some localized zones of peat/organic materials will remain in place under the existing Wellington Road 34 platform, or as part of the subaqueous subexcavation and backfilling operation.

The settlement associated with compression of the loose backfill layer will occur during and immediately following construction as the embankment fill is raised, and any peat remaining in the outer portion of the embankment (outside of the 1H:1V loading zone beyond the shoulder rounding) will only affect settlement under the side slopes and not the roadway or shoulders. However, to address the settlement associated with localized zones/pockets of peat/organic materials that remain under the existing Wellington Road 34 platform or pockets that are trapped within or below the subaqueous backfill, it is recommended that the Wellington Road 34 high fill embankments be constructed to the pavement subgrade level and that final paving be delayed for as long as feasible within the construction schedule, and ideally for at least three months. An Operational Constraint for this preloading is provided in Appendix G for inclusion in the specifications; this Operational Constraint does not apply to the sections of immediate approach embankment behind the Wellington Road 34 underpass abutments, for which shorter durations are available in the construction schedule between completion of the bridge, abutment backfilling and final paving.

8.6 Monitoring During and Following Construction

A limited settlement monitoring program will be implemented along the Wellington Road 34 approach embankments following subexcavation and backfilling of the peat/organic material and construction of the embankments prior to paving. Following fill placement to pavement subgrade level, settlement monitoring pins will be established at the north and south shoulders of the Wellington Road 34 embankments at a horizontal spacing of approximately 25 m over the length of the embankment preload area. These monitoring pins will be surveyed weekly for the first month, then twice monthly thereafter during the preload period to monitor the magnitude and rate of settlement prior to paving. This program is outlined in the Operational Constraint for the Wellington Road 34 embankment preloading (see Appendix G).

Per RFP Section 2.4.9.11, measurement of differential settlements between the abutments and abutment approaches shall be taken at Months 3, 6, 12, 18 and 24 of the General Warranty period. Immediately following paving, elevations at the centreline of each lane of the Mid-Block Connection Road and Wellington Road 34 shall be measured at the bridge abutments and at distances of 20 m, 50 m, 75 m and 100 m from the abutments.

9.0 CLOSURE

This Foundation Design Report was prepared and reviewed by Michael Beadle, P.Eng., Senior Principal and Lisa Coyne, P.Eng., Fellow and MTO Principal Foundations Contact.

Michael Beadle, P.Eng.
Senior Principal, Senior Geotechnical Engineer

Lisa Coyne, P.Eng.
Fellow, MTO Principal Foundations Contact

LCC/MEB/al

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Scale: N.T.S.

Date: August 3, 2023

HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS
BOREHOLE LOCATIONS - KEY PLAN

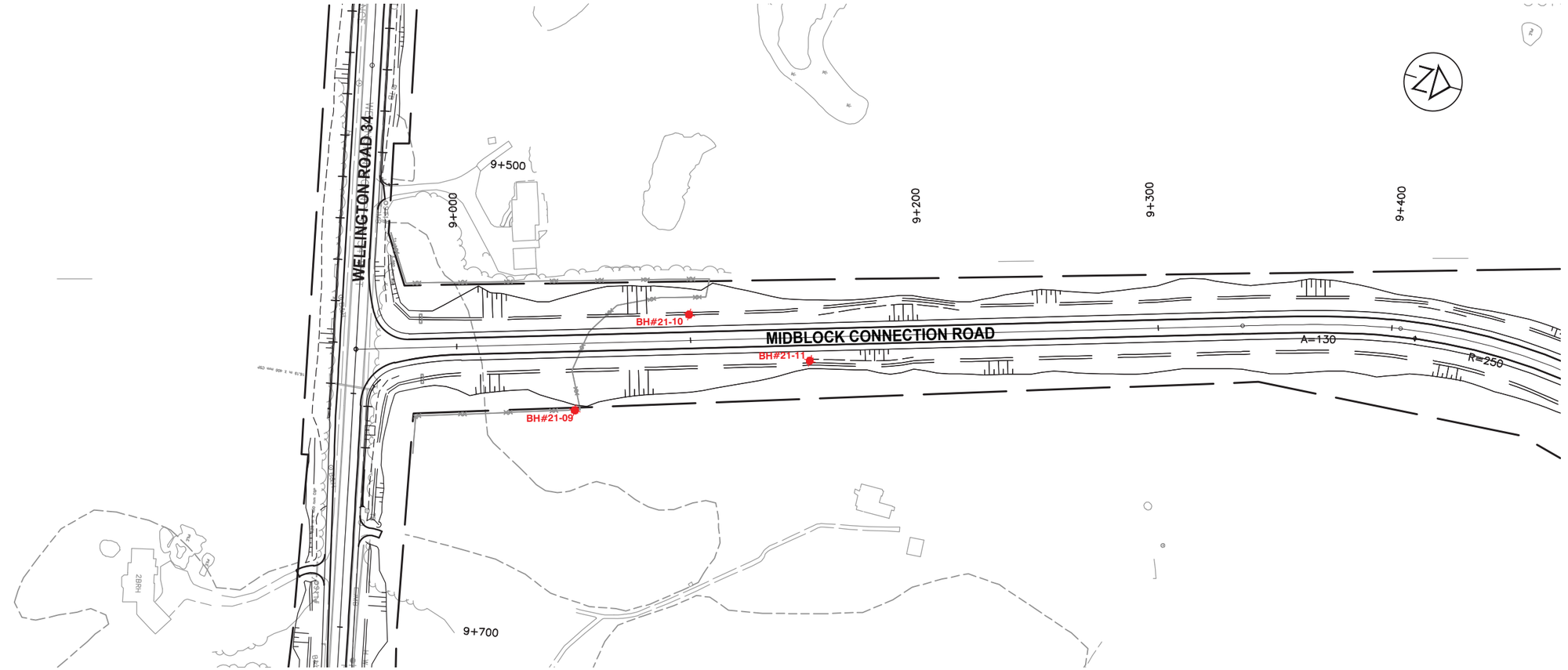
HIGHWAY 6 HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE PROJECT

PROJECT	SUBMISSION PHASE IDENTIFIER	DISCIPLINE	STRUCTURE NUMBER	DESIGN ELEMENT	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H6D	-	GEO	00	SKE	DWG	001	A

Borehole No.	Northing	Easting	Elevation
21-09	4813274.1	249319.2	315.6
21-10	4813309.7	249266.4	316.6
21-11	4813364.8	249271.1	313.0

LEGEND

- BOREHOLE LOCATION – 2021 INVESTIGATION BY PML
- BOREHOLE LOCATION – 2022 INVESTIGATION BY WSP
- TEST PIT LOCATION – 2023 INVESTIGATION BY WSP



NOTES:

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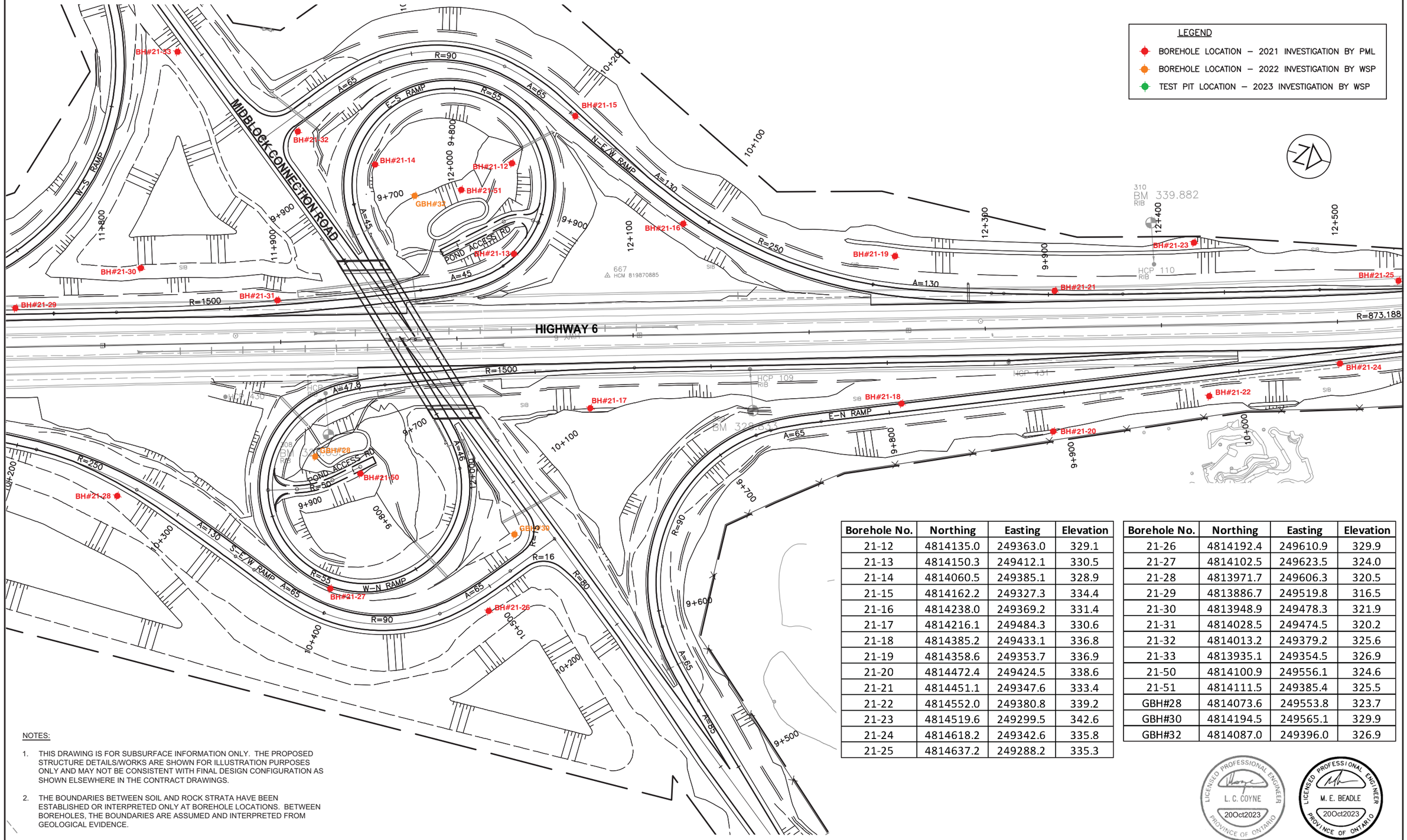
HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS
BOREHOLE LOCATIONS
MID-BLOCK CONNECTION ROAD- DEEP CUT SECTION 2

HIGHWAY 6 HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE PROJECT

PROJECT	SUBMISSION STAGE IDENTIFIER	DISCIPLINE	STRUCTURE NUMBER	DESIGN ELEMENT	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H6D	-	GEO	00	SKE	DWG	002	A



Borehole No.	Northing	Easting	Elevation
21-12	4814135.0	249363.0	329.1
21-13	4814150.3	249412.1	330.5
21-14	4814060.5	249385.1	328.9
21-15	4814162.2	249327.3	334.4
21-16	4814238.0	249369.2	331.4
21-17	4814216.1	249484.3	330.6
21-18	4814385.2	249433.1	336.8
21-19	4814358.6	249353.7	336.9
21-20	4814472.4	249424.5	338.6
21-21	4814451.1	249347.6	333.4
21-22	4814552.0	249380.8	339.2
21-23	4814519.6	249299.5	342.6
21-24	4814618.2	249342.6	335.8
21-25	4814637.2	249288.2	335.3

Borehole No.	Northing	Easting	Elevation
21-26	4814192.4	249610.9	329.9
21-27	4814102.5	249623.5	324.0
21-28	4813971.7	249606.3	320.5
21-29	4813886.7	249519.8	316.5
21-30	4813948.9	249478.3	321.9
21-31	4814028.5	249474.5	320.2
21-32	4814013.2	249379.2	325.6
21-33	4813935.1	249354.5	326.9
21-50	4814100.9	249556.1	324.6
21-51	4814111.5	249385.4	325.5
GBH#28	4814073.6	249553.8	323.7
GBH#30	4814194.5	249565.1	329.9
GBH#32	4814087.0	249396.0	326.9

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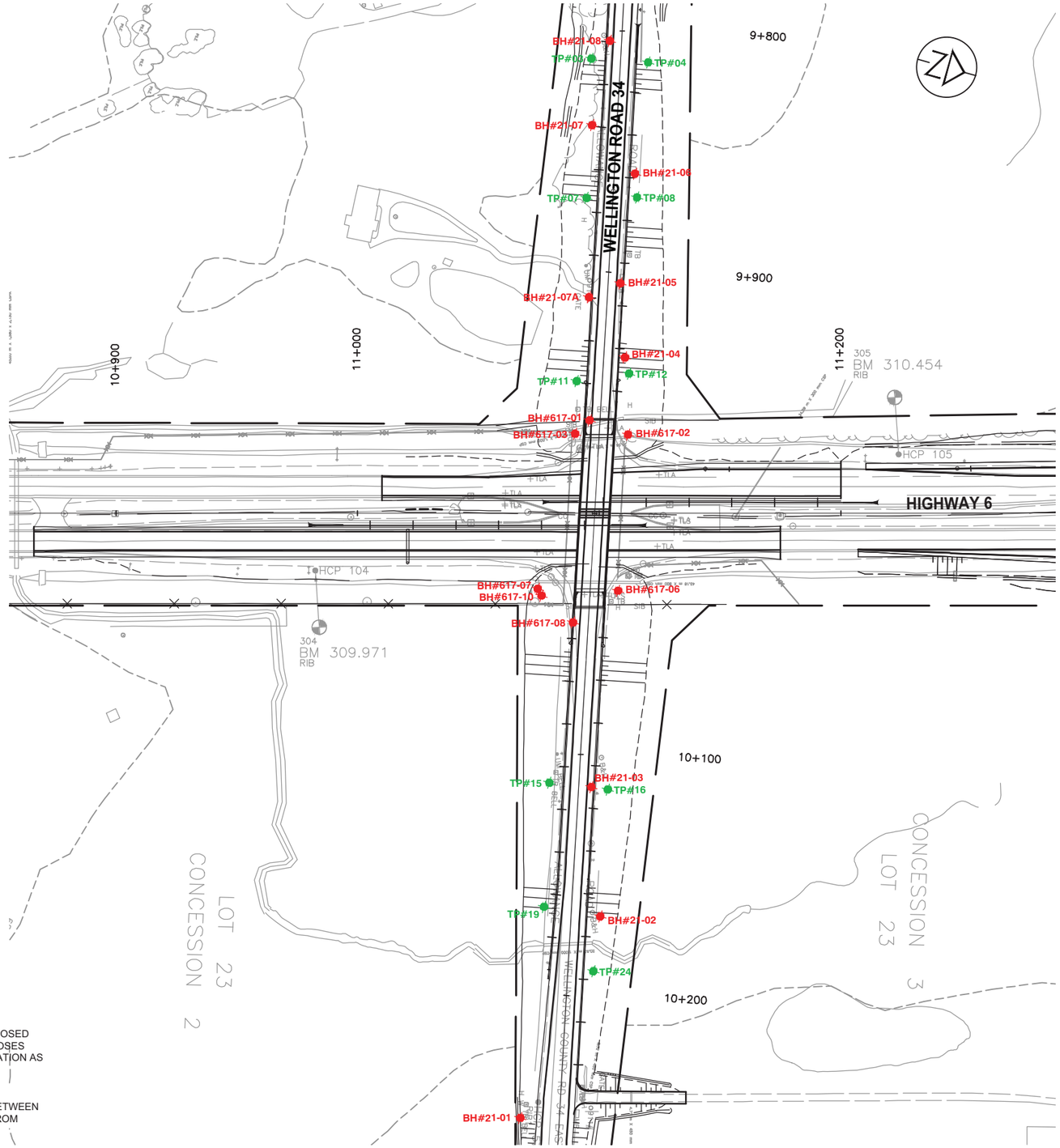
HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS
BOREHOLE LOCATIONS
MID-BLOCK INTERCHANGE - HIGH FILL AREAS 3 AND 6 AND DEEP CUT SECTIONS 3 TO 6

HIGHWAY 6 HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE PROJECT

PROJECT	SUBMISSION STAGE IDENTIFIER	DISCIPLINE	STRUCTURE NUMBER	DESIGN ELEMENT	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H6D	-	GEO	00	SKE	DWG	003	A



LEGEND

- BOREHOLE LOCATION – 2021 INVESTIGATION BY PML
- BOREHOLE LOCATION – 2022 INVESTIGATION BY WSP
- TEST PIT LOCATION – 2023 INVESTIGATION BY WSP

Borehole No.	Northing	Easting	Elevation
21-01	4813308.7	249977.7	309.1
21-02	4813317.5	249888.4	308.9
21-03	4813299.2	249837.9	309.7
21-04	4813263.5	249663.1	308.9
21-05	4813253.2	249634.1	310.6
21-06	4813246.5	249588.8	309.1
21-07	4813223.9	249574.4	309.4
21-07A	4813242.3	249643.2	310.3
21-08	4813221.3	249538.8	310.8
617-01	4813256.6	249692.1	310.3
617-02	4813273.5	249693.4	309.0
617-03	4813252.4	249699.1	309.1
617-06	4813287.4	249756.7	308.7
617-07	4813255.2	249765.1	308.8
617-08	4813273.1	249774.5	309.5
617-10	4813257.5	249767.4	309.3

Test Pit No.	Northing	Easting	Elevation
TP-03	4813216	249548	310.0
TP-04	4813239	249543	309.8
TP-07	4813230	249604	309.0
TP-08	4813250	249598	308.9
TP-11	4813247	249678	308.7
TP-12	4813267	249669	308.7
TP-15	4813282	249841	308.4
TP-16	4813306	249837	308.6
TP-19	4813294	249891	308.2
TP-24	4813321	249911	308.6

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HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS
BOREHOLE LOCATIONS
WELLINGTON ROAD 34 - HIGH FILL AREAS 4 AND 5

HIGHWAY 6 HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE PROJECT

PROJECT	SUBMISSION STAGE IDENTIFIER	DISCIPLINE	STRUCTURE NUMBER	DESIGN ELEMENT	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H6D	-	GEO	00	SKE	DWG	004	A

Borehole No.	Northing	Easting	Elevation
21-34	4814370.6	249707.8	321.5
21-35	4814396.6	249722.2	321.7
21-36	4814435.7	249720.9	325.1
21-37	4814416.7	249749.6	321.1
21-38	4814365.8	249790.9	319.7
21-39	4814284.1	249889.9	318.0
21-40	4814292.3	249854.9	318.5
21-41	4814246.8	249895.5	319.2
21-42	4814206.7	249950.0	321.1
21-43	4814120.8	250017.4	312.4

LEGEND

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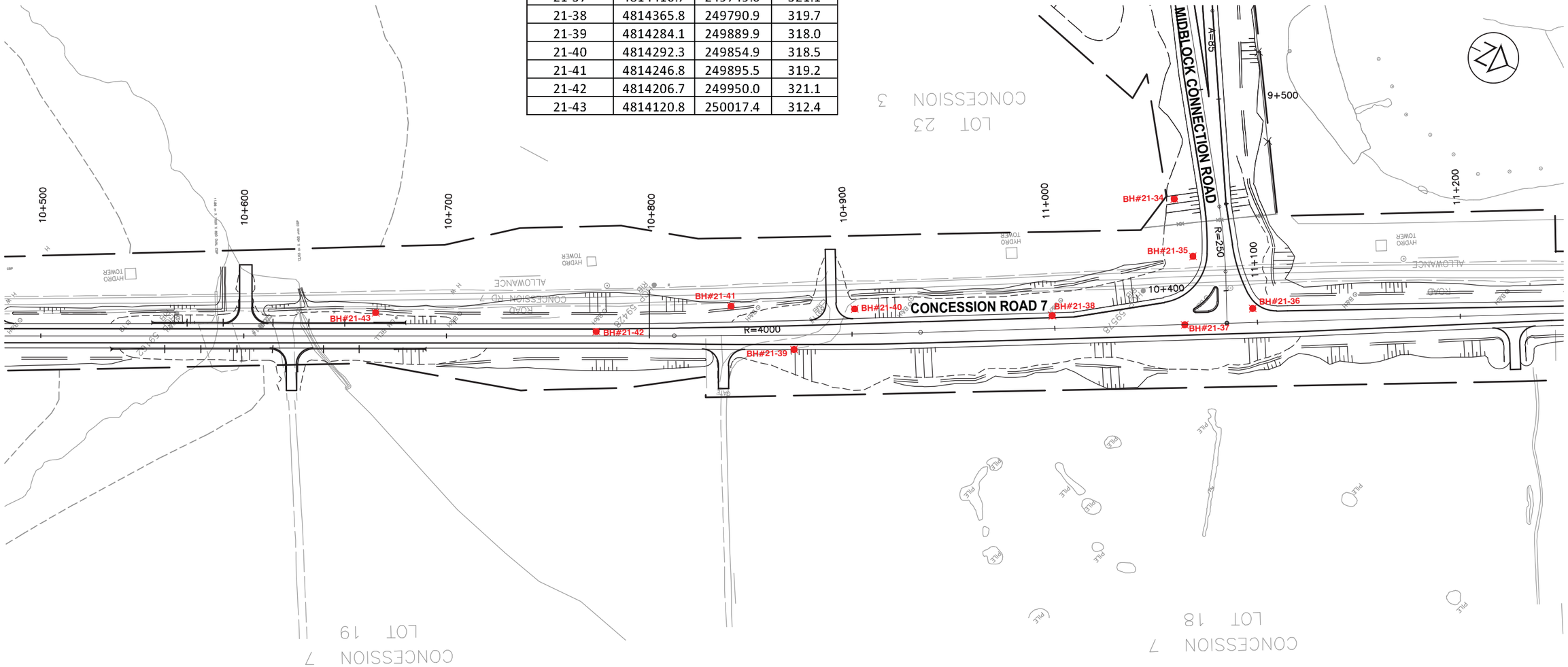

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HIGH FILL EMBANKMENT AND DEEP CUT SECTIONS
BOREHOLE LOCATIONS
CONCESSION ROAD 7 - HIGH FILL AREAS 1 AND 2 AND DEEP CUT AREA 1

HIGHWAY 6 HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE PROJECT

PROJECT	SUBMISSION STAGE IDENTIFIER	DISCIPLINE	STRUCTURE NUMBER	DESIGN ELEMENT	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H6D	-	GEO	00	SKE	DWG	005	A

APPENDIX A

Borehole Records - 2017-2021 Investigations

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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
$\epsilon_1, \epsilon_2, \epsilon_3$	%	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_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_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	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No 21-01

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 308.7 N; 249 977.7 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.22 LATITUDE 43.457682 LONGITUDE -80.177445 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.1	GROUND SURFACE						309				
308.9 / 0.2	TOPSOIL										
	CLAYEY SILT, some sand, trace gravel Firm, Brown, Moist		1	SS	4	▼			○		
	SILTY SAND, gravelly Compact to very dense, Brown, Moist (FILL)		2	SS	14		308		○		
			3	SS	52				○		
306.8 / 2.3	SILTY SAND/SANDY SILT, gravelly Loose to compact, Brown, Moist (TILL)		4	SS	9		307		⊣		
			5	SS	12		306		○		
			6	SS	8		305		○		
304.5 / 4.6	CLAYEY SILT, trace sand, trace gravel Hard, Brown, Moist (TILL)		7	SS	31		304		○		0 2 76 22
			8	SS	39		303		○		
			9	SS	36				○		
			10	SS	57		302		○		
			11	SS	61		301		○		
			12	SS	73/28cm		300		⊣		
298.6 / 10.5	End of borehole						299				

▼ Groundwater level measured upon completion of drilling

NOTE: No cave-in was noted in the borehole upon extration of augers

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

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-02

1 OF 1 **METRIC**

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 317.5 N; 249 888.4 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.18 LATITUDE 43.457755 LONGITUDE -80.178550 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.9	GROUND SURFACE										
0.0	PEAT, fine fibrous to amorphous Dark brown, Wet		1	SS	WH				119.5		
			2	SS	WH		308		140		
307.4											
1.5	SILTY SAND/SANDY SILT, trace gravel Compact, Brown, Moist (TILL)		3	SS	11	▼	307				
			4	SS	9	▽					2 27 64 7
			5	SS	16		306				
			6	SS	12		305				
			7	SS	10		304				
303.6											
5.3	CLAYEY SILT, trace sand, trace gravel Stiff to Hard, Brown, Moist (TILL)		8	SS	15						5 15 61 19
			9	SS	33		303				
			10	SS	39		302				
			11	SS	19		301				
			12	SS	14		300				
298.5							299				1 3 79 17
10.4	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

▼ Groundwater level observed upon completion of drilling

NOTE: No cave-in was noted in the borehole upon extration of augers

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 19/'21	3.3	305.7
Aug. 24/'21	1.8	307.1

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen

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

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-03

1 OF 2

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 299.2 N; 249 837.9 E ORIGINATED BY V.L./P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021-07-21/2021-08-10 LATITUDE 43.457587 LONGITUDE -80.179172 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.7	GROUND SURFACE										
0.0	200mm Granular Base over silty sand, with gravel (GRANULAR FILL)		1	SS	44						
308.9							309				
0.8	SILTY SAND, gravelly Compact to loose, Brown, Moist (FILL)		2	SS	13						22 38 28 12
			3	SS	6	▼	308				
307.4											
2.3	SILTY CLAY, peat and organics Soft, Dark Brown, Wet		4	SS	4		307		147.6		
			5	SS	4						
305.9							306				
3.8	SILTY SAND/SANDY SILT, trace gravel Compact to very dense, Brown, Moist (TILL)		6	SS	13						
			7	SS	13		305				
			8	SS	20		304				
			9	SS	19		303				
	clayey silt, very stiff		10	SS	17		302				4 22 57 17
			11	SS	12		301				
			12	SS	10		300				
	gravelly		13	SS	50/13cm		299				27 36 28 9
			14	SS	57		298				
							297				
							296				34 40 22 4
							295				

Continued Next Page

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

RECORD OF BOREHOLE No 21-03

2 OF 2 **METRIC**

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 299.2 N; 249 837.9 E ORIGINATED BY V.L./P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021-07-21/2021-08-10 LATITUDE 43.457587 LONGITUDE -80.179172 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
294.7											
294.4			15	SS	50/5cm						
15.3	End of Borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTES:

1. Borehole caved-in at a depth of 2.3 m (EL. 307.4) below the existing ground surface upon extraction of augers.

2. Borehole was terminated at a depth of 10.7 m (EL. 299.0) below the existing ground surface. Borehole was moved 1.1 m north of the original staked location and drilling was continued.

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

RECORD OF BOREHOLE No 21-04

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 263.5 N; 249 663.1 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Manual SPT COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.11 LATITUDE 43.457252 LONGITUDE -80.181328 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.9	GROUND SURFACE										
0.0	PEAT, fine fibrous to amorphous Dark brown, Wet		1	SS	WH				255.5		
			2	SS	WH		308		186		
307.1			3	SS	2	▽					
1.8	SANDY GRAVEL, some silt, trace clay Loose to compact, Brown, Wet (TILL)		4	SS	11		307				
			5	SS	6						
			6	SS	20		306				54 31 13 2
			7	SS	13		305				
			8	SS	20						
			9	SS	11		304				49 47 (4)
			10	SS	11						
302.3			11	SS	23		303				
6.6	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

NOTES:

1. Groundwater not encountered upon completion of drilling
2. Borehole caved-in at a depth of 3.0 m (EL. 305.9) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-05

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 253.2 N; 249 634.1 E ORIGINATED BY V.L

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.21 LATITUDE 43.457157 LONGITUDE -80.181685 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.6	GROUND SURFACE										
310.6 / 0.0	150mm ASPHALT over										
310.4 / 0.2	150mm granular fill over silty sand, some gravel (PAVEMENT STRUCTURE)		1	SS	70				○		
309.8							310				
0.8	SILTY SAND, gravelly Very dense to compact, Brown, Moist		2	SS	56				○		
			3	SS	22	▼ ▽	309		○		
	GRAVEL, sandy Dense to very dense, Brown, Moist to wet (FILL)		4	SS	48		308				54 39 (7)
			5	SS	50/ 125mm						
306.8							307				
3.8	SILTY SAND, some gravel Dense to compact, Brown, Wet (TILL)		6	SS	39				○		
			7	SS	18		306		○		
			8	SS	15		305		○		14 73 (13)
			9	SS	20				○		
							304				
			10	SS	18		303		○		
							302				
			11	SS	25				○		17 59 (24)
							301				
							300				
			12	SS	23				○		
299.3											
11.3	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 2.3 m (EL. 308.3) below the existing ground surface upon extraction of augers.

$+^3, \times^3$: Numbers refer to Sensitivity

$○^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-06

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 246.5 N; 249 588.8 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Manual SPT COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.11 LATITUDE 43.457093 LONGITUDE -80.182244 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.1	GROUND SURFACE						309				
0.0	PEAT, fine fibrous to amorphous Dark brown, Wet		1	SS	WH	▽			○		
308.3							308				
0.8	SAND, some silt, some to trace gravel Loose to very dense, Brown, Wet to moist (TILL)		2	SS	6						
			3	SS	6	▼			○		
			4	SS	4		307		○		18 69 (13)
			5	SS	8				○		
			6	SS	11		306		○		4 84 9 3
			7	SS	22						
			8	SS	20		305		○		
303.9			9	SS	74/25cm		304		○		8 81 (11)
5.2	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 2.4 m (EL. 306.7) below the existing ground surface upon extraction of augers.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 21-07

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 223.9 N; 249 574.4 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.17 LATITUDE 43.456889 LONGITUDE -80.182420 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.4	GROUND SURFACE										
0.0	TOPSOIL/PEAT		1	SS	2		309				
			2	SS	WH				279.6		
307.9							308				
1.5	SILTY SAND/SANDY SILT, gravelly Loose to dense, Brown to grey, Wet (TILL)		3	SS	10						
			4	SS	5		307				25 61 (14)
			5	SS	20		306				
			6	SS	13						
			7	SS	7	▽	305				29 32 32 7
			8	SS	16		304				
			9	SS	15		303				
			10	SS	15		302				
	some clay, trace gravel		11	SS	26		301				
299.3			12	SS	50		300				1 13 69 17
10.1	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

NOTES:
1. Groundwater not encountered upon completion of drilling.
2. Borehole caved-in at a depth of 8.8 m (EL. 300.6) below the existing ground surface upon extraction of augers.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-07A

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 242.3 N; 249 643.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.17 LATITUDE 43.457060 LONGITUDE -80.181571 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.3	GROUND SURFACE										
310.1 0.0	TOPSOIL										
0.2	SILTY SAND/SANDY SILT, some gravel to gravelly Loose, Brown, Moist		1	SS	7		310		○		
309.1 1.2	(FILL) SILTY SAND/SANDY SILT, gravelly Compact to dense, Brown, Moist		2	SS	4				○		18 32 40 10
	(TILL)		3	SS	47		309		○		
			4	SS	24	▽	308		○		47 39 (14)
307.2			5	SS	40				○		
3.1	End of borehole										

▽ Groundwater level observed during drilling

NOTES:
1. Groundwater not encountered upon completion of drilling.
2. No cave-in was noted in the borehole upon extration of augers.

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

RECORD OF BOREHOLE No 21-08

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 221.3 N; 249 538.8 E ORIGINATED BY V.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.20 LATITUDE 43.456863 LONGITUDE -80.182860 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.8	GROUND SURFACE										
310.8 / 0.0	100mm ASPHALT over										
310.7 / 0.1	150mm granular fill over silty sand, some gravel (PAVEMENT STRUCTURE)		1	SS	24				○		
310.0							310				
0.8	SANDY SILT, trace gravel, peat, organics Loose to compact, Brown, Moist (FILL)		2	SS	7				○		
			3	SS	22	▼ ▽	309		○		
308.5											
2.3	SANDY SILT, trace gravel Loose to compact, Brown, Moist to wet (TILL)		4	SS	12		308		○H		8 13 66 13
			5	SS	21				○		
			6	SS	12		307		○		
			7	SS	16		306		○		
			8	SS	9				○		0 27 66 7
			9	SS	7		305		○		
							304				
			10	SS	13		303		○		
							302				
			11	SS	15				○		4 19 63 14
							301				
300.4			12	SS	26				○		
10.4	End of Borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 2.3 m (EL. 308.5) below the existing ground surface upon extraction of augers.

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

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-09

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 274.1 N; 249 319.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.12 LATITUDE 43.457322 LONGITUDE -80.185578 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
315.6	GROUND SURFACE										
315.4 0.2	TOPSOIL										
	SILTY SAND, some gravel Loose to very dense, Brown, Moist to wet (TILL)		1	SS	8		315		○		
			2	SS	18				○		17 47 31 5
			3	SS	15		314		○		
			4	SS	71/8cm				○		
	Sandy gravel, some silt, dense		5	SS	45		313		○		48 36 (16)
			6	SS	38		312		○		
			7	SS	17		311		○		
309.7			8	SS	55		310		○		42 46 (12)
5.9	End of borehole										

▽ Groundwater level observed during drilling

NOTES:

1. Groundwater not encountered upon completion of drilling
2. Borehole caved-in at a depth of 5.5 m (EL. 310.1) below the existing ground surface upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	4.3	311.3
Aug. 16/'21	4.6	311.1
Aug. 24/'21	Dry	---

Monitoring Well Legend:

- Monument Casing
- Bentonite Seal
- Filter Sand
- Screen
- Cave-in

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

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-10

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 309.7 N; 249 266.4 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.28 LATITUDE 43.457639 LONGITUDE -80.186234 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
316.6	GROUND SURFACE										
0.0 / 316.2	TOPSOIL		1	SS	7		316	○	○		
0.4	SILTY SAND/SANDY SILT, trace gravel to gravelly Loose to very dense, Brown, Moist (TILL)		2	SS	13				○		1 13 77 9
			3	SS	16		315		○		
			4	SS	23		314		○		
			5	SS	16		313		○		
			6	SS	19				○		16 48 29 7
			7	SS	32	▼	312		○		
			8	SS	22		311		○		
			9	SS	12				○		24 63 (13)
			10	SS	26		310				
			11	SS	5/13cm		309		○		
			12	SS	5/13cm		308				
306.1							307		○		
10.5	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 5.5 m (EL. 311.1) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-11

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 364.8 N; 249 271.1 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.28 LATITUDE 43.458135 LONGITUDE -80.186181 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
313.0	GROUND SURFACE										
0.0 / 312.4	TOPSOIL		1	SS	13			○			
0.6	SILTY SAND, gravelly Compact to dense, Brown, Moist (TILL) Sandy gravel, some silt		2	SS	29		312	○			
			3	SS	11	▽	311	○			35 37 21 7
			4	SS	11	▽		○			
			5	SS	35		310	○			
			6	SS	32		309	○			
			7	SS	49		308	○			38 42 (20)
			8	SS	31			○			
			9	SS	32		307	○			
							306				
			10	SS	47		305	○			
303.9							304				
9.1	End of borehole										

▽ Groundwater level observed during drilling

▽ Groundwater level measured in monitoring well

NOTE: No cave-in was noted in the borehole upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	1.7	311.3
Aug. 16/'21	1.9	311.1
Aug. 11/'21	1.9	311.1
Aug. 24/'21	1.9	311.1

Monitoring Well Legend:

- Monument Casing
- Bentonite Seal
- Filter Sand
- Screen

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 21-12

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 135 N; 249 363.0 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.03 LATITUDE 43.465075 LONGITUDE -80.185124 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.1	GROUND SURFACE										
0.0 / 328.8	TOPSOIL, organics										
0.3	SILTY SAND, trace gravel to gravelly Loose to very dense, Brown, Moist (TILL)		1	SS	4		329		○		
			2	SS	10		328		○		7 49 (44)
			3	SS	10				○		
			4	SS	10		327		○		
			5	SS	39		326		○		
	very loose		6	SS	WH		325		○		
			7	SS	54		324		○		20 55 (25)
			8	SS	48				○		
			9	SS	69		323		○		
			10	SS	44		322		○		24 36 36 4
			11	SS	92		321				
319.3							320		○		
9.8	End of borehole										

WH Split-spoon penetration due to weight of hammer and rods

NOTES:

1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	Dry	---
Aug. 17/'21	Dry	---
Aug. 24/'21	Dry	---

Monitoring Well Legend:

- Monument casing
- Soil cuttings and bentonite seal
- Bentonite seal
- Filter sand
- Screen

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

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RECORD OF BOREHOLE No 21-13

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 150.3 N; 249 412.1 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.03 LATITUDE 43.465215 LONGITUDE -80.184520 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
330.5	GROUND SURFACE										
0.0 / 330.1	TOPSOIL, organics		1	SS	5		330	○	○		
0.4	SILTY SAND, gravelly to some gravel Loose to very dense, Brown, Moist (TILL)		2	SS	35				○		22 53 (25)
			3	SS	22		329		○		
			4	SS	29		328		○		
			5	SS	35				○		37 31 (32)
			6	SS	28		327		○		
			7	SS	41		326		○		
			8	SS	47		325		○		
			9	SS	42		324		○		
			10	SS	59		323		○		18 44 (38)
							322				
321.2			11	SS	50/15cm				○		
9.3	End of borehole										

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-14

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 060.5 N; 249 385.1 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.30 LATITUDE 43.464405 LONGITUDE -80.184844 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
328.9	GROUND SURFACE										
0.0 / 328.5	TOPSOIL, organics		1	SS	5				○		
0.4	SILTY SAND, trace to some gravel Loose to very dense, Brown, Moist (TILL)		2	SS	18		328		○		
			3	SS	25		327		○		
			4	SS	22				○		0 50 (50)
			5	SS	27		326		○		
			6	SS	51		325		○		
			7	SS	53		324		○		19 52 (29)
			8	SS	52				○		
			9	SS	50/15cm		323		○		
			10	SS	50		321		○		19 54 (27)
			11	SS	34		320		○		
318.7			12	SS	55		319		○		
10.2	End of borehole										

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-15

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 162.2 N; 249 327.3 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.03 LATITUDE 43.465317 LONGITUDE -80.185568 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.4	GROUND SURFACE										
0.0 / 334.1	TOPSOIL, organics										
0.3	SILTY SAND, some gravel to gravelly Loose to very dense, Brown, Moist (TILL)		1	SS	4		334		○		
			2	SS	22				○		
			3	SS	18		333		○		13 50 (37)
			4	SS	25		332		○		
			5	SS	42		331		○		
			6	SS	44				○		
			7	SS	46		330		○		
			8	SS	47		329		○		
			9	SS	50/10cm				○		21 48 23 8
327.8							328				
6.6	Borehole terminated due to auger refusal										

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-16

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 238 N; 249 369.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.04 LATITUDE 43.466002 LONGITUDE -80.185058 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
331.4	GROUND SURFACE										
0.0 / 330.9	TOPSOIL, organics		1	SS	4		331	○	○		
0.5	SILTY SAND, some gravel to gravelly Very loose, Brown, Moist (TILL)		2	SS	3			○	○		
	Compact to dense		3	SS	22		330	○	○		
			4	SS	40		329	○	○		14 50 (36)
			5	SS	30		328	○	○		
			6	SS	42			○	○		
	Sand, dense		7	SS	30		327	○	○		
			8	SS	37		326	○	○		29 54 (17)
			9	SS	30		325	○	○		
			10	SS	32	▽	324	○	○		
			11	SS	49		323	○	○		
			12	SS	39		322	○	○		13 62 19 6
321.3 / 10.1	End of borehole										

▽ Groundwater observed during drilling

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. Borehole caved-in at a depth of 7.8 m (EL. 323.6) below the existing ground surface upon extraction of augers.

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

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RECORD OF BOREHOLE No 21-17

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 216.1 N; 249 484.3 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.12 LATITUDE 43.465814 LONGITUDE -80.183633 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
330.6	GROUND SURFACE								
0.0	TOPSOIL								
330.2			1	SS	13		330		
0.4	SILTY SAND, some gravel to gravelly Compact to dense, Brown, Moist (TILL)		2	SS	27				
			3	SS	30		329		10 43 40 7
			4	SS	26		328		
			5	SS	34		327		
			6	SS	33				
			7	SS	30		326		13 43 35 9
			8	SS	38		325		
			9	SS	25		324		
	gravelly		10	SS	42		323		39 49 9 3
			11	SS	31		322		
320.8							321		
9.8	End of borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-18

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 385.2 N; 249 433.1 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Manual SPT COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.16 LATITUDE 43.467332 LONGITUDE -80.184284 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.8	GROUND SURFACE										
336.6	TOPSOIL										
0.2	SILTY SAND/SAND Loose to very dense, Brown, Moist (TILL) Sand, Compact		1	SS	6				○		
			2	SS	11		336		○		0 44 42 14
			3	SS	19				○		0 88 (12)
			4	SS	22		335		○		
			5	SS	25				○		
			6	SS	18		334		○		
			7	SS	15		333		○		
			8	SS	26				○		
			9	SS	56		332		○		0 65 (35)
331.4											
5.4	End of borehole										

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extration of augers.

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

RECORD OF BOREHOLE No 21-19

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 358.6 N; 249 353.7 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.05 LATITUDE 43.467086 LONGITUDE -80.185262 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.9	GROUND SURFACE										
0.0 / 336.5	TOPSOIL, organics		1	SS	22		336		○		
0.4	SILTY SAND/SANDY SILT, trace gravel Compact to dense, Brown, Moist (TILL)		2	SS	35				○		
			3	SS	45		335		○		
			4	SS	29				○		1 55 (44)
			5	SS	42		334		○		
			6	SS	29		333		○		
			7	SS	38		332		○		
	gravelly		8	SS	50				○		32 39 (29)
			9	SS	40		331		○		
			10	SS	34	▽	330		○		
	Silt, Very dense, Wet		11	SS	51	▼	329		○		
326.8			12	SS	53		328		○		0 4 82 14
10.1	End of borehole						327				

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 9.1 m (EL. 327.8) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-20

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 472.4 N; 249 424.5 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.21 LATITUDE 43.468116 LONGITUDE -80.184399 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.6	GROUND SURFACE										
338.4 0.2	TOPSOIL, organics										
	SILTY SAND, gravelly to trace gravel Loose to very dense, Brown, Moist (TILL)		1	SS	6		338		○		
	gravelly		2	SS	33				○		
			3	SS	64		337		○		32 50 (18)
			4	SS	70/23cm				○		
	Sand		5	SS	54		336		○		
			6	SS	23		335		○		5 71 21 3
			7	SS	18		334		○		
			8	SS	21		333		○		
			9	SS	31		332		○		
			10	SS	43		331		○		1 72 (27)
			11	SS	44		330		○		
328.8 9.8	End of borehole						329				

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-21

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 451.1 N; 249 347.6 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.06 LATITUDE 43.467918 LONGITUDE -80.185347 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
333.4	GROUND SURFACE										
333.2 0.2	TOPSOIL										
	SILTY SAND Compact, Brown, Moist (FILL)		1	SS	11		333	○			
			2	SS	26			○			0 49 45 6
331.9 1.5	SANDY SILT Compact to very dense, Brown, Moist (TILL)		3	SS	31		332	○			
			4	SS	27		331	○			
			5	SS	34		330	○			
	Clayey silt, Very stiff		6	SS	17			⊕			0 0 68 32
			7	SS	28		329	○			
			8	SS	42		328	○			0 41 50 9
			9	SS	37		327	○			
325.5			10	SS	86/20cm		326	○			
7.9	Borehole terminated due to auger refusal										

▽ Groundwater observed during drilling

▼ Groundwater measured in monitoring well

NOTE: No cave-in was noted in the borehole upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 09/'21	5.0	328.4
Aug. 16/'21	5.1	328.3
Aug. 19/'21	5.1	328.3

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 21-22

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 552 N; 249 380.8 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.22 LATITUDE 43.468830 LONGITUDE -80.184947 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.2	GROUND SURFACE										
0.0 / 338.9	TOPSOIL, organics										
0.3	SILTY SAND, gravelly to trace gravel Loose to dense, Brown to grey, Moist (TILL)		1	SS	3		339		○		
			2	SS	14		338		○		
			3	SS	25				○		
			4	SS	41		337		○		
	Sand		5	SS	29		336		○		
			6	SS	41		335		○		35 42 19 4
			7	SS	39				○		
			8	SS	25		334		○		
			9	SS	30		333		○		
							332				
			10	SS	22				○		0 75 (25)
						▽	331				
			11	SS	31		330		○		
329.4 / 9.8	End of borehole										

▽ Groundwater level observed during drilling

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

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RECORD OF BOREHOLE No 21-23

1 OF 1 **METRIC**

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 519.6 N; 249 299.5 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.05 LATITUDE 43.468531 LONGITUDE -80.185948 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.6	GROUND SURFACE										
342.4 0.2	TOPSOIL										
	SILTY SAND/SANDY SILT, gravelly to trace gravel Loose, Brown, Moist (TILL) Compact to dense		1	SS	4		342		○		
			2	SS	5				○		
			3	SS	13		341		○		
			4	SS	21		340		○		
			5	SS	17				○		35 42 (23)
			6	SS	19		339		○		
			7	SS	13		338				
			8	SS	16		337		○		0 50 46 4
			9	SS	20				○		
			10	SS	15		336				
			11	SS	27		335		○		
			12	SS	32		334				
332.5 10.1	End of borehole						333		○		

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-24

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 618.2 N; 249 342.6 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.18 LATITUDE 43.469422 LONGITUDE -80.185425 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.8	GROUND SURFACE										
335.6 0.2	TOPSOIL										
	SANDY SILT/SILTY SAND, trace gravel to gravelly Compact to very dense, Brown, Moist (TILL)		1	SS	15		335		○		
			2	SS	17				○		
			3	SS	22		334		○		0 48 (52)
			4	SS	26				○		
			5	SS	13		333		○		
			6	SS	17		332		○		
			7	SS	25		331		○		
	Clayey silt, Stiff		8	SS	14				○		
			9	SS	18		330		⊳⊢		0 0 69 31
							329				
			10	SS	29		328		○		
							327				
			11	SS	75				○		25 40 28 7
325.4			12	SS	49		326		○		
10.4	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured in monitoring well

NOTE: Borehole caved-in at a depth of 8.8 m (EL. 327.0) below the existing ground surface upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 19/'21	8.6	327.2
Aug. 24/'21	8.6	327.2

Monitoring Well Legend:

- Monument casing
- Soil cuttings and bentonite seal
- Bentonite seal
- Filter sand
- Screen
- Cave-in

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 21-25

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 637.2 N; 249 288.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.06 LATITUDE 43.469589 LONGITUDE -80.186100 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.3	GROUND SURFACE										
0.0	SANDY GRAVEL Loose to dense, Brown, Moist (FILL)		1	SS	5		335		○		
			2	SS	37				○		
			3	SS	33		334		○		
			4	SS	44	▼	333		○		48 38 (14)
			5	SS	33	▽	332		○		
331.9											
3.4	SILTY SAND, gravelly Compact to dense, Brown, Moist (TILL)		6	SS	16				○		
			7	SS	46		331		○		
			8	SS	11		330		○		
			9	SS	30		329		○		23 52 22 3
			10	SS	21		328		○		
327.1											
8.2	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 2.7 m (EL. 332.6) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-26

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 192.4 N; 249 610.9 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.12 LATITUDE 43.465609 LONGITUDE -80.182067 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.9	GROUND SURFACE										
0.0	TOPSOIL		1	SS	10				○		
329.1							329				
0.8	SILTY SAND, some gravel to gravelly Compact to dense, Brown, Moist (TILL)		2	SS	17				○		18 40 35 7
			3	SS	30		328		○		
			4	SS	26				○		
							327				
			5	SS	15				○		25 42 27 6
			6	SS	22		326		○		
			7	SS	21		325		○		
			8	SS	28				○		
			9	SS	32		324		○		
							323				
			10	SS	35		322		○		
							321				
			11	SS	42				○		22 53 21 4
			12	SS	40		320		○		
319.4											
10.5	End of borehole										

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-27

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 102.5 N; 249 623.5 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.13 LATITUDE 43.464801 LONGITUDE -80.181902 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
324.0	GROUND SURFACE										
0.0	TOPSOIL		1	SS	7				○		
323.2							323				
0.8	SILTY SAND, some gravel Compact to very dense, Brown, Moist (TILL)		2	SS	27				○		
			3	SS	16		322		○		12 47 36 5
			4	SS	18				○		
			5	SS	14		321		○		
	Clayey silt, Stiff to very stiff		6	SS	17		320		⊕		15 21 49 15
			7	SS	14		319		○		
			8	SS	24				○		
			9	SS	30		318		○		26 45 23 6
							317				
			10	SS	42		316		○		
							315				
			11	SS	30				○		
							314				
313.6			12	SS	100				○		
10.4	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured in monitoring well

NOTE: No cave-in was noted in the borehole upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	Dry	---
Aug. 09/'21	8.1	315.9
Aug. 19/'21	8.1	315.9

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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RECORD OF BOREHOLE No 21-28

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 971.7 N; 249 606.3 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.13 LATITUDE 43.463623 LONGITUDE -80.182101 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.5	GROUND SURFACE										
0.0 / 319.9	TOPSOIL		1	SS	18		320		○		
0.6	SILTY SAND, gravelly to trace gravel Compact to very dense, Brown, Moist (TILL)		2	SS	19				○		
			3	SS	33		319		○		
			4	SS	16		318		○		25 48 23 4
			5	SS	32		317		○		
			6	SS	34				○		
			7	SS	35		316		○		8 50 36 6
			8	SS	50		315		○		
			9	SS	55				○		
							314				
			10	SS	61		313		○		
312.3											
8.2	End of borehole										

NOTES:

1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-29

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 886.7 N; 249 519.8 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers - Switched to Hollow Stem Augers at 3.8 m COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.09 - 2021.08.16 LATITUDE 43.462851 LONGITUDE -80.183161 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
316.5	GROUND SURFACE										
316.3 0.2	TOPSOIL, organics										
	SILTY SAND/SANDY SILT, gravelly to trace gravel Loose to very dense, Brown, Moist to wet (TILL)		1	SS	6		316		○		
			2	SS	48				○		
			3	SS	28		315		○		23 45 (32)
			4	SS	34		314		○		
			5	SS	16/8cm				○		
			6	SS	32		313		○		
			7	SS	31		312		○		
			8	SS	13		311		○		8 58 (34)
			9	SS	23		310		○		
			10	SS	19		309		○		
	Silt, Dense to very dense		11	SS	42		308		○		1 16 77 6
306.1			12	SS	62		307		○		
10.4	End of borehole										

▼ Groundwater level measured upon completion of drilling

▼ Groundwater level measured in monitoring well

NOTE: Borehole caved-in at a depth of 9.8 m (EL. 306.7) below the existing ground surface upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 17/'21	5.0	311.5
Aug. 19/'21	5.0	311.5

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen
- Cave-in

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No 21-30

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 948.9 N; 249 478.3 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.29 LATITUDE 43.463408 LONGITUDE -80.183680 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.9	GROUND SURFACE										
0.0 / 321.3	TOPSOIL		1	SS	8		321	○	○		
0.6	SILTY SAND/SANDY SILT, trace gravel to gravelly Compact to very dense, Brown to grey, Moist (TILL)		2	SS	29			○	○		
			3	SS	33		320	○	○		
			4	SS	17			○	○		6 49 (45)
			5	SS	34		319	○	○		
			6	SS	53			○	○		
			7	SS	30		318	○	○		
			8	SS	61			○	○		29 46 (25)
			9	SS	92/25cm		317	○	○		
			10	SS	89			○	○		
			11	SS	75/28cm	▼	316	○	○		
			12	SS	54			○	○		0 30 65 5
311.4							315				
10.5	End of borehole						314				
							313				
							312				

▼ Groundwater level measured upon completion of drilling

NOTES:

1. No cave-in was noted in the borehole upon extraction of augers.
2. Auger refusal on probable boulder was encountered at a depth of 6.7 m (EL. 315.2) below the existing ground surface. Borehole was moved 2.0 m north of the original staked location and drilling was continued.

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

RECORD OF BOREHOLE No 21-31

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 028.5 N; 249 474.5 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.09 LATITUDE 43.464124 LONGITUDE -80.183736 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.2	GROUND SURFACE										
320.0 0.0	TOPSOIL										
0.2	SILTY SAND/SANDY SILT, some gravel Compact to very dense, Brown, moist (TILL)		1	SS	11		320		○		
			2	SS	32				○		14 49 (37)
			3	SS	61		319		○		
			4	SS	81		318		○		
			5	SS	96/28cm		317		○		
			6	SS	50/13cm				○		
			7	SS	70		316		○		15 46 33 6
			8	SS	50/10cm		315		○		
			9	SS	63		314		○		
			10	SS	55	▽	313		○		0 46 (54)
			11	SS	71/25cm	▼	312		○		
			12	SS	59		311		○		
309.8 10.4	End of borehole						310				

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-32

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 013.2 N; 249 379.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.30 LATITUDE 43.463979 LONGITUDE -80.184912 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.6	GROUND SURFACE										
0.0	TOPSOIL		1	SS	28		325		○		
324.8											
0.8	SILTY SAND, gravelly to some gravel Compact to very dense, Brown, Moist (TILL)		2	SS	14				○		
			3	SS	31		324				
			4	SS	26		323		○		
			5	SS	43				○		
			6	SS	32		322		○		33 41 21 5
			7	SS	32		321		○		
			8	SS	37		320		○		
			9	SS	28				○		18 48 28 6
317.9			10	SS	50/8cm		319				
7.7	Borehole terminated due to auger refusal						318		○		

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

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RECORD OF BOREHOLE No 21-33

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 935.1 N; 249 354.5 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.30 LATITUDE 43.463274 LONGITUDE -80.185210 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.9	GROUND SURFACE										
0.0	TOPSOIL		1	SS	9				○		
326.1											
0.8	SANDY SILT/SILTY SAND, trace gravel to gravelly Compact to dense, Brown, Moist (TILL)		2	SS	21		326		○		
			3	SS	16		325				1 33 (66)
			4	SS	21		324		○		
			5	SS	19				○		
			6	SS	20		323		○		
			7	SS	27		322		○		
			8	SS	25		321				21 42 31 6
			9	SS	27				○		
							320				
			10	SS	28		319		○		
							318				
			11	SS	35						12 41 41 6
			12	SS	32		317		○		
316.5											
10.4	End of borehole										

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-34

1 OF 1 **METRIC**

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 370.6 N; 249 707.8 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Manual SPT COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.11 LATITUDE 43.467221 LONGITUDE -80.180888 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.5	GROUND SURFACE										
321.3 0.2	TOPSOIL										
	SILTY SAND/SANDY SILT, trace gravel Loose to very dense, Brown, Moist to wet (TILL)		1	SS	2		321		○		
			2	SS	7				○		
			3	SS	4	▼	320		○		
			4	SS	3	▽			○		29 37 30 4
			5	SS	37		319		○		
			6	SS	41				○		
			7	SS	48		318		○		3 19 63 15
317.1			8	SS	50/10cm				○		
4.4	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 1.8 m (EL. 319.7) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-35

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 396.6 N; 249 722.2 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.16 LATITUDE 43.467194 LONGITUDE -80.180628 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.7	GROUND SURFACE										
0.0	TOPSOIL		1	SS	3				○		
320.9							321				
0.8	SANDY SILT, trace gravel Loose to dense, Brown, Moist to wet (TILL)		2	SS	12				○		
			3	SS	14		320		○		
			4	SS	20		319		○		0 18 69 13
			5	SS	20		318		○		
			6	SS	28	▼			○		
			7	SS	22	▽	317		○		
			8	SS	24		316		○		
	Silt, Compact		9	SS	20				○		0 4 87 9
			10	SS	31		314		○		
			11	SS	20		313		○		
			12	SS	6		312		○		
311.2											
10.5	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 4.3 m (EL. 315.2) below the existing ground surface upon extraction of augers.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 21-36

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 435.7 N; 249 720.9 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Manual SPT COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.11 - 2021.08.16 LATITUDE 43.467808 LONGITUDE -80.180731 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.1	GROUND SURFACE										
0.0 / 324.5	TOPSOIL		1	SS	6		325		○		
0.6	SILTY SAND/SANDY SILT, some gravel Compact to very dense, Brown, Moist (TILL)		2	SS	23				○		
			3	SS	52		324		○		
			4	SS	65		323		○		10 39 43 8
			5	SS	68				○		
	gravelly		6	SS	110		322		○		43 37 (20)
321.5											
3.6	End of borehole										

NOTES:

1. Groundwater level was not encountered during or upon completion of drilling
2. Cave-in was not noted in the borehole upon extraction of augers.
3. Split spoon refusal was encountered at a depth of 1.8 m (EL. 323.3) below the existing ground surface. Borehole was moved 6.0 m south of the original staked location and drilling was continued.

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

RECORD OF BOREHOLE No 21-37

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 416.7 N; 249 749.6 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.15 LATITUDE 43.467638 LONGITUDE -80.180376 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.1	GROUND SURFACE						321				
321.0	TOPSOIL										
0.2	SANDY SILT/SILTY SAND, gravelly Loose to dense, Brown, Moist to wet (TILL)		1	SS	8				○		
			2	SS	22		320		○		
			3	SS	15				○		
			4	SS	14		319		○		3 24 65 8
			5	SS	15		318		○		
			6	SS	14				○		
			7	SS	21		317		○		
			8	SS	34				○		
	Sandy gravel, Dense to very dense		9	SS	54		316		○		40 44 (16)
			10	SS	37		315		○		
311.9			11	SS	100/10cm		314		○		
9.2	End of borehole						313				
							312				

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. Borehole caved-in at a depth of 6.7 m (EL. 314.4) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-38

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 365.8 N; 249 790.9 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.16 LATITUDE 43.467184 LONGITUDE -80.179860 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.7	GROUND SURFACE										
319.6 / 0.1	TOPSOIL										
319.5 / 0.2	SILTY SAND/SANDY SILT, trace gravel to gravelly Loose to very dense, Brown, Moist (TILL)		1	SS	4		319		○		
			2	SS	6				○		
			3	SS	15		318		○		7 21 61 11
			4	SS	11	▼	317		○		
			5	SS	31				○		
			6	SS	36		316		○		22 49 25 4
			7	SS	40		315		○		
			8	SS	51		314		○		
			9	SS	83		313		○		
			10	SS	37		312		○		
			11	SS	45		311		○		
310.0 / 9.7	End of borehole						310				

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 3.0 m (EL. 316.7) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-39

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 284.1 N; 249 889.9 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.15 LATITUDE 43.466455 LONGITUDE -80.178628 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
318.0	GROUND SURFACE										
0.0	SANDY SILT, trace gravel Compact to very dense, Brown, Moist (FILL)		1	SS	29				○		
			2	SS	74		317		○		
316.5											
1.5	SILT, some clay, some sand Very loose to very dense, Brown, Moist (TILL)		3	SS	7				○		
			4	SS	5		316		○		
			5	SS	WH		315		○		1 20 65 14
			6	SS	53		314		○		
			7	SS	11		313		○		
312.7											
5.3	SANDY GRAVEL, some silt Dense to very dense, Brown, Moist (TILL)		8	SS	46	▽	312		○		34 32 28 6
			9	SS	37				○		
			10	SS	32		311		○		
			11	SS	35		310		○		43 42 12 3
			12	SS	61		309		○		
307.5							308				
10.5	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

NOTES:

1. Groundwater level was not encountered in the borehole upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

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RECORD OF BOREHOLE No 21-40

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 292.3 N; 249 854.9 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.16 LATITUDE 43.466526 LONGITUDE -80.179061 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
318.5	GROUND SURFACE										
318.3 0.2	TOPSOIL										
	SILT, some clay, trace sand Very loose to loose, Brown, Moist (TILL)		1	SS	7		318		○		
			2	SS	3				○		
			3	SS	4		317		○		
			4	SS	5		316		○		0 11 70 19
315.4											
3.1	SANDY GRAVEL, some silt Compact to very dense, BRown, Moist to wet (TILL)		5	SS	13		315		○		
			6	SS	48				○		
			7	SS	67		314		○		
			8	SS	100/20cm		313		○		
			9	SS	77	▼	312		○		
						▽					
			10	SS	53		311		○		47 39 (14)
							310				
			11	SS	37		309		○		
308.8											
9.8	End of borehole										

▽ Groundwater level observed during drilling

▼ Groundwater level measured upon completion of drilling

NOTE: Borehole caved-in at a depth of 7.0 m (EL. 311.5) below the existing ground surface upon extraction of augers.

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

RECORD OF BOREHOLE No 21-41

1 OF 1 **METRIC**

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 246.8 N; 249 895.5 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.19 LATITUDE 43.466120 LONGITUDE -80.178555 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.2	GROUND SURFACE										
319.0 0.0	TOPSOIL										
0.2	SANDY SILT, trace gravel Loose, Brown, Moist (FILL)		1	SS	7		319		○		
317.8			2	SS	7		318		○		1 27 55 17
1.4	SANDY SILT, trace gravel to gravelly Compact to very dense, Brown, Moist (TILL)		3	SS	12				○		
			4	SS	50/8cm		317		○		
315.5			5	SS	19		316		○		24 34 34 8
3.7	End of borehole										

NOTES:
1. Groundwater level was not encountered in the borehole during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

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

RECORD OF BOREHOLE No 21-42

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 206.7 N; 249 950 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.19 LATITUDE 43.465763 LONGITUDE -80.177878 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.1	GROUND SURFACE										
0.0 / 320.7	TOPSOIL		1	SS	9		321		○		
0.4	SILTY SAND/SANDY SILT, trace gravel to gravelly Compact to very dense, Brown, Moist (TILL)		2	SS	12		320		○		
			3	SS	15				○		21 39 33 7
			4	SS	17		319		○		
			5	SS	35		318		○		
			6	SS	50/13cm				○		3 16 69 12
			7	SS	48		317		○		
			8	SS	47		316		○		
			9	SS	79		315		○		
			10	SS	85		314		○		1 10 64 25
			11	SS	50/13cm	▽	313		○		
311.1			12	SS	50/14cm		312		○		
10.0	End of borehole										

▽ Groundwater level observed during drilling

NOTE: Borehole caved-in at a depth of 10.4 m (EL. 310.7) below the existing ground surface upon extraction of augers.

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

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RECORD OF BOREHOLE No 21-43

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 120.8 N; 250 017.4 E ORIGINATED BY P.J.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.19 LATITUDE 43.464994 LONGITUDE -80.177036 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.4	GROUND SURFACE										
312.2 / 0.2	TOPSOIL										
	SANDY SILT, trace to some clay, trace gravel Loose, Brown, Moist (FILL)		1	SS	3		312		○		
			2	SS	7				○		
310.9 / 1.5	SANDY GRAVEL, some silt Compact to very dense, Brown, Wet to moist (TILL)		3	SS	19	▽	311		○		
			4	SS	20	▽	310		○		
			5	SS	50		309		○		45 42 (13)
			6	SS	32				○		
			7	SS	28		308		○		
			8	SS	21		307		○		37 41 17 5
			9	SS	50/13cm				○		
305.4 / 7.0	Borehole terminated due to auger refusal						306				

▽ Groundwater level observed during drilling

▼ Groundwater level measured in monitoring well

NOTE: Borehole caved-in at a depth of 6.7 m (EL. 305.7) below the existing ground surface upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	1.9	310.6
Aug. 09/'21	2.1	310.3
Aug. 11/'21	2.0	310.4
Aug. 19/'21	2.0	310.4

Monitoring Well Legend:
- Monument casing
- Bentonite seal
- Filter sand
- Screen
- Cave-in

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 21-50

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 100.9 N; 249 556.1 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.21 LATITUDE 43.464782 LONGITUDE -80.182734 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
324.6	GROUND SURFACE										
0.0	TOPSOIL		1	SS	2		324		○		
323.8											
0.8	SILTY SAND, some gravel to gravelly Compact to very dense, Moist (TILL)		2	SS	16				○		
			3	SS	13		323		○		
			4	SS	28		322				14 43 37 6
			5	SS	37				○		
			6	SS	30		321		○		
			7	SS	100/10cm		320				
			8	SS	100/28cm		319		○		
			9	SS	77						15 45 33 7
							318				
316.9			10	SS	100/10cm		317		○		
7.7	End of borehole										

Groundwater level measured in monitoring well

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 04/'21	Dry	---
Aug. 09/'21	6.8	318.7
Aug. 19/'21	Dry	---

Monitoring Well Legend:
- Monument casing
- Soil cuttings and bentonite seal
- Bentonite seal
- Filter sand
- Screen

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

ONTARIO MTO 17TF006A - PART A_AUGUST 11 2021-NL.GPJ ONTARIO MTO.GDT 10/12/21

RECORD OF BOREHOLE No 21-51

1 OF 2

METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 111.5 N; 249 385.4 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.04 LATITUDE 43.464865 LONGITUDE -80.184845 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.5	GROUND SURFACE										
0.0	TOPSOIL, organics, alluvium Very loose, Dark brown, Moist		1	SS	3		325		○		
			2	SS	2				○		4 50 (46)
324.0							324				
1.5	SILTY SAND, some gravel to gravelly Compact to very dense, Brown, Moist (TILL)		3	SS	27				○		
			4	SS	37		323		○		
			5	SS	37				○		
			6	SS	53		322		○		
			7	SS	58		321		○		28 45 (27)
			8	SS	50/15cm				○		
			9	SS	48		320		○		
			10	SS	36		319		○		
			11	SS	42		318		○		18 40 32 10
			12	SS	50		317				
314.2							316		○		
11.3	End of borehole						315				

▼ Groundwater level measured in monitoring well

NOTES:
1. Groundwater not encountered during or upon completion of drilling.
2. No cave-in was noted in the borehole upon extraction of augers.

Continued Next Page

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

RECORD OF BOREHOLE No 21-51 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 814 111.5 N; 249 385.4 E ORIGINATED BY F.M.

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2021.08.04 LATITUDE 43.464865 LONGITUDE -80.184845 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
310.5											

Monitoring Well Readings:

Date	Depth (m)	Elev.
Aug. 09/'21	Dry	---
Aug. 17/'21	Dry	---

Monitoring Well Legend:

- Monument casing
- Soil cuttings and bentonite seal
- Bentonite seal
- Filter sand
- Screen

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

RECORD OF BOREHOLE No 35-617-01

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 256.6 N; 249 692.1 E (MTM ON10) ORIGINATED BY M.F.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.21 LATITUDE 43.457238 LONGITUDE -80.180900 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.3	GROUND SURFACE										
0.0	SILTY SAND TO SAND, some gravel Very dense, Brown, Moist (FILL)		1	SS	82		310		○		
			2	SS	53				○		23 64 12 1
			3	SS	32		309		○		
308.1						▽					
2.2	SANDY SILT TO SILTY SAND, trace/some gravel Loose to compact, Brown, Wet (TILL)		4	SS	5		308		○		
			5	SS	7		307		○		
			6	SS	25		306		○		
	dense		7	SS	13				○		6 39 52 3
			8	SS	9		305		○		
			9	SS	38		304		○		
			10	SS	34		303		○		
							302				
300.5			11	SS	46		301		○		19 72 8 1
9.8	End of borehole										

▽ Groundwater level observed during drilling

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

RECORD OF BOREHOLE No 35-617-02

1 OF 2

METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 273.5 N; 249 693.4 E (MTM ON10) ORIGINATED BY M.Kh./S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow stem Augers, Wash Boring, NQ Rock Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.11.29 - 2017.12.04 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.0	GROUND SURFACE										
0.0	SILTY SAND Very loose, Brown, Wet (FILL)		1	SS	WH						
308.3							308				
0.7	SANDY SILT TO SILTY SAND, some gravel Very loose, Grey, Wet to moist (TILL)		2	SS	2						
			3	SS	1		307				
			4	SS	9						
			5	SS	2		306				
	Silt, trace sand		6	SS	1		305				
			7	SS	9		304				
	occasional cobbles compact		8	SS	10/3cm		303				
			9	SS	21		302				22 72 (6)
			10	SS	30		301				
			11	SS	23		300				19 31 43 7
			12	SS	29		299				
294.0							298				
							297				
							296				
							295				

Continued Next Page

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

RECORD OF BOREHOLE No 35-617-02 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 273.5 N; 249 693.4 E (MTM ON10) ORIGINATED BY M.Kh./S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow stem Augers, Wash Boring, NQ Rock Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.11.29 - 2017.12.04 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
294.0											
15.0	SANDY SILT TO SILTY SAND, with gravel Very dense, Grey, Wet to moist (TILL)		13	SS	61/23cm		293		○		
292.2			14	SS	50/0cm						
16.8	DOLOSTONE/DOLOMITE Slightly weathered		RUN 1	RC NQ	REC 99%		292				RQD 85%
	Slightly to moderately weathered		RUN 2	RC NQ	REC 99%		291 290				RQD 82%
289.2											
19.8	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

NOTES:

1. Borehole charged with drilling water, thus groundwater level could not be measured upon completion of drilling
2. The presence of cobbles is inferred by auger grinding observed during drilling and is not indicative of quantity.

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

RECORD OF BOREHOLE No 35-617-03

1 OF 2

METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 252.4 N; 249 699.1 E (MTM ON10) ORIGINATED BY S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers, Wash Boring, Cone Penetration Test COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.06 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
309.1	GROUND SURFACE					
0.0	SANDY SILT, trace/with gravel, cobbles Loose, Brown, Moist (FILL)		1	AS	4	
308.4						
0.7	SANDY SILT TO SILTY SAND, some/with gravel Very loose to loose, Grey, Moist (TILL)		2	SS	6	
			3	SS	2	
			4	SS	6	
	Silt		5	SS	7	
	compact		6	SS	10	▽
			7	SS	18	
	occasional cobbles		8	SS	11	
			9	SS	29	
			10	SS	31	
			11	SS	29	
296.3						
12.8	End of borehole Start of cone penetration test					
295.7						
13.4	End of cone penetration test Refusal on probable bedrock					

▽ Groundwater level observed during drilling

ELEVATION SCALE: 309, 308, 307, 306, 305, 304, 303, 302, 301, 300, 299, 298, 297, 296

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

100/5cm

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
8	31	61	7	1
10	54	23	18	5

Continued Next Page

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

RECORD OF BOREHOLE No 35-617-03 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 252.4 N; 249 699.1 E (MTM ON10) ORIGINATED BY S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers, Wash Boring, Cone Penetration Test COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.06 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
294.1	NOTES: 1. Borehole charged with drilling water, thus groundwater level could not be measured upon completion of drilling 2. The presence of cobbles is inferred by auger grinding observed during drilling and is not indicative of quantity.										

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

RECORD OF BOREHOLE No 35-617-03A 1 OF 1 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 254.4 N; 249 700.0 E (MTM ON10) ORIGINATED BY S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.11 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.1	GROUND SURFACE						309				
0.0	Borehole 617-3A was drilled 1.0m south of Borehole 617-3 Augered to 9.1m depth without sampling (Refer to Borehole 35-617-03 for stratigraphic details)						308				
							307				
							306				
							305				
							304				
							303				
							302				
							301				
300.0							300				
9.1	End of borehole										

▼ Groundwater level measured in monitoring well

Monitoring Well Readings:

Date	Depth (m)	Elev.
Jan. 09/'18	0.7	308.4
Jan. 17/'18	0.7	308.4
Feb. 15/'18	0.7	308.4
Apr. 03/'18	0.7	308.4
Jul. 30/'21	0.8	308.3
Aug. 16/'21	1.0	308.1
Aug. 19/'21	1.0	308.1
Aug. 24/'21	0.9	308.2

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen

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

RECORD OF BOREHOLE No 35-617-06

1 OF 2

METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 287.4 N; 249 756.7 E (MTM ON10) ORIGINATED BY S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow stem Augers, Wash Boring, NQ Rock Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.14 - 2017.12.15 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.7	GROUND SURFACE										
0.0 / 308.4	TOPSOIL										
0.3 / 308.0	SILTY SAND, trace/with gravel Loose, Brown/grey, Wet (FILL)		1	SS	WH						
0.7	SILTY SAND, trace/some gravel Loose to compact, Brown/grey, Wet (TILL)		2	SS	3		308				
			3	SS	4		307				
			4	SS	14		306				6 72 19 3
			5	SS	10		305				
			6	SS	14		304				
			7	SS	16		303				6 71 20 3
			8	SS	22		302				
			9	SS	38		301				
			10	SS	16		300				19 41 37 3
			11	SS	13		299				
294.6 / 14.1	DOLOSTONE/DOLOMITE Slightly/moderately weathered		RUN 1	RC NQ	REC 85%		298				RQD 52%
293.7							297				
							296				
							295				
							294				

Continued Next Page

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

RECORD OF BOREHOLE No 35-617-06 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 287.4 N; 249 756.7 E (MTM ON10) ORIGINATED BY S.A.

DIST 31 HWY 6 BOREHOLE TYPE Hollow stem Augers, Wash Boring, NQ Rock Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.14 - 2017.12.15 LATITUDE 43.457271 LONGITUDE -80.180239 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
293.7											
15.0	DOLOSTONE/DOLOMITE Slightly/moderately weathered		RUN 2	RC NQ	REC 91%		293				RQD 63%
			RUN 3	RC NQ	REC 79%		292				RQD 69%
291.3											
17.4	End of borehole										

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

NOTES:

1. Borehole was charged with drilling water thus water level could not be established upon completion of drilling
2. Artesian water head stabilized approximately at 1.2 m above the existing ground surface. Monitoring well was decommissioned

Monitoring Well Readings:

Date	Depth (m)	Elev.
Jan. 09/'18	Frozen	---
Jan. 12/'18	-1.2 Flowing	309.9
Feb. 02/'18	Well Decommissioned	

Monitoring Well Legend:

- Monument casing
- Bentonite seal
- Filter sand
- Screen

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

RECORD OF BOREHOLE No 35-617-07 1 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 255.2 N; 249 765.1 E (MTM ON10) ORIGINATED BY M.F.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers, Wash Boring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.19 - 2017.12.20 LATITUDE 43.457338 LONGITUDE -80.179838 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.8	GROUND SURFACE										
0.0 / 308.5	TOPSOIL		1	SS	15				88.7		
0.3 / 308.1	SANDY SILT, trace/some gravel Compact, Brown/grey, Wet (FILL)										
0.7	SANDY SILT TO SILTY SAND, some/with gravel Loose to compact, Brown/grey, Wet (TILL)		2	SS	8		308				
			3	SS	7		307				
			4	SS	3		306				
			5	SS	19						10 40 48 2
			6	SS	11		305				
	Silt, dense		7	SS	48		304				
	compact to dense		8	SS	29		303				15 75 9 1
			9	SS	35		302				
			10	SS	63		301				39 38 21 2
			11	SS	13		299				
297.7			12	SS	18		298				
11.1	End of borehole Start of cone penetration test										
297.2											
11.6	End of cone penetration test Refusal on probable bedrock										

▽ Groundwater level observed during drilling

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Continued Next Page

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

RECORD OF BOREHOLE No 35-617-07 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 255.2 N; 249 765.1 E (MTM ON10) ORIGINATED BY M.F.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers, Wash Boring COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.19 - 2017.12.20 LATITUDE 43.457338 LONGITUDE -80.179838 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH 293.8	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL

NOTES:

1. Borehole was charged with drilling water thus water level could not be established upon completion of drilling
2. Artesian conditions were encountered at a depth of about 11.6 m (EL. 297.2)
3. Due to the artesian conditions, the borehole was backfilled with cement grout immediately after drilling was completed.

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

RECORD OF BOREHOLE No 35-617-08

1 OF 1

METRIC

G.W.P. 3059-20-00 LOCATION Coords: 4 813 273.1 N; 249 774.5 E (MTM ON10) ORIGINATED BY M.F.

DIST 31 HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY L.Y.

DATUM Geodetic DATE 2017.12.18 LATITUDE 43.457338 LONGITUDE -80.179838 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.5	GROUND SURFACE										
309.4 / 0.1	TOPSOIL										
	SILTY SAND, with gravel Very dense to dense, Brown, Moist (FILL)		1	SS	74		309	○	○		
			2	SS	34			○	○		28 57 13 2
308.1 / 1.4	SILTY SAND, trace/some gravel Compact to dense, Brown, Wet (TILL)		3	SS	54	▽	308	○	○		
			4	SS	27		307	○	○		
			5	SS	3			○	○		20 59 17 4
			6	SS	21		306	○	○		
			7	SS	28		305	○	○		
			8	SS	15		304	○	○		
			9	SS	31		303	○	○		
			10	SS	74		302	○	○		3 79 15 3
299.7 / 9.8	End of borehole						301				
							300	○			

▽ Groundwater level observed during drilling

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

RECORD OF BOREHOLE No 35-617-10 1 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 257.5 N; 249 767.4 E (MTM ON10) ORIGINATED BY V.L

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers, Wash Boring, NQ Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.27 - 2021.07.29 LATITUDE 43.457280 LONGITUDE -80.180007 CHECKED BY G.U.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.3	GROUND SURFACE											
0.0	PEAT, fine fibrous to amorphous Dark brown, Wet		1	SS	WH		309					
			2	SS	WH							
			3	SS	WH		308			124.9		
307.0												
2.3	SILTY SAND, trace clay, trace gravel, organics Loose, Brown/Grey, Wet (FILL)		4	SS	6		307			81.9		
306.3												
3.0	SILTY SAND, trace to some gravel Loose to compact, Brown/grey, Wet (TILL)		5	SS	12		306					17 79 (4)
			6	SS	23							
			7	SS	18		305					2 61 33 4
			8	SS	9		304					
			9	SS	13		303					
							302					
			10	SS	12							1 24 63 12
							301					
			11	SS	11		300					
	crushed cobbles						299					
			12	SS	16							42 36 17 5
297.8			13	SS	50/25cm		298					
11.5	DOLOSTONE/DOLOMITE Slightly to moderately weathered		RUN 1	RC NQ	REC 39%							RQD 21%
			RUN 2	RC NQ	REC 100%		297					RQD 72% UCS=165.1 MPa
							296					
294.7							295					
14.6	End of borehole											

Continued Next Page

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

RECORD OF BOREHOLE No 35-617-10 2 OF 2 METRIC

G.W.P. 3059-20-00 LOCATION COORDS: 4 813 257.5 N; 249 767.4 E (MTM ON10) ORIGINATED BY V.L

DIST 31 HWY 6 BOREHOLE TYPE Solid Stem Augers, Wash Boring, NQ Coring COMPILED BY L.Y.

DATUM Geodetic DATE 2021.07.27 - 2021.07.29 LATITUDE 43.457280 LONGITUDE -80.180007 CHECKED BY G.U.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
294.3											

WH Split spoon penetration due to weight of hammer and rods

▽ Groundwater level observed during drilling

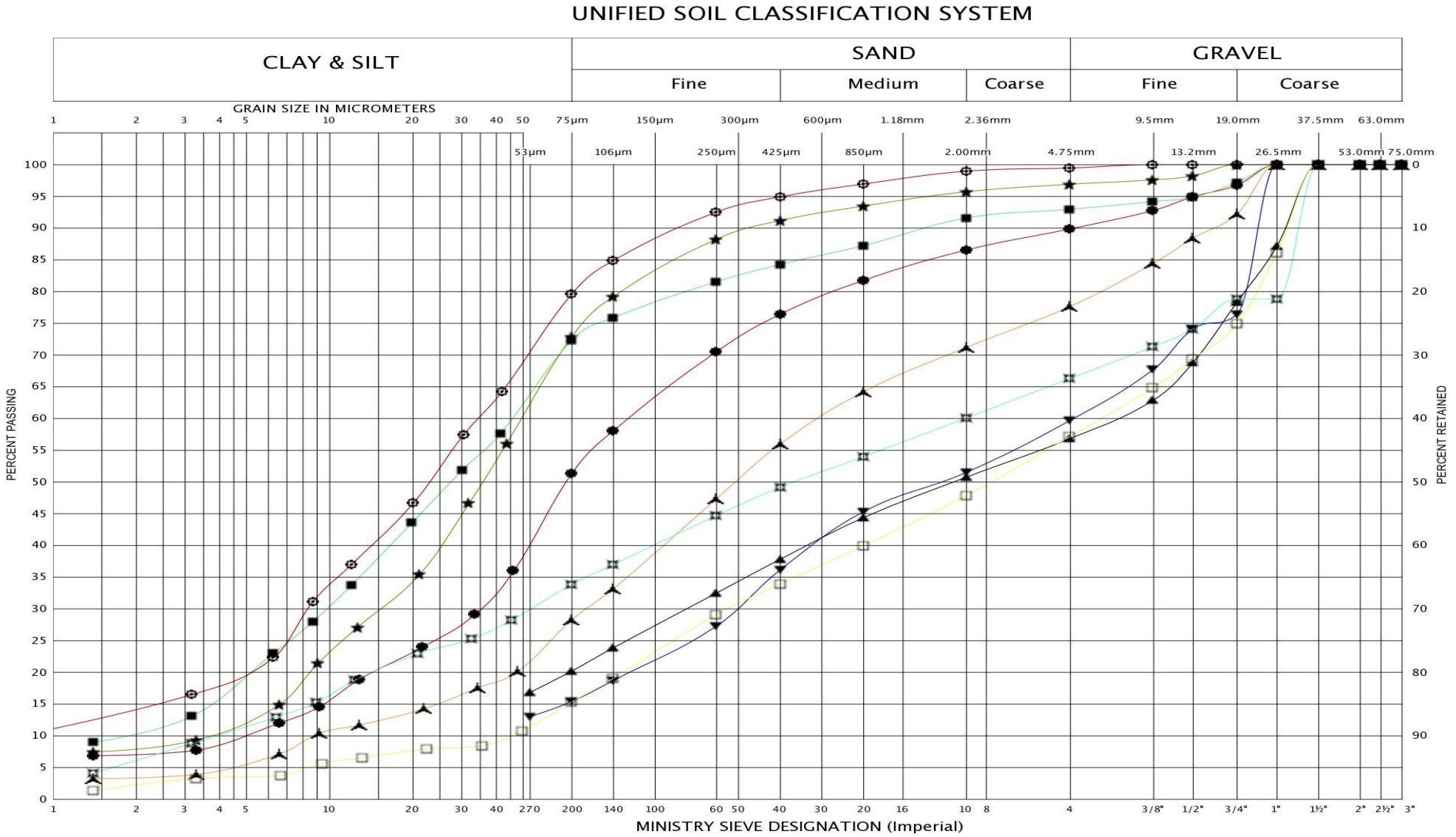
NOTES:

1. Artesian conditions were encountered at a depth of about 11.5 m (EL. 297.8) below the existing ground surface and the groundwater rose to an estimated height of 1.4 m (EL. 310.7) above the existing ground surface.
2. Due to the artesian conditions, a monitoring well was not installed as planned. The borehole was backfilled with cement grout immediately after drilling and rock coring was completed.
3. No cave-in was noted in the borehole upon extraction of augers.
4. The presence of cobbles is inferred by auger grinding observed during drilling and is not indicative of quantity.

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

APPENDIX B

Geotechnical Laboratory Test Results - 2021 Investigation (GEOCRES No. 40P8-293)



LEGEND	BH	21-36	21-36	21-37	21-37	21-38	21-38	21-39	21-39	21-39
	SAMPLE	4	6	4	9	3	6	5	8	11
	SYMBOL	●	▲	★	▼	■	⅄	⊙	⊠	□

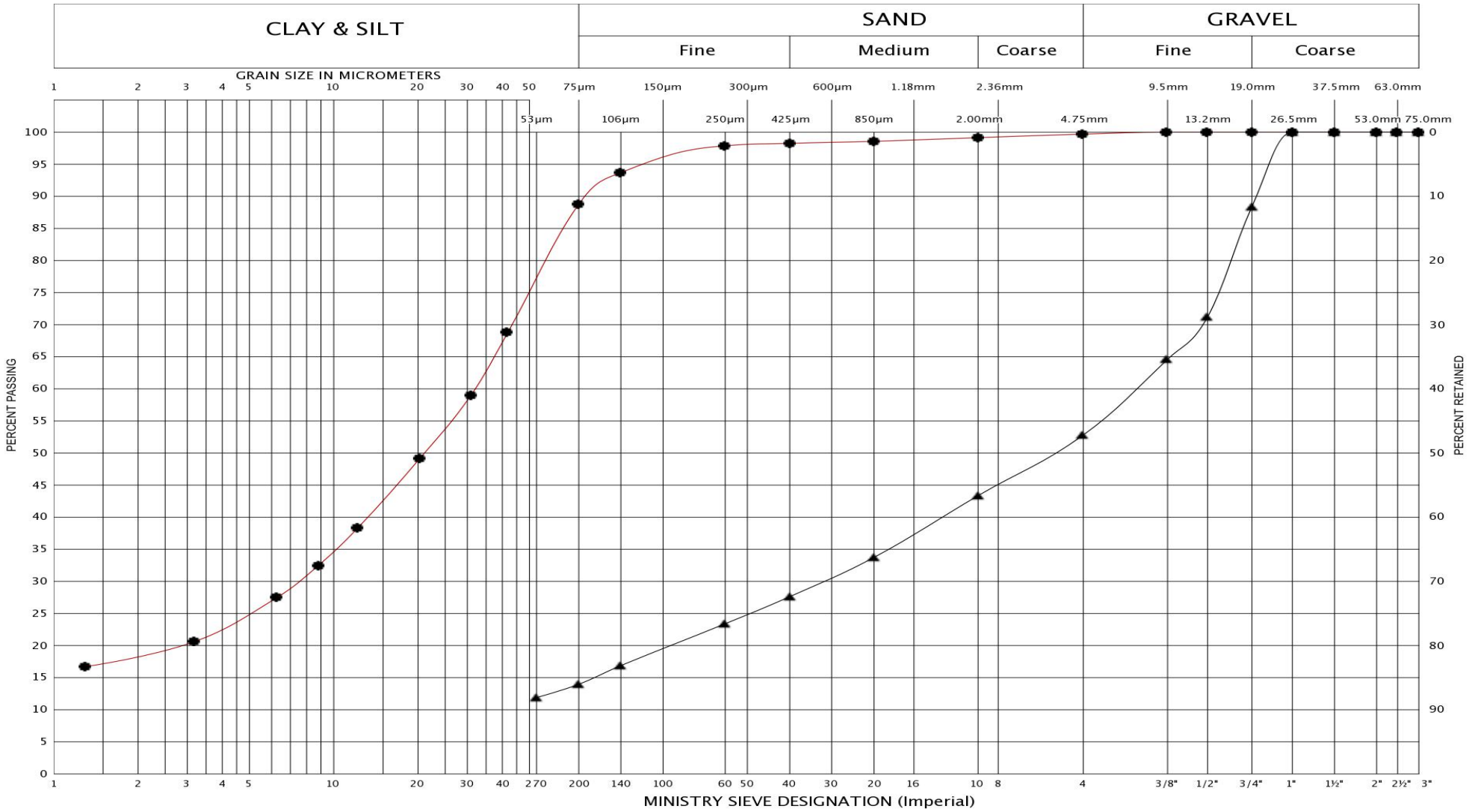
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	HF1-GS-1A
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-40	21-40
	SAMPLE	4	10
	SYMBOL	●	▲

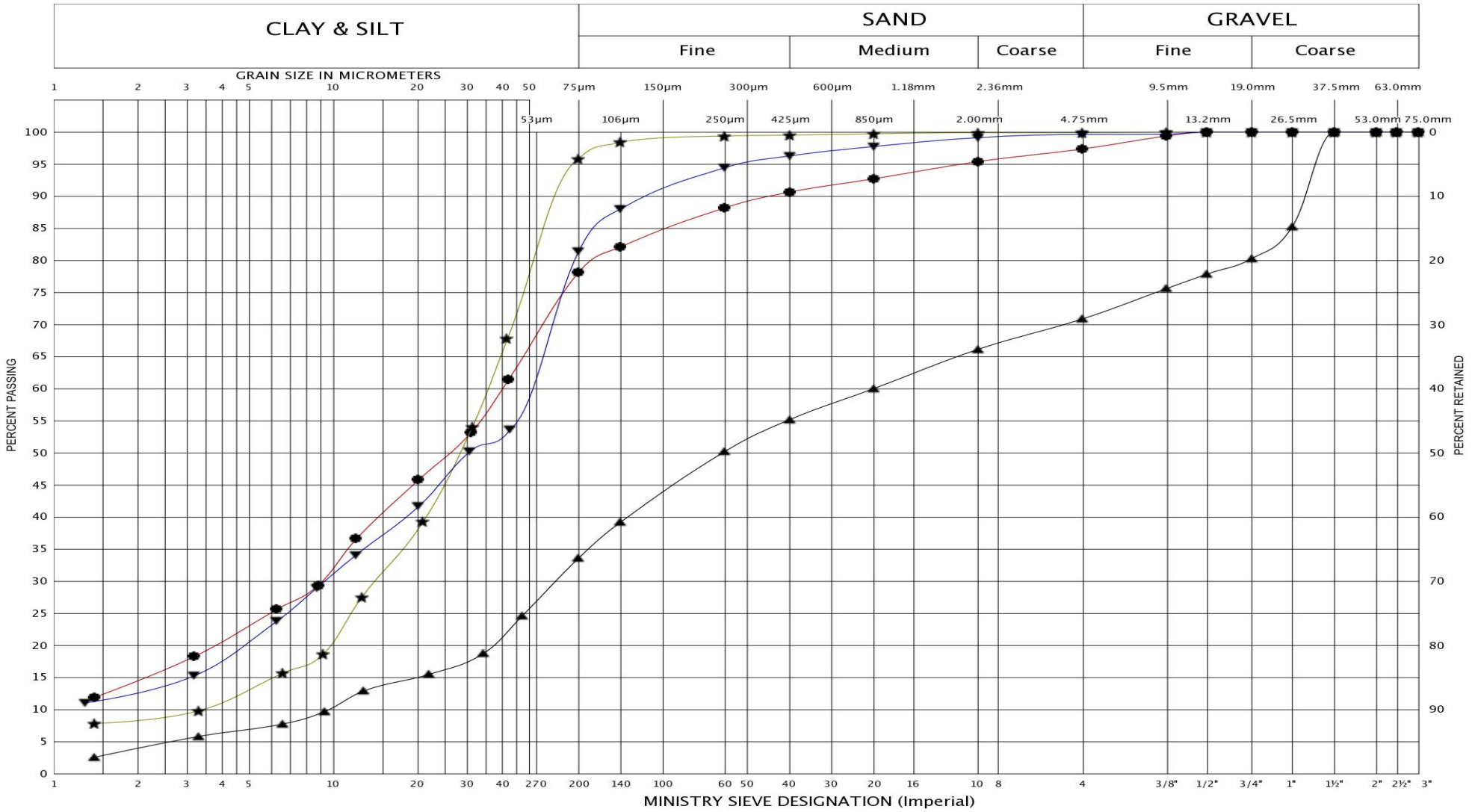
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	HF1-GS-1B
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



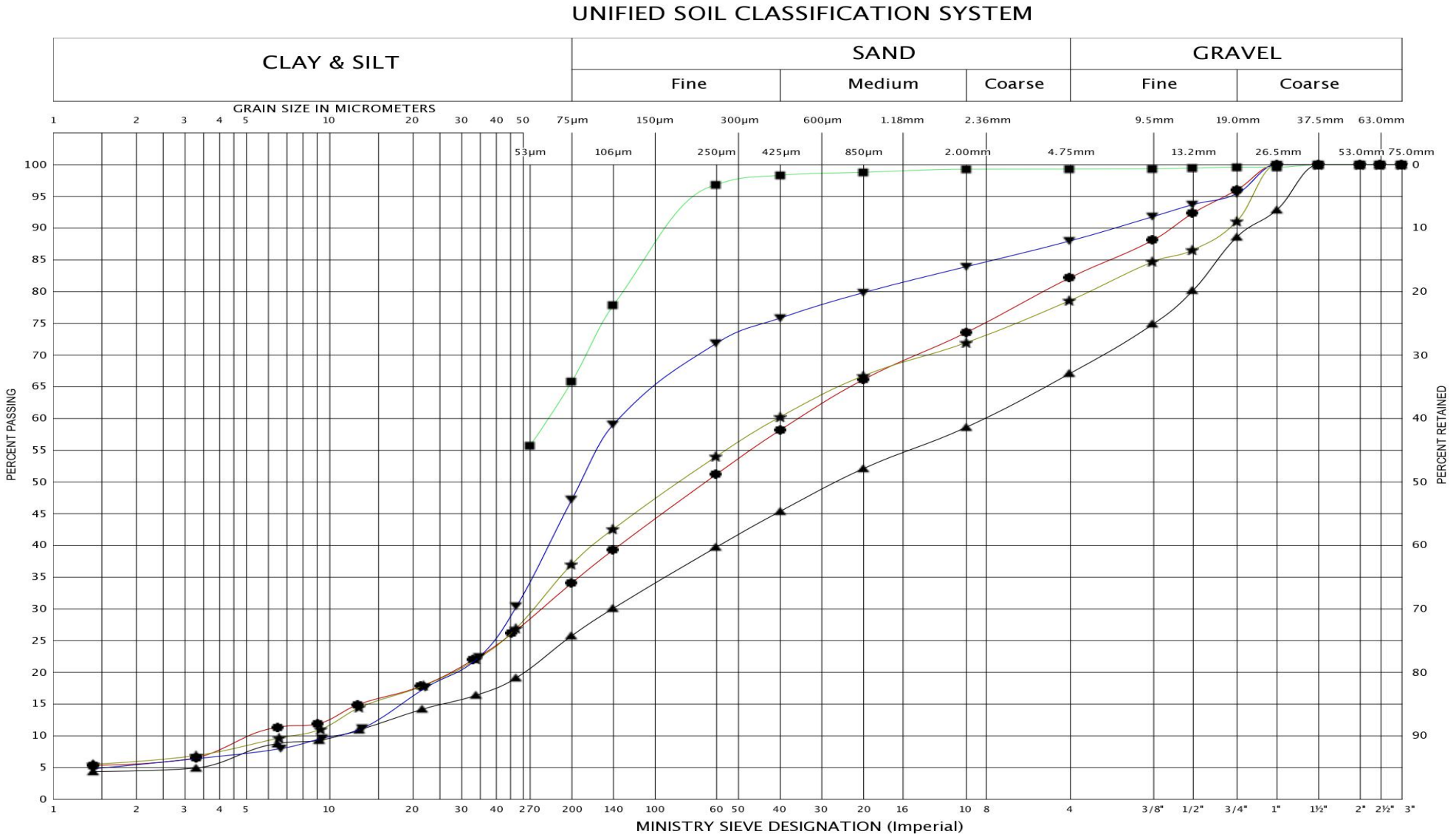
LEGEND	BH	21-34	21-34	21-35	21-35
	SAMPLE	4	7	4	9
	SYMBOL	▲	●	▼	★

Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel (TILL)

FIG No.:	HF2-GS-1
HWY :	6
GWP	3059-20-00



LEGEND	BH	21-32	21-32	21-33	21-33	21-33
	SAMPLE	6	9	3	8	11
	SYMBOL	▲	●	■	★	▼

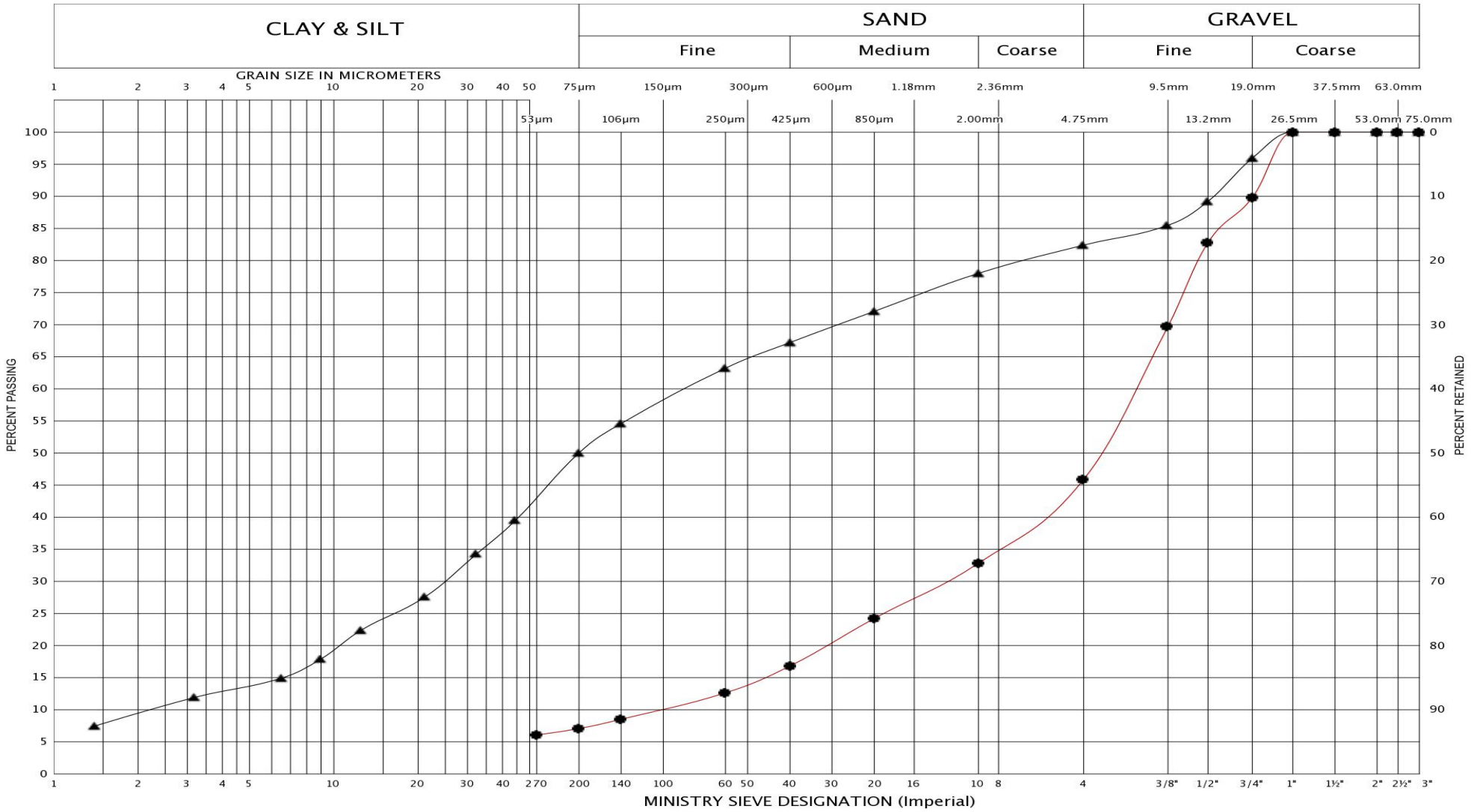
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	HF3-GS-1
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-05	21-07A
	SAMPLE	4	2
	SYMBOL	●	▲

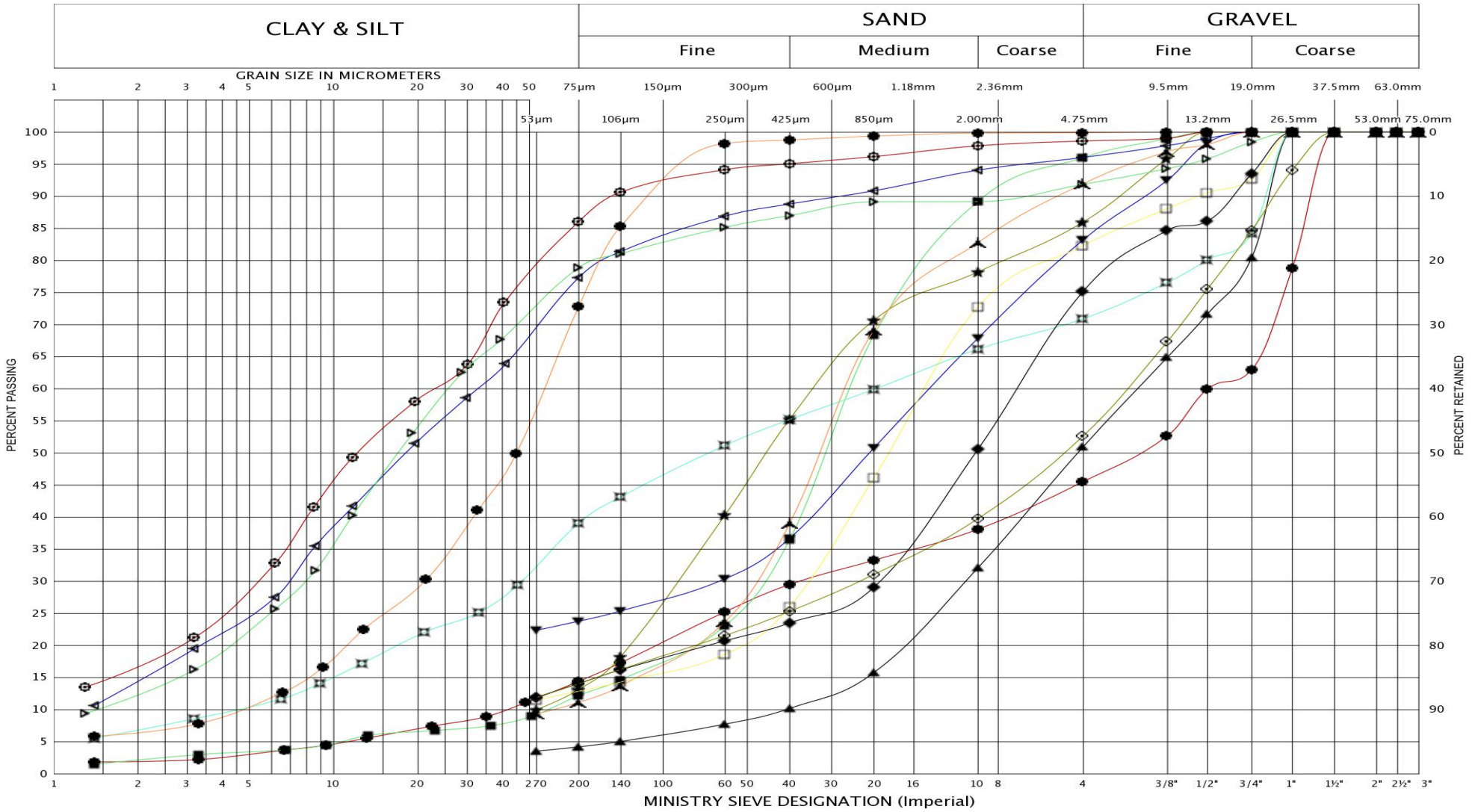
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, some gravel to gravelly (FILL)

FIG No.:	HF4-GS-1A
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



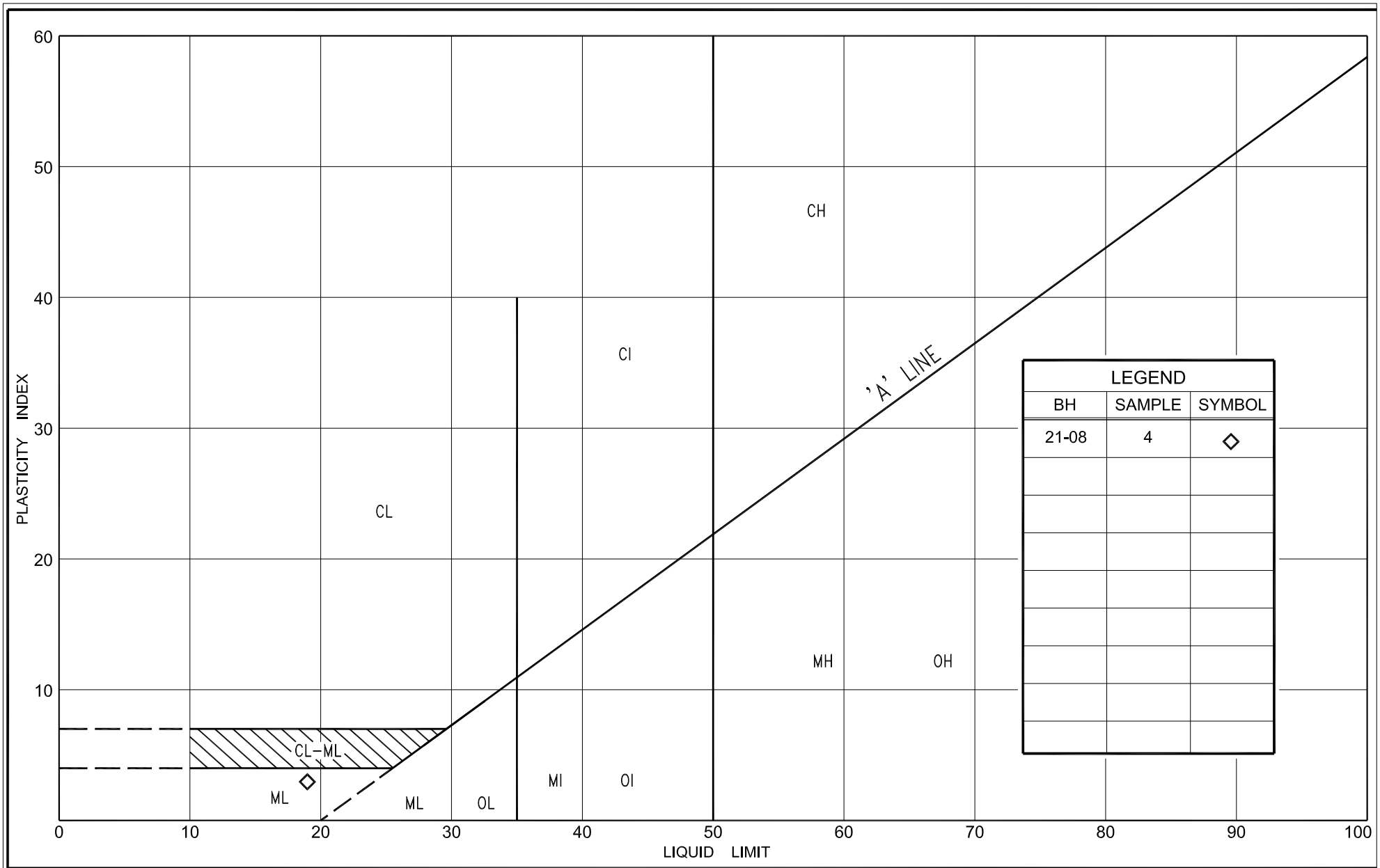
	BH	21-04	21-04	21-05	21-05	21-06	21-06	21-06	21-07	21-07A	21-07	21-07	21-08	21-08	21-08
LEGEND	SAMPLE	6	9	8	11	4	6	9	4	4	7	11	4	8	11
	SYMBOL	●	▲	★	▼	□	■	⅄	◆	◇	⊠	⊕	◗	⬢	◀

Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (Till)

FIG No.:	HF4-GS-1B
HWY :	6
GWP	3059-20-00



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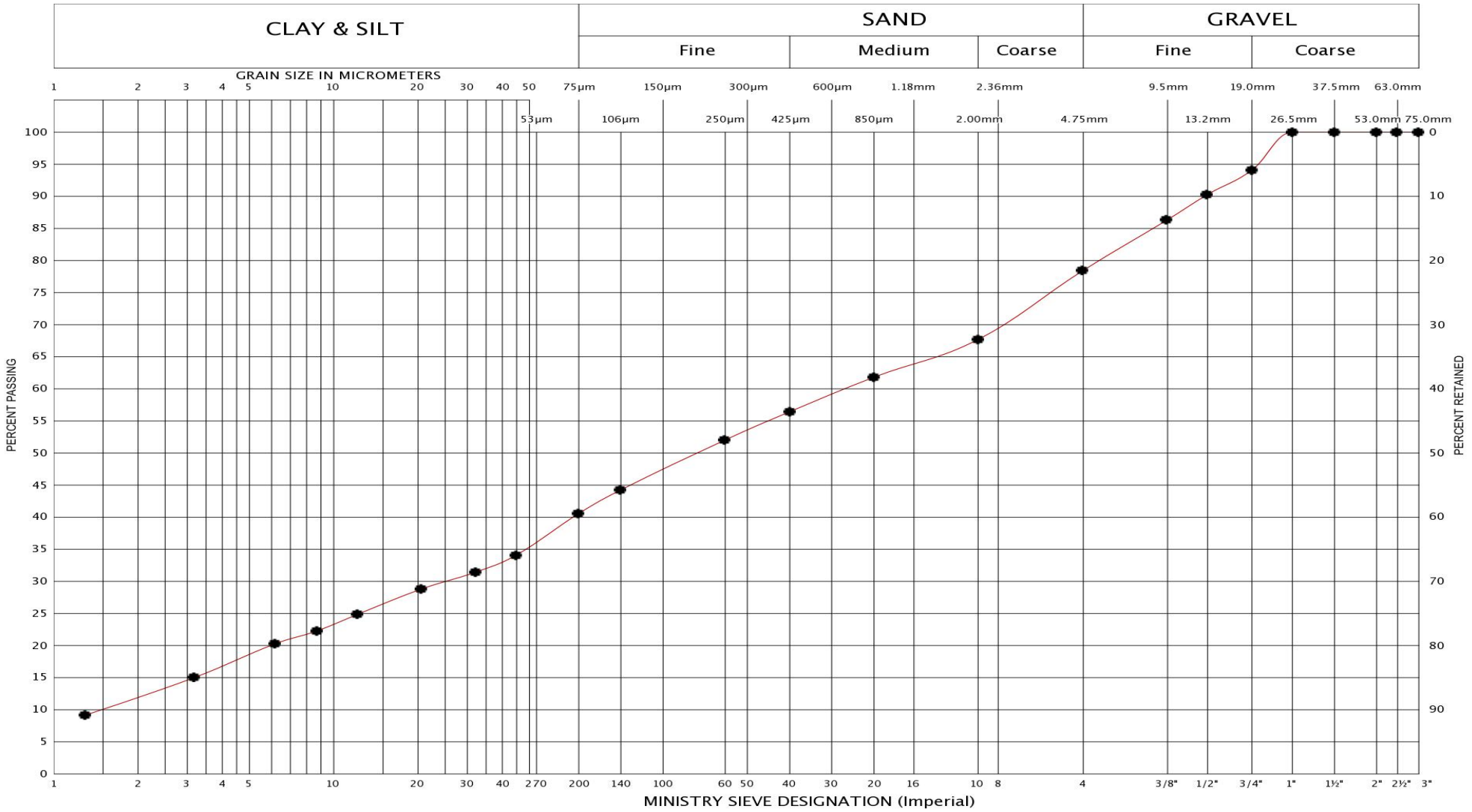
PLASTICITY CHART

SANDY SILT, trace gravel (TILL)

FIG No.	HF4-PC-1
HWY:	6
G.W.P. No.	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-03
	SAMPLE	2
	SYMBOL	●

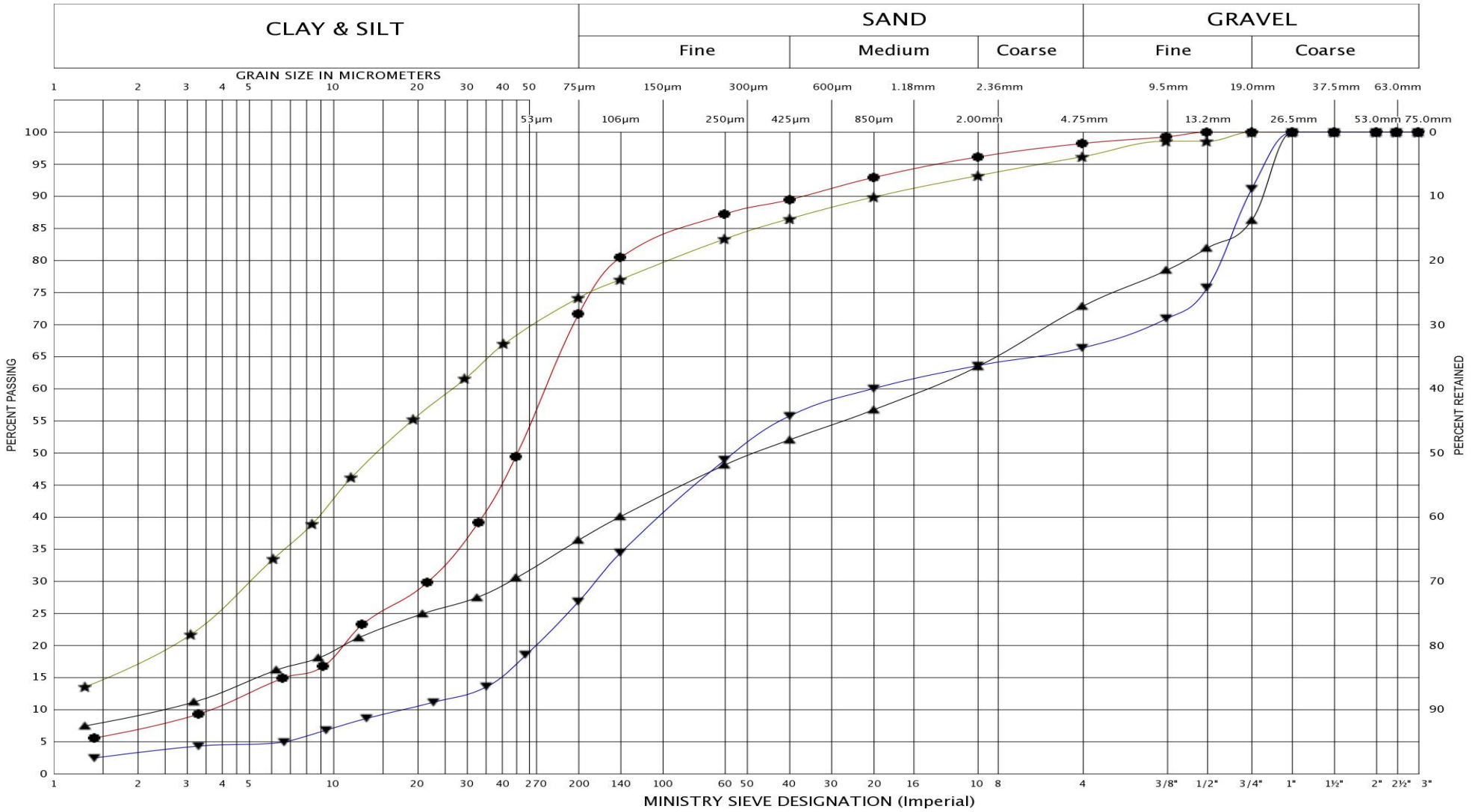
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND, gravelly (FILL)

FIG No.:	HF5-GS-1A
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-02	21-03	21-03	21-03
	SAMPLE	4	10	12	14
	SYMBOL	●	★	▲	▼

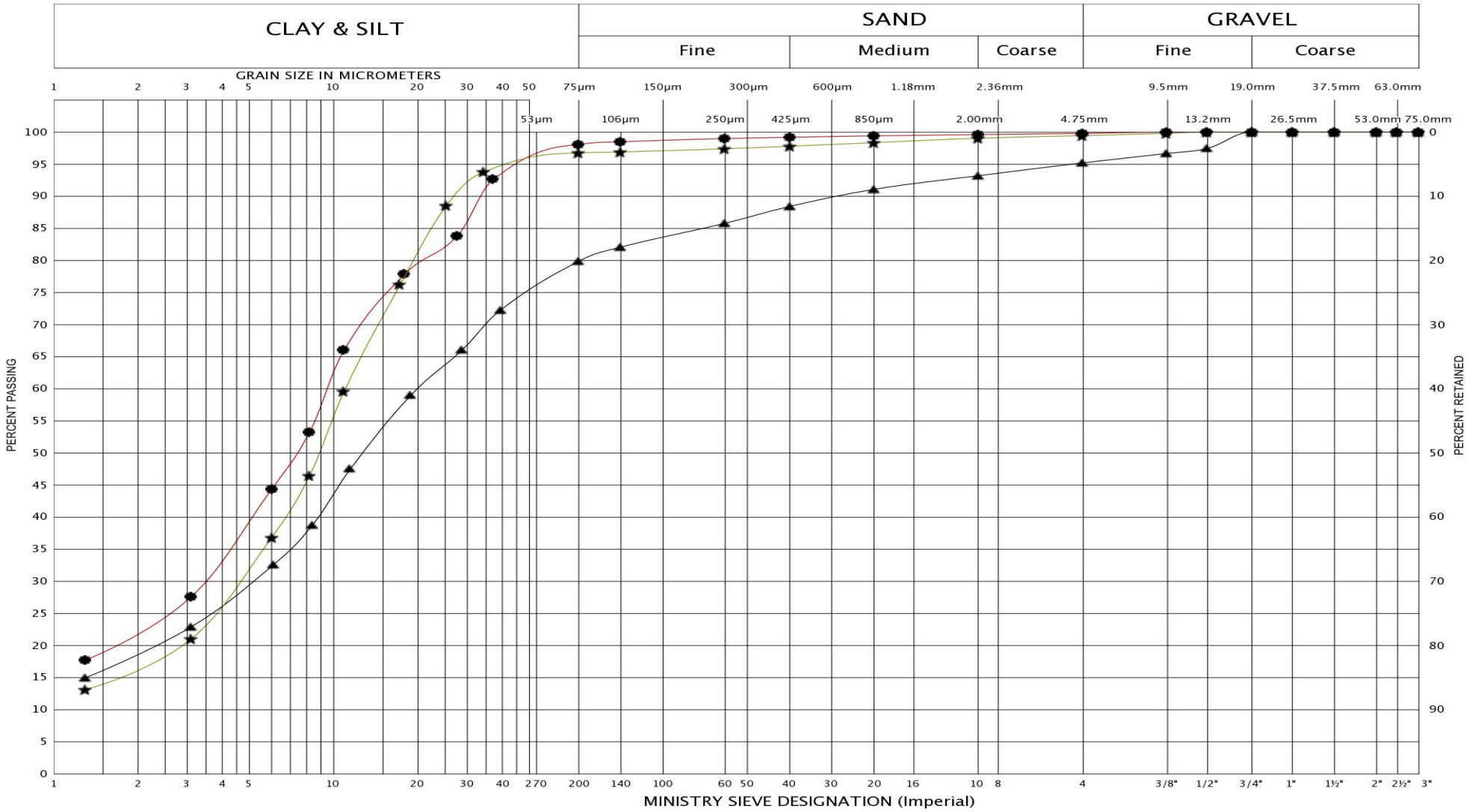
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	HF5-GS-1B
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



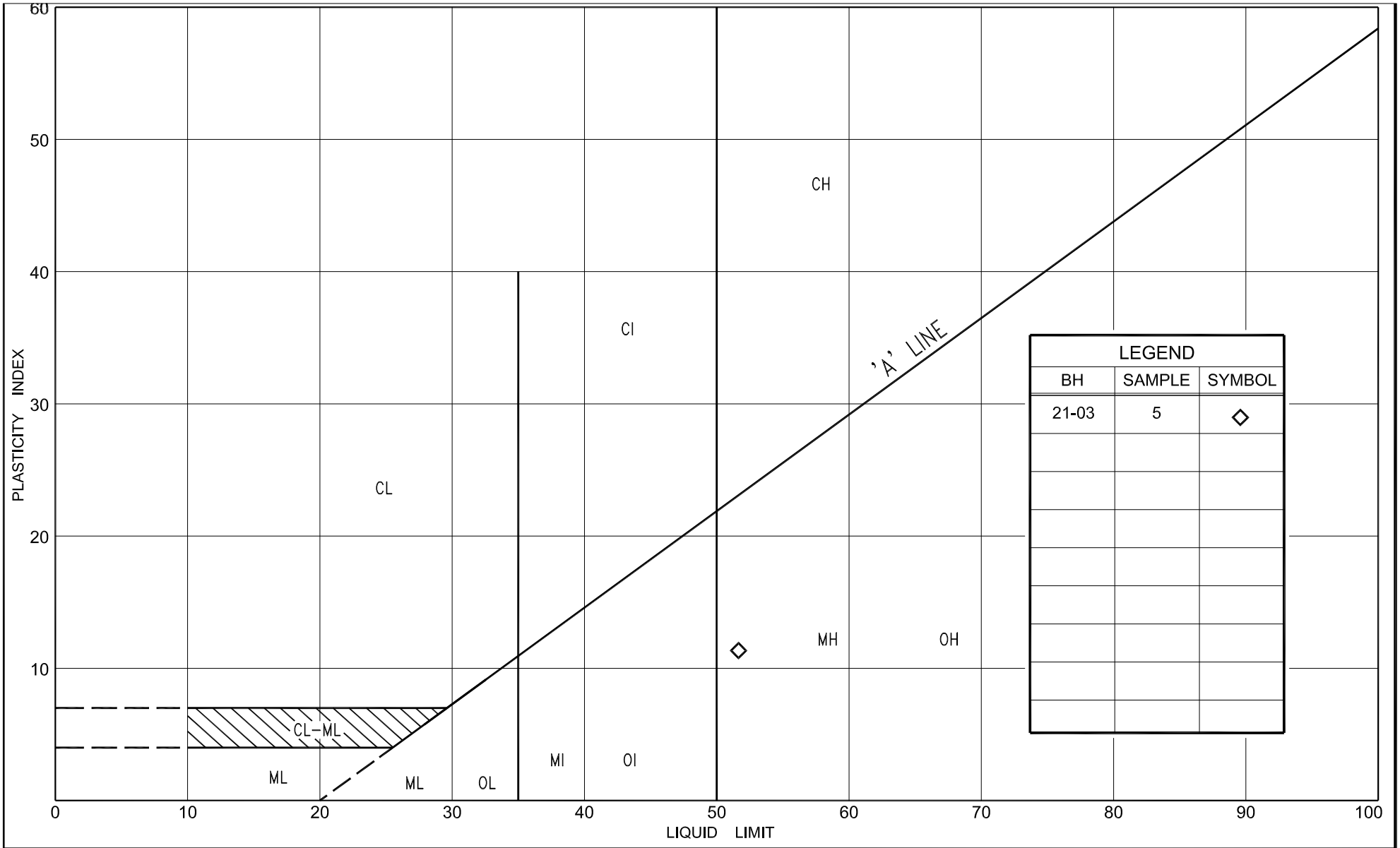
LEGEND	BH	21-01	21-02	21-02
	SAMPLE	7	8	12
	SYMBOL	●	▲	★

Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand, trace gravel (TILL)

FIG No.:	HF5-GS-1C
HWY :	6
GWP	3059-20-00



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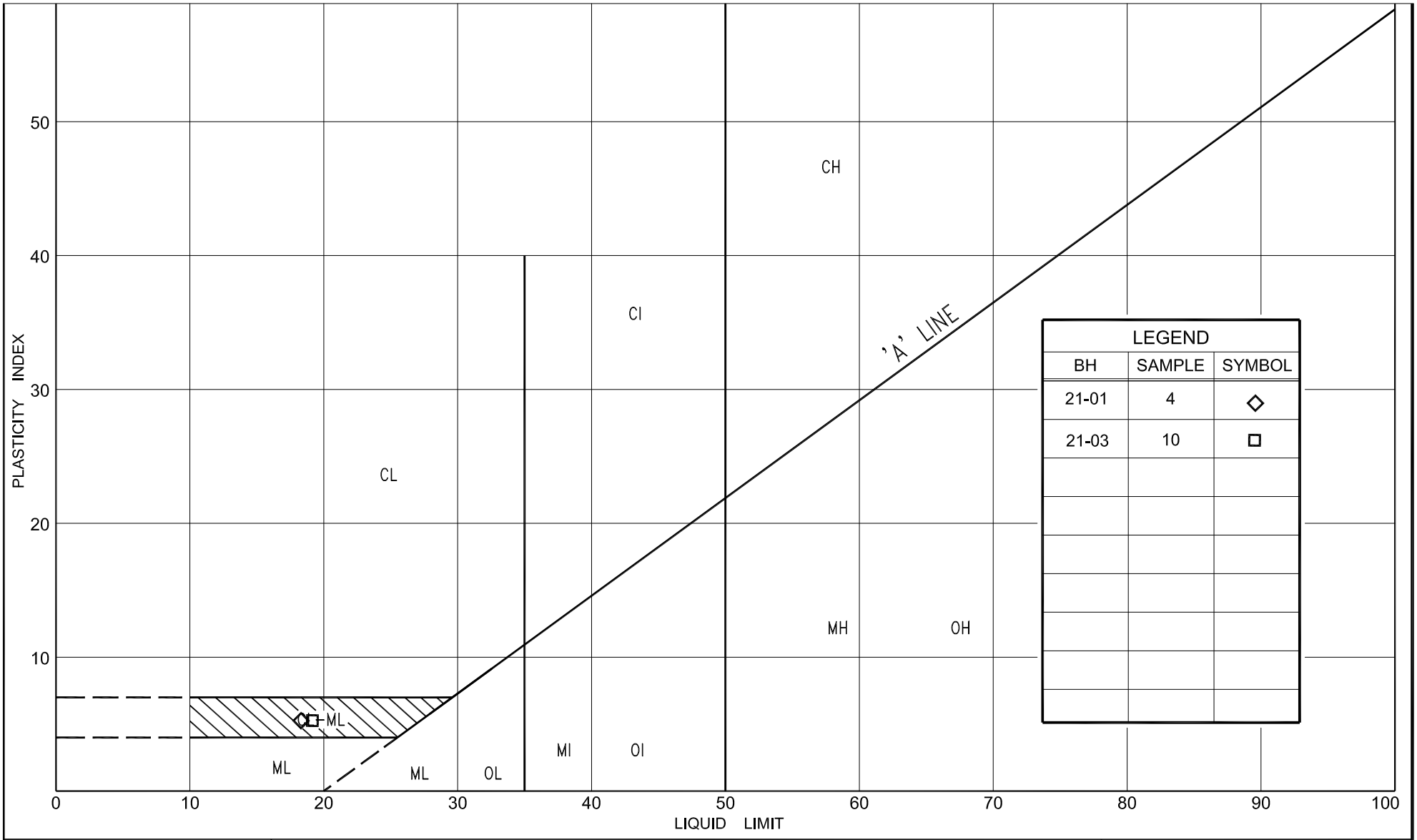
PLASTICITY CHART

SILTY CLAY, peat and organics

FIG No.	HF5-PC-1
HWY:	6
G.W.P. No.	3059-20-00



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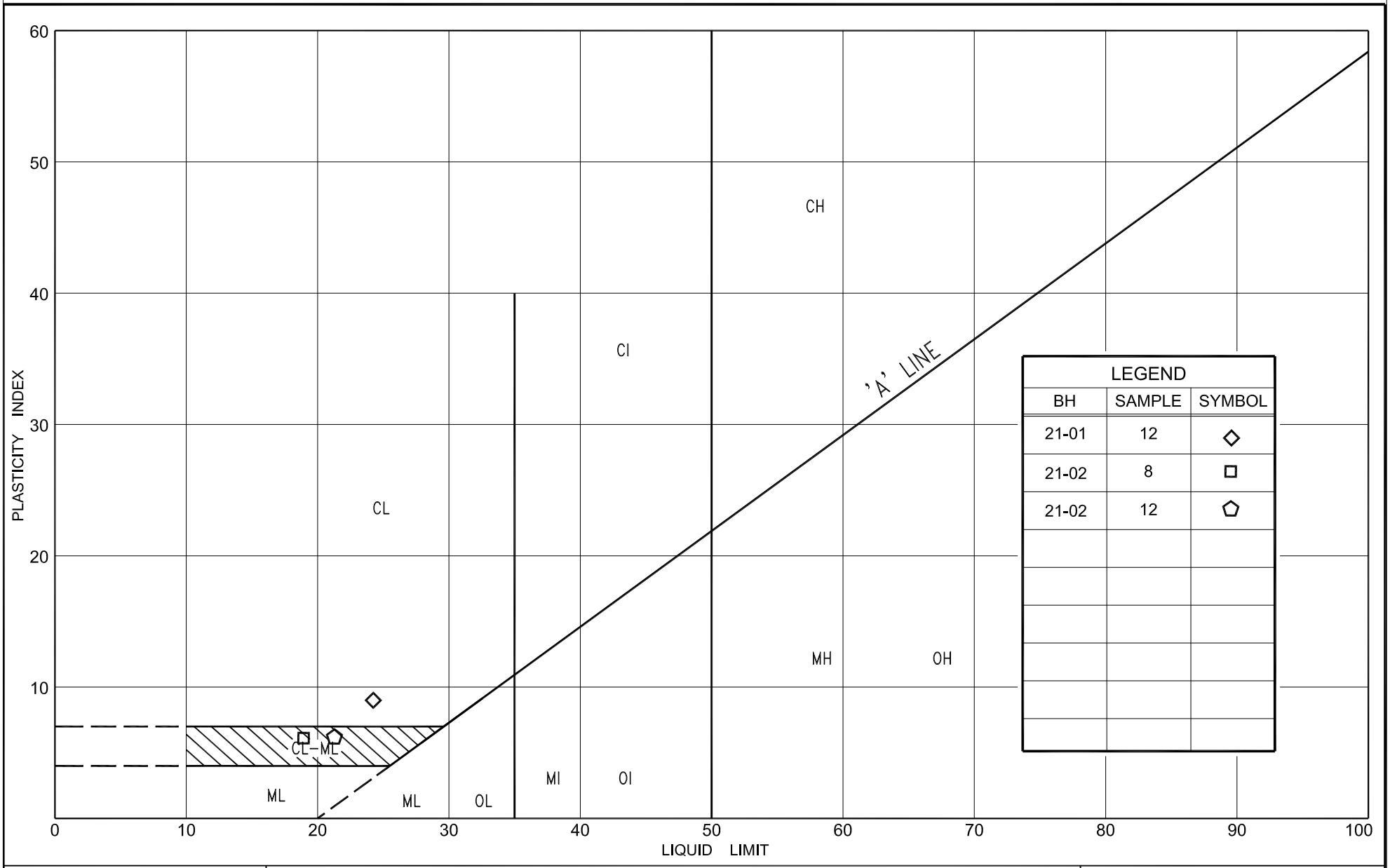
PLASTICITY CHART

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.	HF5-PC-2
HWY:	6
G.W.P. No.	3059-20-00



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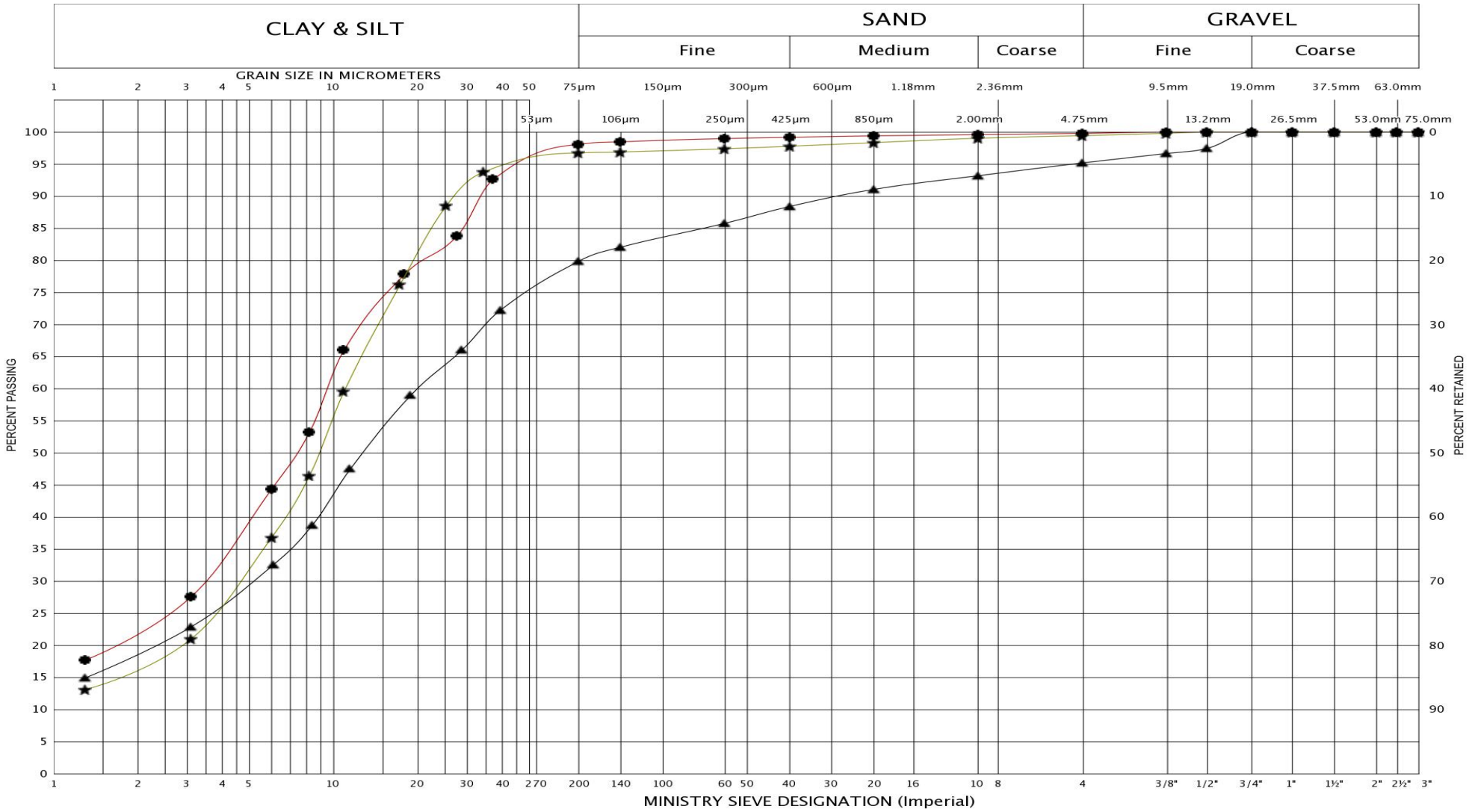
PLASTICITY CHART

CLAYEY SILT, trace sand, trace gravel (TILL)

FIG No.	HF5-PC-3
HWY:	6
G.W.P. No.	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



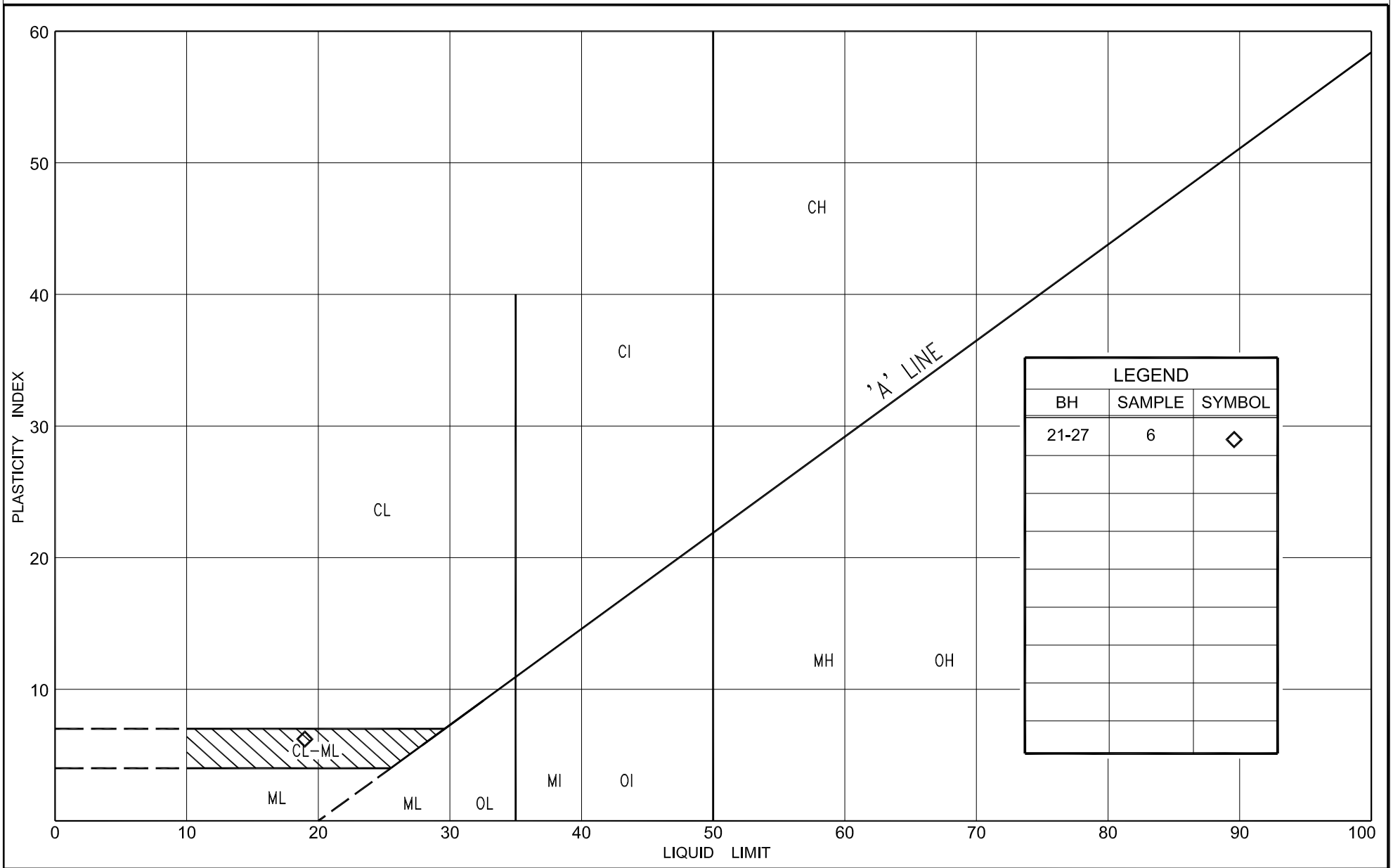
LEGEND	BH	21-26	21-26	21-26	21-27	21-27	21-27	21-28	21-28
	SAMPLE	2	5	11	3	6	9	4	7
	SYMBOL	●	▲	★	■	⅄	▼	□	⊠

Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	HF6-GS-1
HWY :	6
GWP	3059-20-00



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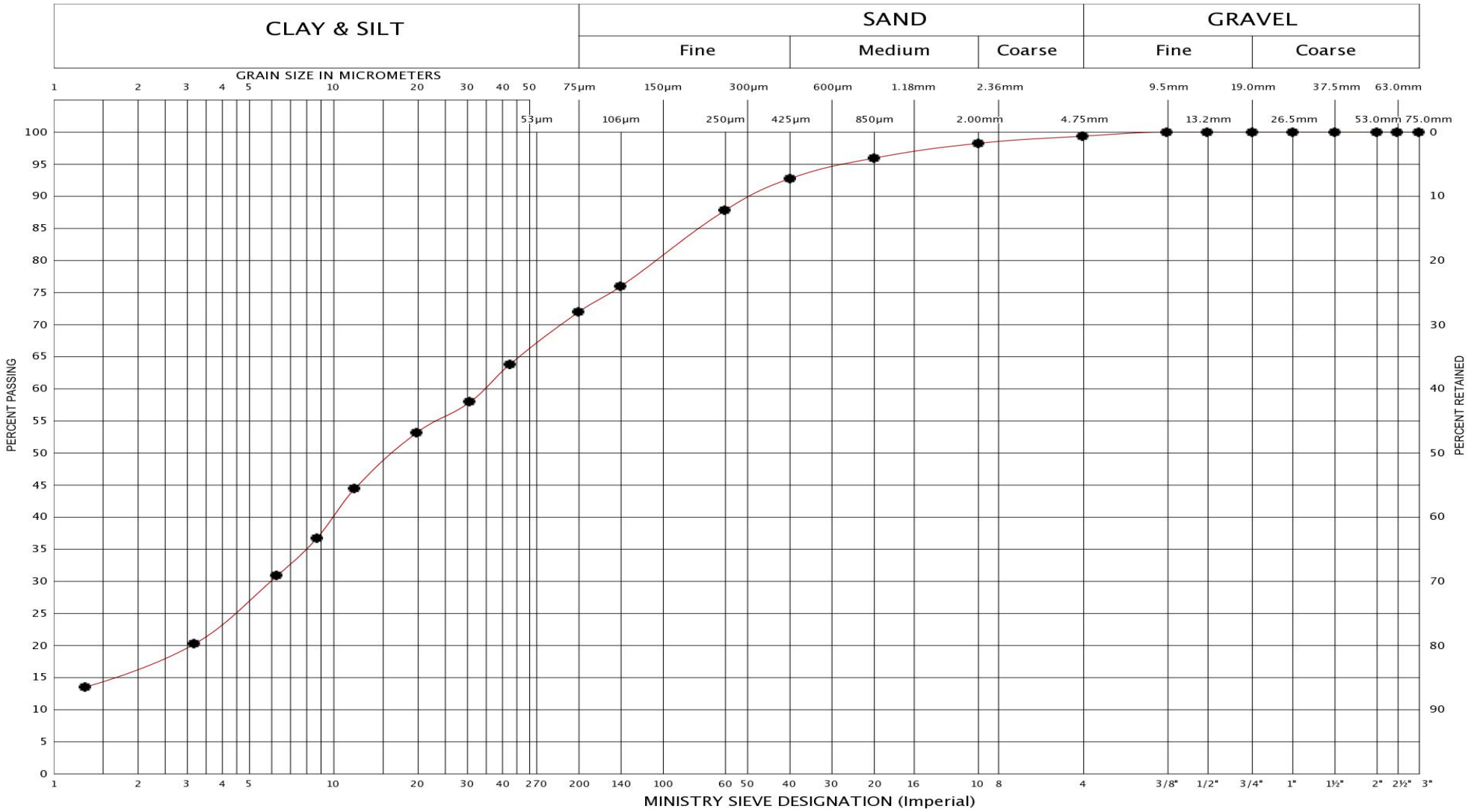
PLASTICITY CHART

SILTY SAND/SANDY SILT, some gravel (TILL)

FIG No.	HF6-PC-1
HWY:	6
G.W.P. No.	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
	BH	21-41
	SAMPLE	2
	SYMBOL	●

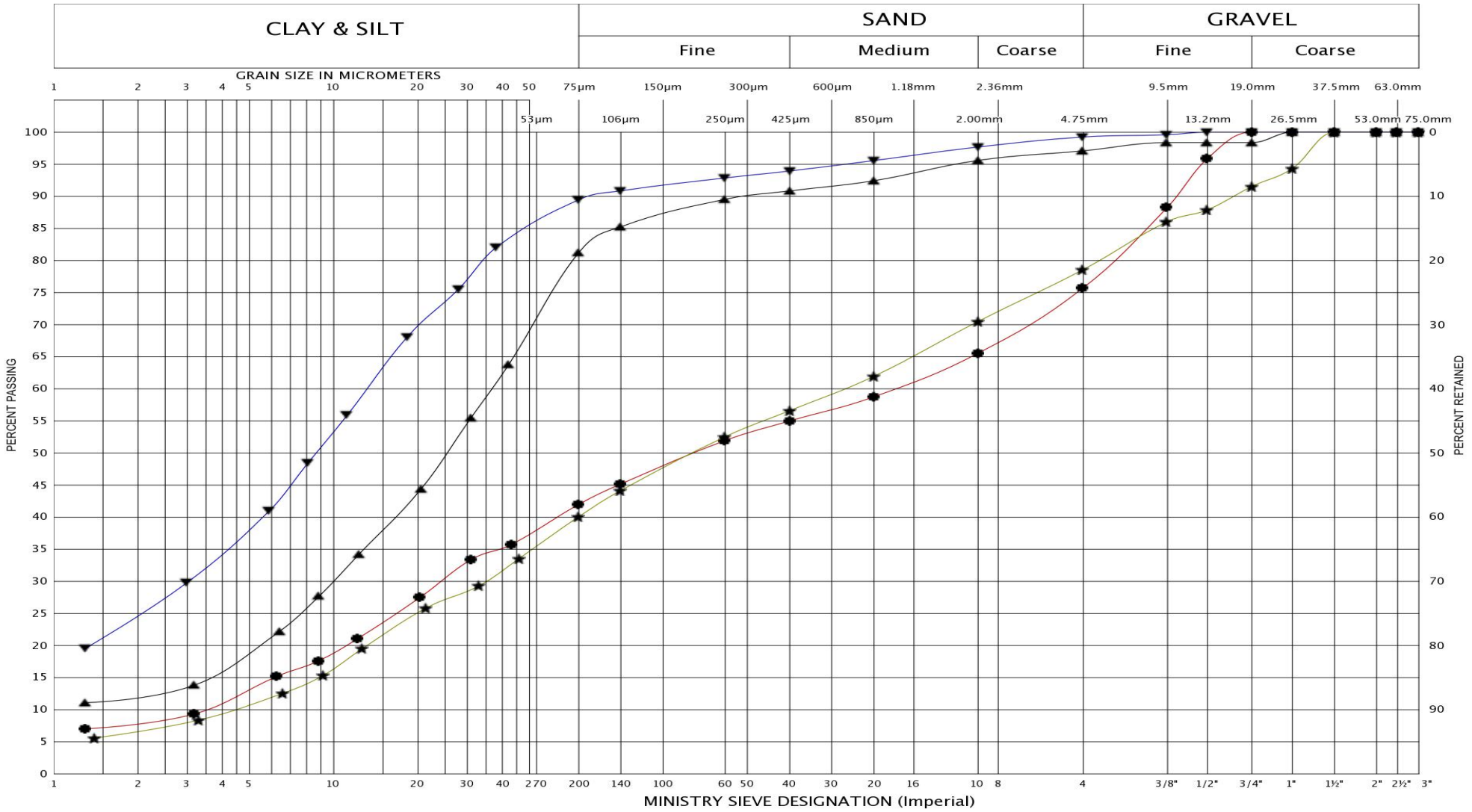
Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT, trace gravel (FILL)

FIG No.:	DC1-GS-1
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-41	21-42	21-42	21-42
	SAMPLE	5	3	6	10
	SYMBOL	●	✱	▲	▼

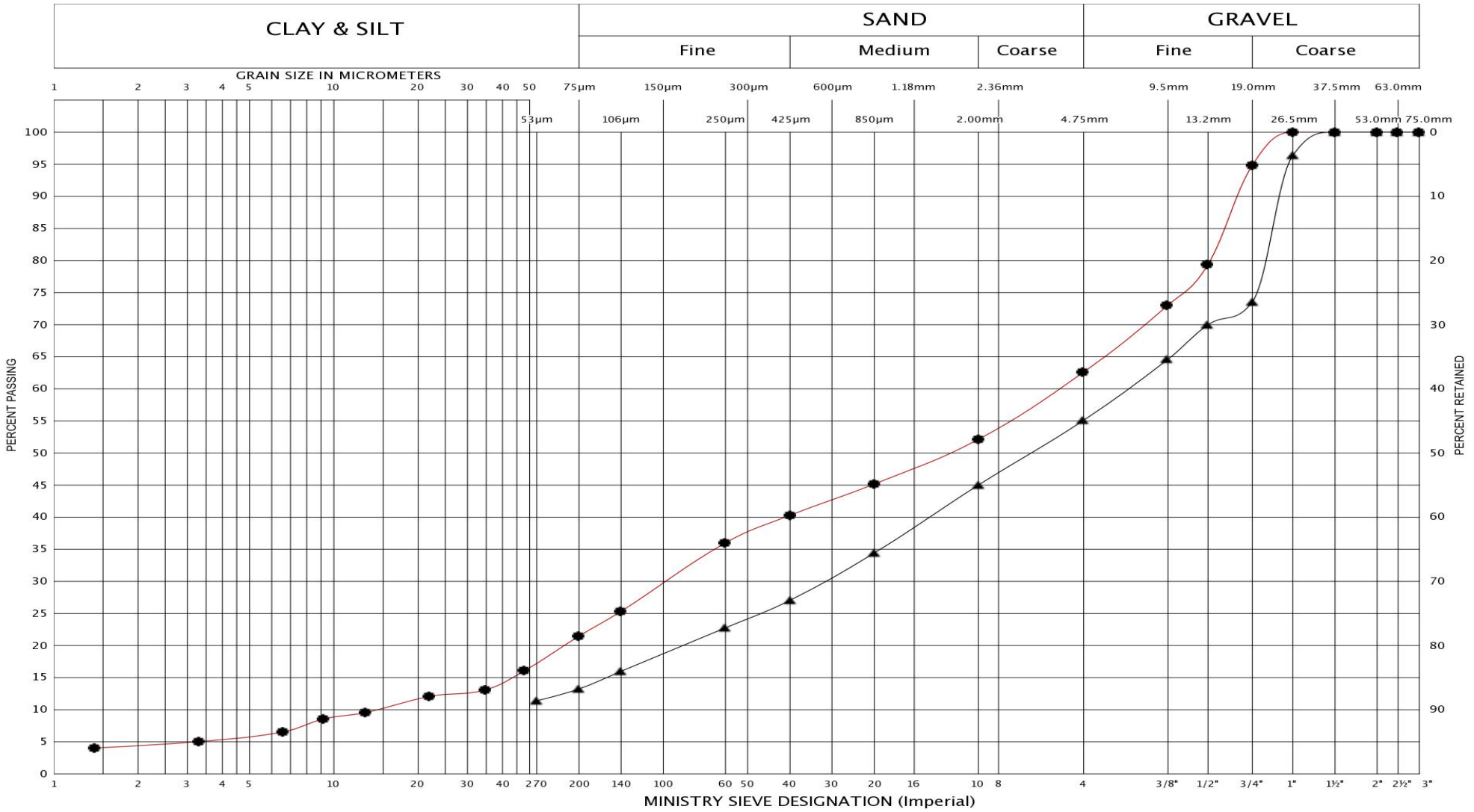
Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	DC1-GS-2
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-43	21-43
	SAMPLE	5	8
	SYMBOL	▲	●

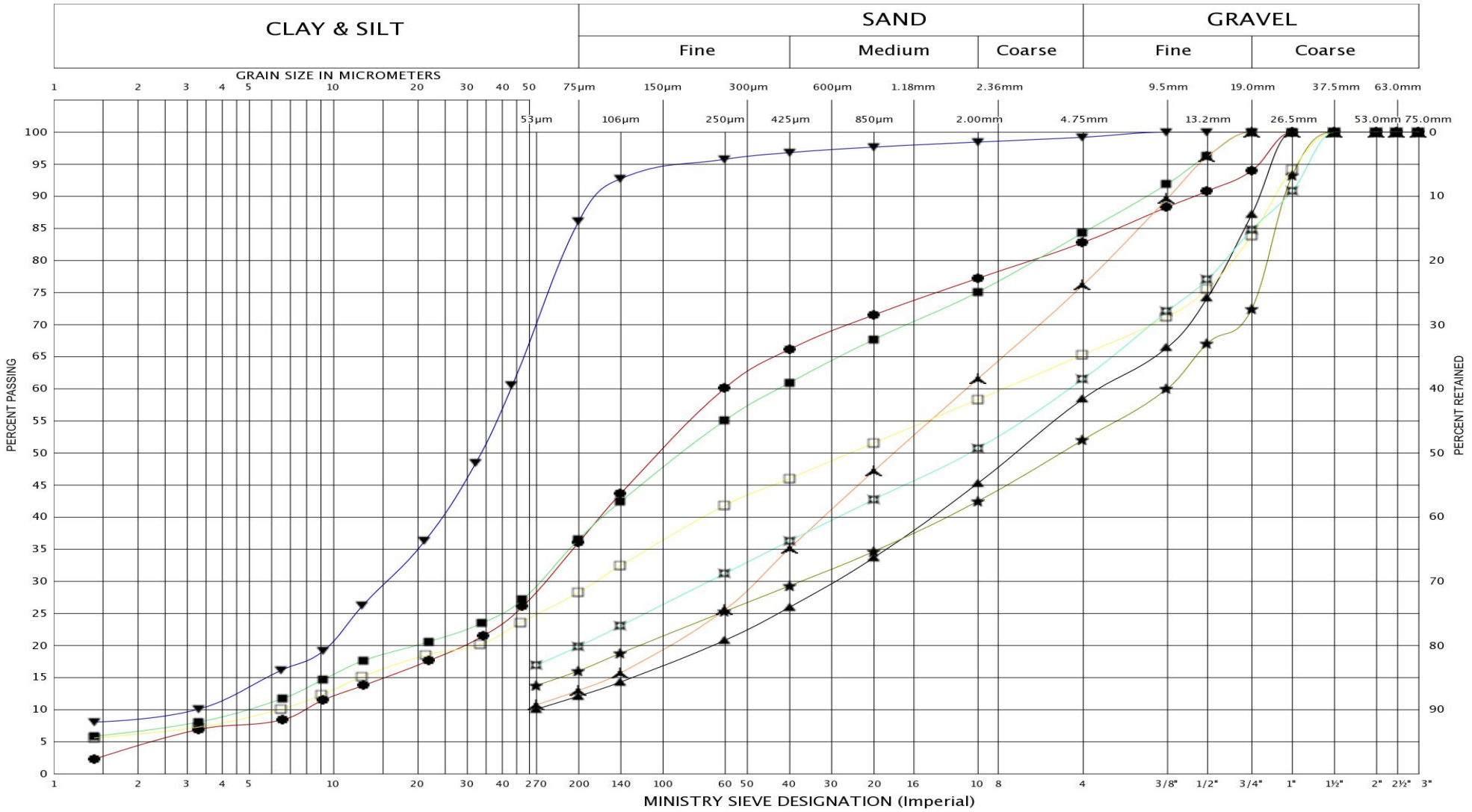
Ontario

GRAIN SIZE DISTRIBUTION

SANDY GRAVEL, some silt (TILL)

FIG No.:	DC1-GS-3
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-09	21-09	21-09	21-10	21-10	21-10	21-11	21-11
	SAMPLE	2	5	8	2	6	9	3	7
	SYMBOL	●	✱	▲	▼	■	⅄	□	⊠

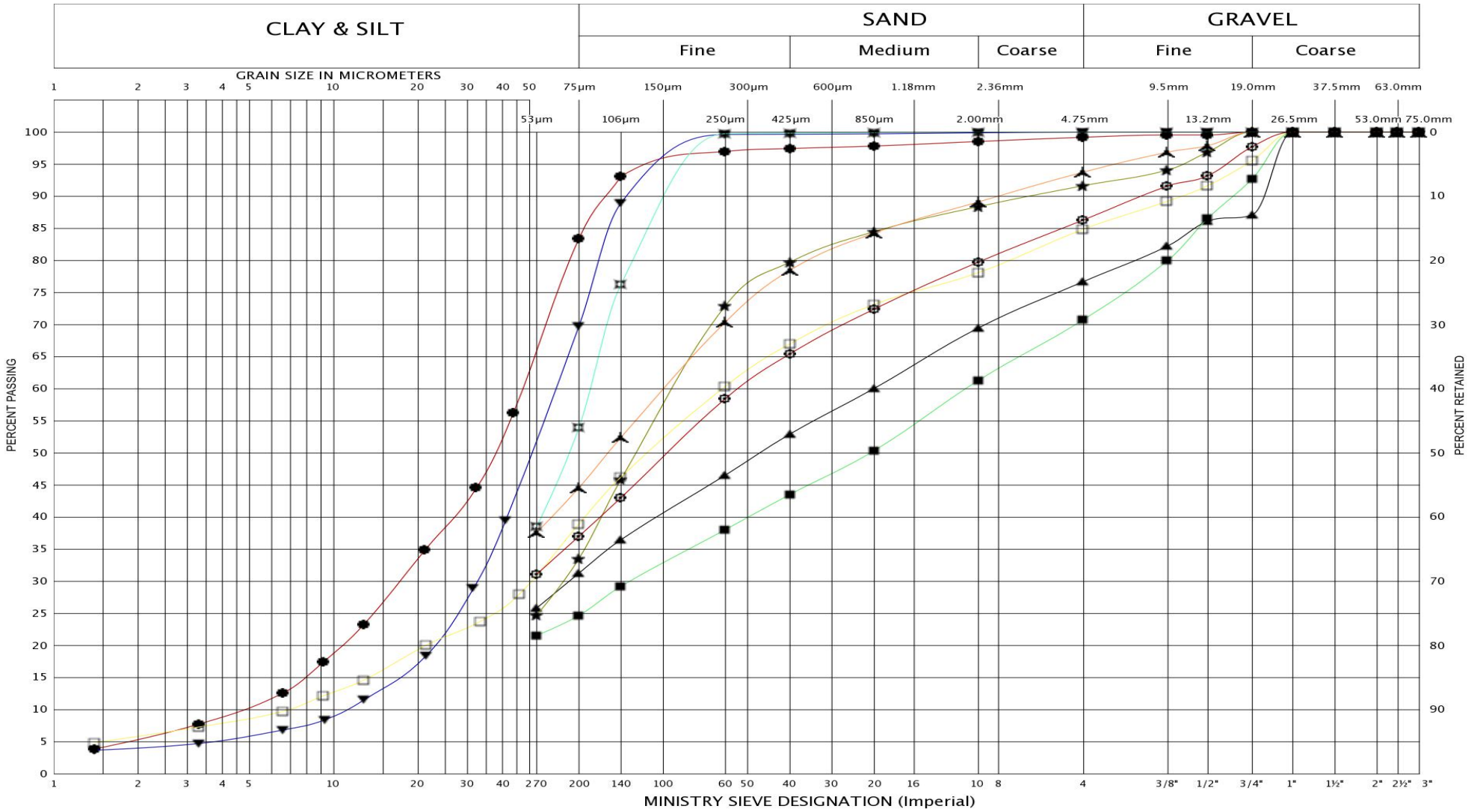
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	DC2-GS-1
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-29	21-29	21-29	21-30	21-30	21-30	21-31	21-31	21-31
	SAMPLE	3	8	11	4	8	12	2	7	10
	SYMBOL	▲	✱	●	⅄	■	▼	⊙	□	⊠

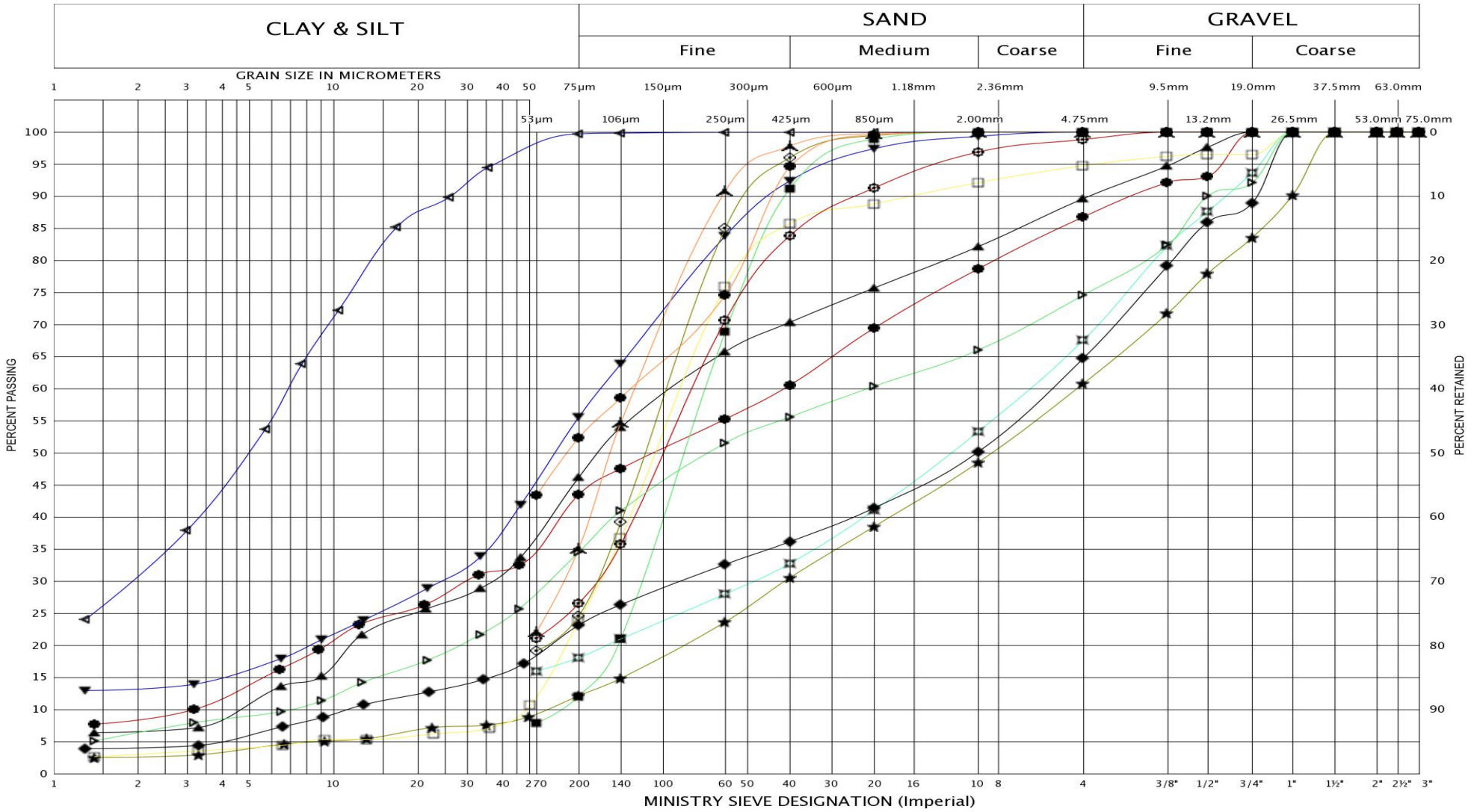
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	DC3-GS-1
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



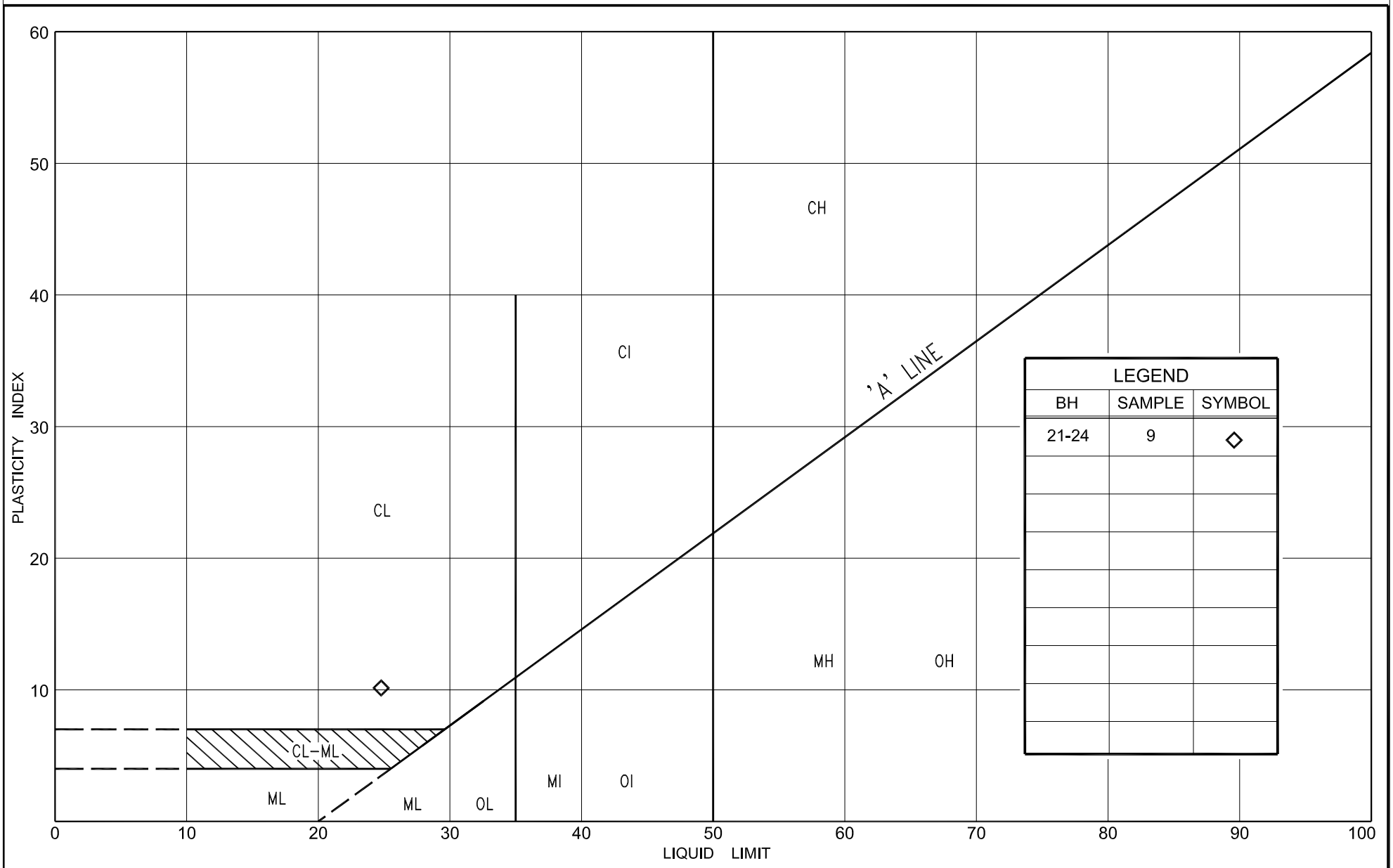
	BH	21-17	21-17	21-17	21-18	21-18	21-18	21-20	21-20	21-20	21-22	21-22	21-24	21-24	21-24
LEGEND	SAMPLE	3	7	10	2	3	9	3	6	10	6	10	3	9	11
	SYMBOL	▲	●	★	▼	■	⅄	✖	□	⊕	◆	◇	⬢	◀	▶

Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SAND, trace gravel to gravelly (TILL)

FIG No.:	DC4-GS-1
HWY :	6
GWP	3059-20-00



Ontario
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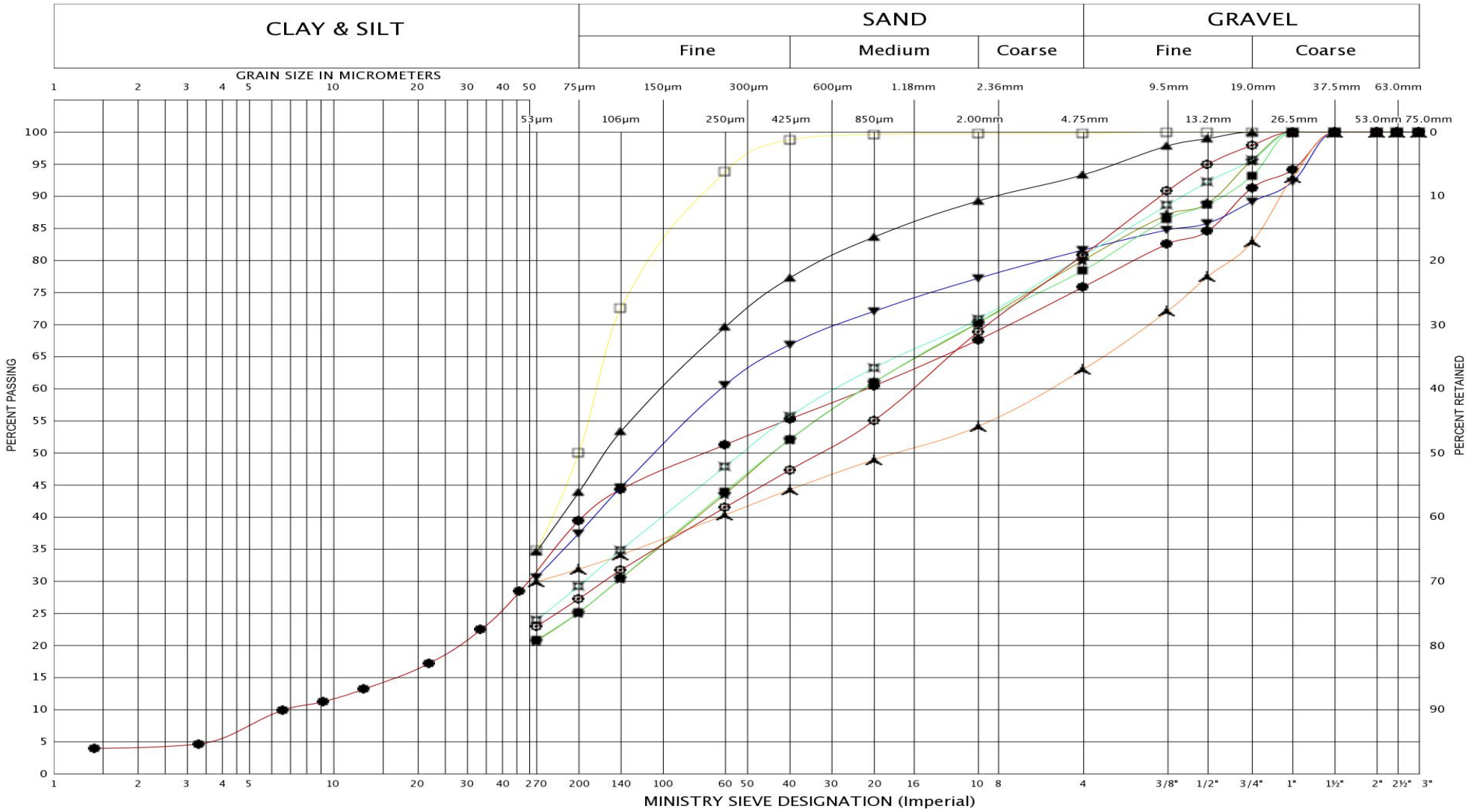
PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	DC4-PC-1
HWY:	6
G.W.P. No.	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-12	21-12	21-12	21-13	21-13	21-13	21-14	21-14	21-14
	SAMPLE	2	7	10	2	5	10	4	7	10
	SYMBOL	▲	✱	●	■	⅄	▼	□	⊠	⊙

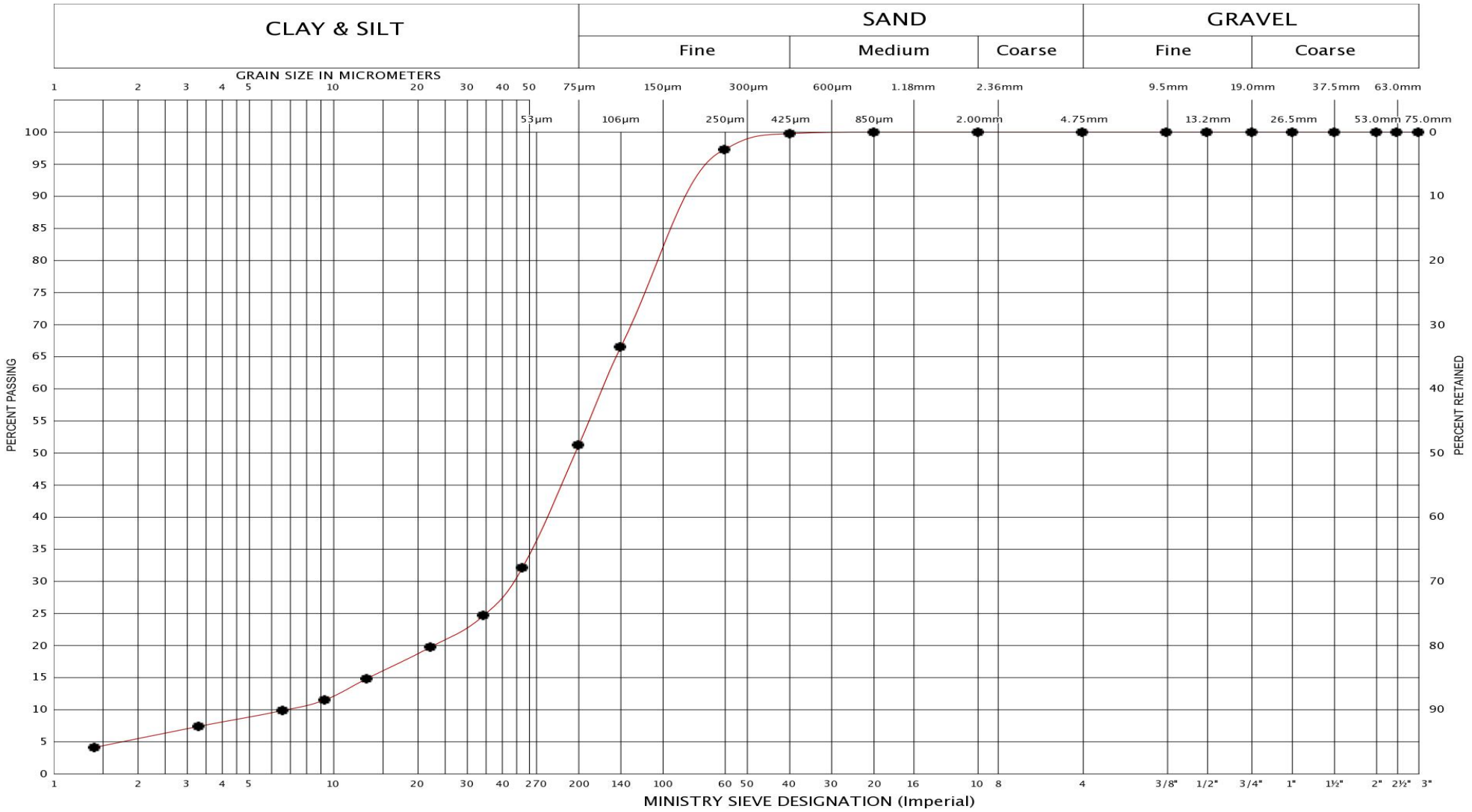
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND, trace gravel to gravelly (TILL)

FIG No.:	DC5-GS-1
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-21
	SAMPLE	2
	SYMBOL	●

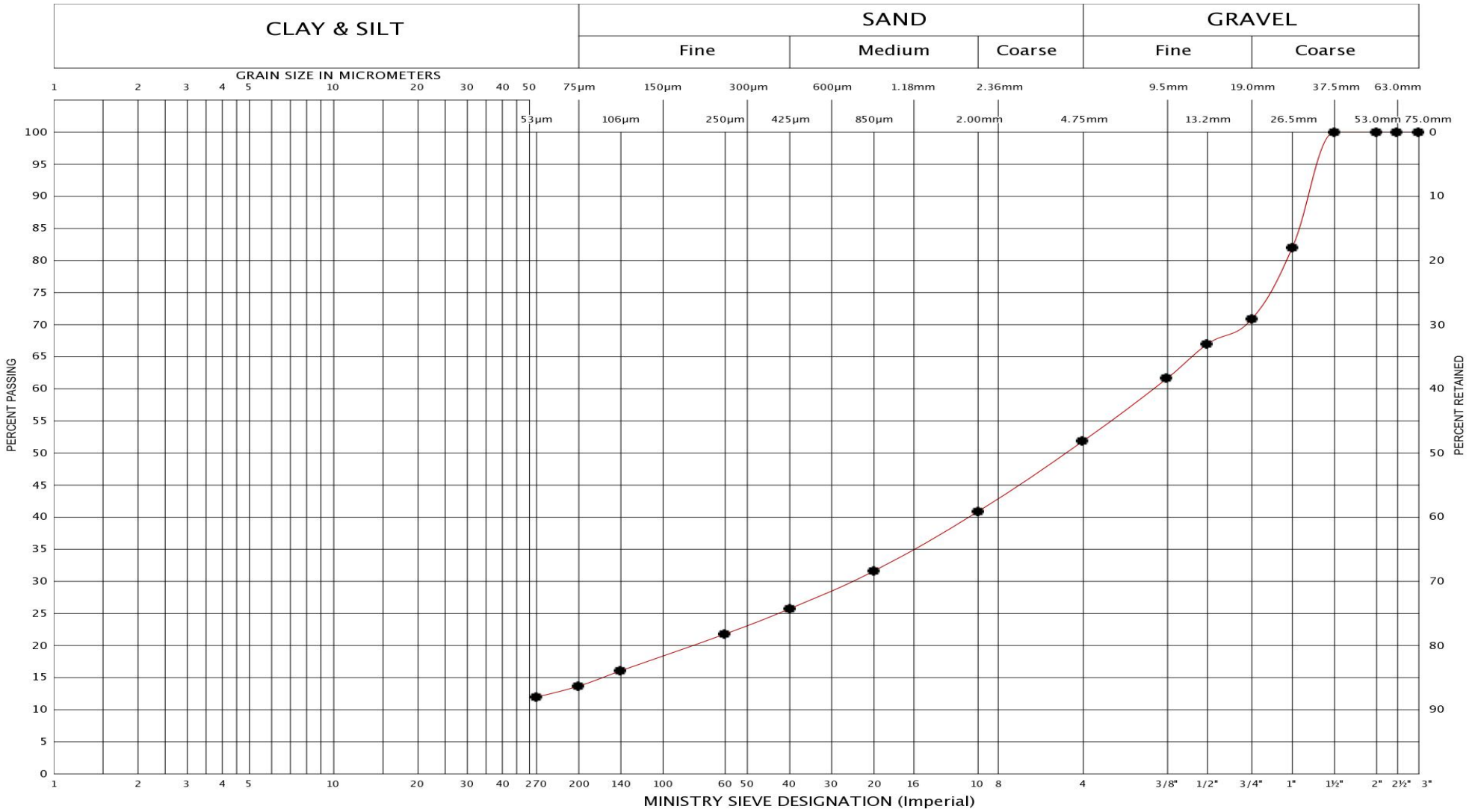
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND (FILL)

FIG No.:	DC6-GS-1A
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	21-25
	SAMPLE	4
	SYMBOL	●

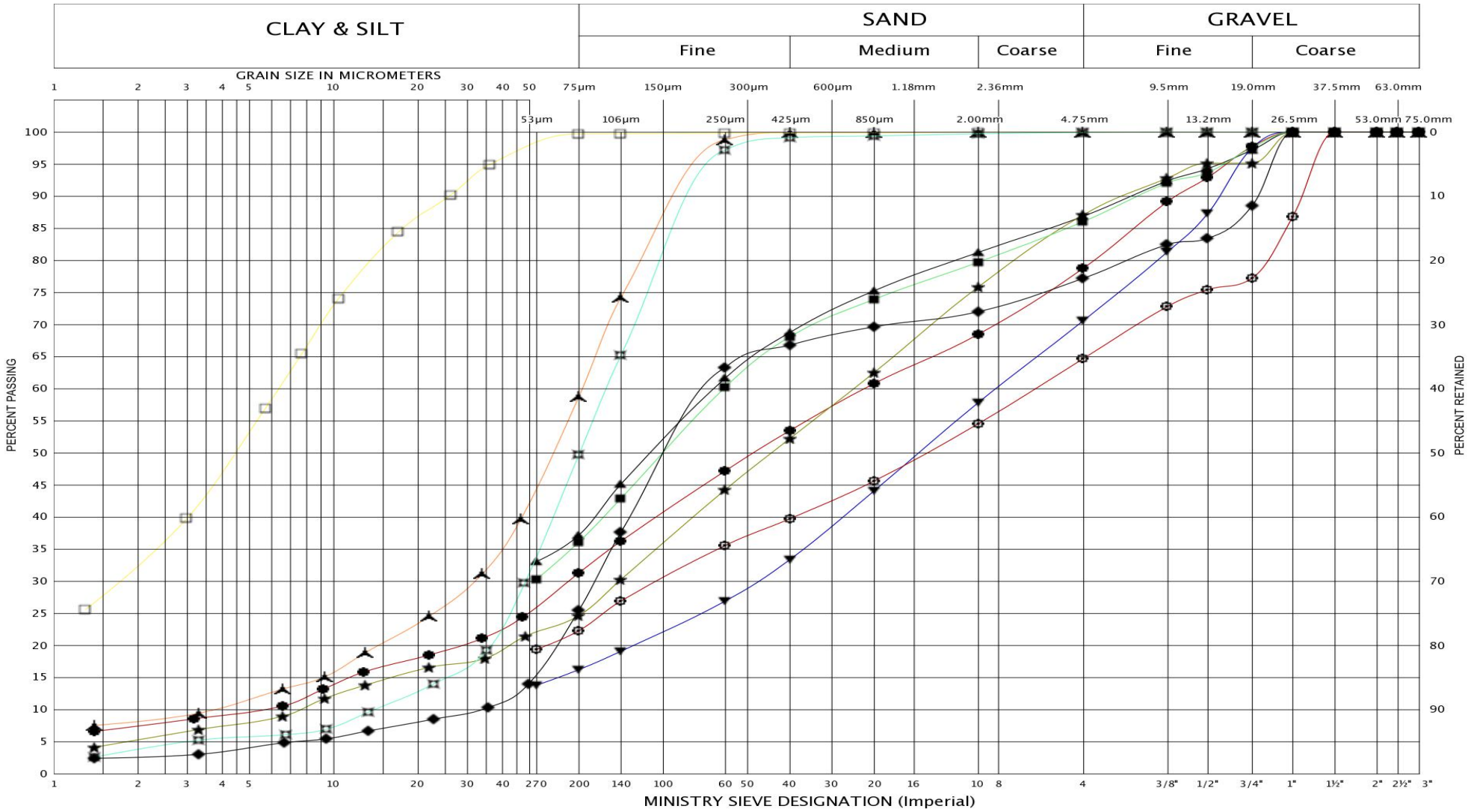
Ontario

GRAIN SIZE DISTRIBUTION

SANDY GRAVEL (FILL)

FIG No.:	DC6-GS-1B
HWY :	6
GWP	3059-20-00

UNIFIED SOIL CLASSIFICATION SYSTEM



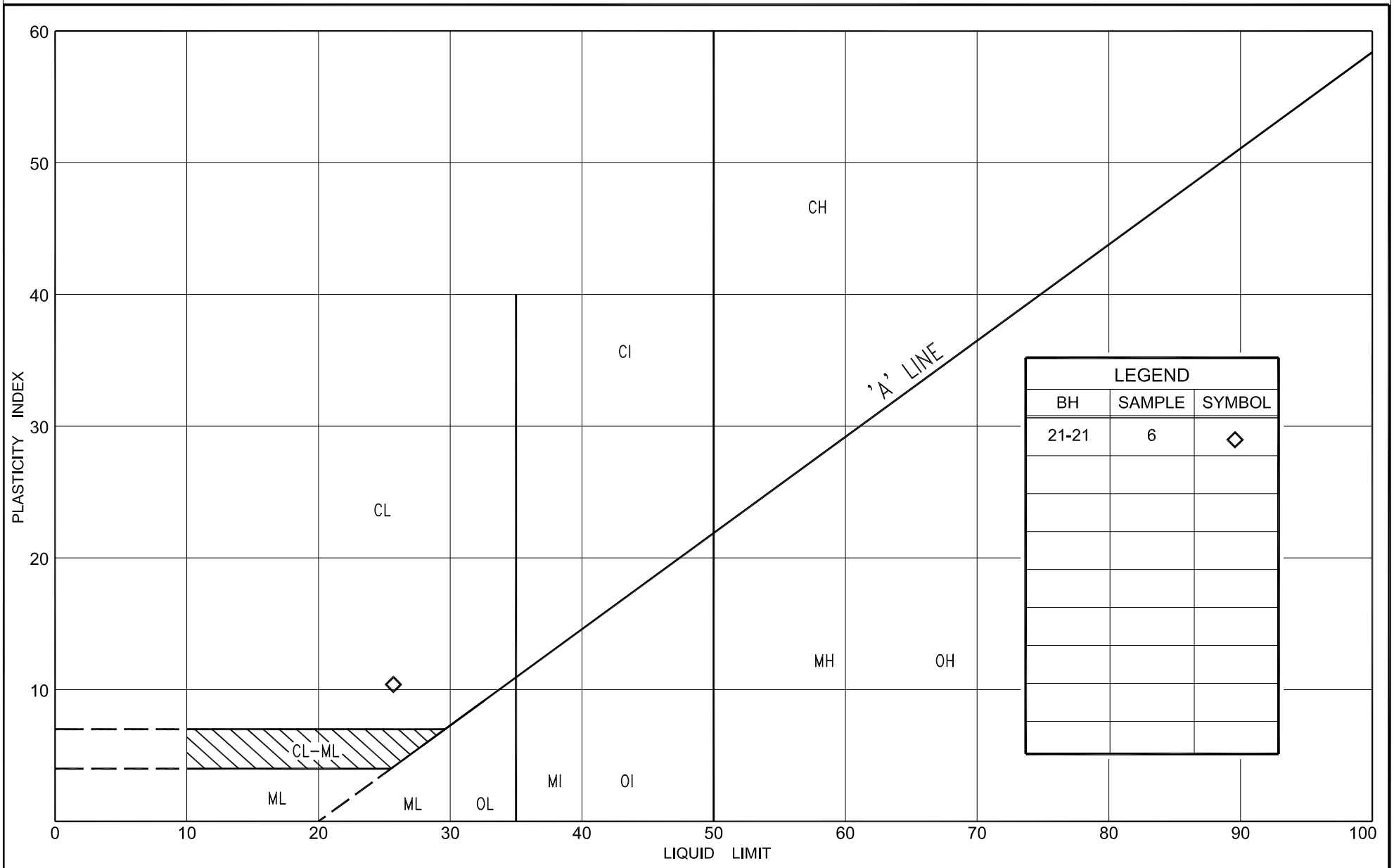
LEGEND	BH	21-15	21-15	21-16	21-16	21-16	21-21	21-21	21-23	21-23	21-25
	SAMPLE	3	9	4	8	11	6	8	5	8	9
	SYMBOL	▲	●	■	▼	★	□	⅄	⊕	⊠	◆

Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND/SANDY SILT, trace gravel to gravelly (TILL)

FIG No.:	DC6-GS-2
HWY :	6
GWP	3059-20-00



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PLASTICITY CHART

CLAYEY SILT (TILL)

FIG No.	DC6-PC-1
HWY:	6
G.W.P. No.	3059-20-00

APPENDIX C

Borehole Records - 2022 Investigation

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS
MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS[1,2]

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (*i.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* trace fines)

1. Only applicable to components not described by Primary Group Name.
2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness[1]

Term	SPT 'N' (blows/0.3m)[2]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

1. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
2. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ. where $\gamma = \rho \cdot g$ (i.e., mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{\alpha(e)}$	secondary compression index
C_α	rate of secondary compression
$C_{\alpha(\varepsilon)}$	modified secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
c′	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or q'	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

PROJECT 22522311

RECORD OF BOREHOLE No GBH-28 SHEET 1 OF 1 METRIC

G.W.P. DB 2021-3004 LOCATION N 4814073.6; E 249553.8 MTM NAD 83 ZONE 10 (LAT. 43.464536; LONG. -80.182760) ORIGINATED BY JGH

DIST West HWY 6 BOREHOLE TYPE 200 mm ID Hollow Stem Augers COMPILED BY GS

DATUM Geodetic DATE June 30, 2022 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
323.7	GROUND SURFACE										
0.0 / 323.3	SILTY SAND (SM) (TOPSOIL) Compact Dark brown Moist		1A	SS	17		323				
0.4 / 322.6	Sandy SILT (ML), trace gravel, contain cobbles Compact Brown Moist		1B								
1.1	SILTY SAND (SM), trace to some gravel, contains cobbles Compact to dense Brown Moist		2	SS	18		322				
			3	SS	39		321				
319.6							320				
4.1	Sandy SILT to SILT (ML), trace sand, trace gravel, contains sand pockets Compact Mottled brown to brown Moist		4	SS	25		319				
317.7			5	SS	26		318				
6.0	SILTY SAND (SM), trace to some gravel, contains sand pockets and cobbles Dense to very dense Brown Moist		6	SS	35		317				
316.2			7	SS	85						
7.5	Gravelly SILTY SAND (SM), contains cobbles Dense Brown Moist		8	SS	46		316				
314.0			9	SS	45		315				
9.8	END OF BOREHOLE						314				

NOTES:

1. Borehole was dry immediately following completion of drilling on June 30, 2022.

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_6_AND_HWY_34\02_DATA\GINT\HWY_6_AND_HWY_34.GPJ GAL-GTA.GDT 7/27/23 JM

PROJECT 22522311

RECORD OF BOREHOLE No GBH-30

SHEET 1 OF 1

METRIC

G.W.P. DB 2021-3004 LOCATION N 4814194.5; E 249565.1 MTM NAD 83 ZONE 10 (LAT. 43.465625; LONG. -80.182632) ORIGINATED BY JGH

DIST West HWY 6 BOREHOLE TYPE 150 mm ID Hollow Stem Augers COMPILED BY GS

DATUM Geodetic DATE July 6, 2022 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.9	GROUND SURFACE										
0.0 / 329.6	SILTY SAND (SM), trace gravel, contains rootlets (TOPSOIL)		1A, 1B	SS	8						
0.3	Loose Dark brown Moist										
	SILTY SAND (SM), trace to some gravel, contains cobbles		2	SS	15		329				
328.5	Loose to compact										
1.5	Brown Moist		3	SS	13						
	SAND (SP) fine to medium, trace to some silt, trace gravel, contains cobbles Compact to loose Brown Moist becoming wet at 3.4 m depth		4	SS	9		328				
			5	SS	14	▽	327				
326.2											
3.7	Gravelly SILTY SAND (SM), contains cobbles Dense Brown		6	SS	31		326				
325.4	Moist										
4.5	Sandy SILT (ML), trace gravel containing sand layers Dense to compact Brown		7	SS	33		325				
324.4	Wet										
5.5	SAND (SP) fine to medium, trace silt Compact to dense Brown Moist to wet		8A, 8B	SS	24		324				
			9	SS	39						
323.2											
6.7	END OF BOREHOLE NOTES: 1. Groundwater encountered at a depth of 3.4 m.										

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_6_AND_HWY_34\02_DATA\GINT\HWY_6_AND_HWY_34.GPJ GAL-GTA.GDT 7/27/23 JM

PROJECT 22522311

RECORD OF BOREHOLE No GBH-32

SHEET 1 OF 1

METRIC

G.W.P. DB 2021-3004 LOCATION N 4814087.0; E 249396.0 MTM NAD 83 ZONE 10 (LAT. 43.464647; LONG. -80.184712) ORIGINATED BY JGH

DIST West HWY 6 BOREHOLE TYPE 200 mm ID Hollow Stem Augers COMPILED BY GS

DATUM Geodetic DATE June 23, 2022 CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
326.9	GROUND SURFACE			
0.0	SILTY SAND (SM), trace gravel (TOPSOIL) Loose to very loose Dark brown Moist	1	SS	6
325.1		2A 2B	SS	3
1.8	SILTY SAND (SM), trace silt, contains rootlets Very loose to dense Brown Moist - Contains cobbles at 3.05 m	3	SS	19
322.5		4	SS	32
4.4	Gravelly SAND (SP), trace silt, contains cobbles Very dense to dense Brown Moist to wet	5	SS	62
320.9		6	SS	49
6.0	SILTY SAND (SM), some gravel, contains cobbles Dense to very dense Brown Moist to wet	7	SS	67
	- Contains silt pockets at 7.9 m to 8.1 m	8	SS	33
318.2				
8.7	SAND (SP) fine to medium, trace silt Dense Brown Moist to wet	9	SS	42
317.2				
9.8	END OF BOREHOLE			

NOTES:

1. Perched groundwater encountered at a depth of 4.9 m during drilling.

2. Monitoring well dry on following dates:
- August 12, 2022
- August 26, 2022
- September 23, 2022
- October 25, 2022
- November 21, 2022
- December 12, 2022

ELEVATION SCALE: 326, 325, 324, 323, 322, 321, 320, 319, 318

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

APPENDIX D

Test Excavation Records - 2023 Investigation

Records of Test Holes in Wetland Area Adjacent to Wellington Road 34

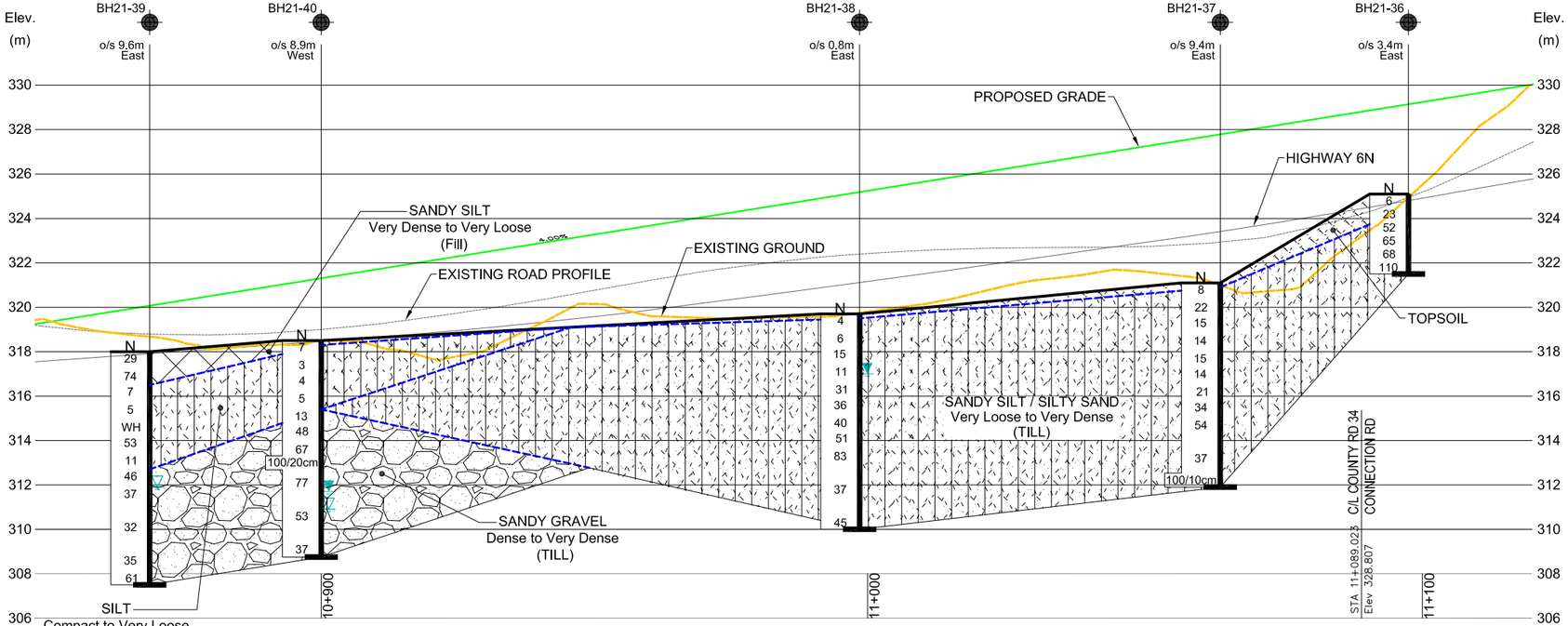
Test Hole No.	MTM NAD83 Northing & Easting	Depth (m)	Soil Description	Undrained Shear Strength (kPa)	Natural Water Content	Comments
TP-03	4813216 249548	0.0 - 0.4	**TOPSOIL,** silty sand, brown, moist, containing organics and roots	--	--	Test hole dry
		0.4 - 0.8	**SILTY SAND**, some gravel, brown, moist, containing roots	--	0.4 m: 14%	
TP-04	4813239 249543	0.0 - 0.4	**TOPSOIL,** silty sand, some gravel, containing cobbles, black, moist	--	-	Groundwater encountered at 0.8 m depth
		0.4 - 0.9	**Silty GRAVELLY SAND**, brown to grey, moist to wet at 0.8 m depth	--	0.4 m: 13%	
TP-07	4813230 249604	0.0 - 0.3	**TOPSOIL,** silty to gravelly sand, containing cobbles, black, wet	--	--	Groundwater level at ground surface
		0.3 - 0.9	**ORGANIC SILTY CLAY,** some sand and gravel, containing cobbles and roots, stiff, mottled grey; moist to wet	Not possible to push field vane	0.3 m: 25%	
		0.9	Test hole terminated in non-organic SILTY SAND	--	--	
TP-08	4813250 249598	0.0 - 0.4	**TOPSOIL,** silty sand, some gravel, containing cobbles and organics, black, moist	--	--	Groundwater encountered at 0.6 m depth
		0.4 - 1.0	**ORGANIC SILTY CLAY,** trace to some sand and gravel, stiff, mottled brown and grey, moist to wet	Not possible to push field vane	0.4 m: 23% 0.6 m: 26%	
		1.0	Test hole terminated in non-organic SILTY SAND	--	--	
TP-11	4813247 249678	0.0 - 0.9	**FIBROUS PEAT,** containing roots, becoming amorphous peat with depth	6 kPa @ 0.6 m	0.0 m: 453%	Groundwater level at ground surface
		0.9 - 1.6	**ORGANIC CLAYEY SILT**, very soft to soft, dark brown, wet	8 kPa @ 0.9 m 13 kPa @ 1.2 m 24 kPa @ 1.5 m	0.9 m: 289%	
		1.6	**CLAYEY SILT**, light brown, wet	--	--	
TP-12	4813267 249669	0.0 - 0.2	**TOPSOIL,** silty sand, black, containing roots and organics	--	--	Groundwater level at ground surface
		0.2 - 0.4	**FIBROUS PEAT**, containing roots	--	0.25 m: 499%	
		0.4 - 1.5	**ORGANIC CLAYEY SILT**, soft, brown	16 kPa @ 0.6 m 19 kPa @ 0.9 m 19 kPa @ 1.2 m	0.4 m: 226%	
		1.5	Test hole terminated in non-organic SILTY SAND	--	--	

Test Hole No.	MTM NAD83 Northing & Easting	Depth (m)	Soil Description	Undrained Shear Strength (kPa)	Natural Water Content	Comments
TP-15	4813282 249841	0.0 - 0.5	**TOPSOIL,** silty sand, containing roots and organics, black, moist to wet	--	--	Groundwater level at 0.1 m depth
		0.5 - 1.0	**ORGANIC CLAYEY SILT,** brown, wet	14 kPa @ 0.7 m 19 kPa @ 1.0 m	0.5 m: 121%	
		1.0 - 1.2	**SANDY PEAT**, dark brown, wet	--	1.1 m: 406%	
		1.2 - 2.0	**ORGANIC SILT**, brown, wet	24 kPa @ 1.3 m	1.2 m: 398%	
		2.0	Test hole terminated in non-organic silty sand	--	--	
TP-16	4813306 249837	0.0 - 0.2	**TOPSOIL,** silty, brown, with roots and organics	--	0.0 m: 348%	Groundwater level at 0.1 m depth
		0.2 - 1.5	**ORGANIC CLAYEY SILT**, brown, wet	16 kPa @ 0.7 m 16 kPa @ 1.0 m 19 kPa @ 1.5 m	0.25 m: 122% 0.3 m: 161% 1.2 m: 113%	
		1.5	Test hole terminated in organic clayey silt; test hole was sloughing and it was not possible to sample deeper	--	--	
TP-19	4813294 249891	0.0 - 0.4	**TOPSOIL,** silty sand, brown, wet	--	--	Groundwater level at 0.1 m depth
		0.4 - 1.1	**SANDY PEAT** containing roots and organics, stiff, brown, wet	--	0.4 m: 477%	
		1.1 - 1.3	**ORGANIC SAND**, grey, wet	--	1.1 m: 41%	
		1.3	Test hole terminated in non-organic SAND	--	--	
TP-24	4813321 249911	0.0 - 0.2	**TOPSOIL,** silty, brown, with roots and organics	--	0.0 m: 154%	Groundwater level at 0.1 m depth
		0.2 - 0.9	**ORGANIC CLAYEY SILT**, stiff, brown, wet	--	0.2 m: 70%	
		0.9 - 1.2	**ORGANIC SAND,** some gravel, grey, wet	--	0.9 m: 69%	
		1.2	Test hole terminated in non-organic SILTY SAND	--	--	

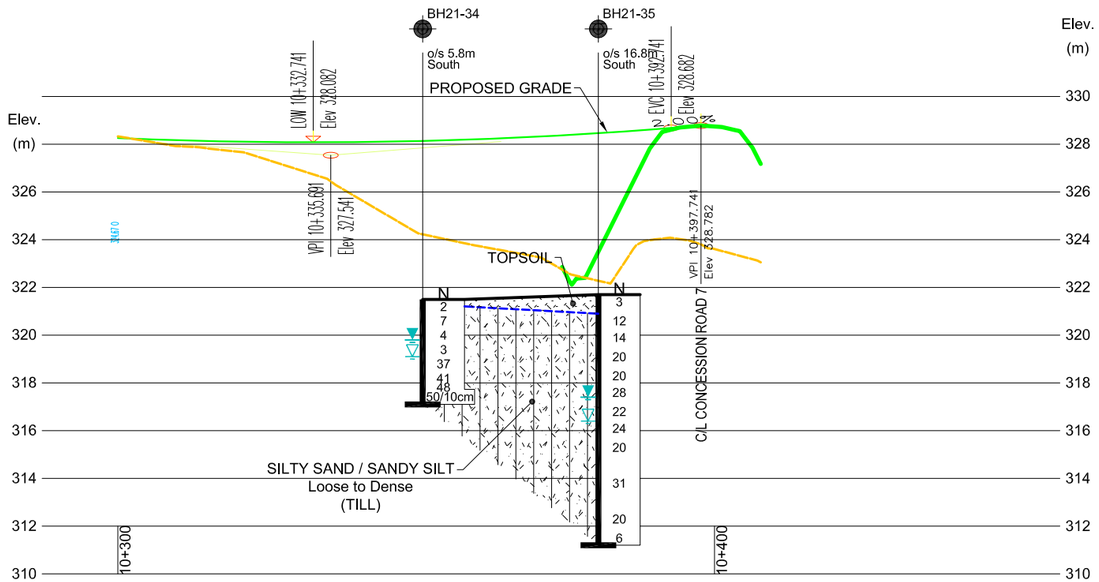
APPENDIX E

Soil Strata Drawings

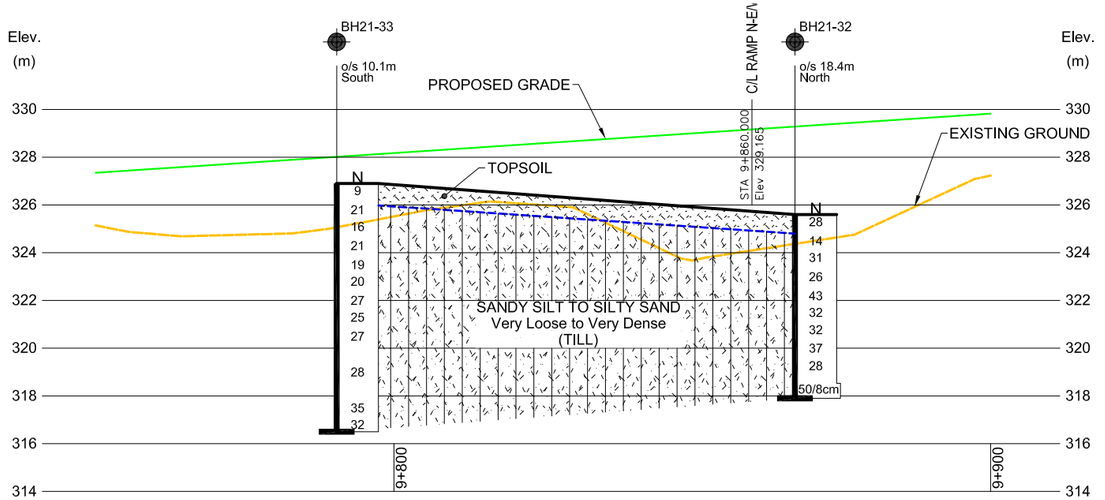
CADD FILE NAME:



HF-1 PROFILE ALONG C/L OF PROPOSED CONCESSION ROAD 7 ALIGNMENT



HF-2 PROFILE ALONG C/L OF PROPOSED WELLINGTON ROAD 34
CONNECTOR ROAD ALIGNMENT



HF-3 PROFILE ALONG C/L OF PROPOSED WELLINGTON ROAD 34
CONNECTOR ROAD ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

BLDG. REF. No.
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SHEET No.
DRAWING No.

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		SCALE (VERT) 1m 0 1 2 3 4 5m

Peto MacCallum Ltd. CONSULTING ENGINEERS

L. A. YIMAM 100500748 OCT. 05/2021 PROVINCE OF ONTARIO

G. G. UWIMANA PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
HIGH FILL SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

Ontario

Dwg. No. MBI-9

Sheet No.

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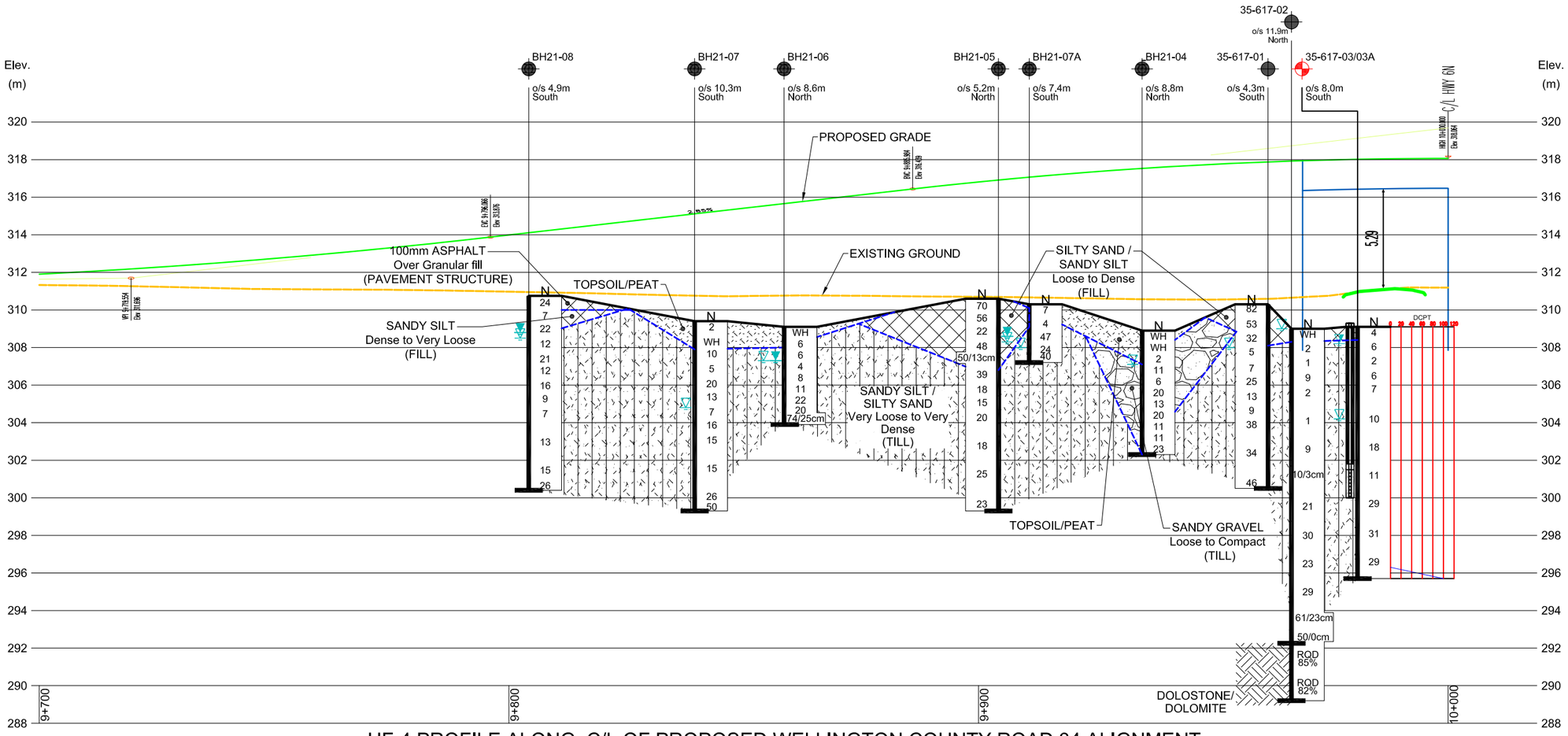

HF-4 PROFILE ALONG C/L OF PROPOSED WELLINGTON COUNTY ROAD 34 ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
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3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

DRAWING No.

REVISIONS	REVISIONS	DRAWING
		Reference AECOM Ltd. Drawing: Hwy6_MidBlock_plan.dwg
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Peto MacCallum Ltd. CONSULTING ENGINEERS

LICENSED PROFESSIONAL ENGINEER L. A. YIMAM 100500748 OCT. 05/2021 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER G. G. UWIMANA OCT. 8, 2021 PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
HIGH FILL SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

Ontario

Dwg. No.	Sheet No.
MBI-10	

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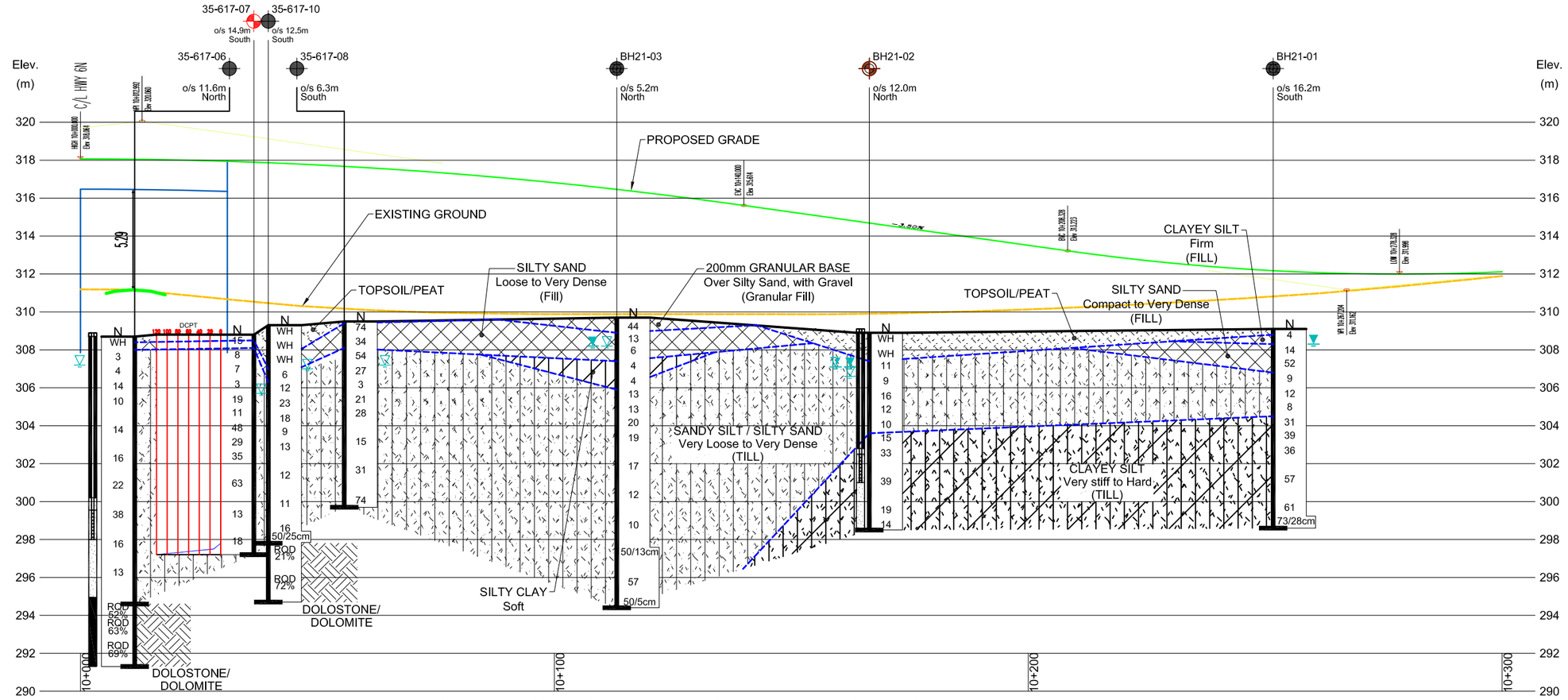

HF-5 PROFILE ALONG C/L OF PROPOSED WELLINGTON COUNTY ROAD 34 ALIGNMENT

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
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BLDG. REF. No.
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SHEET No.
DRAWING No.

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LICENSED PROFESSIONAL ENGINEER L.A. YIMAM 100500748 OCT. 05 2021 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER G. G. UWIMANA OCT 8, 2021 PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
HIGH FILL SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

Ontario

Dwg. No. MBI-11

Sheet No.

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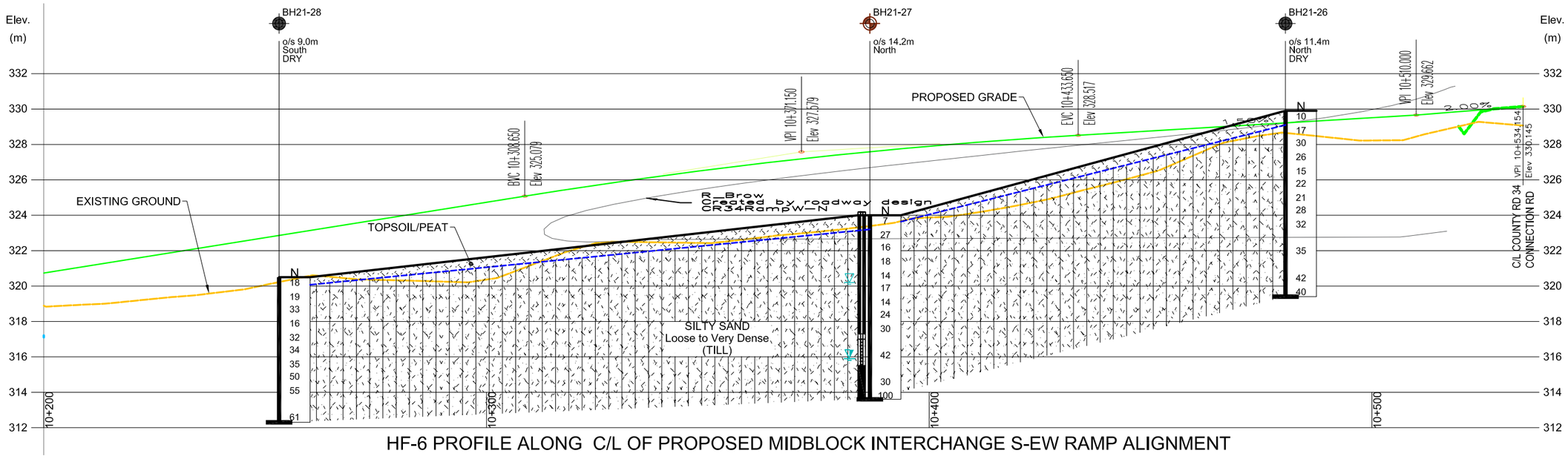

HF-6 PROFILE ALONG C/L OF PROPOSED MIDBLOCK INTERCHANGE S-EW RAMP ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
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BLDG. REF. No.
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SHEET No.
DRAWING No.

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		SCALE (VERT) 1m 0 1 2 3 4 5m

Peto MacCallum Ltd. CONSULTING ENGINEERS

LICENSED PROFESSIONAL ENGINEER L. A. YIMAM 100500748 OCT. 05/2021 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER G. G. UWIMANA OCT. 8, 2021 PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
HIGH FILL SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

Ontario

Dwg. No. MBI-12

Sheet No.

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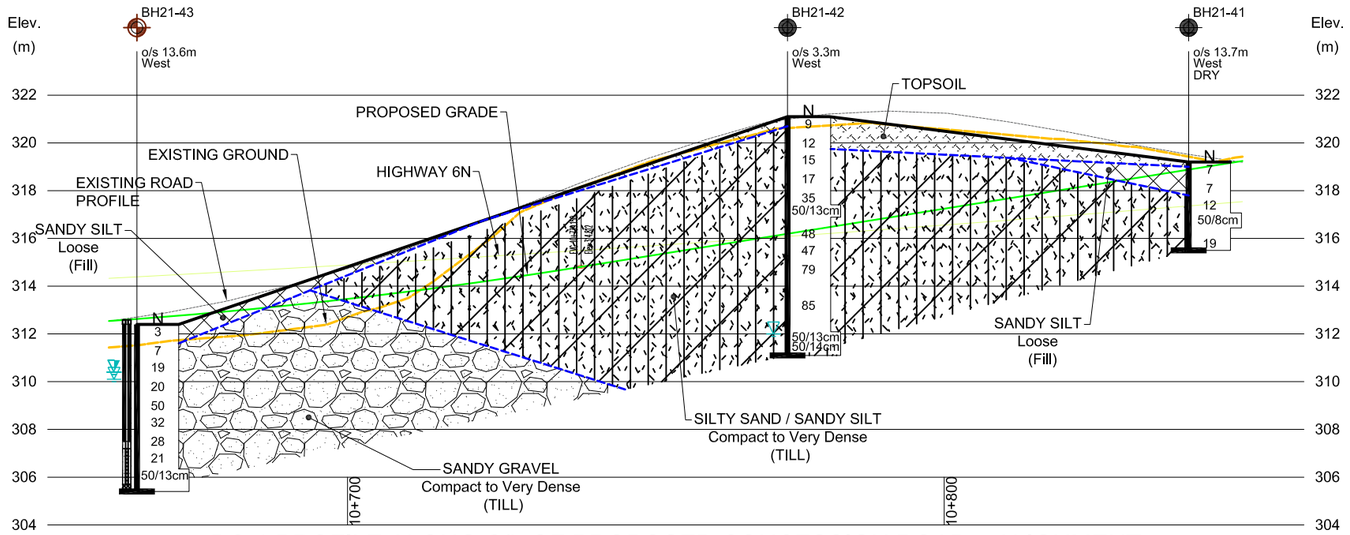
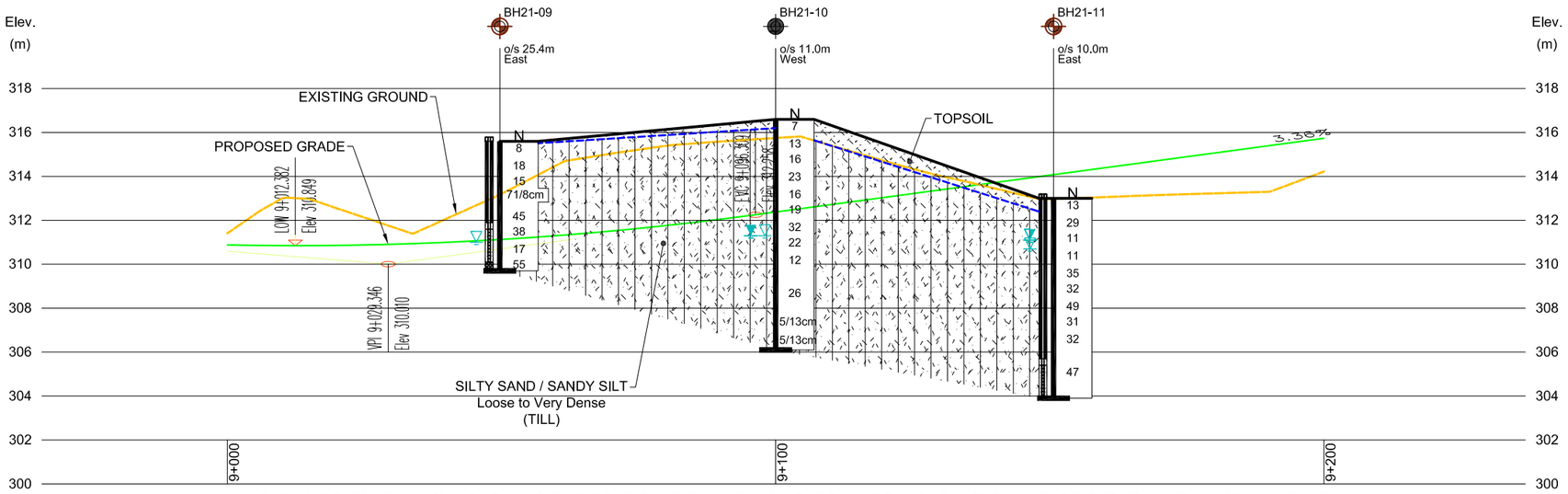


DC-1 PROFILE ALONG C/L OF PROPOSED CONCESSION ROAD 7 ALIGNMENT



DC-2 PROFILE ALONG C/L OF PROPOSED WELLINGTON ROAD 34 CONNECTOR ROAD ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

BLDG. REF. No.
FILE: 177FF0084
SHEET No.
DRAWING No.

REVISIONS	REVISIONS	DRAWING
		Reference AECOM Ltd. Drawing: Hwy6_MidBlock_plan.dwg
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Peto MacCallum Ltd. CONSULTING ENGINEERS

LICENSED PROFESSIONAL ENGINEER L. A. YIMAM 100500748 OCT. 05/2021 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER G. G. UWIMANA PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
DEEP CUT SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

Ontario

Dwg. No. MBI-13

Sheet No.

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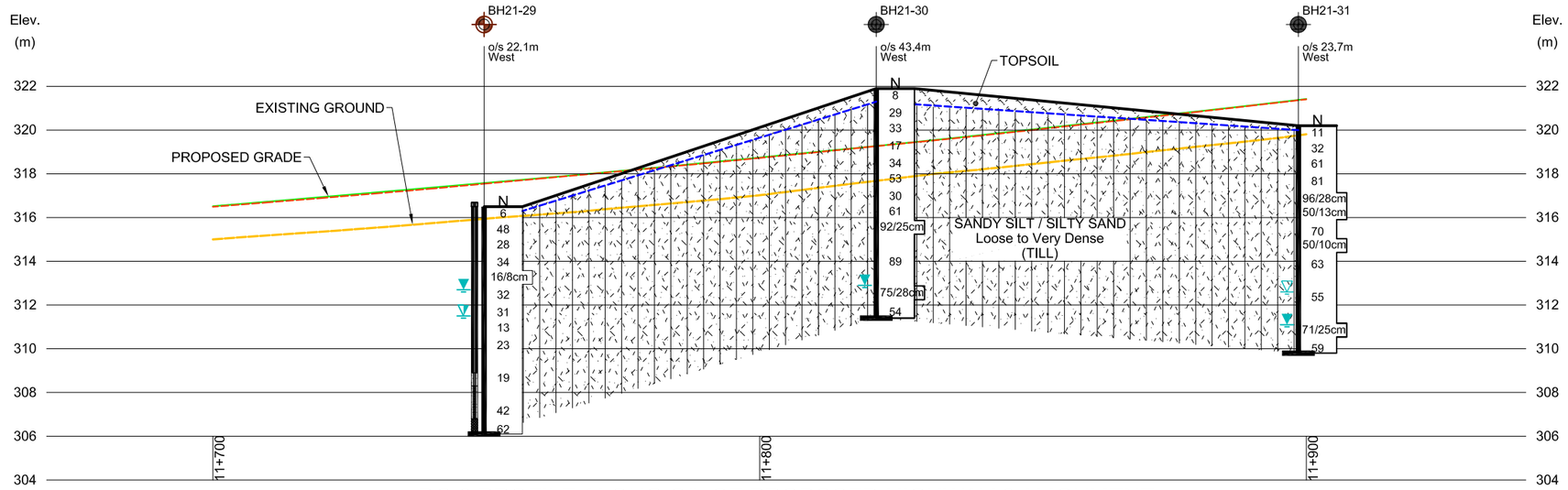
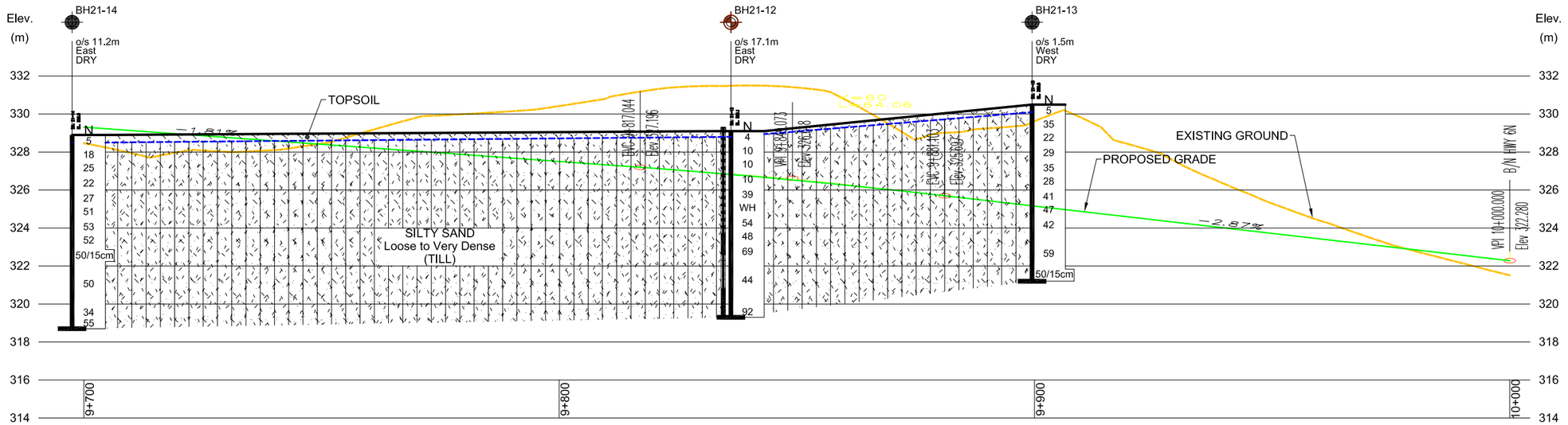


DC-3 PROFILE ALONG C/L OF PROPOSED HIGHWAY 6 ALIGNMENT



DC-5 PROFILE ALONG C/L OF PROPOSED MIDBLOCK INTERCHANGE E-S RAMP ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

BLDG. REF. FILE: 17TF0068 SHEET No.

REVISIONS	REVISIONS	DRAWING
		Reference AECOM Ltd. Drawing: Hwy6_MidBlock_plan.dwg
		SCALE (HORIZ) 25m 0 25 50 75 100m — SCALE (VERT) 1m 0 1 2 3 4 5m

DRAWING No.

Peto MacCallum Ltd. CONSULTING ENGINEERS

L. A. YIMAM 100500748 OCT-05/2021 PROVINCE OF ONTARIO

G. G. UWIMANA PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
DEEP CUT SECTIONS

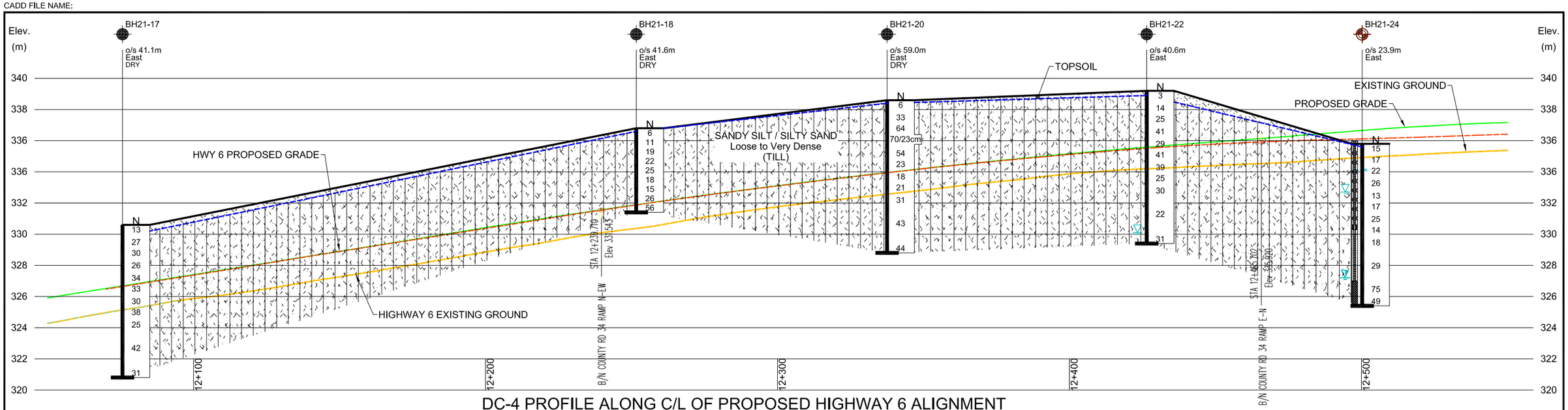
MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

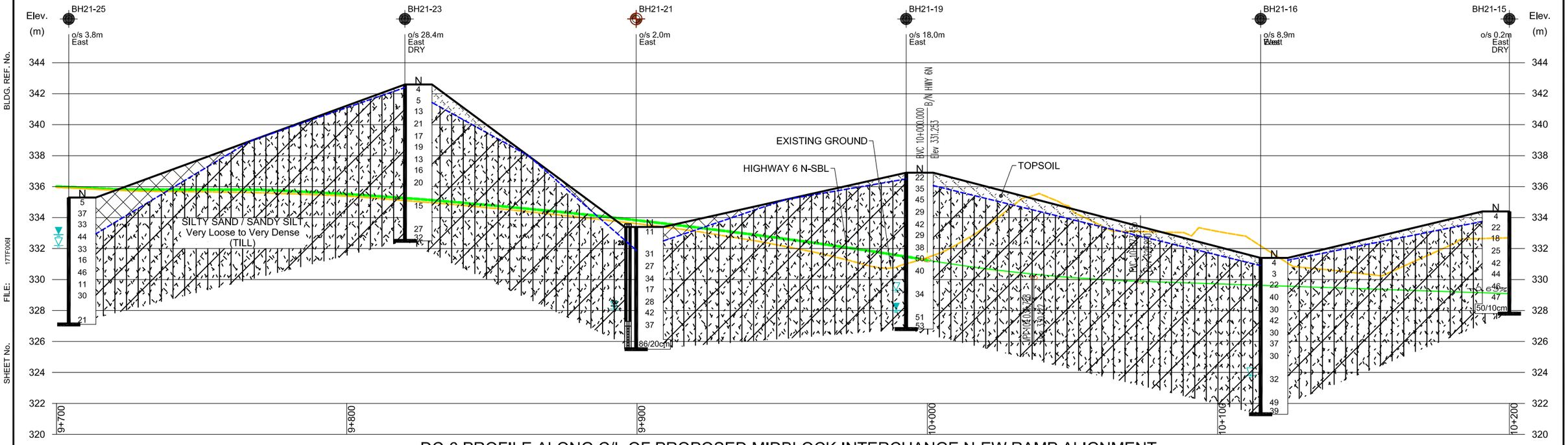
Ontario

Dwg. No. MBI-14 | Sheet No.

CADD FILE NAME:



DC-4 PROFILE ALONG C/L OF PROPOSED HIGHWAY 6 ALIGNMENT



DC-6 PROFILE ALONG C/L OF PROPOSED MIDBLOCK INTERCHANGE N-EW RAMP ALIGNMENT

NOTES:
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE SHEETS.
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3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

BLDG. REF. No.
FILE: 177FF0084
SHEET No.
DRAWING No.

REVISIONS	REVISIONS	DRAWING
		Reference AECOM Ltd. Drawing: Hwy6_MidBlock_plan.dwg
		SCALE (HORIZ) 25m 0 25 50 75 100m
		SCALE (VERT) 1m 0 1 2 3 4 5m

Peto MacCallum Ltd. CONSULTING ENGINEERS

LICENSED PROFESSIONAL ENGINEER L. A. YIMAM 100500748 OCT. 05/2021 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER G. G. UWIMANA PROVINCE OF ONTARIO

GEOCRES NO. 40P8 - 293
DRAWN NLS
CHECKED LY
APPROVED GU

SOIL STRATIGRAPHIC PROFILES
DEEP CUT SECTIONS

MIDBLOCK INTERCHAGE AREA
HIGHWAY 401 AND HIGHWAY 6 IMPROVEMENTS
GWP No. 3059-20-00

Plot Date: 10/08/2021

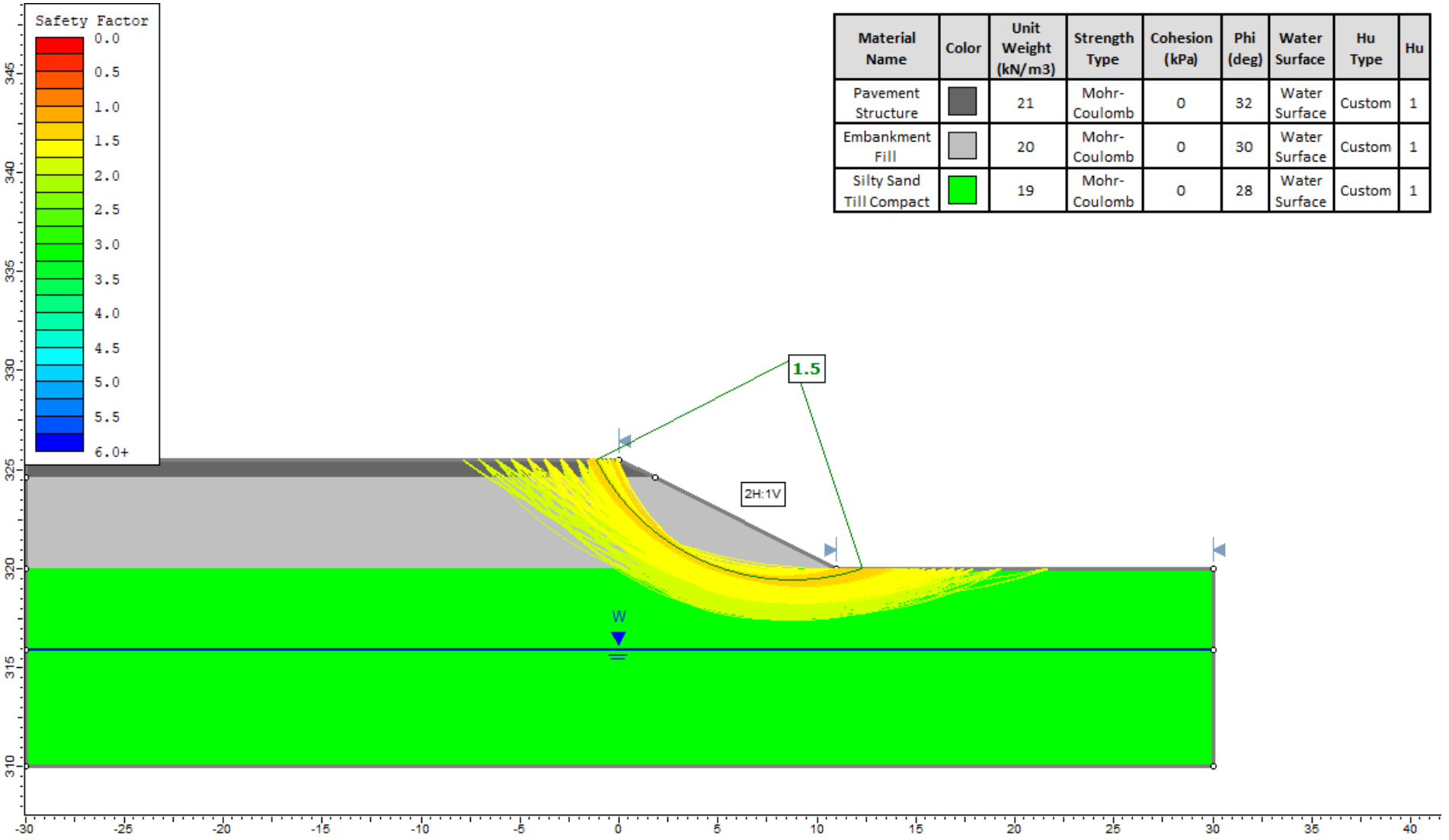
Ontario

Dwg. No. MBI-15

Sheet No.

APPENDIX F

Global Stability Analyses



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Pavement Structure		21	Mohr-Coulomb	0	32	Water Surface	Custom	1
Embankment Fill		20	Mohr-Coulomb	0	30	Water Surface	Custom	1
Silty Sand Till Compact		19	Mohr-Coulomb	0	28	Water Surface	Custom	1

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WSP GOLDER

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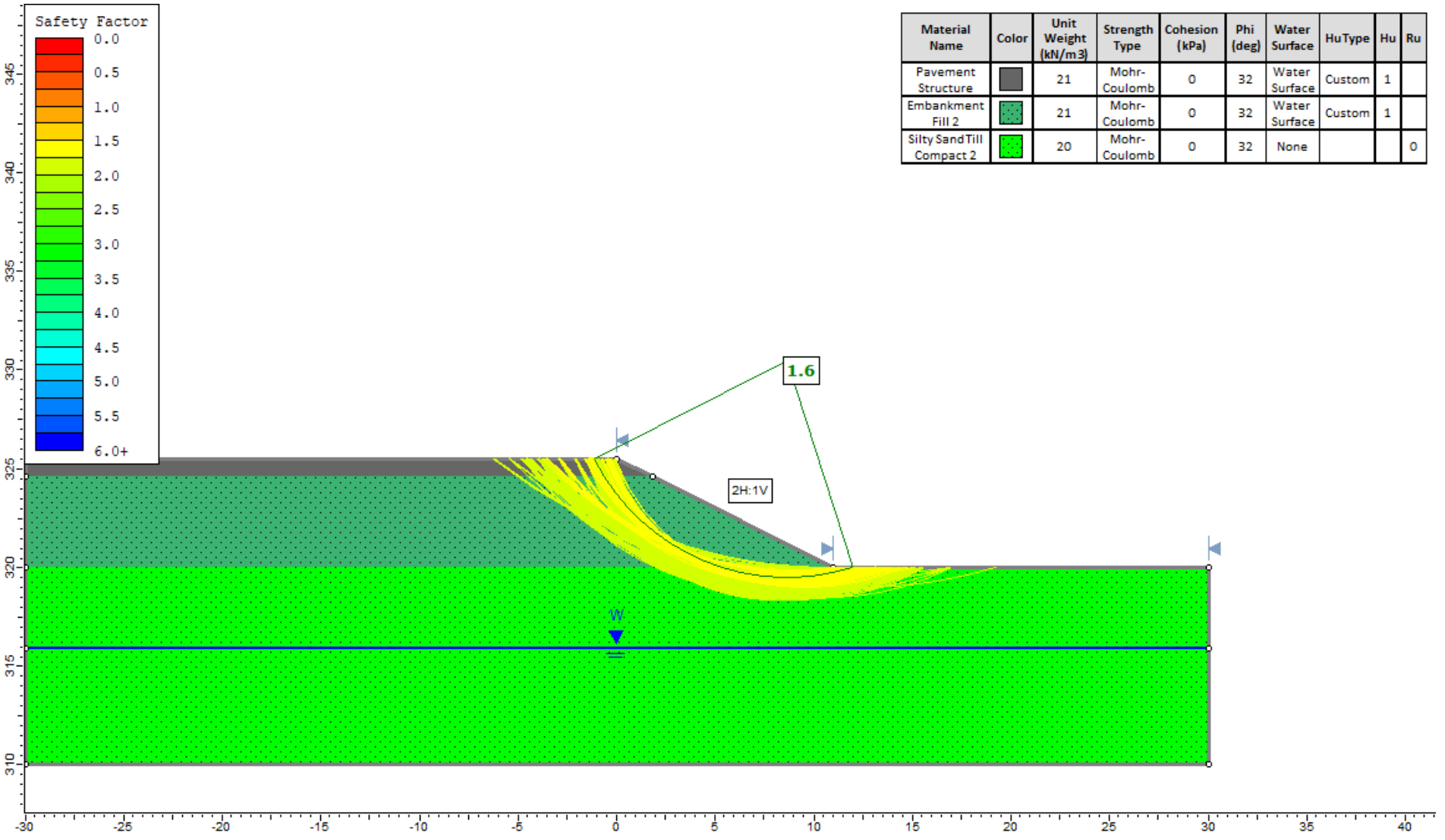
DESIGN	AN
REVIEW	LCC
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
HIGH FILL EMBANKMENT (5.5 M HIGH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	**1000**	**0**	**F-1**



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Pavement Structure		21	Mohr-Coulomb	0	32	Water Surface	Custom	1	
Embankment Fill 2		21	Mohr-Coulomb	0	32	Water Surface	Custom	1	
Silty Sand Till Compact 2		20	Mohr-Coulomb	0	32	None			0

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HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
HIGH FILL EMBANKMENT (5.5 M HIGH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	**1000**	**0**	**F-2**

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HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

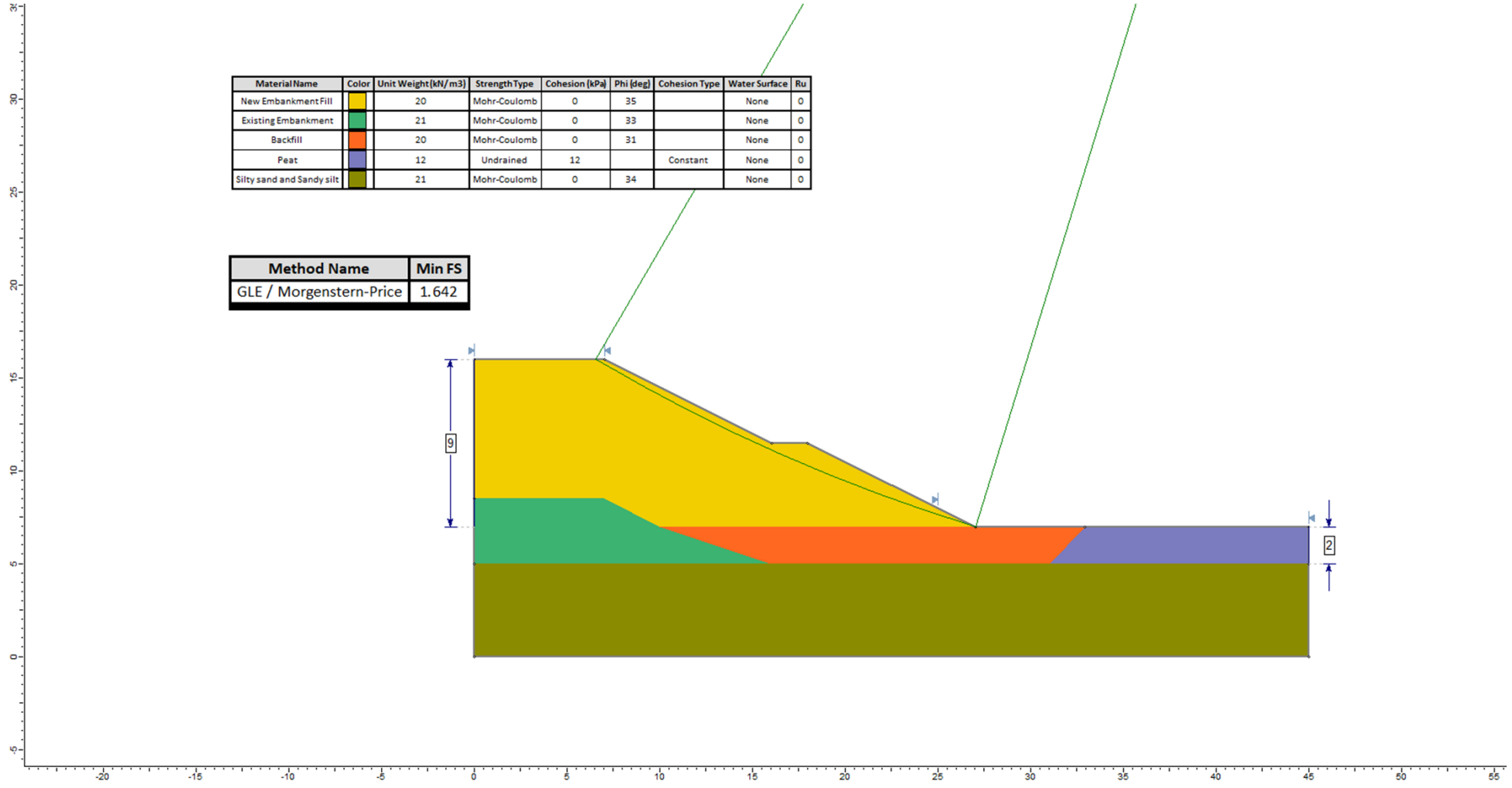
TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
HIGH FILL EMBANKMENT (7.5 M HIGH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	**1000**	**0**	**F-3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0

Material Name	Color	Unit Weight [kN/m3]	Strength Type	Cohesion [kPa]	Phi [deg]	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34		None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.642



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DESIGN	SF
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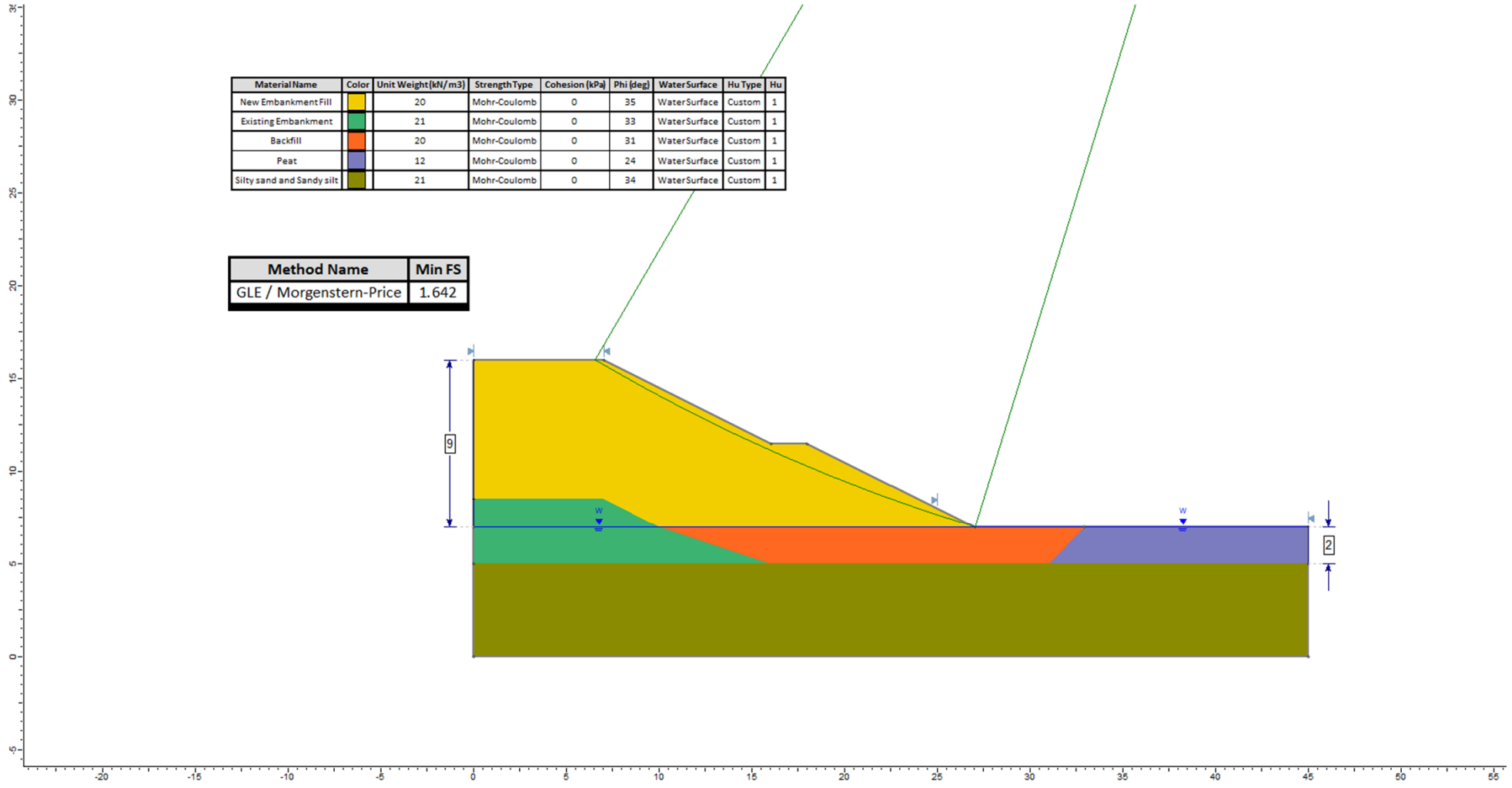
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
9 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-4

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.642



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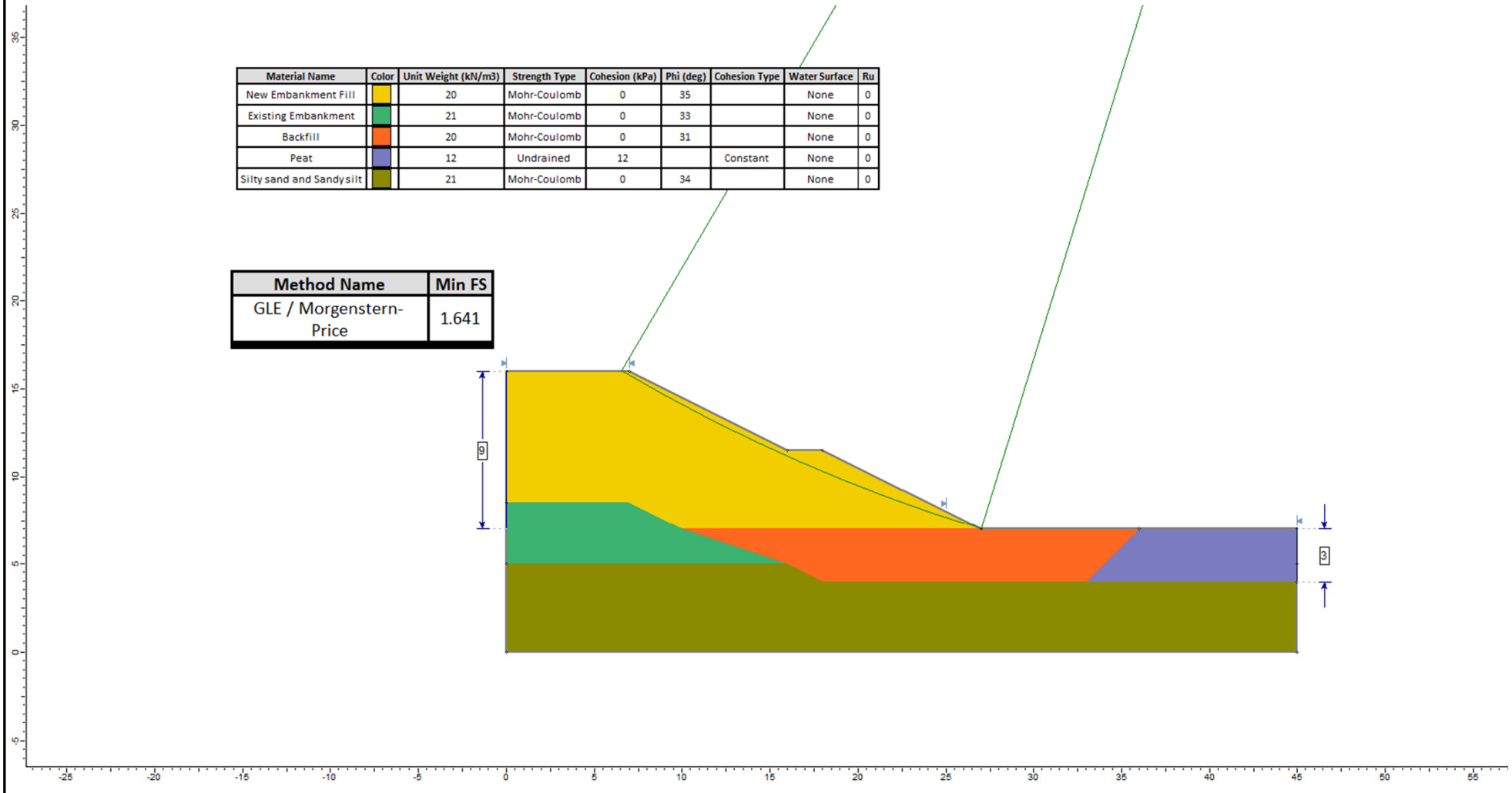
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
9 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-5

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34		None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.641



IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0

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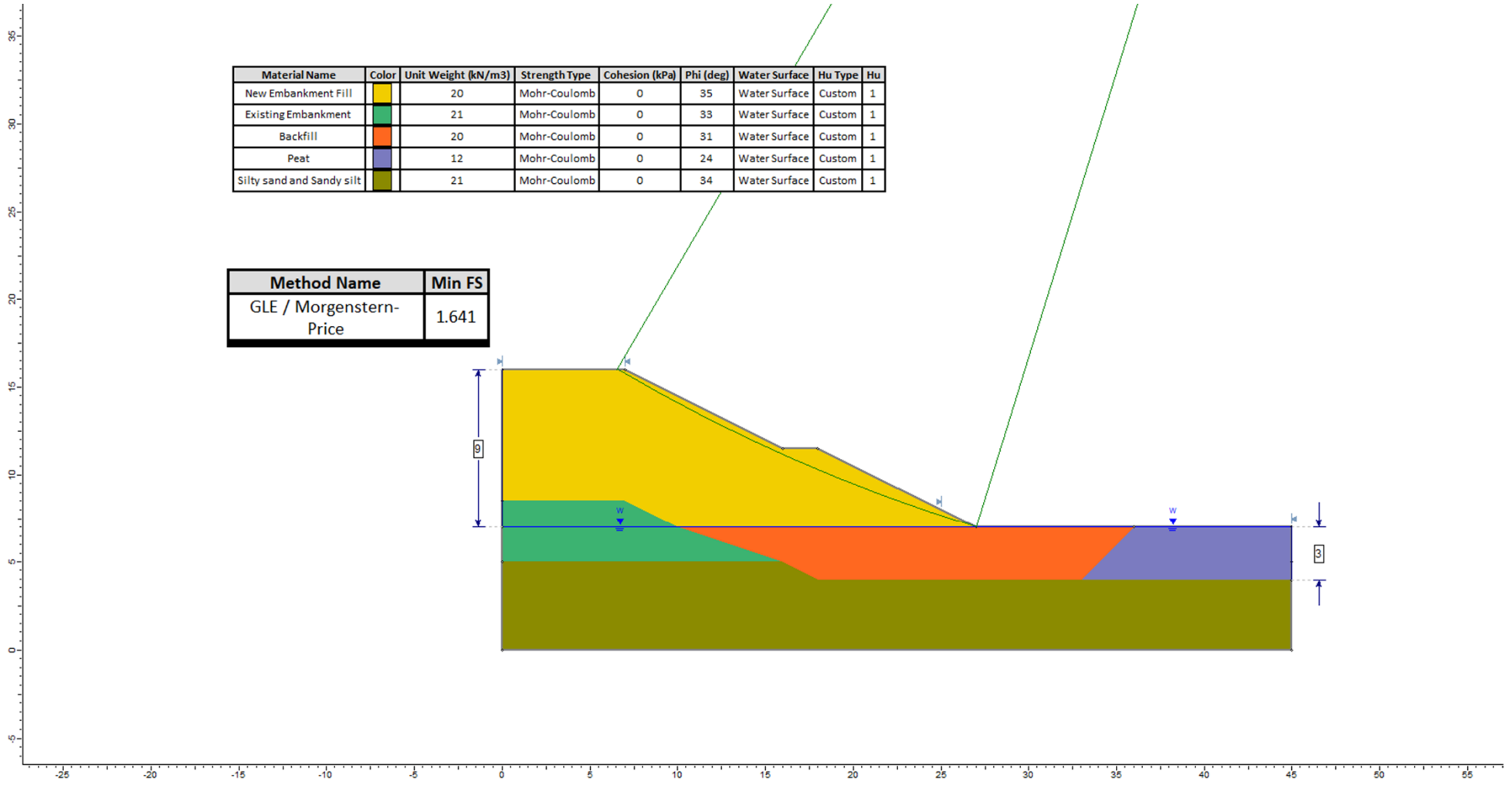
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
9 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-6

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.641



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DESIGN	SF
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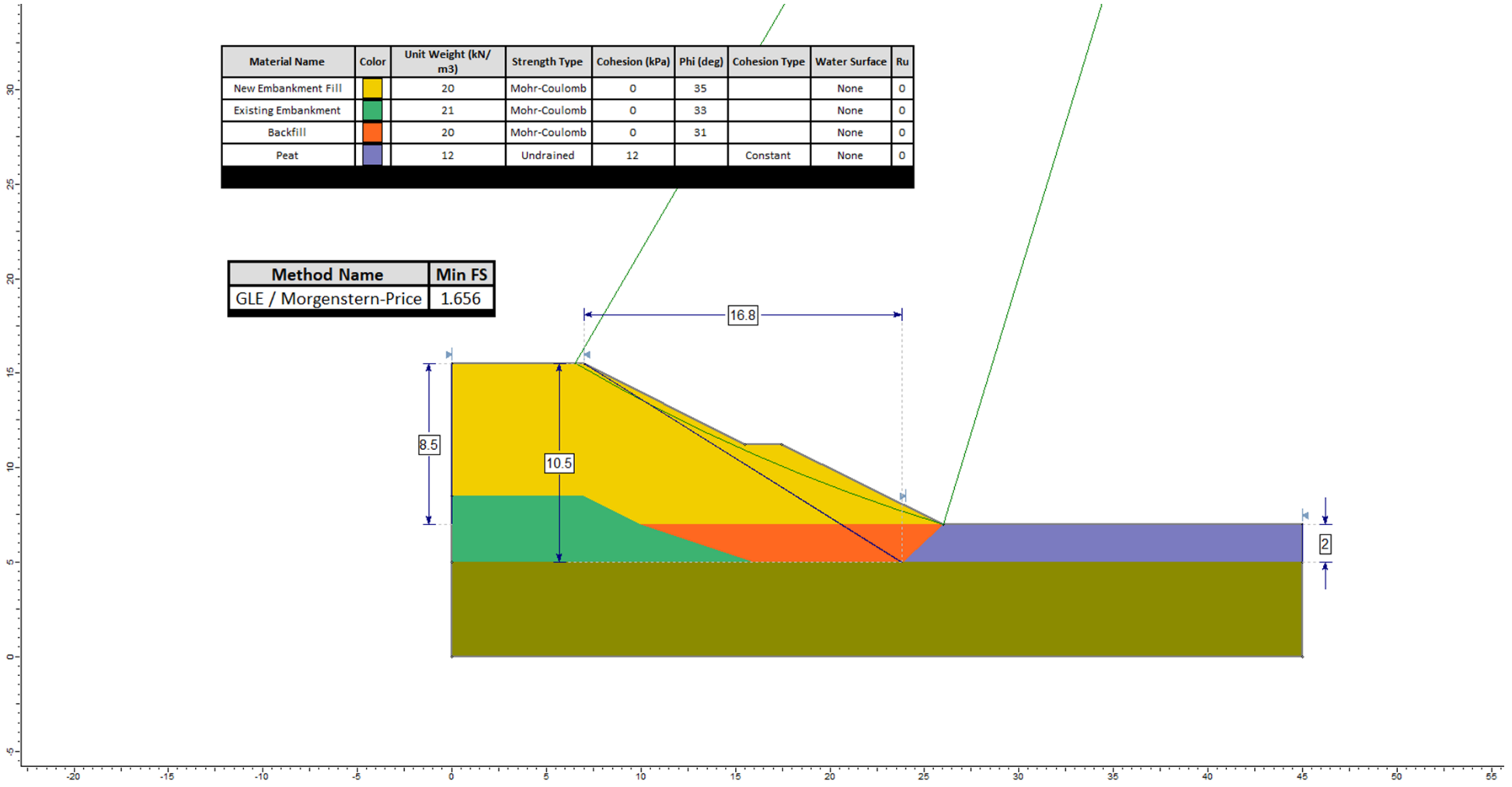
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
9 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-7

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.656



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YYYY-MM-DD	2023-08-02
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DESIGN	SF
REVIEW	LCC
APPROVED	MEB

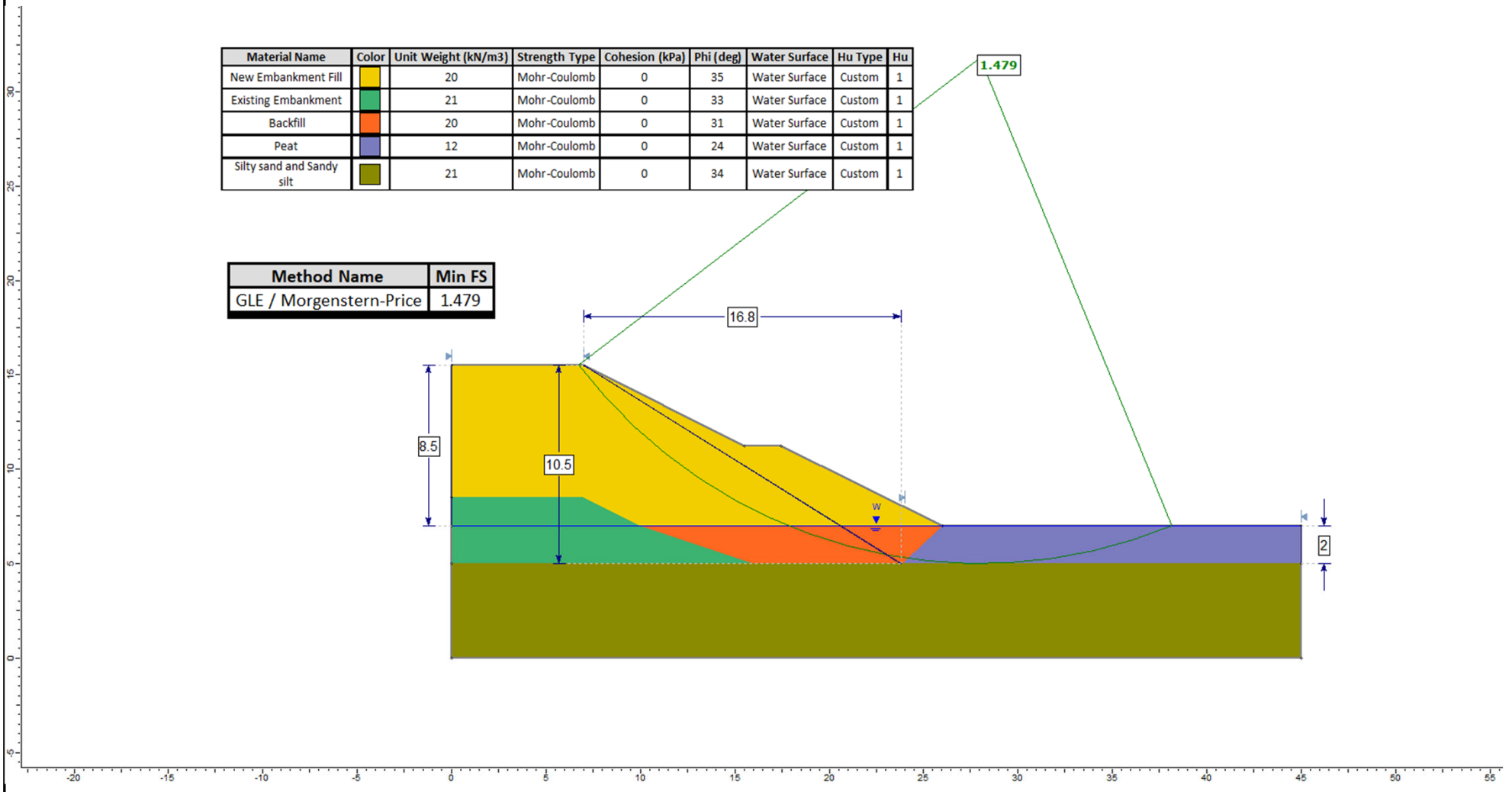
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8.5 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-8

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.479



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MINISTRY OF TRANSPORTATION ONTARIO

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2023-08-02
PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

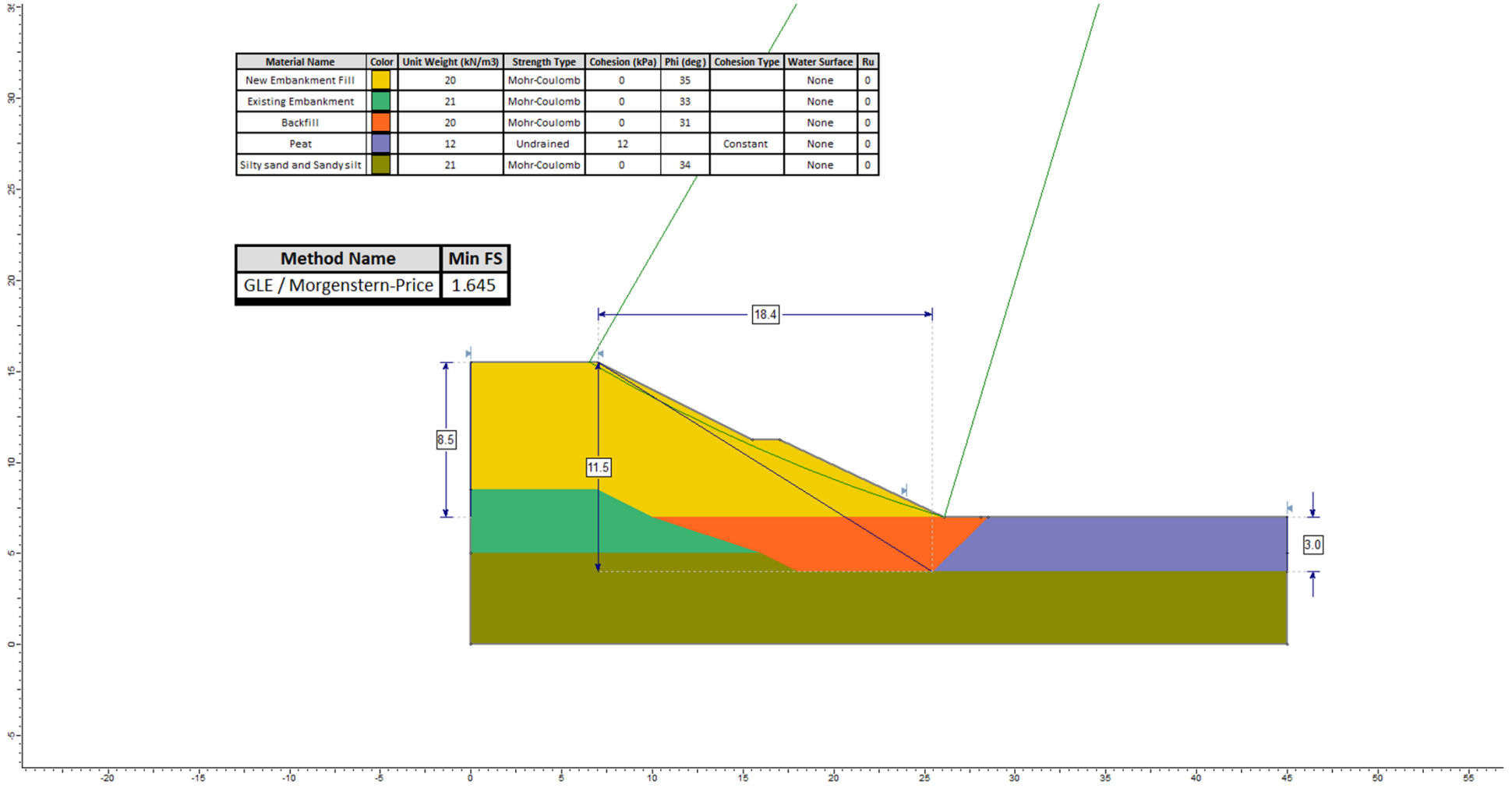
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8.5 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-9

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34		None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.645



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CONSULTANT
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YYYY-MM-DD	2023-08-02
PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

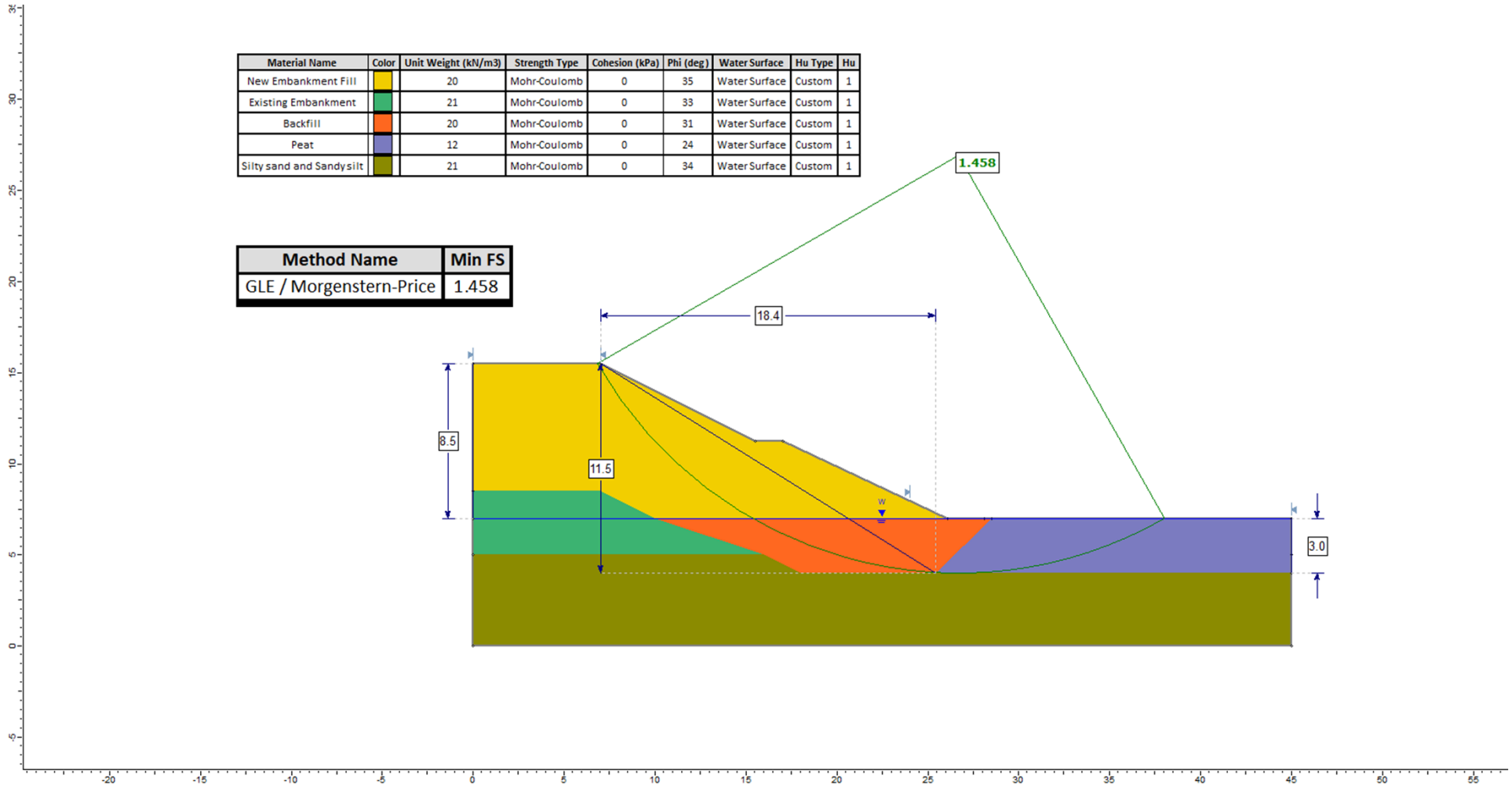
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8.5 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-10

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.458



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MINISTRY OF TRANSPORTATION ONTARIO

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2023-08-02
PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

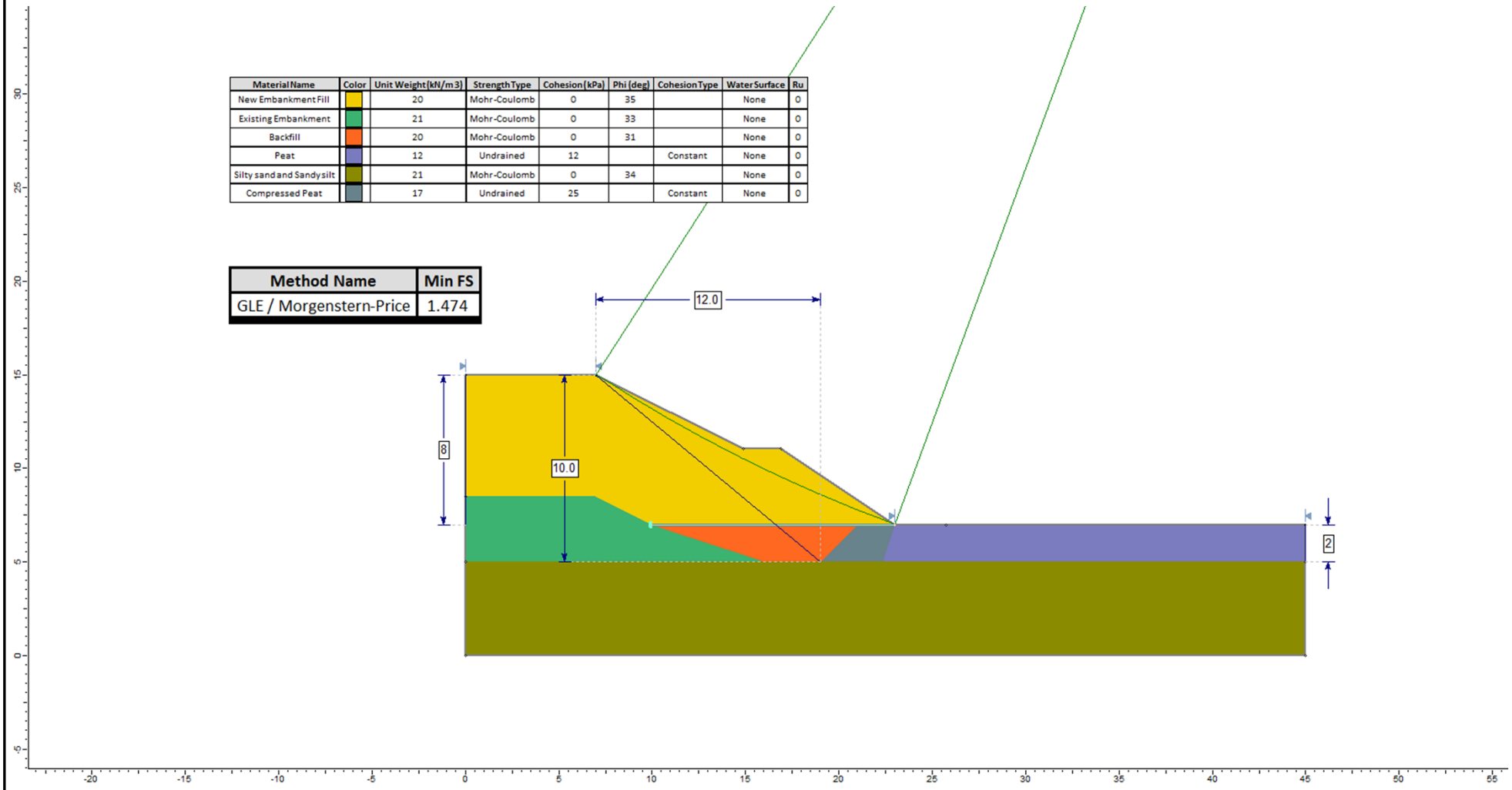
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8.5 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-11

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34		None	0
Compressed Peat		17	Undrained	25		Constant	None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.474



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PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

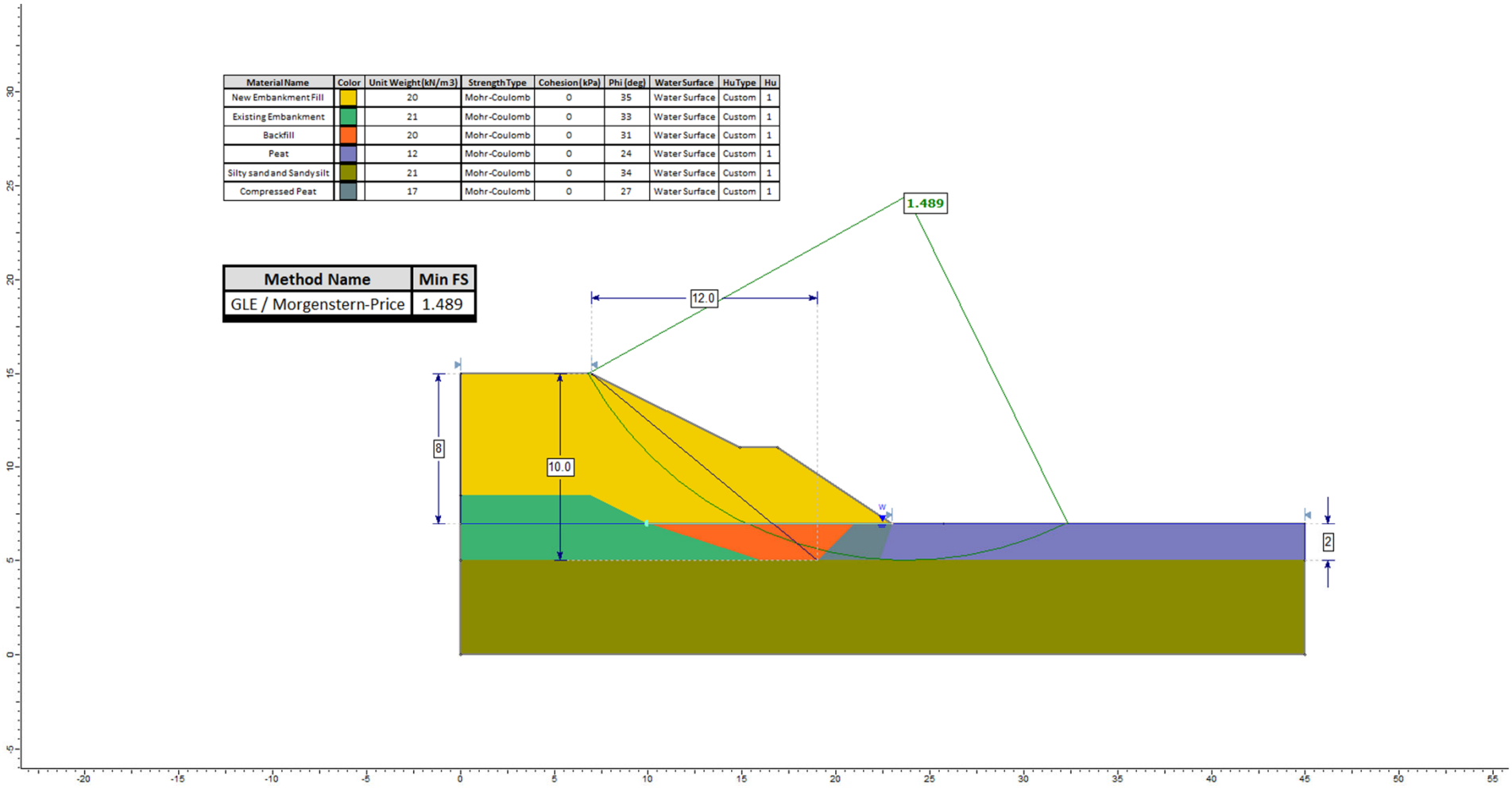
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-12

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1
Compressed Peat		17	Mohr-Coulomb	0	27	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.489



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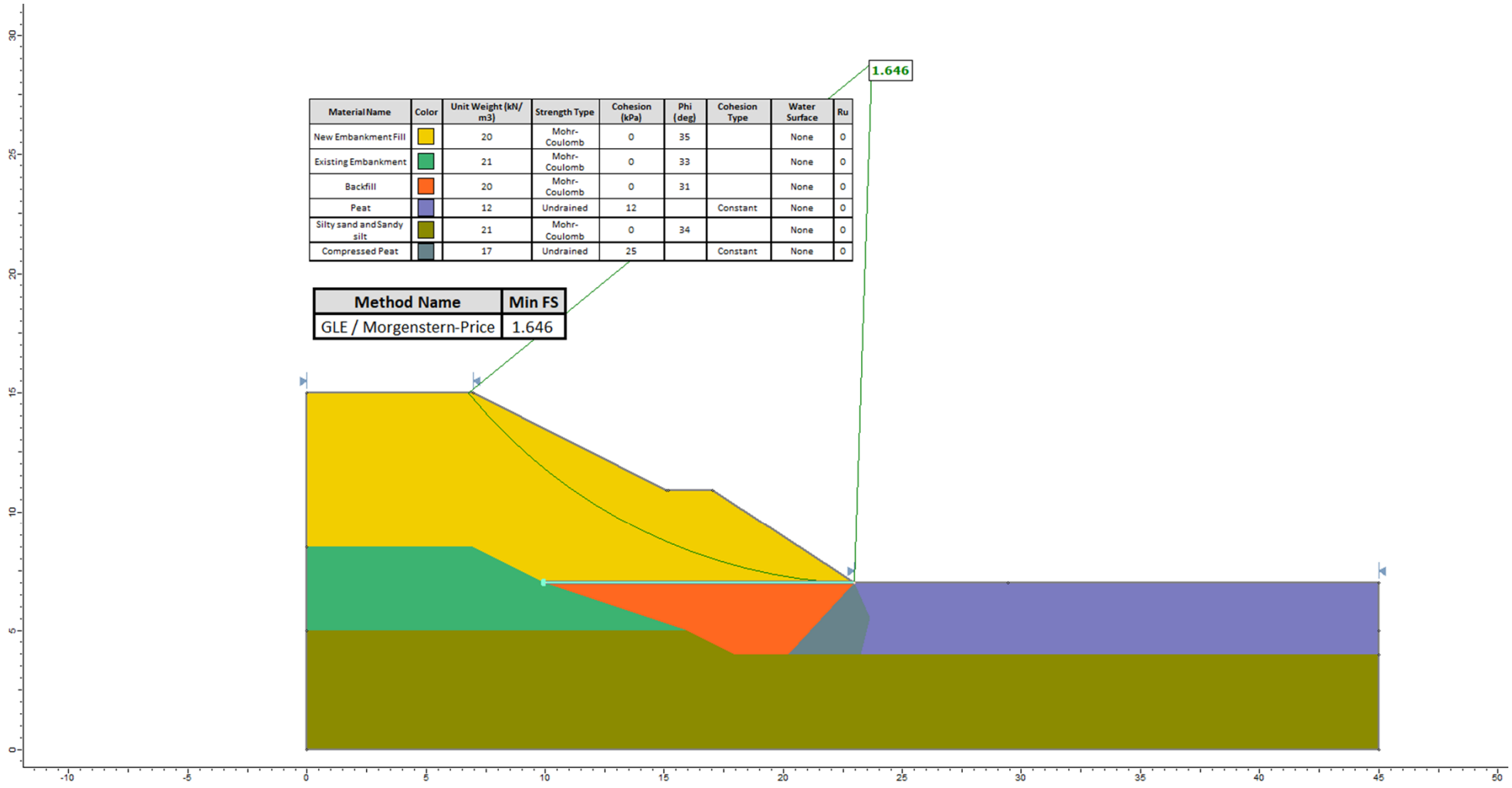
CONSULTANT
WSP GOLDER

YYYY-MM-DD	2023-08-02
PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-13



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DESIGN	SF
REVIEW	LCC
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

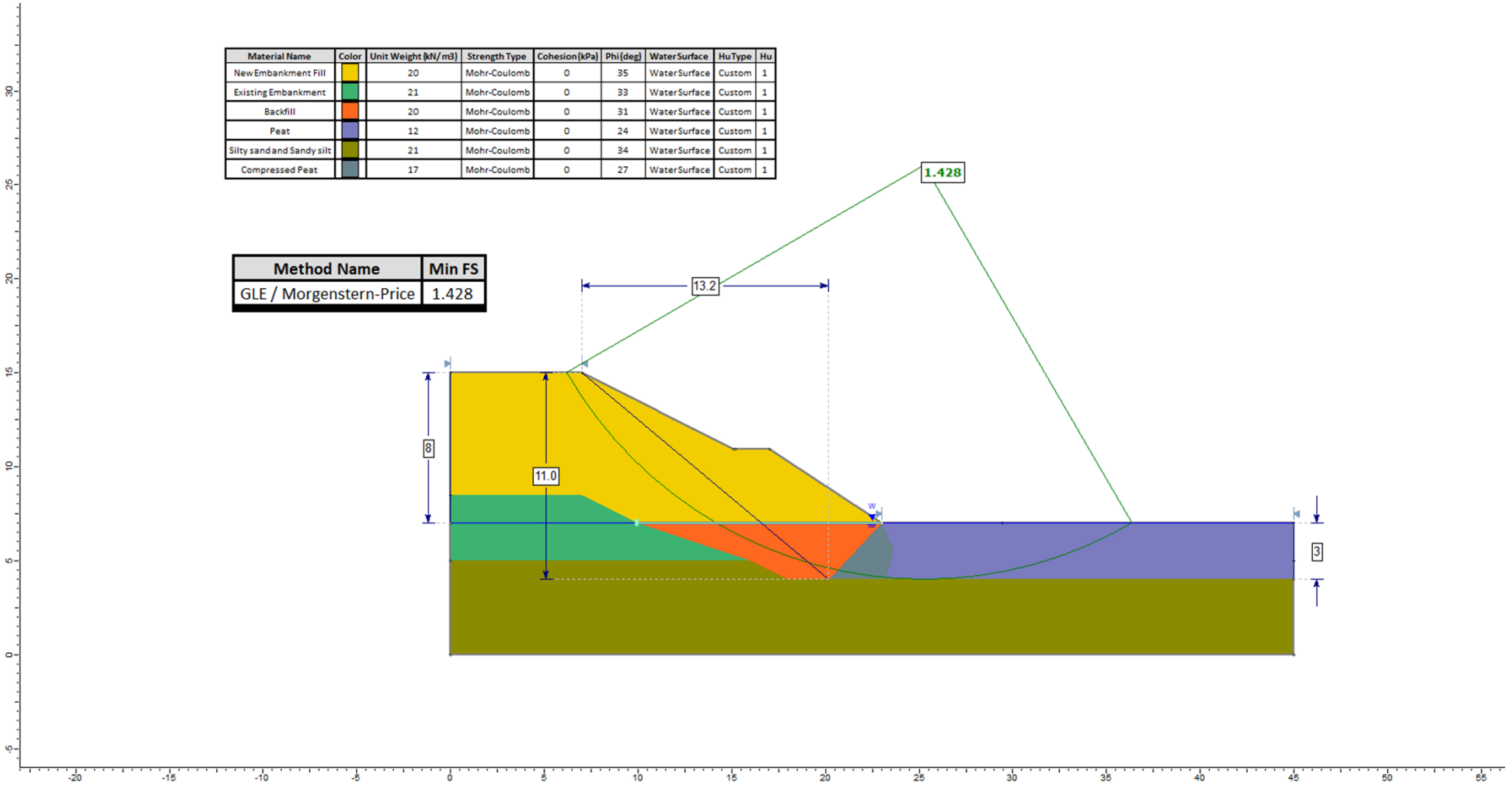
TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-14

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	WaterSurface	HuType	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	WaterSurface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	WaterSurface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	WaterSurface	Custom	1
Peat		12	Mohr-Coulomb	0	24	WaterSurface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	WaterSurface	Custom	1
Compressed Peat		17	Mohr-Coulomb	0	27	WaterSurface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.428



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MINISTRY OF TRANSPORTATION ONTARIO

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2023-08-02
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DESIGN	SF
REVIEW	LCC
APPROVED	MEB

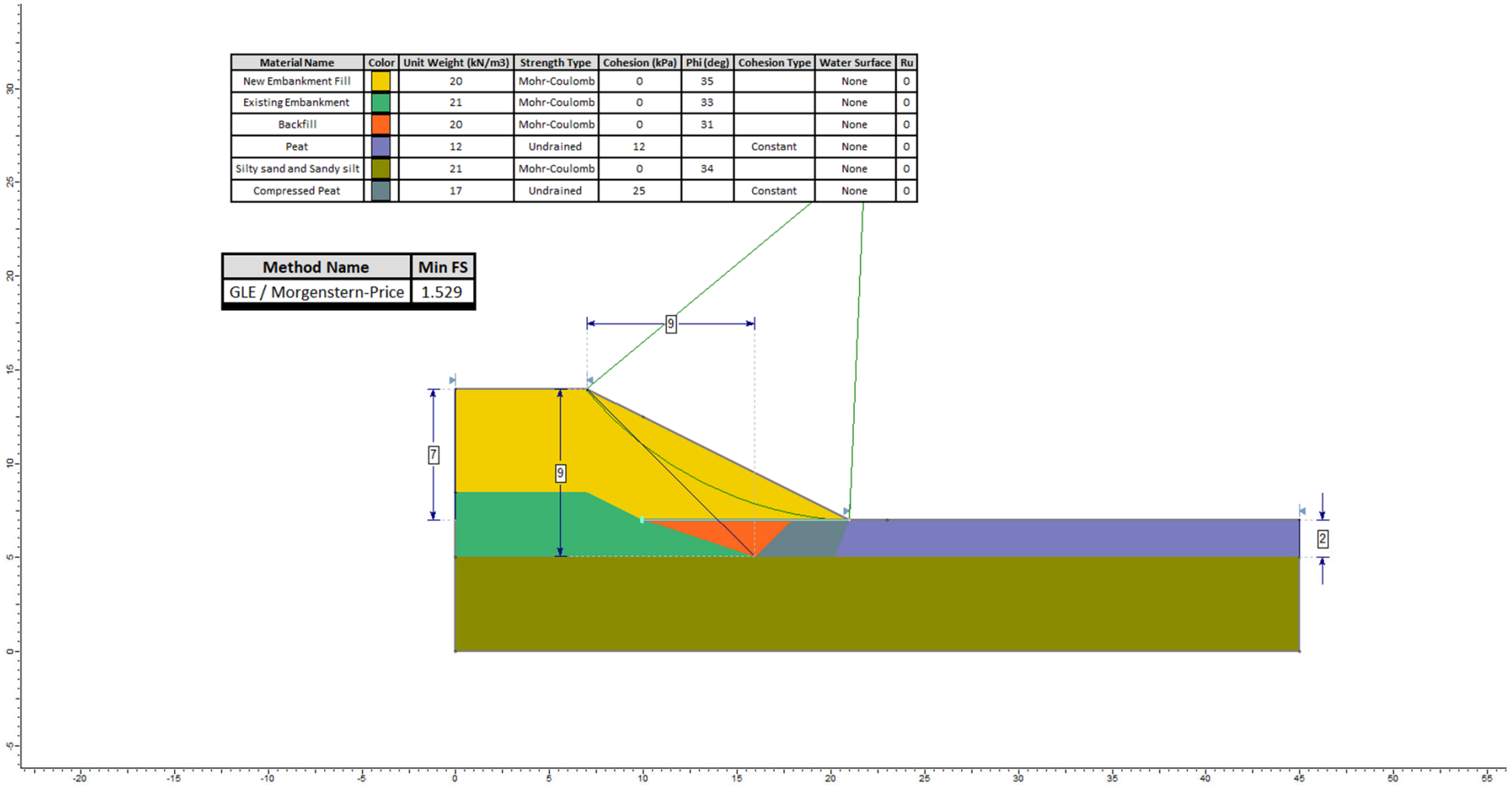
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
8 M HIGH EMBANKMENT WITH 3 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-15

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
New Embankment Fill		20	Mohr-Coulomb	0	35		None	0
Existing Embankment		21	Mohr-Coulomb	0	33		None	0
Backfill		20	Mohr-Coulomb	0	31		None	0
Peat		12	Undrained	12		Constant	None	0
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34		None	0
Compressed Peat		17	Undrained	25		Constant	None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.529



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MINISTRY OF TRANSPORTATION ONTARIO

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2023-08-02
PREPARED	SF
DESIGN	SF
REVIEW	LCC
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

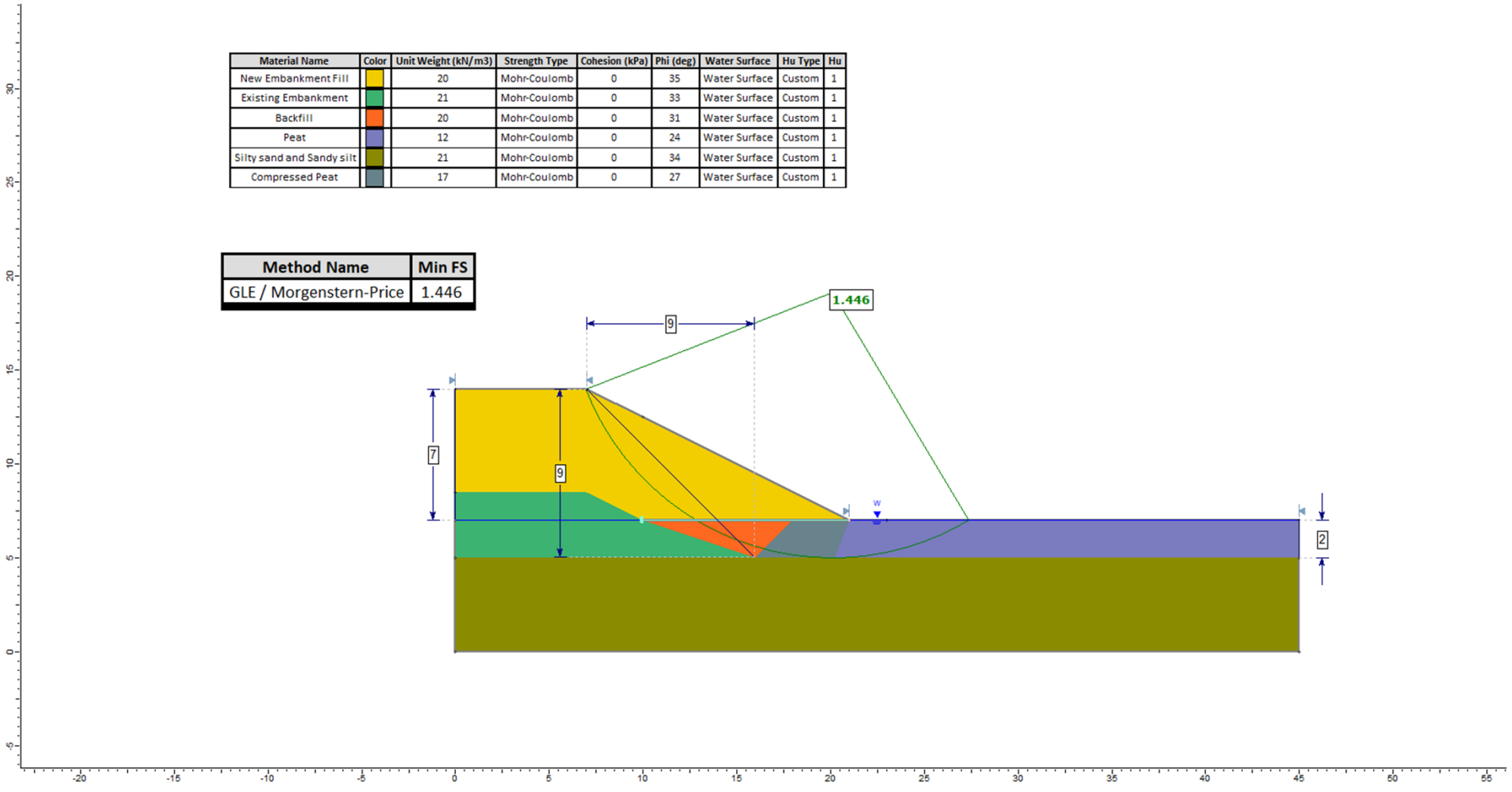
TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
7 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
SHORT-TERM (UNDRAINED) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-16

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
New Embankment Fill		20	Mohr-Coulomb	0	35	Water Surface	Custom	1
Existing Embankment		21	Mohr-Coulomb	0	33	Water Surface	Custom	1
Backfill		20	Mohr-Coulomb	0	31	Water Surface	Custom	1
Peat		12	Mohr-Coulomb	0	24	Water Surface	Custom	1
Silty sand and Sandy silt		21	Mohr-Coulomb	0	34	Water Surface	Custom	1
Compressed Peat		17	Mohr-Coulomb	0	27	Water Surface	Custom	1

Method Name	Min FS
GLE / Morgenstern-Price	1.446



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DESIGN	SF
REVIEW	LCC
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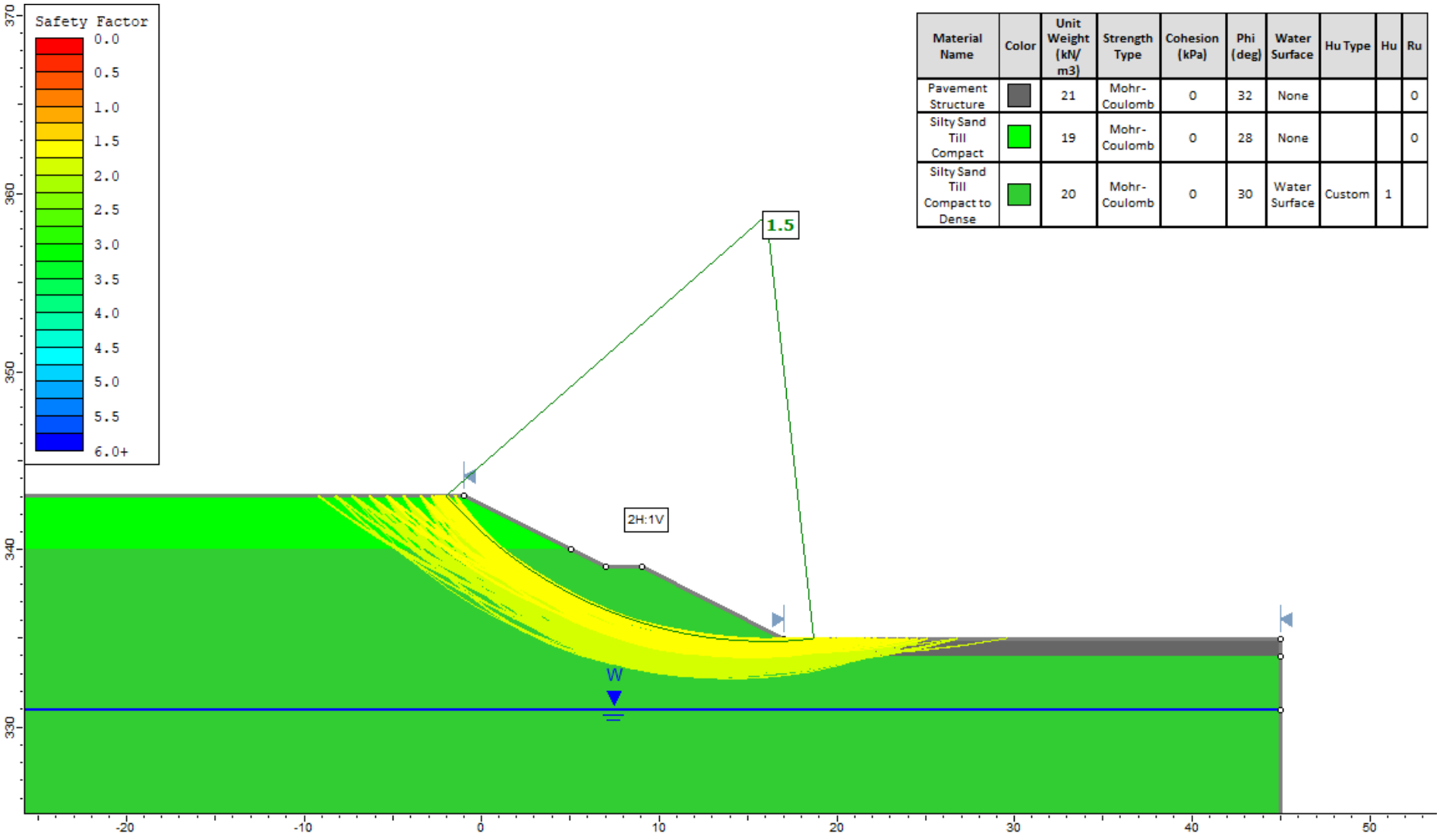
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY – WELLINGTON ROAD 34
7 M HIGH EMBANKMENT WITH 2 M PEAT SUBEXCAVATION
LONG-TERM (EFFECTIVE STRESS) CONDITION

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-17



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Pavement Structure		21	Mohr-Coulomb	0	32	None			0
Silty Sand Till Compact		19	Mohr-Coulomb	0	28	None			0
Silty Sand Till Compact to Dense		20	Mohr-Coulomb	0	30	Water Surface	Custom	1	

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DESIGN	AN
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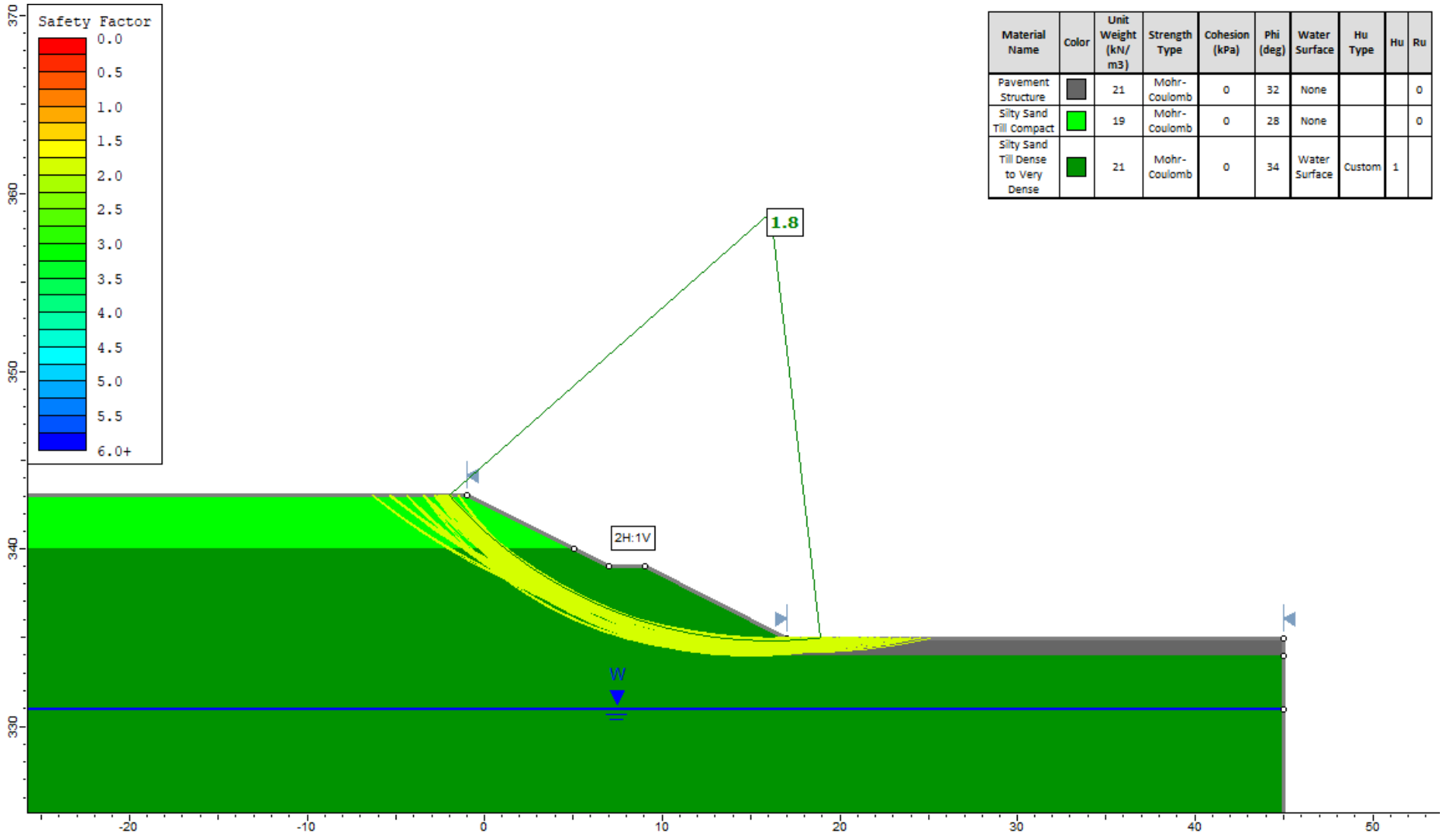
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
DEEP CUT (8 M DEPTH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	**1000**	**0**	**F-18**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Pavement Structure		21	Mohr-Coulomb	0	32	None			0
Silty Sand Till Compact		19	Mohr-Coulomb	0	28	None			0
Silty Sand Till Dense to Very Dense		21	Mohr-Coulomb	0	34	Water Surface	Custom	1	

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YYYY-MM-DD	2022-11-17
PREPARED	AN
DESIGN	AN
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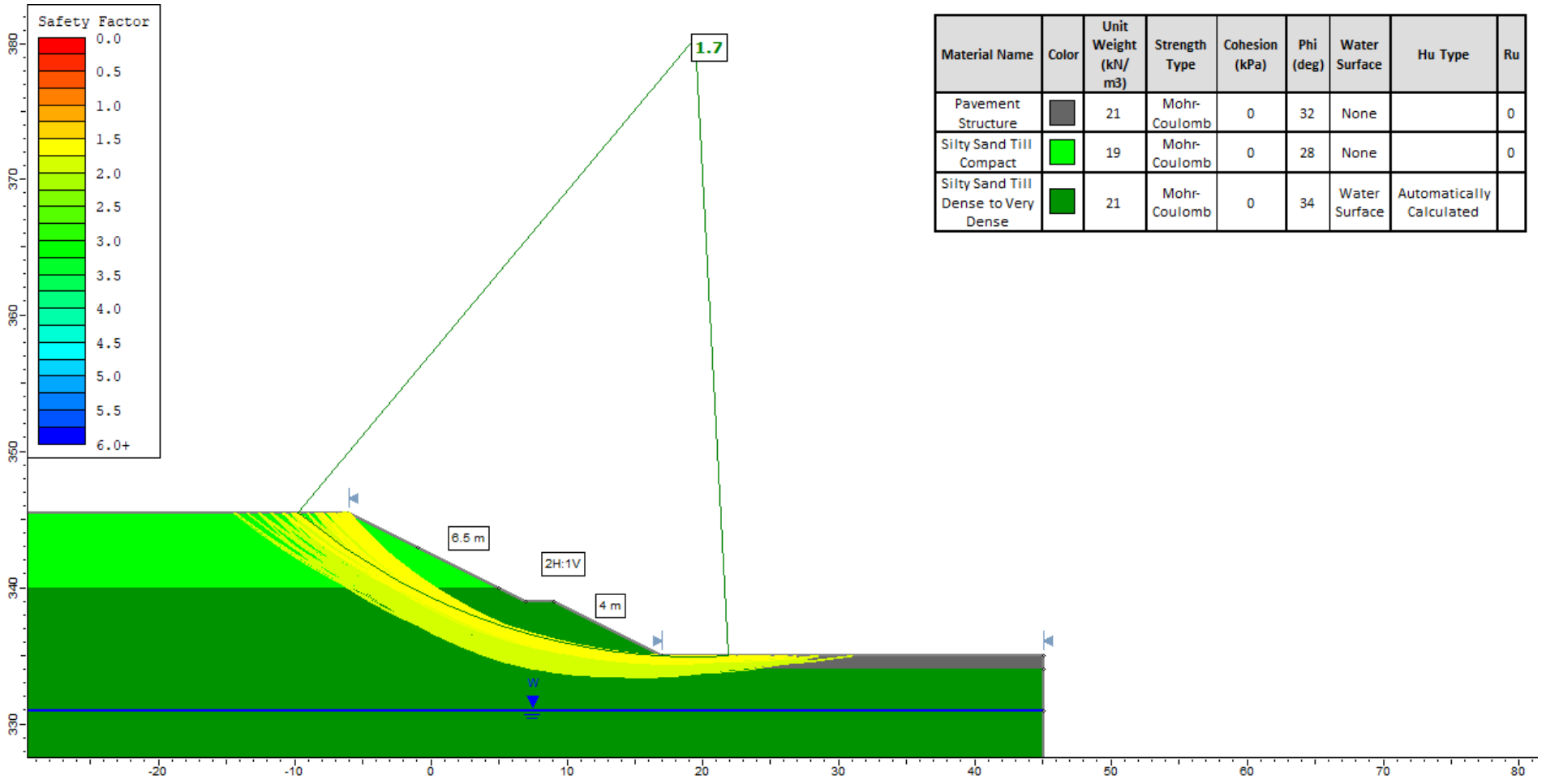
PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
DEEP CUT (8 M DEPTH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-19

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Pavement Structure		21	Mohr-Coulomb	0	32	None		0
Silty Sand Till Compact		19	Mohr-Coulomb	0	28	None		0
Silty Sand Till Dense to Very Dense		21	Mohr-Coulomb	0	34	Water Surface	Automatically Calculated	

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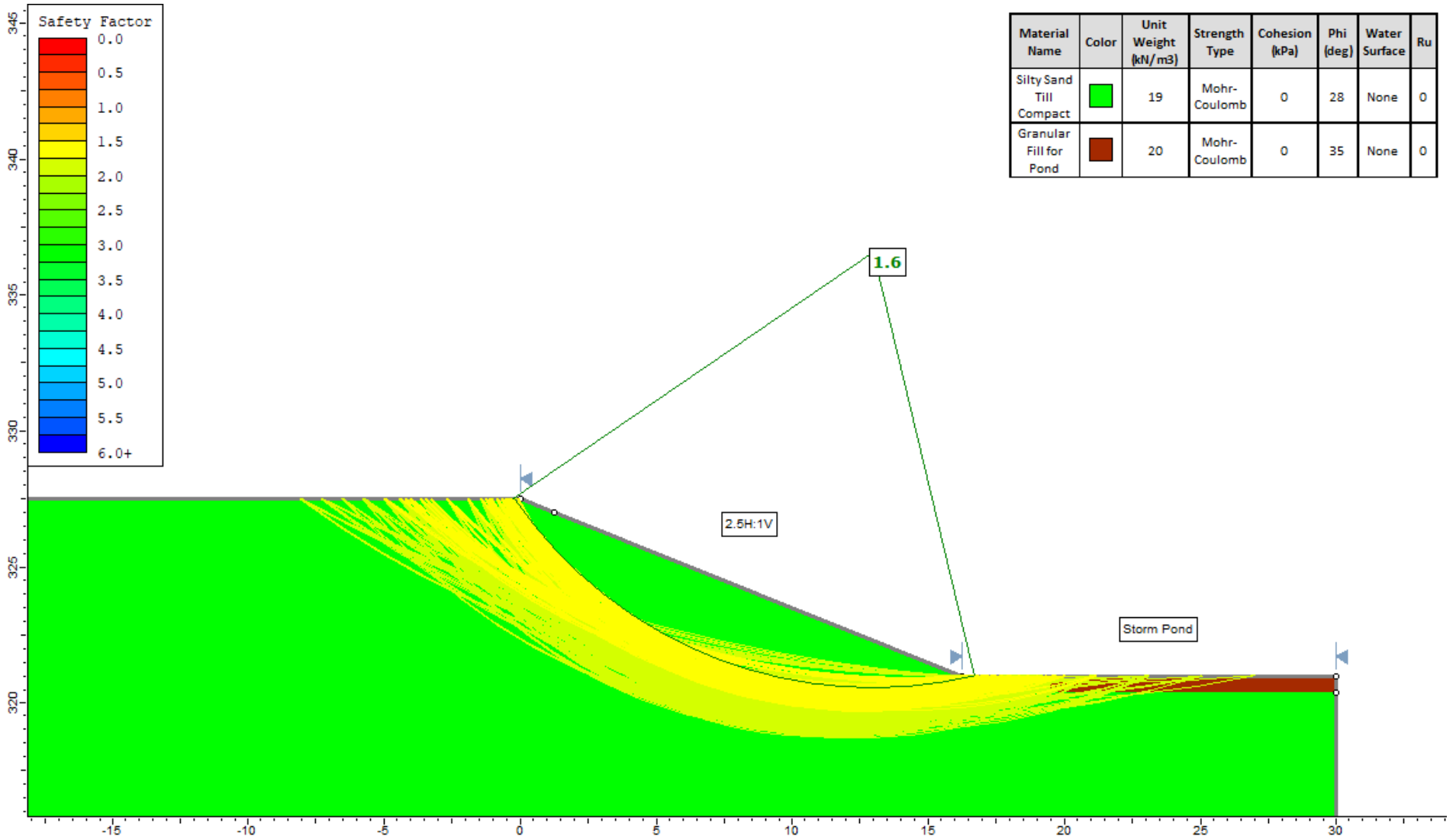
DESIGN	AN
REVIEW	LCC
APPROVED	MEB

PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
DEEP CUT (10.5 M DEPTH)

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	**1000**	**0**	**F-20**



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Sand Till Compact		19	Mohr-Coulomb	0	28	None	0
Granular Fill for Pond		20	Mohr-Coulomb	0	35	None	0

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REVIEW	LCC
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PROJECT
HIGHWAY 6 / HANLON EXPRESSWAY
MID-BLOCK INTERCHANGE IMPROVEMENTS
MTO DB 2021-3004

TITLE
STATIC GLOBAL STABILITY ANALYSIS
MID-BLOCK INTERCHANGE
STORMWATER MANAGEMENT POND CUT SLOPES

PROJECT No.	PHASE No.	REVISION No.	FIGURE No.
22522311	1000	0	F-21

APPENDIX G

Special Provisions

OPERATIONAL CONSTRAINT – Use of Excess Organic Soils in Permanent Berms

Special Provision

This Special Provision addresses incorporating excess organic soils expected to be subexcavated during construction of the new Midblock interchange speed change lanes into the new permanent berms to be constructed within the interchange ROW.

Existing fill or native soils from the Project Area are geotechnically suitable for placement and compaction within the permanent berms. Berm fill materials consisting of existing fill or native soils and/or reused aggregates shall be placed in general accordance with OPSS.PROV 206 (Grading) and OPSS.PROV 501 (Compacting).

As these berms will not support highway or structural loading, it is not strictly required to measure and meet a given compaction level; however, selection of appropriate lift thicknesses, wetting or drying materials to appropriate water contents for compaction and selection of equipment and procedures to meet approximately 90% of Standard Proctor maximum dry density for the materials will promote global and surficial stability of these materials on the berm slopes.

Excess organic soils may be incorporated into lifts within the permanent berms. However, where organic soils are incorporated within the body of the permanent berms, they shall be maintained within the "central" portion of the berm. The outside limits of any excess organic soils incorporated into the permanent berms shall be maintained a minimum distance of approximately 5 m from the finished toe or face of the berm.

The outer "shell" of the berms may consist of excess organic soil that meets requirements for topsoil, benched into the 2H:1V berm side slopes with a maximum thickness (measured perpendicular to the berm side slope) of 500 mm. Appropriate treatment of the berm surfaces shall be provided interim and final conditions to mitigate surficial erosion and sloughing, in accordance with OPSS.PROV 804 (Temporary Erosion Control) and OPSS.PROV 803 (Vegetative Cover).

To incorporate greater volumes of organic material within a permanent berm to optimize on-site reuse of materials throughout construction, a thicker zone of organic material may be placed horizontally in the upper portion of the berms to the maximum height achievable within the footprint available. The outside slope through any such thicker topsoil zone(s) shall be inclined at a maximum of 3H:1V to promote surficial stability. As above, side slope treatments in accordance with OPSS.PROV 804 and OPSS.PROV 803 shall be provided.

PEAT/ORGANIC SUBEXCAVATION

Operational Constraint

This Operational Constraint addresses subexcavation and backfilling of peat/organic soils adjacent to the existing Wellington Road 34 and Highway 6 platforms, between approximately Station 9+775 and 10+245 along Wellington Road 34, within the footprint of the proposed high fill embankments.

Staged subexcavation of the peat/organics shall be carried out to maintain the stability of the existing Wellington Road 34 and/or Highway 6 platform. This operation shall be completed subaqueously, without dewatering or other groundwater control during the excavation and backfilling works. The conceptual staged excavation procedures are outlined as follows:

- Work may be carried out simultaneously from both ends of areas to be subexcavated.
- Temporary excavation slopes through the peat/organic soils and overlying fill materials shall be no steeper than approximately 1.5 horizontal to 1 vertical (1.5H:1V) adjacent to the existing roadways, and approximately 1H:1V at the outside limit of the peat/organic subexcavation areas (i.e., near MTO's right-of-way limit).
- Removal of the peat/organic soils and any overlying fills within the proposed embankment widening immediately adjacent to the existing roadways shall be carried out in short "strip" sections perpendicular to Wellington Road 34 and/or Highway 6, as applicable, with the base of the excavation (as measured parallel to the roadway) not wider than approximately 5 m to maintain the integrity of the existing roadway platforms.
- For excavation areas that are located beyond the zone defined by a line projected at approximately 1.5H:1V from the edge of the existing roadway shoulder, wider strip widths may be permitted depending on the observed behaviour of the temporary excavations in the peat/organic soils, with the intent of this strip width restriction to minimize sloughing and intermixing of peat/organic materials and backfill materials.
- Backfilling of the peat/organic subexcavation areas shall be carried out simultaneously in such a manner that the excavation is not left open for more than the approximately 5 m "strip" width at any given time when excavating in proximity to a roadway.
- The backfill of the peat/organic subexcavation areas may consist of excavated non-plastic granular fill or non-plastic native soils from elsewhere on the Contract; in this case, the backfill material shall contain a minimum of approximately 30% gravel-sized particles, and shall not be clear stone or gap-graded material. Alternatively, OPSS.PROV 1010 Granular B Type II or Type III may be used. Crushed concrete may also be used for this purpose subject to environmental approval.
- Where feasible during subaqueous placement of the upper portions of the backfill below the water table, the material shall be compacted to the extent feasible using the excavator bucket.
- Once the backfill reaches 0.6 m above the water table, placement and compaction of the backfill shall follow OPSS.PROV 209 and OPSS.PROV 501.

WELLINGTON ROAD 34 EMBANKMENT PRELOADING AND MONITORING

Operational Constraint

This Operational Constraint addresses the preloading period for the Wellington Road 34 embankments following completion of the peat/organic subexcavation and backfilling operations, between approximately Stations 9+775 and 10+245 west and east of Highway 6.

The Contractor shall schedule operations such that the Wellington Road 34 embankment fills are placed and compacted up to the pavement subgrade level for a minimum period of three months prior to placement of the Wellington Road 34 pavement structure. This requirement does not apply in the zone immediately behind the new Wellington Road 34 abutments, where embankment construction operations (including placement of backfill to the abutment walls, as well as grading associated with access and operation of construction equipment) shall be completed in accordance with the underpass construction schedule.

Following completion of the preload embankment to the pavement subgrade level, settlement monitoring pins shall be established at the north and south shoulder of the Wellington Road 34 embankment at a horizontal spacing of approximately 25 m over the length of the embankment preload. The Contractor shall survey these monitoring pins weekly for the first month then twice monthly thereafter during the preload period, and provide the monitoring results to the geotechnical/foundation engineer.

Prior to placement of the pavement subbase and base materials and paving, the Contractor shall conduct a survey of the top of the preload and place and compact additional embankment fill as required to achieve the pavement subgrade level.

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