

Foundation Investigation Report

*Temporary Protection Systems at Bridge Site Nos. 37-819, 37-822 and 37-827,
Structure Rehabilitation at Highway 401 / Highway 427, City of Toronto, Ontario,
G.W.P. 2032-11-00*

Submitted to:

AECOM Canada

30 Leek Crescent, 4th Floor
Richmond Hill, Ontario
L4B 4N4

Submitted by:

Golder Associates Ltd.

6925 Century Avenue, Suite #100 Mississauga, Ontario, L5N 7K2 Canada

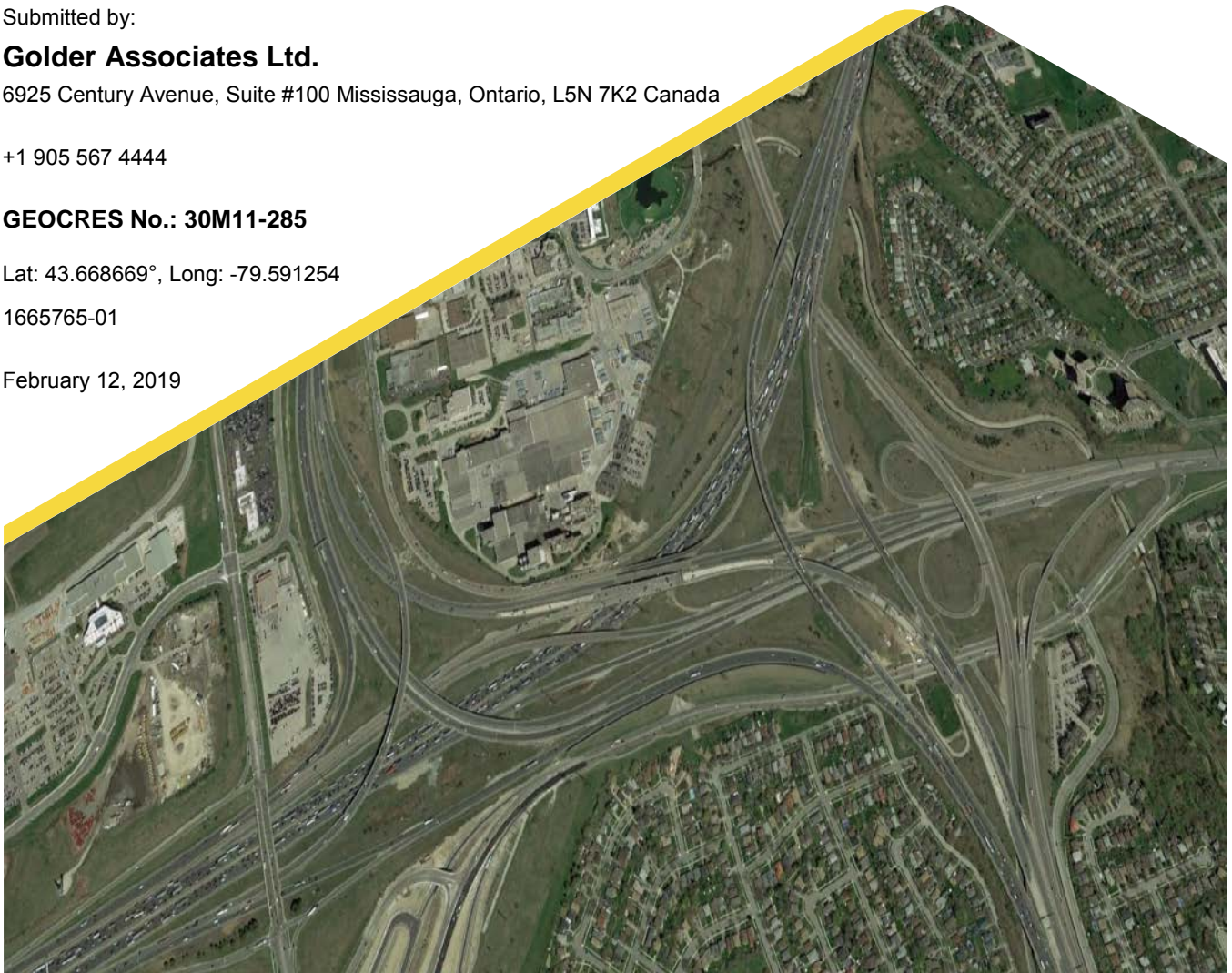
+1 905 567 4444

GEOCREs No.: 30M11-285

Lat: 43.668669°, Long: -79.591254

1665765-01

February 12, 2019



Distribution List

- 1 Electronic Copy - MTO - Central Region
- 1 Electronic Copy - MTO - Foundations Section
- 1 Electronic Copy - AECOM Canada Ltd.
- 1 Electronic Copy - Golder Associates Ltd.

Table of Contents

1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	1
3.0 INVESTIGATION PROCEDURES.....	1
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....	3
4.1 Regional Geology.....	3
4.2 General Overview of Subsurface Conditions	3
4.2.1 Site No. 37-827 (Bridge 70) – Boreholes TP-01 and TP-02	4
4.2.1.1 Asphalt	4
4.2.1.2 Concrete.....	4
4.2.1.3 Fill.....	4
4.2.1.4 Sandy Clayey Silt to Silty Clay.....	4
4.2.1.5 Sand and Silt / Sandy Silt to Silty Sand	5
4.2.1.6 Silty Clay (Till)	5
4.2.1.7 Groundwater Conditions	5
4.2.2 Site No. 37-819 (Bridge 25) – Boreholes TP-03 and TP-04	6
4.2.2.1 Asphalt	6
4.2.2.2 Concrete.....	6
4.2.2.3 Fill.....	6
4.2.2.4 Sand and Gravel	7
4.2.2.5 Silty Clay (Till)	7
4.2.2.6 Shale	7
4.2.2.7 Groundwater Conditions	8
4.2.3 Site No. 37-822/1&2 (Bridge 29) – Boreholes TP-05 and TP-06.....	8
4.2.3.1 Asphalt	8
4.2.3.2 Concrete.....	8
4.2.3.3 Fill.....	8
4.2.3.4 Silt	9
4.2.3.5 Gravelly Silty Sand to Sand and Gravel	9

4.2.3.6	Sand.....	9
4.2.3.7	Silty Clay (Till)	9
4.2.3.8	Shale	10
4.2.3.9	Groundwater Conditions	10
5.0	CLOSURE	11

DRAWINGS

- Drawing 1 Borehole Locations – Temporary Protection Systems – Site No. 37-827 and 37-819
Drawing 2 Borehole Locations – Temporary Protection Systems – Site No. 37-822/1&2

APPENDICES

APPENDIX A - Borehole Records

- Lists of Symbols and Abbreviations
Record of Boreholes TP-01 to TP-06

APPENDIX B - Geotechnical Laboratory Test Results

- Figure B1 Grain Size Distribution – Sandy Clayey Silt (Fill)
Figure B2 Plasticity Chart – Sandy Clayey Silt (Fill)
Figure B3 Grain Size Distribution – Sandy Clayey Silt
Figure B4 Plasticity Chart – Silty Clay to Sandy Clayey Silt
Figure B5 Grain Size Distribution – Sandy Silt to Sand
Figure B6 Grain Size Distribution – Sandy Clayey Silt (Fill)
Figure B7 Plasticity Chart – Clayey Silt to Sandy Clayey Silt (Fill)
Figure B8 Grain Size Distribution – Sand (Fill)
Figure B9 Grain Size Distribution – Sand and Gravel
Figure B10 Grain Size Distribution – Silty Clay (Till)
Figure B11 Plasticity Chart – Silty Clay (Till)
Figure B12 Grain Size Distribution – Silt
Figure B13 Grain Size Distribution – Gravelly Silty Sand
Figure B14 Grain Size Distribution – Sand
Figure B15 Grain Size Distribution – Silty Clay (Till)
Figure B16 Plasticity Chart – Silty Clay (Till)

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed rehabilitation of the existing structures listed below.

- Site No. 37-819 (Bridge 25): Eglinton Avenue East - Highway 401 West Collector Ramp over Highway 401
- Site No. 37-822/1&2 (Bridge 29): Renforth Drive N/S over Highway 401
- Site No. 37-827 (Bridge 70): Eglinton Avenue East - Highway 427 North Ramp over Highway 401

All sites are located within the Highway 401 / Highway 427 Interchange as shown on the Key Plan on Drawings 1 and 2.

This report summarizes the foundation investigation carried out to support the rehabilitation of the existing Highway 401 Underpass structures at the three sites identified above. The Terms of Reference for the foundation engineering services are outlined Golder's change request letter dated June 1, 2018 which forms part of the Consultant's Assignment for the Structure Rehabilitation at Highway 401/Highway 427, Assignment No. 2015-E-0026.

2.0 SITE DESCRIPTION

Site Nos. 37-819 and 37-827 are located about 1.6 km west of the intersection of Martin Grove Road and Eglinton Avenue West, with Site No. 37-827 located about 85 m north of Site No. 37-819. These structures are bordered to the north and west by industrial areas including the Molson Brewery which is about 100 m to 200 m north of the sites. Residential areas are present to the east and south of the sites. The road surface at the two structures is between approximately Elevation 155.5 m and 158.0 m and the Highway 401 grade is about Elevation 151 m. Based on the design drawings, Highway 401 appears to be constructed in cut and the bridge approach embankments consist of partial cut and fill placement.

Site No. 37-822/1&2 (the Renforth Drive Underpass), is located approximately 800 m west of Site Nos. 37-827 and 37-819. The Renforth Drive underpass is bordered by industrial/commercial lands (including the Toronto Pearson International Airport) to the north and commercial land / residential housing to the south. The Renforth Drive road grade is at approximately Elevation 163 m and the surrounding area is at approximately the same elevation. Highway 401 appears to have been constructed primarily in cut and the highway surface is at about Elevation 156 m.

3.0 INVESTIGATION PROCEDURES

The field work for the current investigation at Site No. 37-819, Site No. 37-827 and Site No. 37-822/1&2 was carried out on September 10 to 12, and December 2 and 16, 2018 during which time six boreholes (designated as Boreholes TP-01 to TP-06) were advanced at the sites.

Boreholes TP-01 and TP-02 were advanced within the approaches of Site No. 37-827 (Bridge 70), Boreholes TP-03 and TP-04 were advanced within the approaches of Site No. 37-819 (Bridge 25), and Boreholes TP-05 and TP-

06 were advanced within the approaches of Site No. 37-822/1&2 (Bridge 29). The approximate locations of the boreholes are shown on Drawings 1 and 2.

All completed boreholes were advanced using a CME-55 truck mount drill rig, both supplied and operated by Geo-Environmental Drilling Ltd. of Milton, Ontario. Boreholes TP-01 to TP-04 were advanced using 178 mm outer diameter hollow-stem augers, while Boreholes TP-05 and TP-06 were advanced using 152 mm outer diameter hollow-stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)¹

Boreholes TP-01 and TP-02 were advanced on the east and west approaches of Site No. 37-827 to depths of 9.6 m and 9.2 m below the roadway surface, respectively. Boreholes TP-03 and TP-04 were advanced on the east and west approaches of Site No. 37-819 to a depth of 9.2 m below the roadway surface. Boreholes TP-05 and TP-06 were advanced on the south and north approaches of Site No. 37-822/1&2 to a depth of 9.4 m and 9.3 m, respectively, below the roadway surface. Traffic protection consisted of single lane closures, consistent with MTO Book 7 requirements.

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. All boreholes were backfilled and sealed at the roadway surface with cold patch asphalt upon completion, in accordance with Ontario Regulation 903, Wells (as amended).

The field work was monitored on a full-time basis by a member of Golder's technical staff who located the boreholes in the field relative to on site features, directed the sampling and in situ testing operations, logged the boreholes and examined the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further visual review and geotechnical laboratory testing on selected samples, consisting of natural moisture content, Atterberg limits and grain size distribution conducted in accordance with MTO and / or ASTM Standards as applicable.

The borehole locations provided on the Record of Borehole sheets and shown on Drawings 1 and 2 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, including geographic (Latitude / Longitude) coordinates, the ground surface elevations and borehole drilled depths are summarized below.

Borehole No.	MTM NAD83 (Geographic)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude)	Easting (m) (Longitude)		
TP-01	4,836,948.9 (43.672466)	298,282.7 (-79.580825)	155.5	9.6
TP-02	4,836,903.0 (43.672051)	298,053.8 (-79.583663)	158.0	9.2
TP-03	4,836,826.9 (43.671367)	298,116.4 (-79.582886)	157.3	9.2

¹ ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

Borehole No.	MTM NAD83 (Geographic)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude)	Easting (m) (Longitude)		
TP-04	4,836,805.9 (43.671176)	297,906.1 (-79.585494)	157.8	9.2
TP-05	4,836,436.2 (43.667844)	297,491.7 (-79.590627)	161.7	9.4
TP-06	4,836,634.6 (43.669629)	297,406.2 (-79.591690)	161.4	9.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Till Plains of the Peel Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)².

The Peel Plain physiographic region covers the central portions of the Regional Municipalities of York, Peel and Halton. The general topography of this region consists of level to gently rolling terrain, sloping gradually southward toward Lake Ontario. A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till, which is mapped in this area as the Halton Till, typically consists of clayey silt to silty clay, with occasional sand to silt zones. Shallow, localized deposits of loose sand and silt and/or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial meltwater ponds scattered throughout the Peel Plain and concentrated near river valleys. The recent sand, silt and clay and uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay. The study area, in the western portion of the Peel Plain, is underlain by grey shale of the Georgian Bay Formation.

4.2 General Overview of Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes of the current investigation, and the results of the in situ and laboratory tests are provided on the Record of Borehole Sheets in Appendix A. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4 are uncorrected. The results of the geotechnical laboratory testing on soil samples are presented on the laboratory test figures in Appendix B.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected, however, the factual data presented on the borehole records governs any interpretation of the site conditions.

²Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

4.2.1 Site No. 37-827 (Bridge 70) – Boreholes TP-01 and TP-02

In general, the subsurface conditions at this site consist of asphalt and concrete associated with the Highway 401 pavement structure, underlain by fill. The fill material is underlain by interlayered deposits of sandy silt to sand and sandy clayey silt to silty clay (till).

4.2.1.1 Asphalt

An approximately 90 mm and 80 mm thick layer of asphalt pavement was encountered at ground surface in Boreholes TP-01 and TP-02, respectively.

4.2.1.2 Concrete

An approximately 220 mm and 150 mm thick layer of concrete was encountered underlying the asphalt pavement in Boreholes TP-01 and TP-02, respectively.

4.2.1.3 Fill

A 4.2 m and 2.0 m thick layer of sandy clayey silt fill material was encountered underlying the concrete in Boreholes TP-01 and TP-02, respectively. The base of the fill layer extends to Elevations 151.0 m and 155.8 m in Boreholes TP-01 and TP-02, respectively. Cobbles / obstructions are inferred to be present within the fill layer as augers were grinding at a depth of about 1.5 m in Borehole TP-02 during the drilling investigation.

The Standard Penetration Test (SPT) “N”-values measured within the fill layer range from 12 blows to 29 blows per 0.3 m of penetration, with one discrete value of 61 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

A grain size distribution was carried out on one sample of the sandy clayey silt fill and the results are shown on Figure B1 in Appendix B. An Atterberg limits test was carried out on the sandy clayey silt fill and measured a liquid limit of 27 per cent, a plastic limit of 15 per cent, and corresponding plasticity index of 11 per cent. These results, which are plotted on a plasticity chart on Figure B2 in Appendix B, indicate the fill consists of clayey silt of low plasticity. The natural water content measured on three samples of the sandy clayey silt fill range from 11 per cent to 16 per cent.

4.2.1.4 Sandy Clayey Silt to Silty Clay

A sandy clayey silt deposit was encountered underlying the fill layer Borehole TP-01, and a sandy silty clay layer was encountered within the sandy deposit (described in Section 4.2.1.5 below) in Borehole TP-02. The deposit was 2.7 m thick in TP-1 and about 0.3 m thick in TP-2. The clayey layer contained trace to some gravel.

The SPT “N”-values measured within the sandy clayey silt to sandy silty clay range between 15 blows and 63 blows per 0.3 m of penetration suggesting a stiff to hard consistency.

A grain size distribution was carried out on one sample of the deposit and the results are shown on Figure B3 in Appendix B. Atterberg limits testing was carried out a sample of the deposit and measured a liquid limit of 24 per cent, plastic limit of 14 per cent, and corresponding plasticity index of 10 per cent. The results, which are plotted on a plasticity chart on Figure B4 in Appendix B, indicate that the deposit consists of clayey silt of low plasticity. The natural water content measured on a selected sample of the deposit is 11 per cent.

4.2.1.5 Sand and Silt / Sandy Silt to Silty Sand

A deposit of sand to sand and silt was encountered underlying the sandy clayey silt deposit in Borehole TP-01, and underlying the fill layer in Borehole TP-02. Interlayers of sandy silt to silty sand were encountered below the sandy silty clay layer in TP-2. A summary of the sandy and silty layers encountered in the boreholes is provided below.

Borehole Number	Depth to Top of Layer (m)	Top of Layer Elevation (m)	Thickness (m)	Description
TP-01	7.2	148.3	1.3	Sand and Silt
TP-02	2.2	155.8	0.5	Sand
	3.0	155.0	0.7	Sandy Silt
	3.7	154.3	1.9	Silty Sand

Cobbles are inferred to be present within the sand and silt deposits as augers were grinding within this layer at depths between about 2.4 m and 2.7 m and 5.2 to 5.8 m in Borehole TP-02, and at about 7.9 m in TP-1.

The SPT “N”-values measured within the sandy and silty deposits range between 34 blows per 0.3 m of penetration and 100 blows for 0.23 m of penetration, indicating a dense to very dense level of compactness.

Grain size distributions were carried out on three samples of the deposit and the results are shown on Figure B5 in Appendix B. The natural water content measured on selected samples of the sandy silt to sand deposit range between 7 per cent and 10 per cent.

4.2.1.6 Silty Clay (Till)

A silty clay (glacial till) deposit was encountered underlying the sand and silt layer in Borehole TP-01, and below the silty sand layer in Borehole TP-02. Both boreholes were terminated within the silty clay (till) deposit after penetrating it for about 1.1 m and 3.6 m in TP-01 and TP-02 respectively. The silty clay till deposit is well graded and contains shale fragments / cobbles throughout. Auger grinding was encountered from 7.3 m to 7.6 m and 8.0 m to 9.0 m in TP-02.

The SPT “N”-values measured within the silty clay till range between 32 blows per 0.3 m of penetration and 100 blows per 0.07 m of penetration suggesting a hard consistency.

Atterberg limits testing was carried out a sample of the deposit and measured a liquid limit of 42 per cent, plastic limit of 24 per cent, and corresponding plasticity index of 18 per cent. The results, which are plotted on a plasticity chart on Figure B4 in Appendix B, indicate that the deposit consists of silty clay of medium plasticity. The natural water content measured on a selected sample of the deposit is 14 per cent.

4.2.1.7 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations. The groundwater level recorded in the open boreholes, if present, are provided on the borehole records in Appendix A and are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
TP-01	155.5	Dry	-	September 11, 2018	Open borehole (borehole caved to 8.1m)
TP-02	158.0	6.7	151.3	September 12, 2018	Open borehole (borehole caved to 8.2m)

The groundwater level observations at this site are not considered to represent long-term stabilized groundwater levels. Groundwater levels will be subject to seasonal fluctuations and precipitation events; the water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.2.2 Site No. 37-819 (Bridge 25) – Boreholes TP-03 and TP-04

In general, the subsurface conditions at this site consist of asphalt and concrete associated with the highway ramp pavement structure, underlain by fill. The fill material is underlain by a sand and gravel deposit that is further underlain by a silty clay till deposit. Weathered shale bedrock was encountered underlying the silty clay till deposit.

4.2.2.1 Asphalt

An approximately 90 mm and 100 mm thick asphalt pavement was encountered at ground surface in Boreholes TP-03 and TP-04, respectively.

4.2.2.2 Concrete

An approximately 230 mm thick layer of concrete was encountered immediately below the asphalt pavement in Boreholes TP-03 and TP-04.

4.2.2.3 Fill

An approximately 3.4 m and 4.1 m thick layer of fill was encountered underlying the concrete in Boreholes TP-03 and TP-04, respectively. The base of the fill layer extends to approximately Elevations 153.6 m and 153.4 m in Boreholes TP-03 and TP-04, respectively. The fill encountered is variable in composition and is generally comprised of clayey silt to sandy clayey silt. A 0.8 m thick layer of sand fill was encountered within the cohesive fill in Borehole TP-04 at a depth of about 1.4 m, corresponding to Elevation 156.4 m. Cobbles / obstructions are inferred to be present within the fill layer due to auger grinding at depths between about 0.6 m and 0.9 m in Borehole TP-03 and below a depth of 4.3 m in borehole TP-04. The sandy clayey silt encountered below a depth of 2.2 m in TP-04 resembled a glacial till and may be recompacted native till material. The till deposits in this area are known to contain cobbles and boulders and thus, the presence of cobbles/boulders should be anticipated within the fill layer.

The SPT “N”-values measured within the cohesive portion of the fill range from 15 blows per 0.3 m of penetration to 100 blows for 0.25 m of penetration, suggesting a stiff to hard consistency. One SPT “N”-value measured within the non-cohesive portion of the fill in Boreholes TP-04 was 45 blows per 0.3 m of penetration, indicating a dense level of compactness.

A grain size distribution was carried out on one sample of the sandy clayey silt fill and the results are shown on Figure B6 in Appendix B. Atterberg limits testing was carried out on two samples of clayey silt fill and measured liquid limits of 20 per cent and 22 per cent, plastic limits of 13 per cent and 14 per cent, and corresponding plasticity indices of 7 per cent and 8 per cent. These results, which are plotted on a plasticity chart on Figure B7 in Appendix B, indicate that the fill is comprised of clayey silt of low plasticity. The natural water content measured on select samples of the clayey silt fill are between 9 per cent and 11 per cent.

A grain size distribution test was carried out on one sample of the sand fill and the results are shown on Figure B8 in Appendix B. The natural water content measured on one sample of the sand fill layer is about 5 per cent.

4.2.2.4 Sand and Gravel

A 1.2 m and 1.0 m thick sand and gravel deposit was encountered underlying the cohesive fill in Boreholes TP-03 and TP-04, respectively. The surface of the sand and gravel deposit was encountered at Elevations 153.6 m and 153.4 m in Boreholes TP-03 and TP-04, respectively.

The SPT “N”-values measured within the sand and gravel deposit are 54 blows per 0.3 m of penetration to 100 blows for 0.25 m of penetration, indicating a very dense level of compactness.

Grain size distribution tests were carried out on two samples of the sand and gravel and the results are shown on Figure B9 in Appendix B. The natural water content measured on two samples of the sand and gravel deposit is about 5 per cent.

4.2.2.5 Silty Clay (Till)

A 2.7 m and 1.3 m thick deposit of silty clay till was encountered underlying the sand and gravel deposit in Boreholes TP-03 and TP-04, respectively. The surface of the silty clay glacial till deposit was encountered at Elevation 152.4 m in both boreholes. Although not encountered during drilling operations, cobbles/boulders and shale fragments are known to be present within the glacial till soils in this local region and should be anticipated to be present within this till deposit.

The SPT “N”-values measured within the silty clay till deposit range from 31 to 54 blows per 0.3 m of penetration, suggesting a hard consistency.

A grain size distribution was carried out on one sample of the silty clay till deposit and the results are shown on Figure B10 in Appendix B and confirm a well-graded distribution. Atterberg limits testing was carried out on one selected sample of the silty clay till deposit and measured a liquid limit of 36 per cent, plastic limit of 20 per cent, and a plasticity index of 16 per cent. These results, which are plotted on a plasticity chart on Figure B11 in Appendix B, indicate that the till deposit is a silty clay of intermediate plasticity. The natural water content measured on two selected samples of the silty clay till deposit is about 10 and 14 per cent.

4.2.2.6 Shale

Shale bedrock was encountered underlying the silty clay till deposit at depths of 7.6 m (Elevations 149.7 m) and 6.7 m (Elevation 151.1 m) in Boreholes TP-03 and TP-04, respectively. The shale was confirmed from limited recovery within split-spoon samples. The shale is inferred to be weathered within the upper portion; however, the amount and extent of weathering was not confirmed as bedrock coring was not carried out.

4.2.2.7 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations. The groundwater level recorded in the open boreholes, if present, are indicated on the borehole records in Appendix A and are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
TP-03	157.3	6.3	151.0	September 10, 2018	Open borehole (borehole caved to 7.0 m)
TP-04	157.8	Dry	-	September 11, 2018	Open borehole

The groundwater level observations at this site are not considered to represent long-term stabilized groundwater levels. The groundwater level will be subject to seasonal fluctuations and precipitation events; the water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.2.3 Site No. 37-822/1&2 (Bridge 29) – Boreholes TP-05 and TP-06

In general, the subsurface conditions at this site consist of asphalt and concrete associated with the Renforth Drive pavement structure, underlain by fill. The fill material is underlain by cohesionless deposits of silt, gravelly silty sand and sand and gravel. Shale bedrock was encountered below the cohesionless deposits in both boreholes. In Borehole TP-06, a deposit of silty clay till was encountered between the cohesionless deposits and the shale bedrock.

4.2.3.1 Asphalt

An approximately 70 mm and 90 mm thick layer of asphalt pavement was encountered at ground surface in Boreholes TP-05 and TP-06, respectively.

4.2.3.2 Concrete

An approximately 230 mm and 160 mm thick layer of concrete was encountered underlying the asphalt pavement in Boreholes TP-05 and TP-06, respectively.

4.2.3.3 Fill

A 1.2 m and 1.1 m thick layer of fill material was encountered underlying the concrete in Boreholes TP-05 and TP-06, respectively. The fill material was comprised of silty sand in Borehole TP-05 and clayey silt in Borehole TP-06. The base of the fill layer extends to Elevations 160.2 m and 159.9 m in Boreholes TP-05 and TP-06, respectively. Clay pockets were encountered within the silty sand fill in Borehole TP-05 between depths of 0.8 m and 1.4 m.

The Standard Penetration Test (SPT) “N”-value measured within the silty sand fill layer is 17 blows per 0.3 m of penetration, indicating a compact level of compactness. The SPT “N”-value measured within the clayey silt fill layer is 9 blows per 0.3 m of penetration, suggesting a stiff consistency.

4.2.3.4 Silt

A 3.2 m thick deposit of silt was encountered underlying the silty sand fill layer in Borehole TP-05 at a depth of 1.5 m, corresponding to Elevation 160.2 m.

The SPT “N”-values measured within the silt deposit range from 31 blows to 69 blows per 0.3 m of penetration, indicating a dense to very dense level of compactness.

A grain size distribution was carried out on two samples of the silt deposit and the results are shown on Figure B12 in Appendix B. The natural water content measured on three selected samples of the silt deposit range between about 11 and 25 per cent.

4.2.3.5 Gravelly Silty Sand to Sand and Gravel

A 4.0 m thick deposit of gravelly silty sand to sand and gravel was encountered underlying the silt deposit in Borehole TP-05. The deposit grades from a gravelly silty sand to a sand and gravel with depth, with the surface of the gravelly silty sand deposit encountered at Elevation 157.0 m, and the surface of the sand and gravel deposit encountered at Elevation 154.5 m. Cobbles / boulders are inferred to be present within the gravelly silty sand to sand and gravel deposit due to auger grinding at depths below about 5 m, with auger refusal encountered at a depth of about 6.0 m. As a result, Borehole TP-05 was backfilled and relocated about 3 m to the south and re-drilled to 6 m where sampling operations were continued until termination of the borehole.

The SPT “N”-values measured within the gravelly silty sand to sand and gravel deposit range from 61 blows to 86 blows per 0.3 m of penetration, indicating a dense to very dense level of compactness.

A grain size distribution was carried out on one sample of the gravelly silty sand deposit and the results are shown on Figure B13 in Appendix B. The natural water content measured on two selected samples of the gravelly silty sand to a sand and gravel deposit is about 6 and 7 per cent.

4.2.3.6 Sand

A 5.7 m thick sand deposit was encountered underlying the clayey silt fill in Borehole TP-06 at a depth of 1.5 m, corresponding to Elevation 159.9 m. A 0.3 m thick gravelly clayey silt layer was encountered at a depth of 4.2 m within the sand deposit. Cobbles / boulders are inferred to be present within the sand deposit due to effective split-spoon refusal at various sampling intervals below about 2.5 m below ground surface auger grinding during drilling operations at a depth of about 7.0 m.

The SPT “N”-values measured within the sand deposit range from 45 blows per 0.3 m of penetration to 165 blows per 0.28 m of penetration, indicating a dense to very dense level of compactness.

A grain size distribution was carried out on two samples of the sand deposit and the results are shown on Figure B14 in Appendix B. Atterberg limits testing was carried out on one selected sample of the sand deposit and was non-plastic. The natural water content measured on four selected samples of the sand deposit range between about 3 and 10 per cent. The natural water content measured on one selected sample of the gravelly clayey silt layer is about 9 per cent.

4.2.3.7 Silty Clay (Till)

A 1.5 m thick silty clay till deposit was encountered underlying the sand deposit in Borehole TP-06 at a depth of 7.2 m, corresponding to Elevation 154.2 m. Shale fragments were encountered within the silty clay deposit.

Although not encountered during drilling operations, cobbles/boulders are known to be present within the glacial till soils in this local region and should be anticipated to be present within this till deposit.

The SPT “N”-value measured within the silty clay till deposit is 50 blows per 0.3 m of penetration, suggesting a hard consistency.

A grain size distribution was carried out on one sample of the silty clay till deposit and the results are shown on Figure B15 in Appendix B. Atterberg limits testing was carried out on one selected sample of the silty clay till deposit and measured a liquid limit of 36 per cent, plastic limit of 22 per cent, and a plasticity index of 14 per cent. These results, which are plotted on a plasticity chart on Figure B16 in Appendix B, indicate that the deposit is a silty clay of intermediate plasticity. The natural water content measured on one selected sample of the silty clay till deposit is about 11 per cent.

4.2.3.8 Shale

Shale bedrock was encountered underlying the sand and gravel deposit in Borehole TP-05 at a depth of 8.7 m (Elevation 153.0 m) and underlying the silty clay till deposit in Borehole TP-06 at a depth of 8.7 m (Elevation 152.7 m). The shale was confirmed from limited recovery within split-spoon samples. The shale is inferred to be weathered within the upper portion; however, the amount and extent of weathering was not confirmed as bedrock coring was not carried out.

4.2.3.9 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations. The groundwater level recorded is provided on the borehole records in Appendix A and is summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
TP-05	161.7	7.9	153.8	December 16, 2018	Open borehole (borehole caved to 8.2m)
TP-06	161.4	4.6	156.8	December 2, 2018	Open borehole (borehole caved to 5.8m)

The groundwater level observations at this site are not considered to represent long-term stabilized groundwater levels. Groundwater levels will be subject to seasonal fluctuations and precipitation events; the water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Carter Comish, E.I.T. and reviewed by Ms. Nikol Kochmanová, P.Eng. Mr. Kevin J. Bentley, P.Eng., an Associate and MTO Foundations Designated Contact of Golder, conducted an independent technical and quality control review of this report.

Golder Associates Ltd.



Nikol Kochmanová, Ph.D, P.Eng., PMP
Geotechnical Engineer

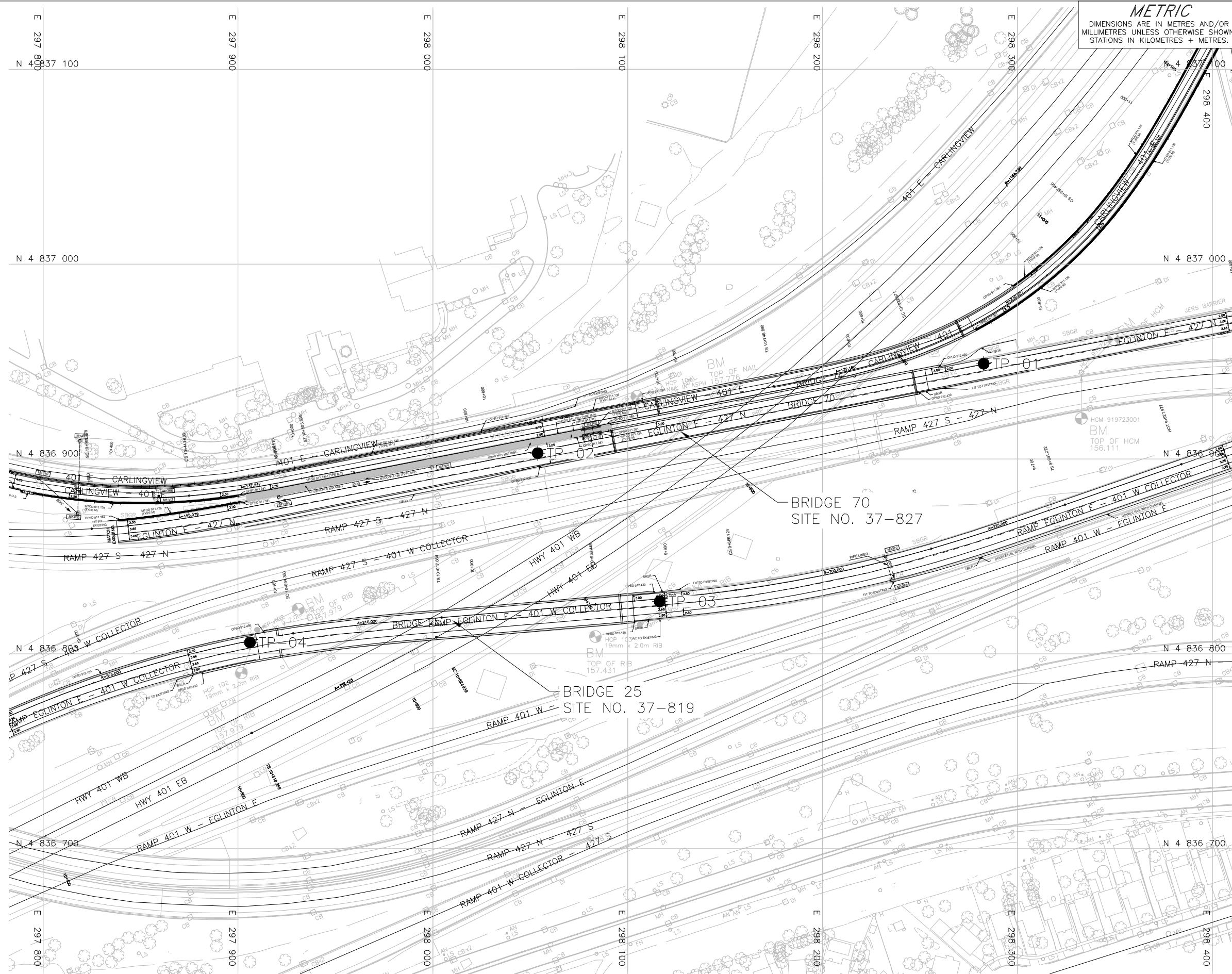


Kevin J. Bentley, M.E.Sc., P.Eng.
Associate, MTO Foundations Designated Contact

CC/NK/KJB/rb

Golder and the G logo are trademarks of Golder Associates Corporation

\\golder.gds\gal\whitby\active\2016\3 proj\1665765 aecom_2015-e-0026_hwy 401-427\fnsl6. deliverables\1. temp protections\3. final\1665765 fidr 2019feb8 temporary protection systems.docx



PLAN
SCALE
20 0 20 40 m

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

CONT No. .
GWP No. 2032-11-00

HIGHWAY 401/427 INTERCHANGE
TEMPORARY PROTECTION SYSTEMS - SITE NO.
37-827 AND 37-819
BOREHOLE LOCATIONS



KEY PLAN

SCALE
2 0 2 4 km

LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
TP-01	155.5	4836948.9	298282.7
TP-02	158.0	4836903.0	298053.8
TP-03	157.3	4836826.9	298116.4
TP-04	157.8	4836805.9	297906.1



NOTES

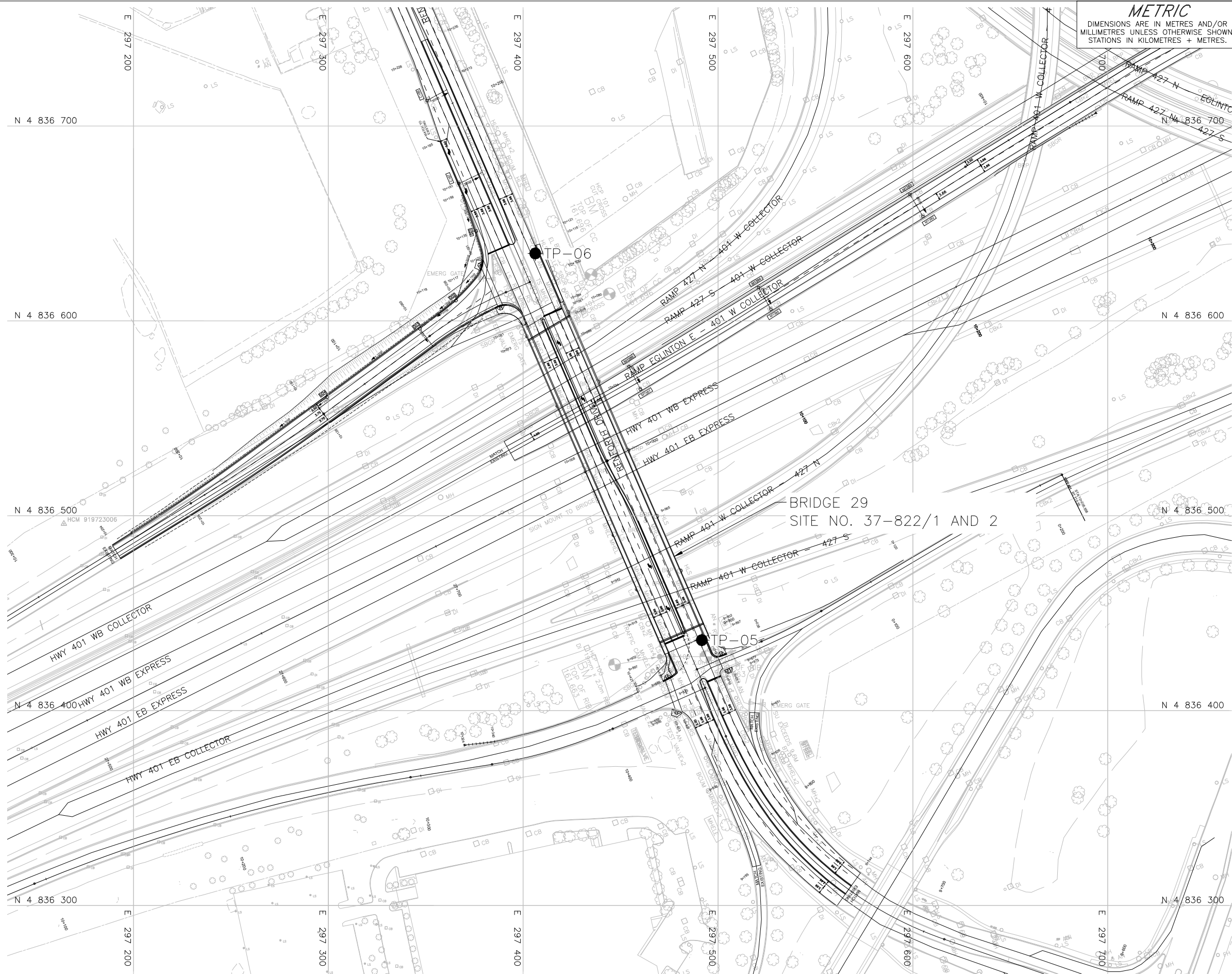
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

REFERENCE

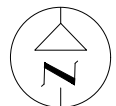
Base plans provided in digital format by AECOM, drawing file nos. Hwy401_base_C1.dwg, Hwy401_KM_alignment_C1.dwg and 401KM_NC_C1.dwg, received November 05, 2018.

NO.	DATE	BY	REVISION
Geocres No. 30M11-285			
HWY. 401		PROJECT NO. 1665765	DIST. .
SUBM'D. CC	CHKD. CC	DATE: 02/11/2019	SITE: .
DRAWN: DD	CHKD. NK	APPD. KJB	DWG. 1



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

CONT No. .
GWP No. 2032-11-00



HIGHWAY 401/427 INTERCHANGE
TEMPORARY PROTECTION SYSTEMS - SITE NO.
37-822/1 AND 2
BOREHOLE LOCATIONS

SHEET



LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
TP-05	161.7	4836436.2	297491.7
TP-06	161.4	4836634.6	297406.2



NOTES

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

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

REFERENCE

Base plans provided in digital format by AECOM, drawing file nos. Hwy401_base_C1.dwg, Hwy401_KM_alignment_C1.dwg and 401KM_NC_C1.dwg, received November 05, 2018.

NO.	DATE	BY	REVISION
Geocres No. 30M11-285			
HWY. 401		PROJECT NO. 1665765	
SUBM'D. CC		DATE: 02/11/2019	
DRAWN: DD		DWG. 2	

APPENDIX A

Borehole Records

LIST OF SYMBOLS

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
ν	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

(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 = $(w_l - w_p)$
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_{α}	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
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
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	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

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

Notes: 1
2

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

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. 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.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; 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

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness	N
Condition	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	C_u, S_u	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
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, G_s)
DS	direct shear test
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	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand

PROJECT		1665765		RECORD OF BOREHOLE No TP-01		SHEET 1 OF 1		METRIC								
G.W.P.		2032-11-00		LOCATION		N 4836948.9; E 298282.7 MTM NAD 83 ZONE 10 (LAT. 43.672466; LONG. -79.580825)		ORIGINATED BY								
DIST		Central HWY 401		BOREHOLE TYPE		178 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY								
DATUM		Geodetic		DATE		September 11, 2018		CHECKED BY								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
155.5	GROUND SURFACE						20	40	60	80	100					
0.0	ASPHALT (90 mm)															
0.3	CONCRETE (220 mm)															
	Sandy clayey silt, trace to some gravel, trace organics (rootlets) between 3.7 m and 4.5 m (FILL) Stiff to hard Brown to grey, mottled at 1.5 m Moist		1	SS	29											
			2	SS	24											
			3	SS	61											
			4	SS	13											
			5	SS	12											
151.0																
4.5	Sandy CLAYEY SILT, trace to some gravel Stiff to hard Brown/grey mottling throughout Moist		6	SS	15											
			7	SS	63											
148.3																
7.2	SAND and SILT, some gravel, trace clay Very dense grey Moist - Auger grinding at 7.9 m		8	SS	72/0.13											
147.0																
8.5	SILTY CLAY, trace sand, trace gravel (TILL) Hard Grey Moist		9	SS	100/0.28											
145.9																
9.6	END OF BOREHOLE															
	NOTES: 1. Borehole caved to 8.1 m on removal of augers. 2. Open borehole dry on completion of drilling.															

PROJECT		RECORD OF BOREHOLE				No TP-02		SHEET 1 OF 1		METRIC		
G.W.P.		2032-11-00		LOCATION		N 4836903.0; E 298053.8 MTM NAD 83 ZONE 10 (LAT. 43.672051; LONG. -79.583663)		ORIGINATED BY		AJ		
DIST		Central HWY 401		BOREHOLE TYPE		178 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY		EN		
DATUM		Geodetic		DATE		September 12, 2018		CHECKED BY		NK		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
							20 40 60 80 100			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		
							20 40 60 80 100			W _p W W _L		
							○ UNCONFINED + FIELD VANE			WATER CONTENT (%)		
							● QUICK TRIAXIAL × REMOULDED					
158.0	GROUND SURFACE											GR SA SI CL
0.0	ASPHALT (80 mm)											
0.2	CONCRETE (150 mm)											
	Sandy clayey silt, some gravel (FILL)											
	Stiff											
	Brown to mottled brown/grey											
	Moist											
	- Auger grinding at 1.5 m											
155.8												
2.2	SAND, some gravel, trace to some silt, trace clay											
155.3	Dense											
155.0	Brown											
3.0	Moist											
	- Auger grinding between 2.4 m and 2.7 m											
154.3	Sandy SILTY CLAY, trace to some gravel											
3.7	Hard											
	Mottled brown/grey											
	Moist											
	Sandy SILT, trace gravel											
	Very dense											
	Red/brown											
	Moist											
	Silty SAND, trace gravel, trace clay, containing clayey silt pockets											
152.4	Dense to very dense											
5.6	Brown											
	Moist to wet											
	- Auger grinding from 5.2 m to 5.8 m											
	SILTY CLAY, some sand, trace gravel (TILL)											
	Hard											
	Grey											
	Moist to wet											
	- Auger grinding from 7.3 m to 7.6 m											
150.1												
7.9	- Contains shale fragments below 7.9 m											
	- Auger grinding from 8.0 m to 9.0 m depth											
148.8												
9.2	END OF BOREHOLE											
NOTES:												
1. Borehole caved to 8.2 m on removal of augers.												
2. Water level in open borehole at a depth of 6.7 m (El. 151.3 m) upon completion of drilling.												
3. Shale fragments in tip of split-spoon of Sample 8.												

PROJECT		1665765		RECORD OF BOREHOLE No TP-03		SHEET 1 OF 1		METRIC					
G.W.P.		2032-11-00		LOCATION		N 4836826.9; E 298116.4 MTM NAD 83 ZONE 10 (LAT. 43.671367; LONG. -79.582886)		ORIGINATED BY					
DIST		Central HWY 401		BOREHOLE TYPE		178 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY					
DATUM		Geodetic		DATE		September 10, 2018		CHECKED BY					
								NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L			
157.3	GROUND SURFACE												
0.0	ASPHALT (90 mm)												
0.3	CONCRETE (230 mm)												
	Clayey silt, trace to some sand, some gravel (FILL) Stiff to hard Brown to grey, mottled at 2.3 m Moist - Auger grinding between 0.6 m and 0.9 m.		1	SS	32								
			2	SS	15								
			3	SS	24								
			4	SS	33								
153.6													
3.7	SAND and GRAVEL, trace to some silt, trace clay, higher clay and silt content at a 4.6 m Very dense Brown Moist		5	SS	100/0.25								40 47 10 3
152.4			6	SS	54								
4.9	SILTY CLAY, some sand, some gravel (TILL) Hard Grey Moist												
			7	SS	31								15 17 43 25
149.7													
7.6	Weathered SHALE (BEDROCK)		8	SS	100/0.0								
148.1			9	SS	100/0.10								
9.2	END OF BOREHOLE												
NOTES: 1. Borehole caved to 7.0 m on removal of augers. 2. Water level in open borehole at a depth of 6.3 m (Elev. 151.0 m) upon completion of drilling.													

PROJECT		RECORD OF BOREHOLE				No TP-04		SHEET 1 OF 1		METRIC						
G.W.P.		2032-11-00		LOCATION		N 4836805.9; E 297906.1 MTM NAD 83 ZONE 10 (LAT. 43.671176; LONG. -79.585494)		ORIGINATED BY		AJ						
DIST		Central HWY 401		BOREHOLE TYPE		178 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY		EN						
DATUM		Geodetic		DATE		September 11, 2018		CHECKED BY		NK						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × REMOULDED</div><div>20406080100</div></div>			<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div><div>W_p W W_L</div><div>WATER CONTENT (%)</div><div>102030</div></div>					
157.8	GROUND SURFACE						157									
0.0	ASPHALT (100 mm)						156					18 65 13 4				
0.3	CONCRETE (230 mm)						155									
	Clayey silt, some sand, some gravel (FILL)						154					6 34 43 17				
	Hard						153					38 47 11 4				
	Brown to grey						152									
	Moist						151									
156.4	Sand, some gravel, some silt, trace clay (FILL)						150									
1.4	Dense						149									
155.6	Brown															
2.2	Moist															
	Sandy clayey silt, trace to some gravel (FILL)															
	Very stiff to hard															
	Grey															
	Moist															
153.4	- Auger grinding between 4.3 m and 5.5 m															
4.4	SAND and GRAVEL, trace to some silt, trace clay															
	Very dense															
152.4	Brown															
5.4	Moist															
	SILTY CLAY, some sand (TILL)															
	Hard															
	Grey															
	Moist															
151.1	Weathered SHALE (BEDROCK)															
6.7																

PROJECT		1665765		RECORD OF BOREHOLE No TP-05		SHEET 1 OF 1		METRIC									
G.W.P.		2032-11-00		LOCATION		N 4836436.2; E 297491.7 MTM NAD 83 ZONE 10 (LAT. 43.667844; LONG. -79.590627)		ORIGINATED BY									
DIST		Central HWY 401		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY									
DATUM		Geodetic		DATE		December 16, 2018		CHECKED BY									
								NK									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
161.7	GROUND SURFACE																
0.0	ASPHALT (70 mm)																
0.3	CONCRETE (230 mm)																
160.2	Silty sand, some gravel (FILL) Compact Brown Moist - Clay pockets from 0.8 m to 1.4 m		1	SS	17												
1.5	SILT, trace sand, trace clay Dense to very dense Brown Moist becoming wet below 3.7 m		2	SS	31												
			3	SS	63												
			4	SS	69												
			5	SS	45												
157.0	Gravelly silty SAND Very dense Brown Moist - Auger grinding at 5.0 m		6A 6B	SS	61												
4.7	- Auger refusal encountered at a depth of 6.0 m; borehole was moved 3.0 m to the south		7	SS	86												
154.5	SAND and GRAVEL, some silt Very dense Brown-grey Moist		8	SS	63												
7.2																	
153.0	SHALE, weathered (BEDROCK) Grey		9	SS	100/0.13												
8.7																	
152.3	END OF BOREHOLE																
9.4	NOTES: 1. Auger refusal was encountered at a depth of 6.0 m and borehole was moved 3.0 m to the south and drilling operations continued. 2. Borehole dry on completion of drilling. 3. Borehole caved to 8.2 m on removal of augers. 4. Water level in open borehole at a depth of 7.9 m below ground surface (Elev. 153.8 m) on removal of augers.																

PROJECT		1665765		RECORD OF BOREHOLE No TP-06		SHEET 1 OF 1		METRIC					
G.W.P.		2032-11-00		LOCATION		N 4836634.6; E 297406.2 MTM NAD 83 ZONE 10 (LAT. 43.669629; LONG. -79.591690)		ORIGINATED BY					
DIST		Central HWY 401		BOREHOLE TYPE		152 mm O.D. Hollow Stem Augers, CME 55 Truck Mounted Drill Rig		COMPILED BY					
DATUM		Geodetic		DATE		December 2, 2018		CHECKED BY					
								NK					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L			
161.4	GROUND SURFACE												
0.0	ASPHALT (90 mm)												
0.3	CONCRETE (160 mm)												
	Clayey silt, some sand, trace gravel (FILL)												
	Stiff												
	Brown												
	Moist												
159.9			1	SS	9								
1.5	SAND, some gravel, trace to some silt, trace clay												
	Dense to very dense												
	Brown												
	Moist												
			2	SS	45								
			3	SS	100/0.23								
			4	SS	122								
			5A	SS	99								
157.2	Gravelly CLAYEY SILT, some sand												
156.9	Hard												
4.5	Grey												
	SAND, some gravel, trace to some silt, trace clay												
	Very dense												
	Grey												
	Wet												
			6	SS	67								
			7	SS	165/0.28								
154.2	- Auger grinding at 7.0 m depth												
7.2	SILTY CLAY, some sand, trace gravel, contains trace shale fragments (TILL)												
	Hard												
	Grey												
			8	SS	50								
152.7	SHALE, weathered (BEDROCK)												
8.7	Grey												
	Moist												
152.1	- Auger grinding at 8.8 m												
9.3	END OF BOREHOLE												
	NOTES:												
	1. Water level at a depth of 9.0 m below ground surface (Elev. 152.4 m) inside augers on completion of drilling.												
	2. Borehole caved to 5.8 m on removal of auger.												
	3. Water level at a depth of 4.6 m below ground surface (Elev. 156.8 m) after removal of augers.												

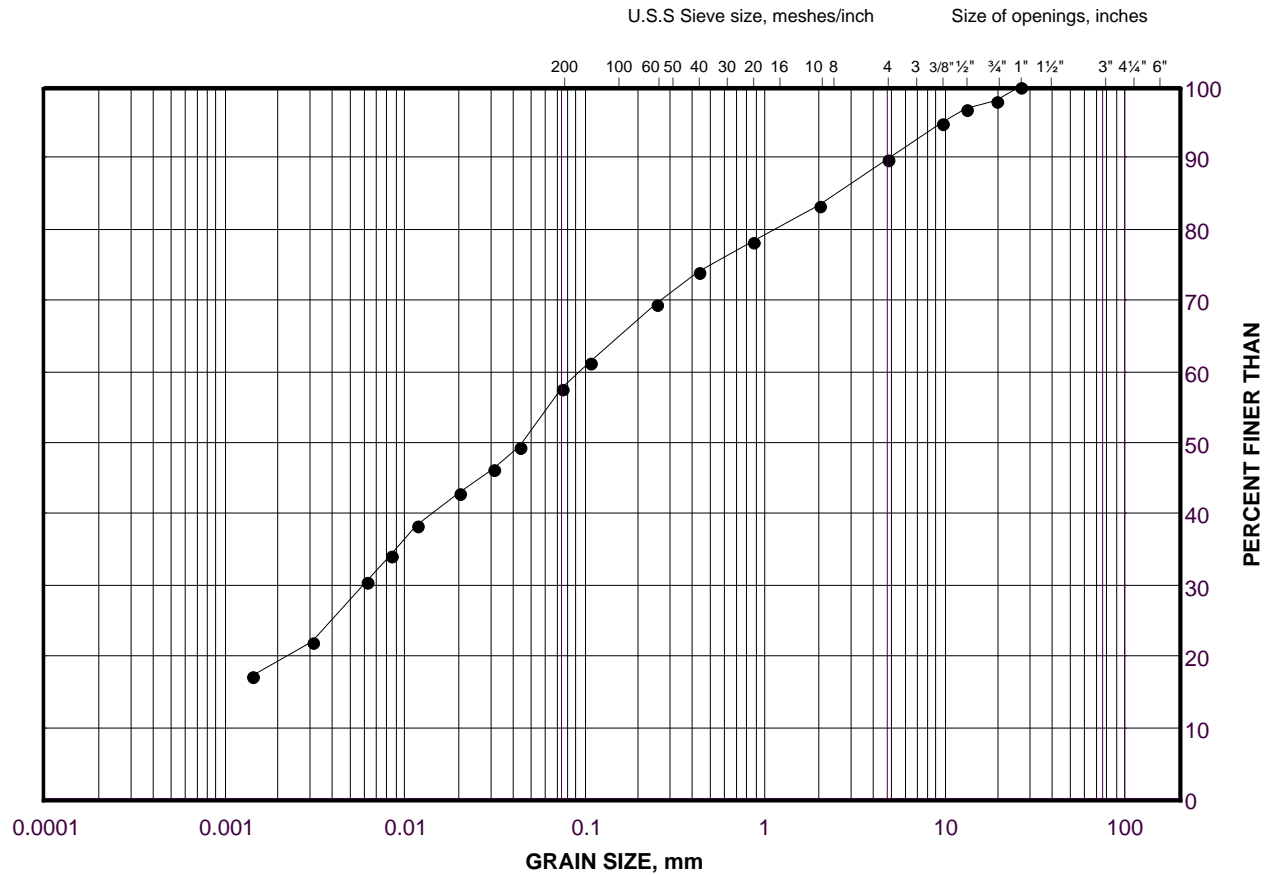
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

FIGURE B1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

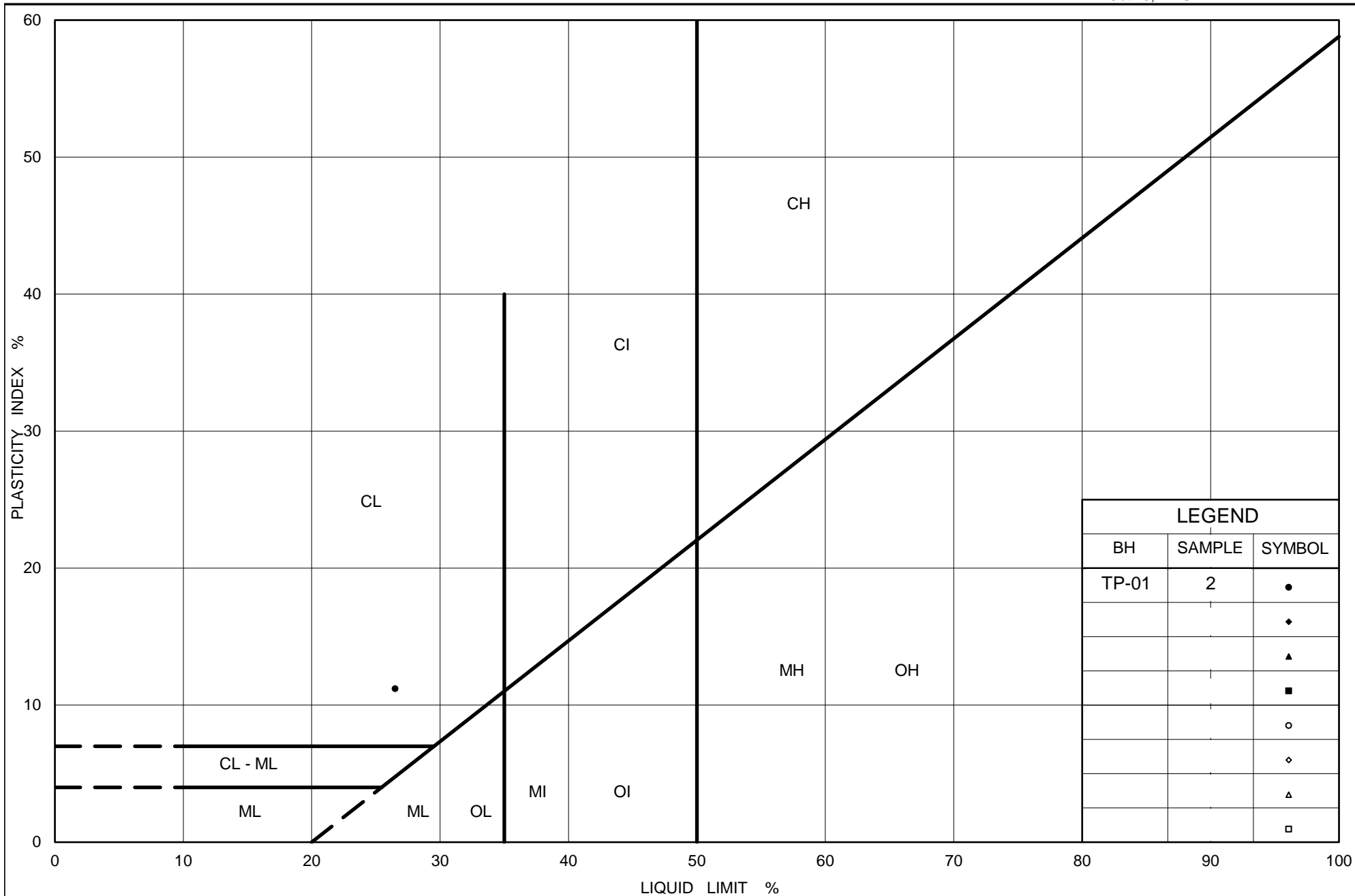
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-01	2	153.7

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 28-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Sandy Clayey Silt (Fill)

Figure No. B2

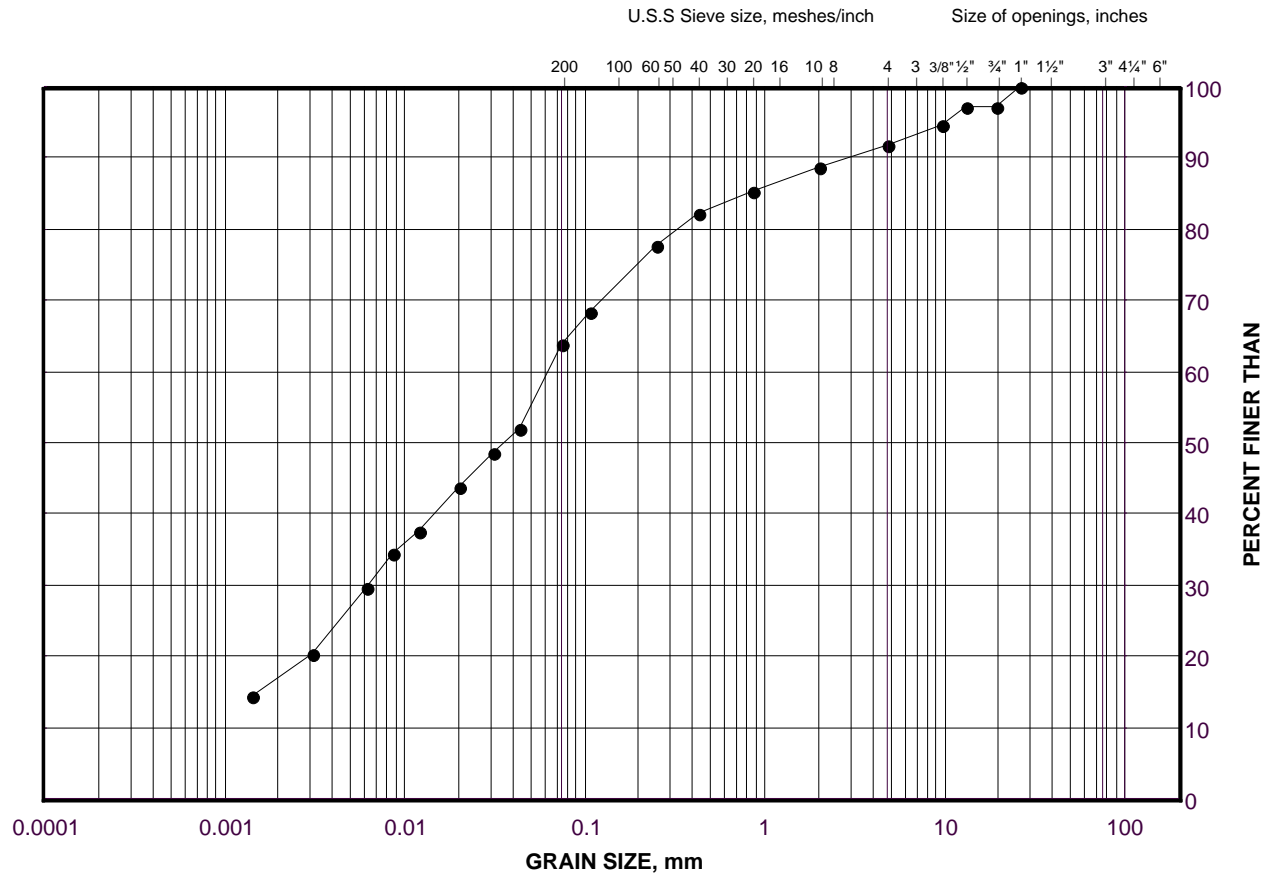
Project No. 1665765

Checked By: NK

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt

FIGURE B3



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

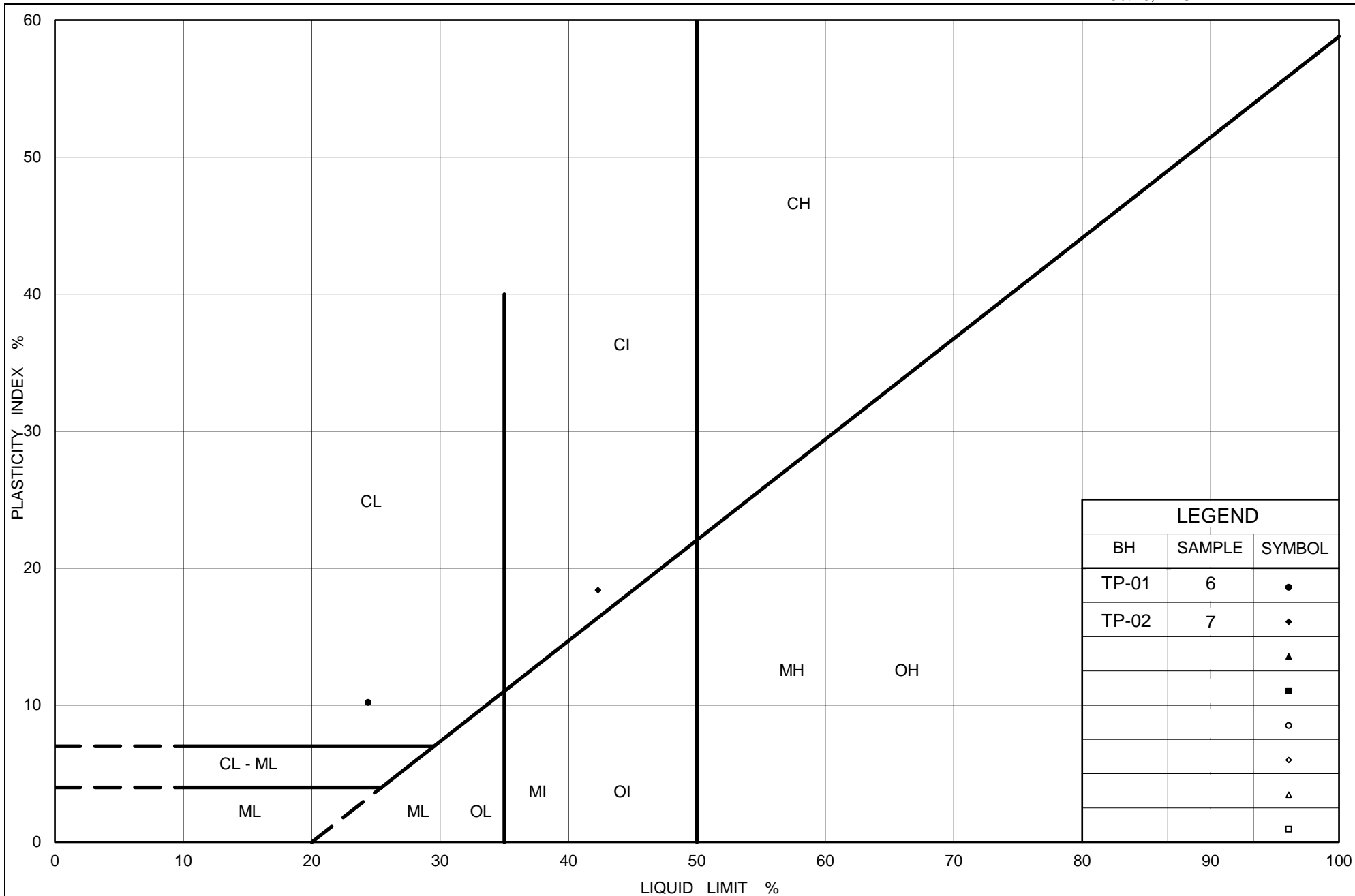
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-01	6	150.6

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 28-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Silty Clay to Sandy Clayey Silt

Figure No. B4

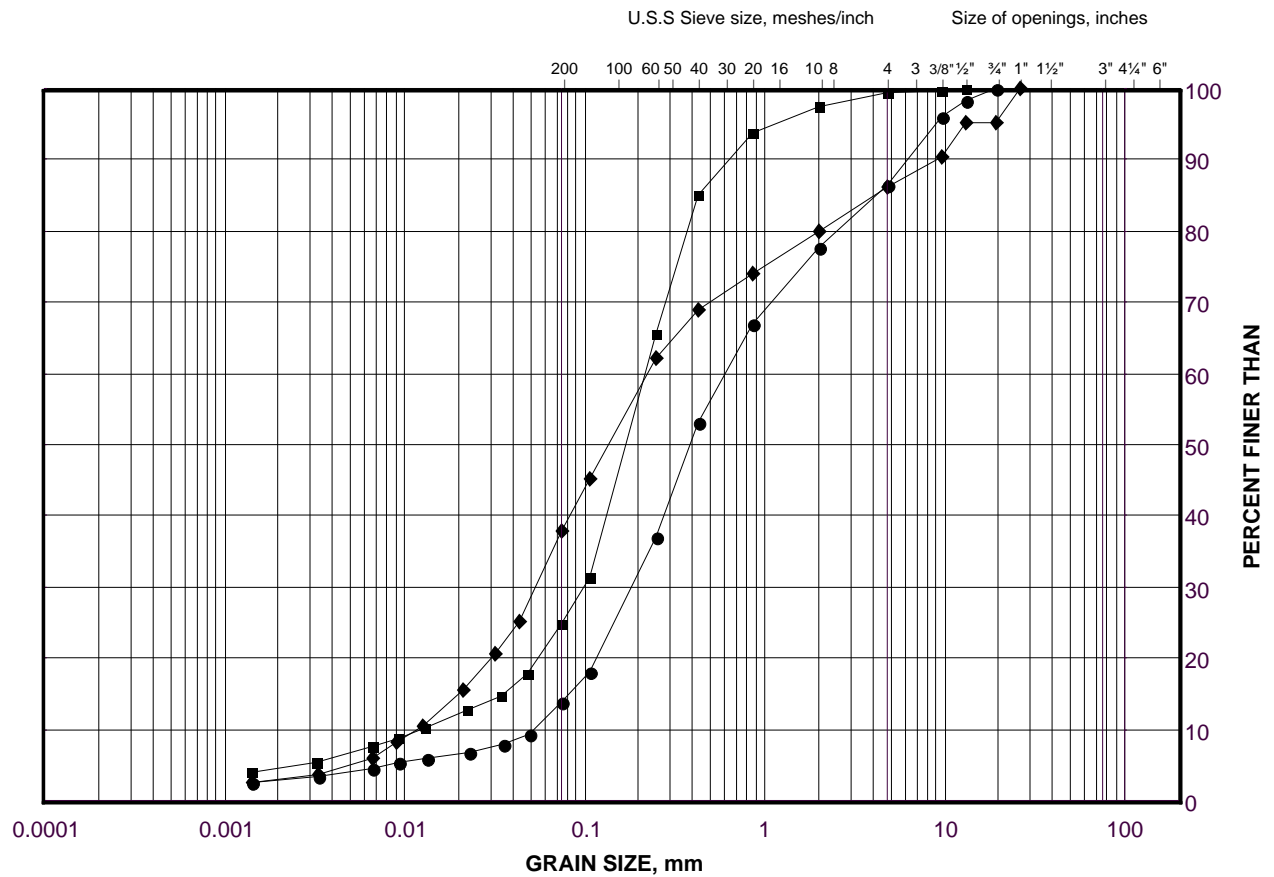
Project No. 1665765

Checked By: NK

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand

FIGURE B5



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
●	TP-02	3A	155.5
■	TP-02	5	153.9
◆	TP-01	8	147.7

Project Number: 1665765

Checked By: NK

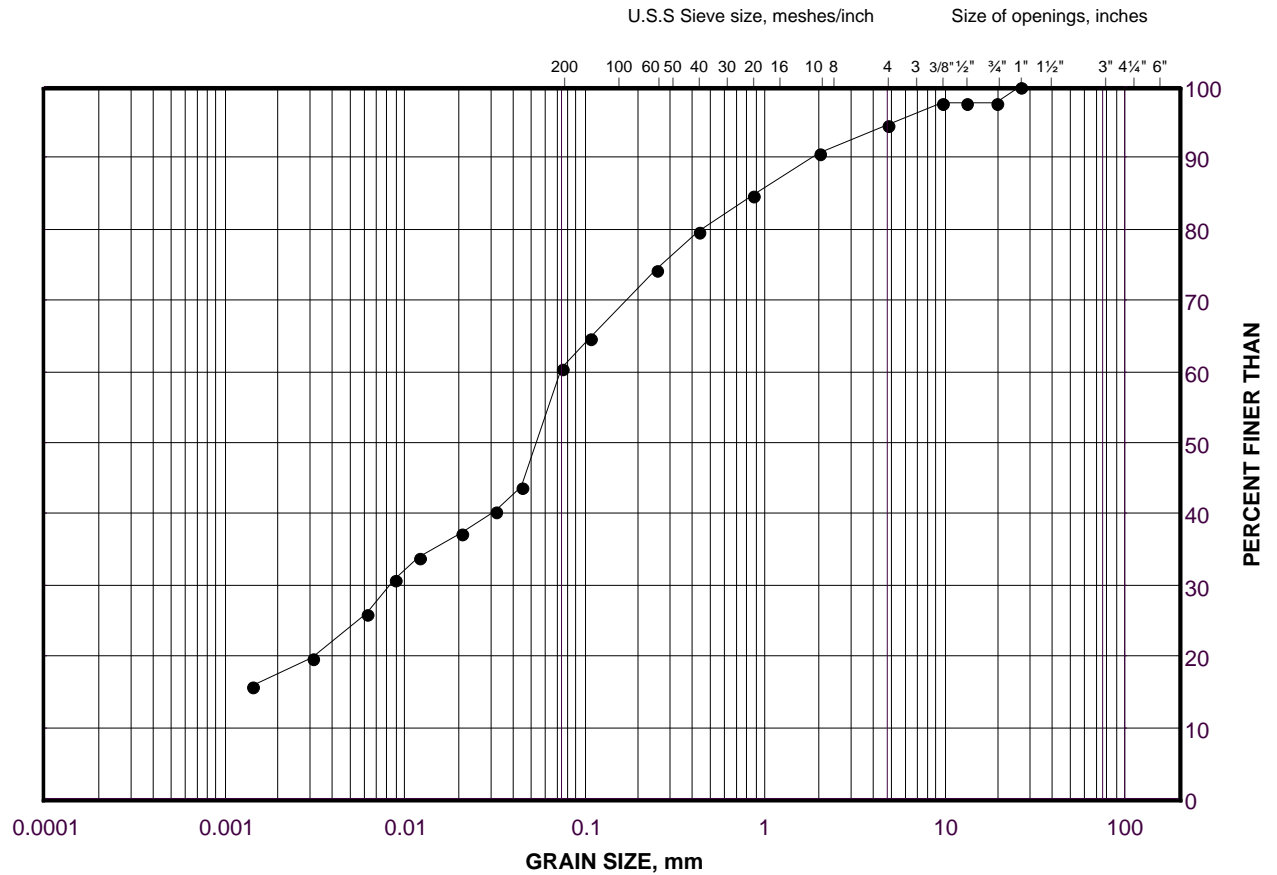
Golder Associates

Date: 28-Nov-18

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

FIGURE B6



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

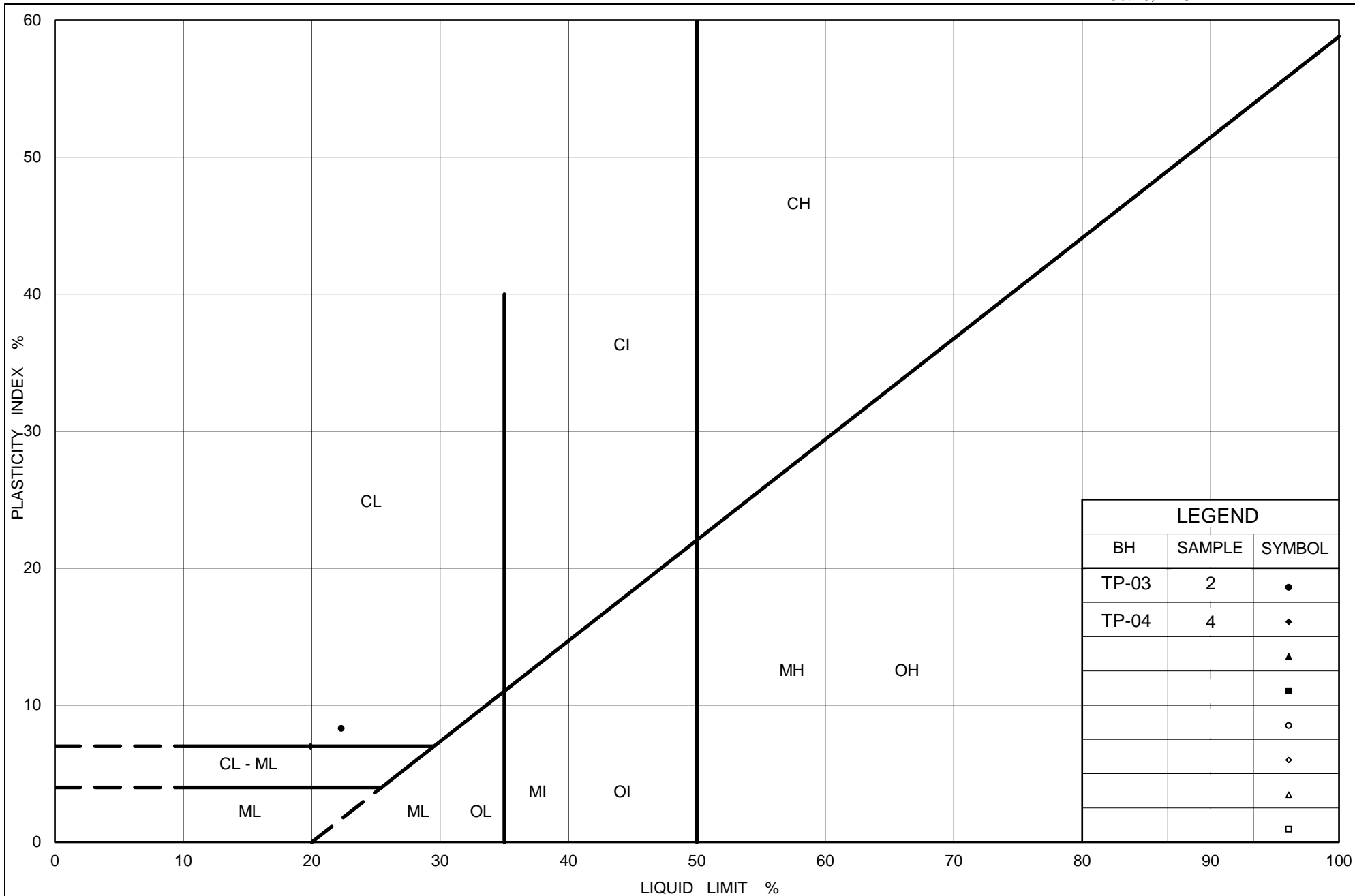
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-04	4	154.5

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 28-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt to Sandy Clayey Silt (Fill)

Figure No. B7

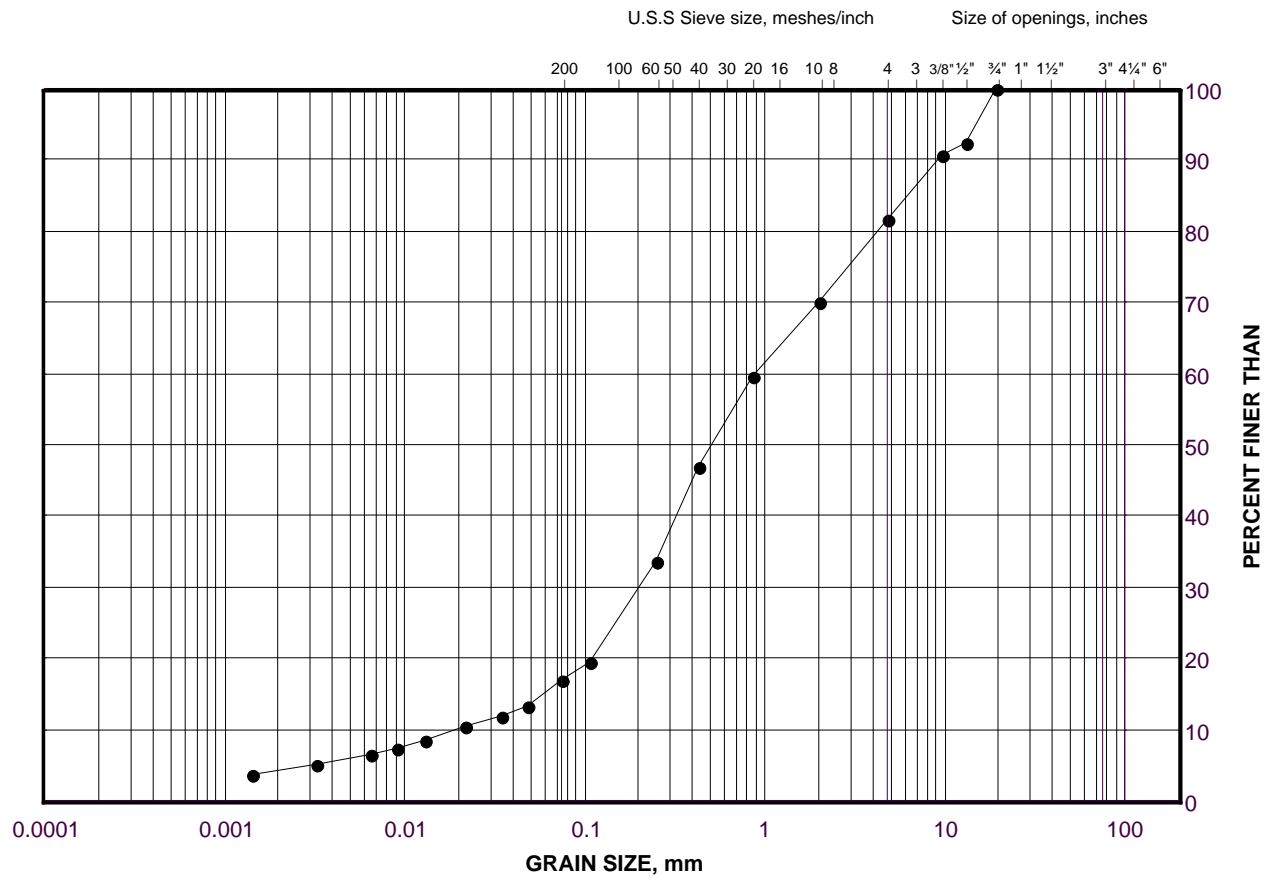
Project No. 1665765

Checked By: NK

GRAIN SIZE DISTRIBUTION

Sand (Fill)

FIGURE B8



SILT AND CLAY SIZES				FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED				SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-04	2	156.0

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 28-Nov-18

Sand and Gravel

U.S.S Sieve size, meshes/inch

Size of openings, inches

PERCENT FINER THAN

GRAIN SIZE, mm

Grain Size (mm)	Percent Finer Than (%) - Circles	Percent Finer Than (%) - Squares
0.075	5	5
0.15	10	10
0.3	20	20
0.6	35	30
1.2	50	45
2.5	65	60
5.0	80	80
10.0	95	95
20.0	100	100

SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

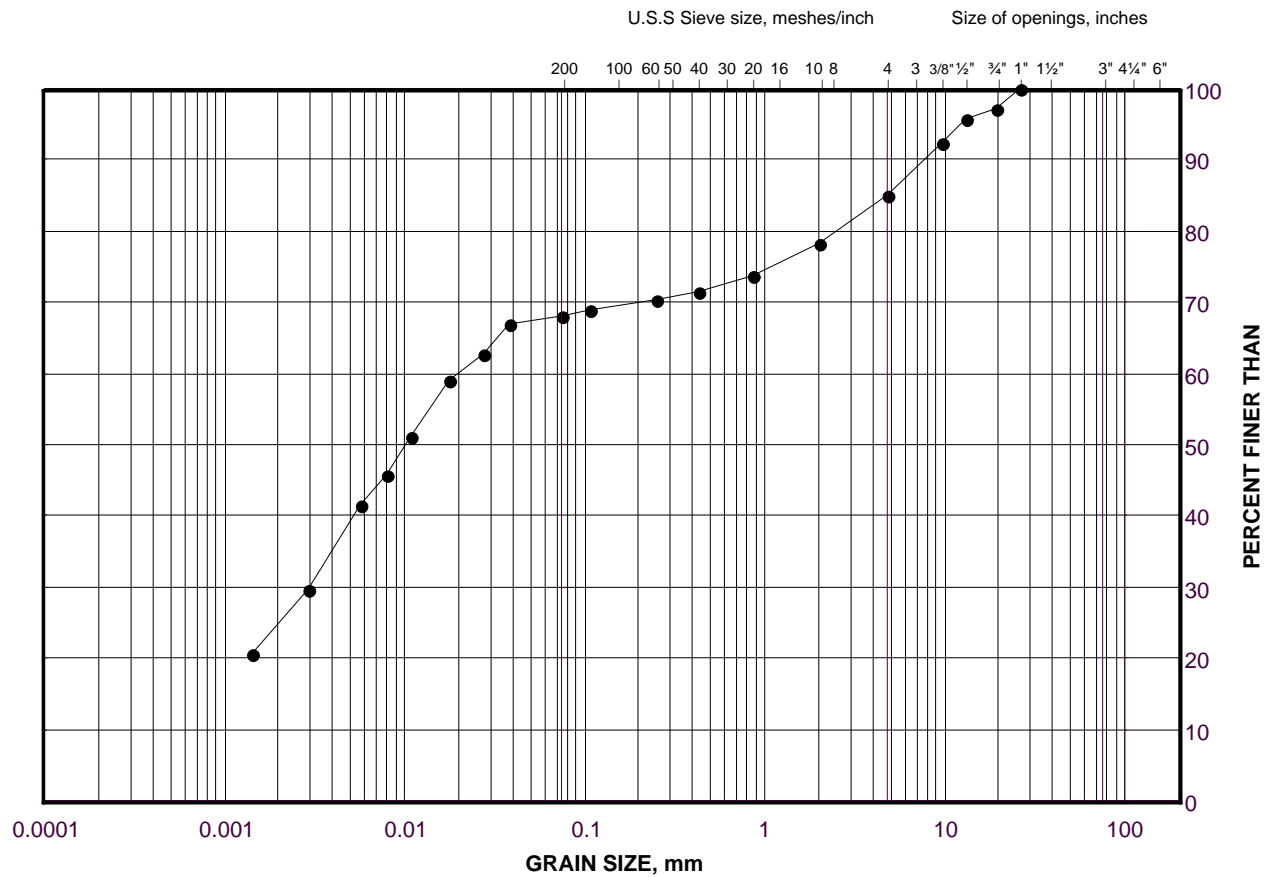
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
●	TP-03	5	153.2
■	TP-04	6	153.1

Date: 28-Nov-18

GRAIN SIZE DISTRIBUTION

Silty Clay (Till)

FIGURE B10



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

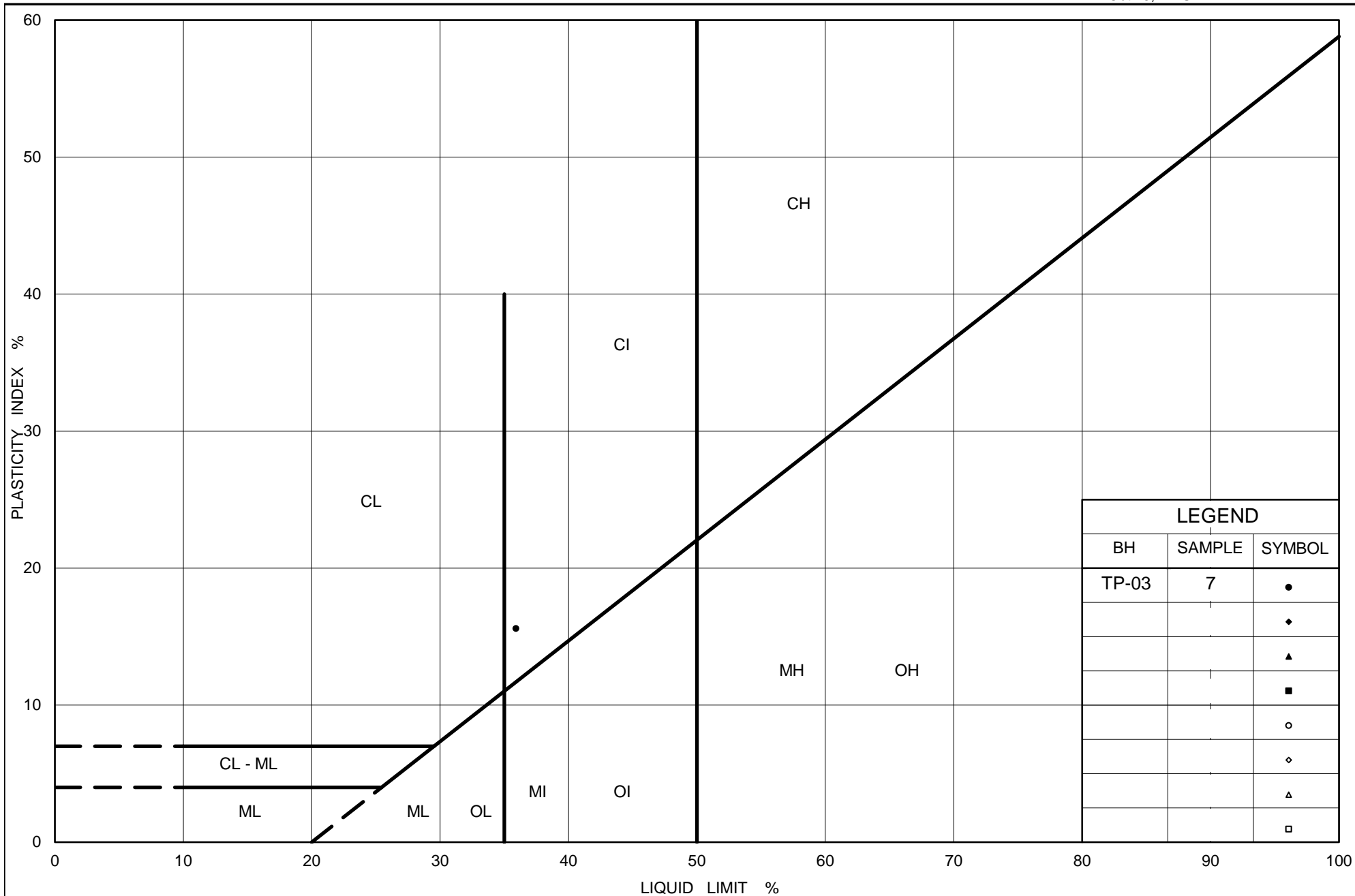
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-03	7	150.9

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 28-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay (Till)

Figure No. B11

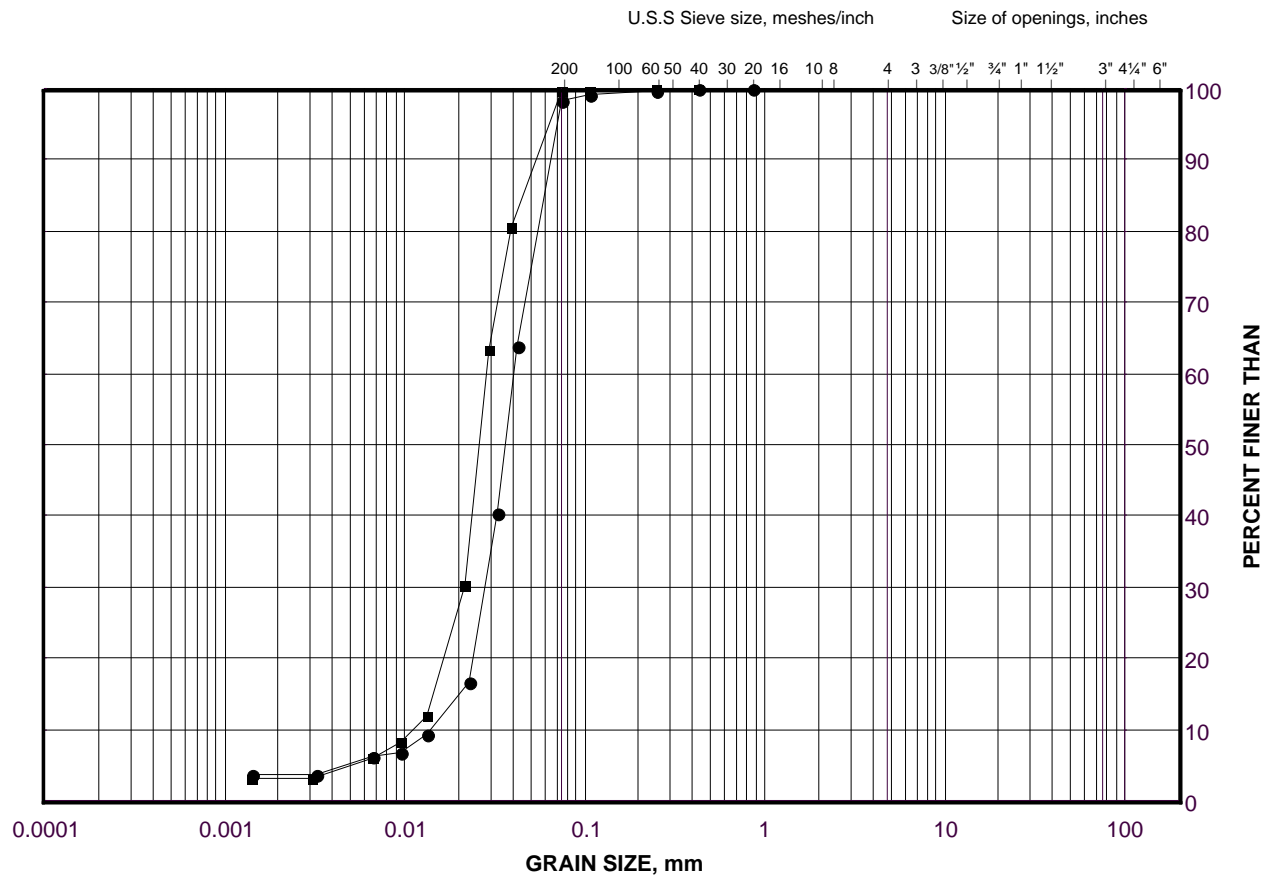
Project No. 1665765

Checked By: NK

GRAIN SIZE DISTRIBUTION

Silt

FIGURE B12



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
●	TP-05	2	159.9
■	TP-05	5	157.6

Project Number: 1665765

Checked By: NK

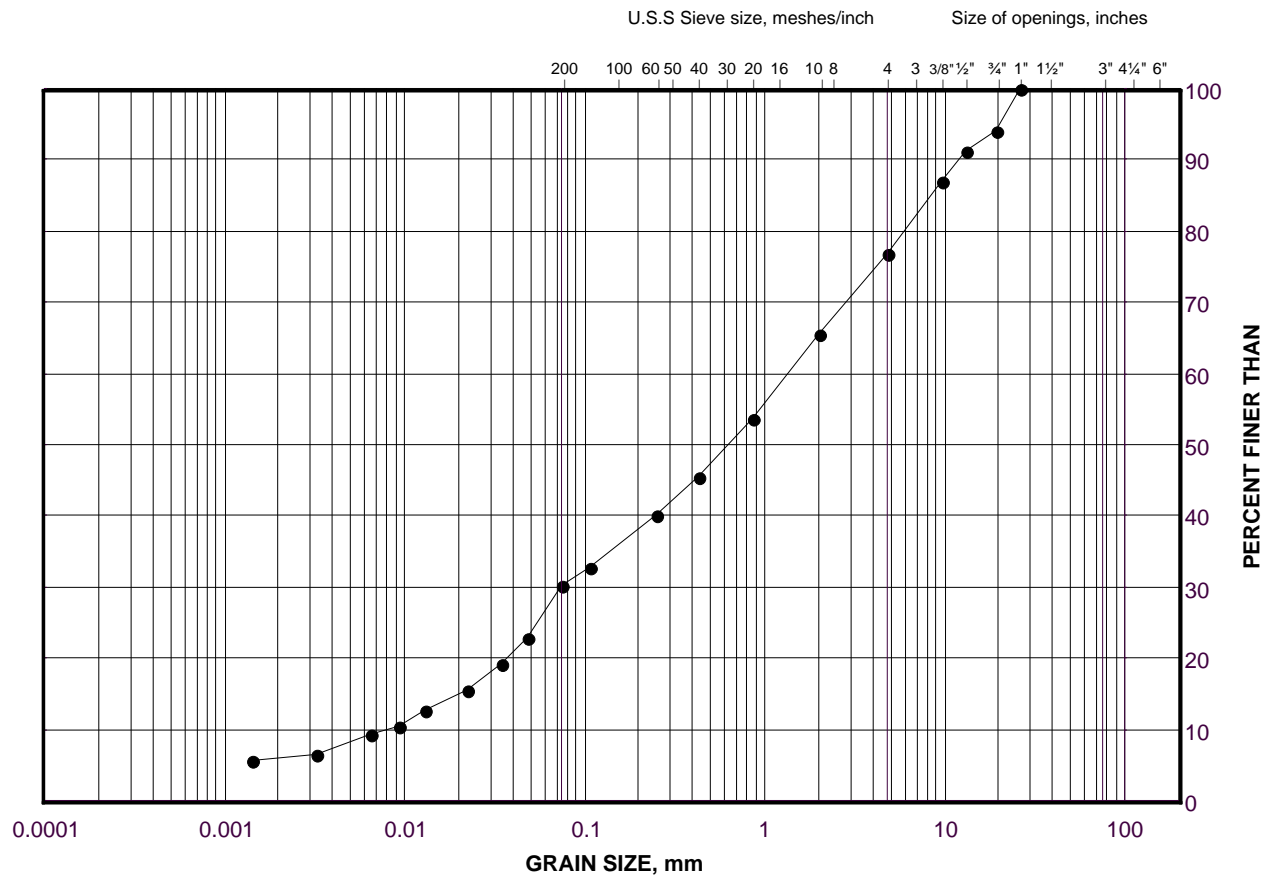
Golder Associates

Date: 16-Jan-19

GRAIN SIZE DISTRIBUTION

Gravelly Silty Sand

FIGURE B13



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-05	7	155.3

Project Number: 1665765

Checked By: NK

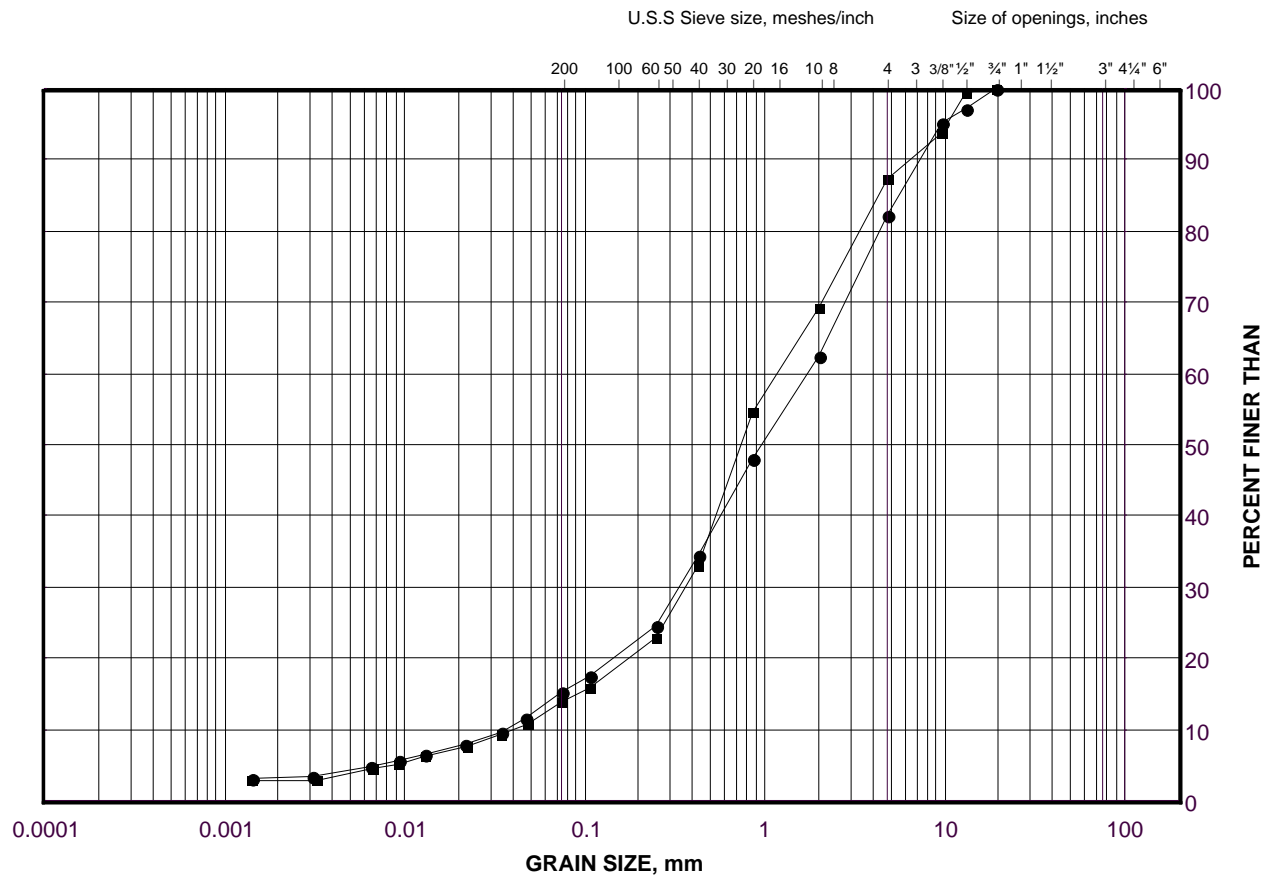
Golder Associates

Date: 16-Jan-19

GRAIN SIZE DISTRIBUTION

Sand

FIGURE B14



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
●	TP-06	2	159.6
■	TP-06	6	156.5

Project Number: 1665765

Checked By: NK

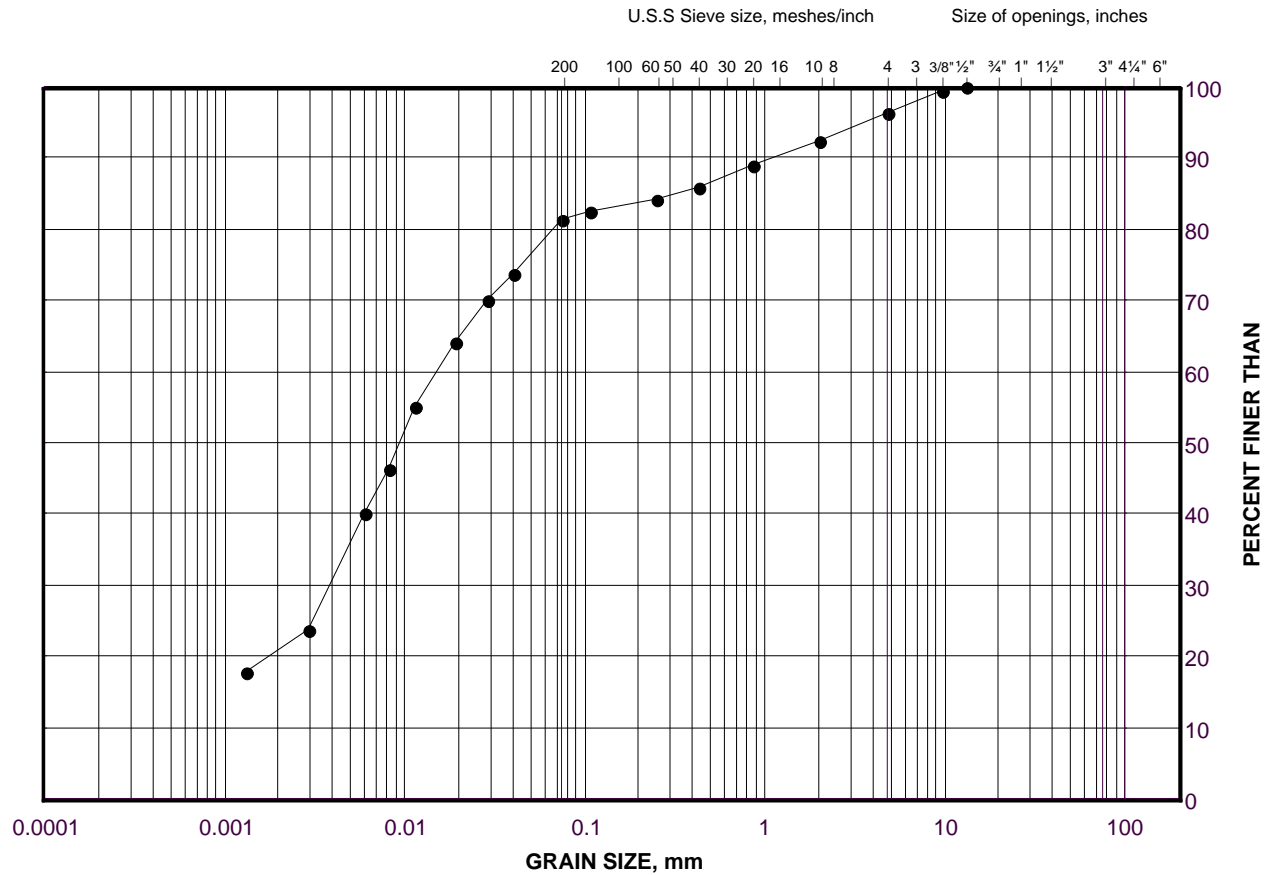
Golder Associates

Date: 16-Jan-19

GRAIN SIZE DISTRIBUTION

Silty Clay (Till)

FIGURE B15



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

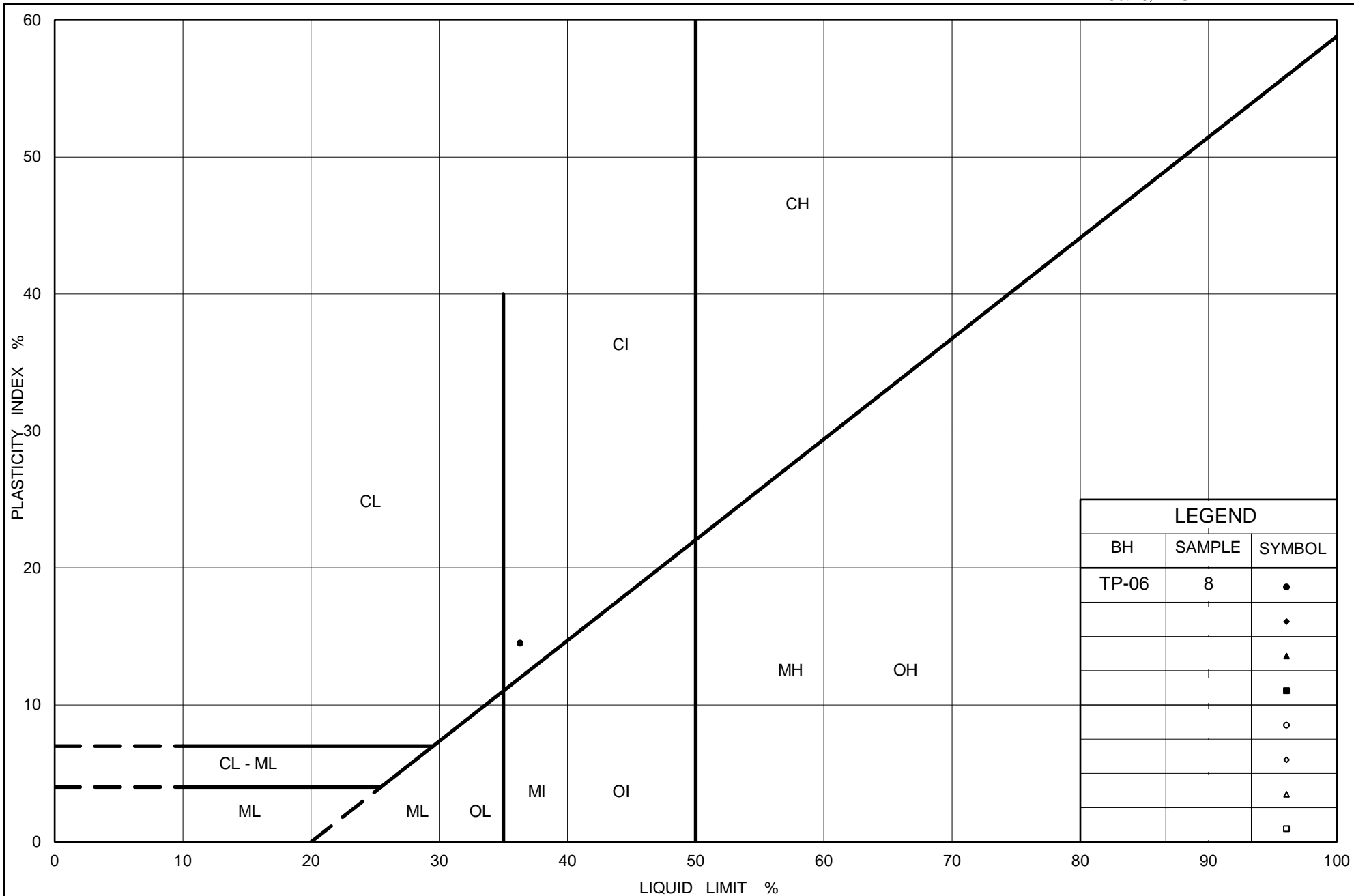
SYMBOL	Test Pit	SAMPLE	ELEVATION(m)
•	TP-06	8	153.5

Project Number: 1665765

Checked By: NK

Golder Associates

Date: 16-Jan-19



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay (Till)

Figure No. B16

Project No. 1665765

Checked By: NK



golder.com