

Foundation Investigation and Design Report

*Closed Circuit Television Poles and Sign Supports
Highway 400 Widening from North of King Road to
South of Lloydtown-Aurora Road, King City, Ontario
Assignment No. 2017-E-0016-015, G.W.P. 2835-02-00*

Submitted to:

Morrison Hershfield Limited

125 Commerce Valley Drive West
Markham, Ontario
L3T 7W4

Submitted by:

Golder Associates Ltd.

100 Scotia Court, Whitby, Ontario, L1N 8Y6, Canada
+1 905 723 2727

1786658-WO15-CCTV

November 25, 2021

GEOCRES No. 30M13-236

Latitude: 43.963872

Longitude: -79.575919

Distribution List

- 1 Electronic Copy - Morrison Hershfield Limited
- 1 Electronic Copy - Ministry of Transportation, Central Region
- 1 Electronic Copy - Golder Associates Ltd.

Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

| | |
|--|----------|
| 1.0 INTRODUCTION | 1 |
| 2.0 PROJECT / SITE DESCRIPTION | 1 |
| 3.0 INVESTIGATION PROCEDURES | 2 |
| 3.1 1982 Investigation (GEOCRE 31D00-298)..... | 2 |
| 3.2 2010 to 2015 Investigations (GEOCRE 30M13-214 and 30M13-217) | 2 |
| 3.3 Current Investigation | 3 |
| 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS..... | 4 |
| 4.1 Regional Geology..... | 4 |
| 4.2 Subsurface Conditions | 5 |
| 4.2.1 Asphalt | 5 |
| 4.2.2 Topsoil..... | 5 |
| 4.2.3 Fill..... | 5 |
| 4.2.4 Organic Silt to Peat | 6 |
| 4.2.5 Clayey Silt-Silt to Silty Clay | 6 |
| 4.2.6 Silt to Sand..... | 7 |
| 4.2.7 Clayey Silt-Silt to Clayey Silt (Till)..... | 7 |
| 4.2.8 Groundwater | 8 |
| 4.3 Analytical Testing Results..... | 9 |
| 5.0 CLOSURE | 9 |

PART B - FOUNDATION DESIGN REPORT

| | |
|---|-----------|
| 6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS | 11 |
| 6.1 General..... | 11 |
| 6.2 Frost Protection | 11 |
| 6.3 Geotechnical Parameters..... | 11 |
| 6.4 Design of CCTV Pole Foundations | 11 |
| 6.4.1 Axial Capacity | 12 |

| | | |
|------------|--|-----------|
| 6.4.2 | Lateral Resistance | 12 |
| 6.5 | Design of VMS and Cantilever Sign Foundations..... | 14 |
| 6.5.1 | Standard Caisson Foundation Design in Soil | 14 |
| 6.5.2 | Site-Specific Caisson Foundation Design in Soil..... | 14 |
| 6.5.3 | Summary..... | 15 |
| 6.6 | Corrosion Assessment and Protection..... | 15 |
| 6.7 | Construction Considerations | 16 |
| 6.7.1 | Control of Soil and Groundwater..... | 16 |
| 6.7.2 | Obstructions | 16 |
| 6.7.3 | CCTV Poles | 16 |
| 6.7.4 | Piezometer Decommissioning | 16 |
| 7.0 | CLOSURE | 16 |

REFERENCES

TABLES

Table 1 Geotechnical Design Parameters for Closed Circuit Television and Sign Foundations

DRAWINGS

Drawing 1 Borehole Locations

APPENDICES

APPENDIX A – Borehole Records and Stratigraphy - Previous Investigation (GEOCRE 31D00-298)

Records of Boreholes 1 to 12

Drawing 78201-A and 78201-B

Figure 6: Hwy 400 Profile Showing Peart Depths (1945 Soundings)

APPENDIX B – Borehole Records - Previous Investigations (GEOCRE 30M13-214 / 30M13-217)

Abbreviations and Terms Used on Records of Boreholes and Test Pits

Lists of Symbols

Records of Boreholes C27-3, C27-4, DC-11, and DC-13

APPENDIX C – Borehole Records - Current Investigation

Abbreviations and Terms Used on Records of Boreholes and Test Pits

Lists of Symbols

Records of Boreholes C27-5, CCTV-2, CCTV-4, CCTV-5, VMS-1 and VMS-2

APPENDIX D– Geotechnical Laboratory Test Results

| | |
|---------------|---|
| Figure D-1 | Grain Size Distribution – SILTY SAND (SM) (FILL) |
| Figure D-2 | Grain Size Distribution – CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (FILL) |
| Figure D-3 | Plasticity Chart – CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (FILL) |
| Figure D-4 | Grain Size Distribution – CLAYEY SILT-SILT (CL-ML) to SILTY CLAY (CI) |
| Figure D-5A/B | Plasticity Chart – CLAYEY SILT-SILT (CL-ML) to SILTY CLAY (CI) |
| Figure D-6A/B | Grain Size Distribution – SILT (ML) of slight plasticity to SAND (SP) |
| Figure D-7 | Plasticity Chart – SILT (ML) of slight plasticity |
| Figure D-8 | Grain Size Distribution – CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (TILL) |
| Figure D-9A/B | Plasticity Chart – CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (TILL) |

APPENDIX E – Analytical Laboratory Test Results

Certificate of Analysis, Report No. R6497732

Certificate of Analysis, Report No. R6534377

APPENDIX F – Non-Standard Special Provision

NSSP Control of Overburden Soils during Excavation

NSSP Decommissioning of Piezometers

PART A

**FOUNDATION INVESTIGATION REPORT
CLOSED CIRCUIT TELEVISION POLES AND SIGN SUPPORTS
HIGHWAY 400 WIDENING, FROM NORTH OF KING ROAD TO
SOUTH OF LLOYDTOWN-AURORA ROAD, KING CITY, ONTARIO
ASSIGNMENT NO. 2017-E-0016-015, G.W.P. 2385-02-00**

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the detail design of the widening of Highway 400 from north of King Road to south of 16th Sideroad, and from north of 16th sideroad to south of Lloydtown-Aurora Road (i.e. from King Road to Lloydtown-Aurora Road), as part of MTO Agreement No. 2017-E-0016, Assignment #15.

This report addresses the foundation investigation carried out for five Closed Circuit Television (CCTV) poles and one overhead Variable Message Sign (VMS) and a review of existing information for one cantilever sign. The proposed CCTV poles and VMS locations are shown on Drawing 1. The purpose of this investigation is to establish the subsurface conditions at the location of the proposed poles / signs based on previous and current borehole drilling and geotechnical laboratory testing on selected samples and based on the results of the investigations, provide foundation engineering recommendations for the design and construction of the proposed poles and sign supports.

This report was developed based on information from the current foundation investigation, supplemented with relevant information from the previous foundation investigations carried out within the project limits. The results of the previous foundation investigations are presented in the following reports:

- i **MTO GEOCRE 31D-298:** "Foundation Investigation Report for Hwy. 400 Over Holland Marsh, Embankment Distress Study, W.P. 7-82-01, District 6, Toronto", prepared by MTO circa 1982.
- i **MTO GEOCRE 30M13-214:** "Foundation Investigation and Design Report, Culverts from Station 13+375 to Station 22+500, Highway 400 Widening from North of King Road to South Canal Bank Road, Regional Municipality of York, G.W.P. 2835-02-00", prepared by Golder (Golder Report Number 09-1111-0018-10), dated December 1, 2015.
- i **MTO GEOCRE 30M13-217:** "Foundation Investigation and Design Report, High Fill Embankments and Deep Cut, Highway 400 Widening from North of King Road to South Canal Bank Road, Regional Municipality of York, G.W.P. 2835-02-00", prepared by Golder (Golder Report Number 09-1111-0018-12), dated March 4, 2016.

2.0 PROJECT / SITE DESCRIPTION

Highway 400 is to be widened from north of King Road to south of 16th Sideroad, and from north of 16th sideroad to south of Lloydtown-Aurora Road (i.e. from King Road to Lloydtown-Aurora Road). The proposed work will bridge the gaps between the previously completed adjacent widening and the widening currently being constructed. As part of the planned highway widening, five CCTV poles, one overhead VMS, and one cantilever sign are proposed for construction. The approximate locations of the proposed poles and signs are summarized below and shown on Drawing 1. In general, the proposed CCTV poles are located at the toe of the existing highway embankment. The proposed supports of the overhead VMS are located on the existing highway shoulders, and the proposed cantilever sign is located on the outside highway shoulder. The approximate existing and proposed ground surface elevations at the proposed pole / sign locations, as interpreted from the ground surface profiles provided by MH, are summarized in the table below.

| Pole / Sign ID | Location Description | Approximate Existing Ground Surface Elevation (m) | Approximate Proposed Ground Surface Elevation (m) |
|-----------------------|--|---|---|
| CCTV Pole No. 1 | Highway 400 Northbound, Station 13+870 | 306.5 | 307.3 |
| CCTV Pole No. 2 | Highway 400 Northbound, Station 14+953 | 306.5 | 306.0 |
| CCTV Pole No. 3 | Highway 400 Northbound, Station 16+964 | 354.6 | 351.0 |
| CCTV Pole No. 4 | Highway 400 Northbound, Station 18+217 | 314.5 | 317.5 |
| CCTV Pole No. 5 | Highway 400 Northbound, Station 19+250 | 317.3 | 318.8 |
| VMS No. 1 | Highway 400 Southbound, Station 25+795 | 220.0 | 220.0 |
| Cantilever Sign No. 1 | Highway 400 Northbound, Station 25+550 | 220.0 | 220.0 |

3.0 INVESTIGATION PROCEDURES

3.1 1982 Investigation (GEOCRE 31D00-298)

As outlined in GEOCRE 31D00-298, a foundation investigation was carried out in 1982 to assess embankment distresses where the highway was constructed over the Holland Marsh. As part of the previous foundation investigation, twelve boreholes (designated as Borehole 1 to 12) were advanced between the former South Canal and North Canal. One of the twelve boreholes (Borehole 2) is located in the vicinity of the proposed cantilever sign. A copy of the borehole records and the associated subsurface profiles are provided in Appendix A.

The borehole locations were measured relative to the former South Canal bridge structure and the former edge of pavement. The approximate location, the ground surface elevation, and borehole depth of Borehole 2 (the borehole nearest the proposed cantilever sign) are summarized below.

| Pole ID | Borehole No. | Approximate Location | Ground Surface Elevation (m) | Borehole Depth (m) |
|------------------------|--------------|--|------------------------------|--------------------|
| Cantilever Signs No. 1 | 2 | Northbound Highway 400 About 685 m north of South Canal Bridge (correlating to about Station 25+585) | 220.0 | 5.8 |

3.2 2010 to 2015 Investigations (GEOCRE 30M13-214 and 30M13-217)

As outlined in GEOCRE 30M13-214 and 30M13-217, between November 4, 2010 and November 2, 2015 a foundation investigation was carried out for various foundation elements between north of King Road to south of Canal Bank Road. As part of the previous foundation investigation, two boreholes (designated as Borehole C27-3 and C27-4) were advanced in the vicinity of the proposed CCTV No. 1 pole location and two boreholes (designated as Boreholes DC-11 and DC-13) were advanced in the vicinity of the proposed CCTV No. 3 pole location, at the locations shown on Drawing 1. Copies of the relevant borehole records are provided in Appendix B.

The borehole locations and ground surface elevations were surveyed by Callon Dietz Incorporated, Ontario Land Surveyors. The relevant borehole locations (in MTM NAD 83 Zone 10 northing and easting coordinates and latitude and longitude), the ground surface elevations (referenced to Geodetic datum), and borehole depths are summarized below.

| Pole ID | Borehole No. | Location (MTM NAD 83, Zone 10) | | Ground Surface Elevation (m) | Borehole Depth (m) |
|-----------------|--------------|--------------------------------|----------------------------|------------------------------|--------------------|
| | | Northing (m) (Latitude, °) | Easting (m) (Longitude, °) | | |
| CCTV Pole No. 1 | C27-3 | 4,866,367.3 (43.937272) | 299,192.6 (-79.569849) | 307.9 | 14.3 |
| | C27-4 | 4,866,367.2 (43.937271) | 299,214.3 (-79.569579) | 306.3 | 12.8 |
| CCTV Pole No. 3 | DC-11 | 4,869,323.0 (43.963872) | 298,708.0 (-79.575919) | 358.9 | 15.9 |
| | DC-13 | 4,869,392.1 (43.964494) | 298,696.6 (-79.576062) | 355.0 | 8.2 |

3.3 Current Investigation

The current foundation investigation was carried out between November 9 and 27, 2020, during which time six boreholes (designated as Boreholes C27-5, CCTV-2, CCTV-4, CCTV-5, VMS-1 and VMS-2) were advanced to depths of 10.4 m and 11.3 below ground surface. The boreholes were advanced near the proposed CCTV pole locations and the proposed VMS support locations, as shown on Drawings 1 to 3. The borehole records are provided in Appendix C.

The field investigation was carried out using a D-50T track-mounted drill rig, supplied and operated by Walker Drilling Inc. of Utopia, Ontario. The boreholes were advanced using 210 mm outside diameter continuous flight hollow stem augers. Soil samples were generally 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. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions.

The groundwater conditions in the open boreholes were observed during the drilling operations and a standpipe piezometer was installed in Boreholes CCTV-4 and CCTV-5 to permit monitoring of the groundwater level at the borehole locations. The standpipe piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed at a selected depth within the boreholes. The borehole and annulus surrounding the piezometer pipe above the screen sand pack was backfilled to the ground surface with bentonite pellets and a stick-up monument casing was provided at each piezometer location. Piezometer installation details and water level readings are described on the borehole records presented in Appendix C. All boreholes in which standpipe piezometers were not installed were backfilled to ground surface with bentonite upon completion, in general accordance with Ontario Regulation 903 (as amended).

The field work was observed on a full-time basis by a member of Golder's engineering staff, who located the boreholes, arranged for the clearance of underground utilities, directed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's geotechnical laboratory in Mississauga, Ontario where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO LS and/or ASTM standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples.

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

Select soil samples were submitted to a specialist analytical laboratory under chain of custody procedures for testing of conductivity / resistivity, pH and chemical analysis of sulphate and chloride content, to assess the potential for the soil to cause deterioration to buried concrete and corrosion to steel.

The borehole locations and the ground surface elevations were surveyed by Golder using a Trimble Geo7X with a minimum horizontal and vertical accuracy of 0.1 m. The borehole locations and elevations are referenced relative to MTM NAD 83 (Zone 10) northing and easting, and to geodetic datum (HT2_0 / CGVD 1928:1978), respectively. The borehole locations (including northing/easting and latitude/longitude), ground surface elevations, and drilled depths are summarized below.

| Pole / Sign ID | Borehole No. | MTM NAD83 (Zone 10) | | Ground Surface Elevation (m) | Borehole Depth (m) |
|-----------------|--------------|---------------------------|---------------------------|------------------------------|--------------------|
| | | Northing (m) (Latitude,°) | Easting (m) (Longitude,°) | | |
| CCTV Pole No. 1 | C27-5 | 4,866,302.8 (43.936692) | 299,201.7 (-79.569735) | 307.6 | 11.3 |
| CCTV Pole No. 2 | CCTV-2 | 4,867,319.3 (43.945840) | 299,042.3 (-79.571732) | 305.6 | 10.4 |
| CCTV Pole No. 4 | CCTV-4 | 4,870,520.2 (43.974646) | 298,484.7 (-79.578717) | 317.8 | 11.3 |
| CCTV Pole No. 5 | CCTV-5 | 4,871,604.9 (43.984408) | 298,307.0 (-79.580944) | 317.3 | 11.3 |
| VMS No. 1 | VMS-1 | 4,877,942.1 (44.041432) | 296,758.1 (-79.600349) | 220.0 | 10.4 |
| | VMS-2 | 4,877,951.0 (44.041512) | 296,770.6 (-79.600193) | 220.0 | 11.3 |

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The sections of Highway 400 included in this project traverses the three physiographic regions known as the South Slope, Oak Ridges Moraine and Lake Simcoe Basin of the Simcoe Lowlands, according to *The Physiography of Southern Ontario (Chapman and Putman, 1984)*². The South Slope is present at the southern portion of the project length, extending south from about 2 km north of King Road. The Oak Ridge Moraines is present through the center portion of the project length, extending from about 2 km north of King Road to about 2 km south of Lloydtown-Aurora Road. The Simcoe Lowlands is present at the northern portion of the project length, extending north from about 2 km south of Lloydtown-Aurora Road.

CCTV No. 1 is located within the South Slope physiographic region; CCTV No. 2, 3, and 4 are located within the Oak Ridges Moraine physiographic region; and, CCTV No. 5, VMS No.1, and Cantilever Sign No. 1 are located within the Simcoe Lowlands physiographic region.

The South Slope predominately consists of sandy silt to silty sand till deposits, which is generally composed of unsorted and un-stratified glacial sediment mixtures of any or all of clay, silt, sand, gravel, cobble, and boulders.

The Oak Ridges Moraine predominately consists of sand and gravel, although in the King Township area these soils are often overlain by till. It is understood that during grading for the initial construction of Highway 400 through this area, deep cuts exposed up to about 10 m of till overlying the sand and gravel deposits.

² Chapman, 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.

The Lake Simcoe Basin of the Simcoe Lowlands predominately consists of sand and silt deposits, although the continuity of the sand and silt deposits is divided into several areas of drumlinized till.

Further, VMS No. 1 and Cantilever Sign No. 1 are located within the Holland Marsh which is characterized by peat bogs overlying glaciolacustrine deposits.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during the previous field investigations (Boreholes 2, C27-3, C27-4, and DC-11, DC-13) and current investigation (Boreholes C27-5, CCTV-2, CCTV-4, CTTV-5, VMS-1 and VMS-2) are presented on the borehole records in Appendix A, B, and C, respectively. The results of the geotechnical laboratory tests from the 2010 to 2015 investigations and current foundation investigations are presented in Appendix D and the results of the analytical laboratory tests from the current foundation investigation are presented in Appendix E.

The results of the in situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4.2 are uncorrected. 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. Furthermore, subsurface conditions will vary between and beyond the borehole locations.

4.2.1 Asphalt

An approximately 100 mm to 280 mm thick layer of asphalt was encountered at ground surface at Boreholes 2, C27-3, C27-5, VMS-1, and VMS-2.

4.2.2 Topsoil

An approximately 100 mm to 600 mm thick layer of topsoil was encountered at ground surface at Boreholes C27-4, DC-11, DC-13, CCTV-2, CCTV-4, and CCTV-5.

4.2.3 Fill

An approximately 0.7 m to 4.4 m thick layer of non-cohesive / cohesive fill was encountered below the asphalt / topsoil in Boreholes 2, C27-3, C27-5, CCTV-2, VMS-1, and VMS-2. The fill extends to depths ranging from 0.9 m to 4.5 m below ground surface (Elevation 306.7 m to 217.3 m).

The fill varies from non-cohesive silty sand to sand, trace gravel to gravelly, trace clay to cohesive clayey silt-silt to clayey silt, trace sand to sandy, trace gravel. It is noted that the silty clay fill shown on Borehole 2, should actually be classified as a clayey silt based on the laboratory results provided on the borehole record. The cohesive fill contains trace organics in Boreholes CCTV-2 and contained trace organics, trace rootlets, and sand and silt zones in Borehole C27-3.

The SPT “N”-values measured within the non-cohesive fill generally range from 6 blows to 17 blows per 0.3 m of penetration, indicating a loose to compact compactness. One SPT “N”-value of 59 blows per 0.3 m of penetration was recorded in Borehole 2. The SPT “N”-values measured within the cohesive fill range from 6 blows to 26 blows per 0.3 m of penetration, indicating a firm to very stiff consistency.

As part of Golder’s investigations, grain size distribution testing was carried out on two samples of the non-cohesive fill and on two samples of the cohesive fill; the results are presented on Figures C-1 and C-2 in Appendix D, respectively. Atterberg limit testing was carried out on four samples of the cohesive fill and the

results are presented on Figure D-3 in Appendix D. The Atterberg limit testing measured liquid limits ranging from about 15 % and 27 %, plastic limits ranging from about 10 % to 17 %, and plasticity indices ranging from about 5 % and 10 %, indicating the cohesive fill is of low plasticity. The natural water contents measured on two samples of the non-cohesive fill are about 9 % and 17 % and the natural water contents measured on multiple samples of the cohesive fill range from about 9 % to 20 %.

As part of the 1982 investigation, grain size distribution testing and Atterberg limit testing was carried out on two samples of the cohesive fill, and the results are presented on the borehole record in Appendix A. The Atterberg limit testing measured liquid limits of about 20 % and 22 %, plastic limits of about 12 %, and plasticity indices of about 8 % and 10 %, indicating the cohesive fill is of low plasticity. The natural water contents measured on two samples of the cohesive fill are about 15 %.

4.2.4 Organic Silt to Peat

An approximately 0.4 m to 1.7 m thick layer of organic silt and peat were encountered underlying the fill in Boreholes 2, CCTV-2 and VMS-1. The organic silt and peat deposits were encountered at depths of 1.8 m and 3.3 m below ground surface (Elevations 303.8 m, 218.2 m, and 217.3 m, respectively).

The SPT “N”-values measured within the organic silt and peat range from 3 blows to 7 blows per 0.3 m of penetration, indicating a very loose to loose compactness / firm consistency.

As part of Golder’s investigations, the natural water contents measured on one sample of the organic silt and on one sample of the peat were about 65 % and 412 %, respectively. The organic contents measured on one sample of the organic silt and on one sample of the peat were about 18 % and 89 %, respectively.

As part of the 1982 investigation, laboratory testing was carried out on various samples of peat from all boreholes advanced as part of the investigation. The natural water content measured on all samples of the peat ranged from about 70 % to 524 %. The organic content measured samples of the peat ranged from 28% to 95%. The unit weight measured on samples of the peat ranged from 9.1 kN/m³ to 11.2 kN/m³. Undrained shear strengths measured from field vanes were 42 kPa and 65 kPa, and undrained shear strengths measured from quick triaxial tests ranged from 19 kPa to 87 kPa.

4.2.5 Clayey Silt-Silt to Silty Clay

Layers of clayey silt-silt to silty clay were encountered below topsoil / fill / peat layer / silt to sand layers / till deposit in Boreholes 2, C27-3, C27-4, C27-5, CCTV-4, CCTV-5, VMS-1, and VMS-2. The clayey silt-silt to silty clay layers were encountered at depths ranging from 0.3 m to 10.2 m below ground surface (Elevations 317.2 m to 214.4 m). Where fully penetrated, the layers range in thickness from 0.8 m to 4.7 m. Boreholes 2, C27-3 and VMS-1 were terminated within the layers and at these locations, the layers were 3.3 m, 6.5 m and 6.9 m thick, respectively.

The clayey silt-silt to silty clay layers generally contain trace to some sand, trace gravel. The layers contain organics and rootlets in Boreholes C27-4, CCTV-5, VMS-1. The SPT “N”-values measured within the clayey silt-silt to silty clay layers range from 3 blows to 52 blows per 0.3 m of penetration, indicating a soft to hard consistency but are generally firm to very stiff.

As part of Golder’s investigations, grain size distribution testing was carried out on five samples of the clayey silt-silt to silty clay layers and the results are presented on Figure D-4 in Appendix D. Atterberg limit testing was carried out on nine samples of the clayey silt-silt to silty clay layers and the results are presented on Figure C-5 in

Appendix C. The Atterberg limit testing measured liquid limits ranging from about 19 % and 38 %, plastic limits ranging from about 13 % to 20 %, and plasticity indices ranging from about 4 % and 18 %, indicating the cohesive deposits range from low to medium plasticity. The natural water content measured on samples of the clayey silt-silt to silty clay layers range from about 14 % to 33 %. The organic content measured on one sample of the clayey silt layer in Borehole CCTV-5 is about 3.0 %.

As part of the 1982 investigation, laboratory testing was carried out on various samples of the deposit from all boreholes advanced as part of the investigation. The Atterberg limit testing measured liquid limits ranging from about 19% and 42%, plastic limits ranging from about 15% to 20%, and plasticity indices ranging from about 5% to 23%, indicating the cohesive deposits range from low to medium plasticity. The natural water content measured on samples of the silty clay ranged from about 18% to 41%. The unit weight measured on samples of the silty clay ranged from 17.4 kN/m³ to 20.6 kN/m³. Undrained shear strengths measured from field vanes range from 36 kPa to 92 kPa, undrained shear strengths measured from quick triaxial tests ranges from 21 kPa to 37 kPa, and undrained shear strengths measured from unconfined compression tests ranged from 19 kPa to 57 kPa.

4.2.6 Silt to Sand

Layers of silt to sand were encountered below topsoil / fill / clayey silt-silt to silty clay layers / till deposit in all boreholes, excluding Boreholes C27-3 and VMS-1. The silt to sand layers were encountered at depths ranging from 0.2 m to 11.7 m below ground surface (Elevations 358.7 m to 209.8 m). Where fully penetrated, the layers range in thickness from 0.4 m to 4.3 m. Boreholes DC-11, C27-4, C27-5, CCTV-4, CCTV-5, and VMS-2 were terminated within the layers and at these locations, the layers ranged in sampled thickness from 1.1 m to 10.6 m.

The silt to sand layers generally contain trace to some gravel, trace clay. The layers contain organics and rootlets in Boreholes DC-11, DC-13, and VMS-2. The SPT “N”-values measured within the silt to sand layers range from 3 blows to 82 blows per 0.3 m of penetration, indicating a very loose to very dense compactness, but is generally compact.

As part of Golder's investigations, grain size distribution testing was carried out on nine samples of the silt to sand layers and the results are presented on Figures D-6A and D-6B in Appendix D. Atterberg limit testing was carried out on two samples; one sample was measured to be non-plastic and one sample measured a liquid limit of about 14 %, a plastic limit of about 11 %, and a plasticity index of about 3 %, indicating the sample was slightly plastic. In general, the silt to sand layers are non-plastic. The natural water contents measured on samples of the silt to sand layers range from about 2 % to 24 %.

4.2.7 Clayey Silt-Silt to Clayey Silt (Till)

A cohesive till deposit was encountered below the topsoil / fill / peat / clayey silt-silt to silty clay layers / silt to sand layers in Boreholes DC-11, DC-13, C27-3, C27-4, C27-5, and CCTV-2. The deposit was encountered at depths ranging from 1.5 m to 5.6 m below ground surface (Elevations 357.4 m to 302.0 m). Where fully penetrated, the deposit ranges in thickness from 3.3 m to 4.6 m. Boreholes DC-13 and CCTV-2 were terminated within the deposit and at these locations, the deposit was 6.7 m and 8.2 m in sampled thickness, respectively. A 50 mm thick sand seam layer and a 0.4 m thick sandy silt layer was encountered within the till deposit in Boreholes C27-5 and CCTV-2, respectively.

The till deposit is generally composed of clayey silt-silt to clayey silt, trace sand to sandy, trace to some gravel. The deposit contains organics in Boreholes C27-4. The SPT “N”-values measured within the till deposit range

from 7 blows to 73 blows per 0.3 m of penetration, indicating a firm to hard consistency, but is generally firm to very stiff.

As part of Golder's investigations, grain size distribution testing was carried out on six samples of the till deposit and the results are presented on Figure D-7 in Appendix D. Atterberg limit testing was carried out on nine samples of the till deposit and the results are presented on Figure D-8 in Appendix D. The Atterberg limit testing measured liquid limits ranging from about 16 % and 22 %, plastic limits ranging from about 11 % to 15 %, and plasticity indices ranging from about 4 % and 10 %, indicating the till is of low plasticity. The natural water content measured on samples of the till deposit range from about 11 % to 19 %.

4.2.8 Groundwater

Details of the groundwater levels measured during drilling / in the open boreholes on completion of drilling / in the piezometers installed in select boreholes are presented on the borehole records in Appendix A, B, and C, and as presented below. These observations are based on the conditions at the time of drilling and are not necessarily representative of the stabilized groundwater level at the site. The groundwater level at the site will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

| Pole / Sign ID | Borehole No. | Depth to Groundwater (m) | Groundwater Elevation (m) | Date of Observation | Notes |
|-----------------------|--------------|--|---------------------------|---------------------|---|
| CCTV Pole No. 1 | C27-3 | Dry | <293.6 | Nov 7, 2010 | In borehole upon completion of drilling |
| | C27-4 | 1.8 | 304.5 | Oct 14, 2010 | In borehole upon completion of drilling |
| | C27-5 | Dry | <296.3 | Nov 9, 2020 | In borehole upon completion of drilling |
| CCTV Pole No. 2 | CCTV-2 | Dry | <295.2 | Nov 27, 2020 | In borehole during drilling |
| CCTV Pole No. 3 | DC-11 | Dry | <343.0 | Dec 21, 2010 | In borehole upon completion of drilling |
| | DC-13 | Dry | <346.8 | Dec 21, 2010 | In borehole upon completion of drilling |
| CCTV Pole No. 4 | CCTV-4 | 6.5 | 311.2 | Nov 13, 2020 | In borehole upon completion of drilling |
| | | 6.3 | 311.5 | Dec 4, 2020 | In piezometer |
| | | 6.3 | 311.5 | Feb 10, 2021 | In piezometer |
| CCTV Pole No. 5 | CCTV-5 | 5.6 | 311.7 | Nov 10, 2020 | In borehole upon completion of drilling |
| | | 5.4 | 311.9 | Dec 3, 2020 | In piezometer |
| | | 5.4 | 311.9 | Feb 10, 2021 | In piezometer |
| VMS No. 1 | VMS-1 | 1.0 | 219.0 | Nov 27, 2020 | In borehole upon completion of drilling |
| | VMS-2 | 3.0 | 217.0 | Nov 18, 2020 | In borehole upon completion of drilling |
| Cantilever Sign No. 1 | 2 | As per GEOCRE 31D00-29, due to the low-lying marshy terrain, the groundwater is estimated to be at native ground surface (about Elevation 218 m) | | | |

4.3 Analytical Testing Results

Five soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix E and the results are summarized below.

| Pole / Sign ID | Borehole No. / Sample No. | pH | Resistivity (ohm-cm) | Electrical Conductivity (umho/cm) | Chlorides (µg/g) | Soluble Sulphates (µg/g) |
|-----------------|---------------------------|------|----------------------|-----------------------------------|------------------|--------------------------|
| CCTV Pole No. 1 | C27-5 / 2 | 7.75 | 490 | 2,050 | 920 | <RDL |
| CCTV Pole No. 2 | CCTV-2 / 3B | 7.28 | 780 | 1,280 | 560 | <RDL |
| CCTV Pole No. 4 | CCTV-4 / 4 | 7.90 | 6,300 | 158 | 44 | <RDL |
| CCTV Pole No. 5 | CCTV-5 / 3 | 7.83 | 5,200 | 193 | <200 | <RDL |
| VMS No. 1 | VMS-2 / 3 | 7.94 | 980 | 1,020 | 470 | <RDL |

Note: 1. RDL indicates "Reportable Detection Limit" of 20 µg/g

5.0 CLOSURE

This Foundation Investigation Report was prepared by Anastasia Poliacik, P.Eng., a geotechnical engineer with Golder. Mr. William Cavers, P.Eng., an MTO Foundations Designated Contact and Associate with Golder, conducted an independent technical and quality control review of the report.

Signature Page

Golder Associates Ltd.



Anastasia Poliacik, P.Eng.
Geotechnical Engineer



William Cavers, P.Eng.
MTO Foundations Designated Contact, Senior Geotechnical Engineer

AMP/WC/ljv

Golder and the G logo are trademarks of Golder Associates Corporation

<https://golderassociates.sharepoint.com/sites/21998g/deliverables/wo15-hwy400wideninglloydton/4.cctvandvms/5.final/1786658-wo15-fidr-rev0-20211125-cctvsigns.docx>

PART B

**FOUNDATION DESIGN REPORT
CLOSED CIRCUIT TELEVISION POLES AND SIGN SUPPORTS
HIGHWAY 400 WIDENING FROM NORTH OF KING ROAD TO
SOUTH OF LLOYDTOWN-AURORA ROAD, KING CITY, ONTARIO
ASSIGNMENT NO. 2017-E-0016-015, G.W.P. 2385-02-00**

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides detail foundation recommendations for the design of five Closed Circuit Television (CCTV) poles, one overhead Variable Message Sign (VMS), and one cantilever sign, in support of the detail design of the widening of Highway 400 from north of King Road to south of 16th Sideroad, and from north of 16th sideroad to south of Lloydtown-Aurora Rod (i.e. from King Road to Lloydtown-Aurora Road). These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the previous and current investigations in the vicinity of each sign location.

The discussion and recommendations presented are intended to provide the designer with sufficient information to carry out the design of the sign foundations. The Foundation Investigation Report, discussions and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO), and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in the Foundation Investigation (Part A) of this report. 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 in the Contract Documents. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

6.2 Frost Protection

As per Ontario Provincial Standard Drawing (OPSD) 3090.101 (Foundation Frost Penetration Depths for Southern Ontario), the design frost penetration depth at these sites is 1.5 m below the existing ground surface.

6.3 Geotechnical Parameters

Table 1 following the text of this report, summarizes geotechnical parameters for the soils encountered at the borehole locations. The parameters presented in Table 1 are based on field and laboratory test data as well as accepted correlations (NAVFAC 1986, Bowles, 1984 and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgment based on experience in similar soils.

6.4 Design of CCTV Pole Foundations

It is understood that a standard MTO design for new CCTV poles is not yet available and a detailed analysis is needed to estimate lateral deflections of the proposed CCTV poles to ensure they are within a specified serviceability limit criterion. The CCTV poles are to be designed and constructed in accordance with OPSS 615 (*Construction Specification for Erection of Poles*) and Special Provision 682S30 (*Concrete Poles, Direct Buried in Earth with Camera Raising and Lowering System*).

Table 1 presents a summary of the estimated geotechnical soil and groundwater parameters to support the lateral analysis of the poles to meet serviceability limits for lateral deflection. It is important to note that the “buried” portion of the concrete poles must be in intimate contact with the surrounding ‘undisturbed’ soil, similar to a caisson or driven pile installation, in order for the soil resistance values provided in this report to be valid and representative. If there is a ‘void’ or ‘loosened’ backfill material in the annulus between the buried concrete pole and surrounding soils, this must be taken into consideration during design.

6.4.1 Axial Capacity

The design for the CCTV poles will be governed by the lateral resistance requirements; axial geotechnical resistance is not considered to be a concern given that negligible axial loads are to be applied (other than self-weight of the hollow concrete poles) and given the relatively competent soils throughout this site.

6.4.2 Lateral Resistance

The resistance to lateral loading of vertical buried concrete poles may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction (k_h in kPa/m) is determined based on the equations given below:

For cohesionless soils:

$$k_h = \frac{n_h z}{B} \quad \text{where} \quad \begin{array}{l} n_h \text{ is the constant of horizontal subgrade reaction (kPa/m);} \\ z \text{ is the depth (m); and} \\ B \text{ is the buried concrete or caisson diameter (m)} \end{array}$$

For cohesive soils:

$$k_h = \frac{67 S_u}{B} \quad \text{where} \quad \begin{array}{l} S_u \text{ is the undrained shear strength of the soil (kPa); and} \\ B \text{ is the buried concrete or caisson diameter (m)} \end{array}$$

The above equations and recommended parameters may be used to analyse the interaction between a buried concrete pole or caisson and the surrounding soil (i.e., for serviceability limit state (SLS) design) provided that lateral displacements within the soil do not exceed approximately 10 mm. If deflections exceed 10 mm, a non-linear analysis method should be used to model the behaviour of the soil (e.g. p-y curves). The upper 1.5 m of soil resistance should not be included in the design to account for frost action.

The spring constant, K , for analysis may be obtained by the expression, $K = k_h \times L \times B$ (kN/m), where k_h is the coefficient of horizontal subgrade reaction (kPa/m), B is the buried concrete pole or caisson diameter (m) and L is the length (m) of the buried concrete pole or caisson segment used in the analysis. Table 1 provides the recommended geotechnical parameters for use in the design approach outlined above. In the event that the CCTV poles are located on the highway embankment slope or within about two diameters of the crest of a slope, there would be unbalanced earth pressures around the CCTV foundation due to its foundation being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth pressure coefficient ($K_{p2:1}$), to be used in the foundation design is also included in Table 1.

Considering this is a non-standard MTO design, it is understood that a detailed soil-structure analysis will be carried out by the proprietary CCTV pole designer to meet the specified deflection tolerances at the foundation level and provide associated details on foundation design / embedment and installation procedures to meet the requirements in Special Provision SP682S30.

The lateral pressures obtained from the analysis must not exceed the ultimate lateral geotechnical resistance or the factored structural flexural shear resistance and/or bending moment of the buried concrete pole / caisson. The ultimate resistance should be checked by the structural engineer and the ultimate lateral geotechnical resistance can be checked using the conventional Broms' equation, based on the stratigraphy and geotechnical design parameters given in Table 1.

Alternatively, the unfactored lateral geotechnical resistance can be calculated using passive lateral earth pressure, P_p (kPa) as defined below, distributed along the length of the caisson/buried pole based on the stratigraphy and geotechnical design parameters given in Table 1.

$$P_p = K_p \gamma d_w \text{ above the groundwater table (kPa), and}$$

$$P_p = K_p \gamma d_w + K_p \gamma' (d - d_w) \text{ below the groundwater table (kPa)}$$

where K_p is the passive earth pressure coefficient;

γ is the bulk unit weight (kN/m³);

γ' is the effective unit weight below the groundwater level (kN/m³);

d is the depth below the ground surface (m); and

d_w is the depth to the groundwater level (m).

The unfactored lateral resistance, p_{ult} (kN) for non-cohesive soils should be calculated assuming an equivalent width equal to three times the caisson/buried pole diameter, and an equivalent length equal to six times the caisson/buried pole diameter (Section C6.8.7.1 of CHBDC (2006)), as outlined below:

$$p_{ult} = P_p A_e \text{ (kN)}$$

where A_e is the equivalent area equal to $3D \cdot 6D = 18D^2$ (m²)

D is the caisson/buried pole diameter (m)

Where an undrained shear strength, S_u , is provided for a cohesive soil layer in Table 1, the undrained capacity of the caisson/buried pole should also be checked to determine whether the drained or undrained case will govern. In this case, the lateral resistance for the length of the caisson/buried pole within the cohesive soil should be calculated assuming an internal angle of friction, $\Phi' = 0$ degrees, and an unfactored passive lateral pressure distribution varying from $2 S_u$ at ground surface and increase linearly to $9 S_u$ at and below a depth equivalent to three caisson/buried pole diameters, acting over the actual width of the caisson/buried pole (Section C6.8.7.1 of CHBDC (2006)), as outlined below.

$$p_{ult} = P_p A_e \text{ (kN)}$$

where $P_p = 2 S_u$ at ground surface to $9 S_u$ at and below a depth equivalent to $3D$ (kPa)

A_e is the equivalent area equal to $L \times D$ (m²)

L is the caisson/buried pole length (m)

D is the caisson/buried pole diameter (m)

In accordance with CHBDC (2014), the product of the consequence factor, Ψ , and the geotechnical resistance factor, ϕ_{gu} should be applied to this unfactored lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit States (p_{ULS}) as shown below.

$$p_{ULS} = p_{ult} \cdot \Psi \cdot \phi_{gu} \text{ (kN)}$$

where $\Psi = 1 - 1.15$ (typical to low consequence factor as per Table 6.1 in CHBDC (2019))

$\phi_{gu} = 0.5$ (passive resistance factor for typical degree of understanding, as per Table 6.2 in CHBDC (2019))

6.5 Design of VMS and Cantilever Sign Foundations

Caisson foundations for sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual* (MTO, 2019). The *Sign Support Manual* includes standard caisson foundation designs for ground mounted overhead VMS and single cantilever signs as follows:

- | **Variable Message Sign Supports:** Section 8 (*VMS Overhead Truss*) and Standard Drawing SS118-6.
- | **Cantilever Sign Supports:** Section 3 (*Cantilever Static Sign Supports*) and Standard Drawing SS118-3.

As discussed with MTO, the design guidance provided below for the cantilever sign is based on the information from the 1982 investigation. The parameters have been conservatively estimated based on the results from all boreholes advanced during that investigation and the stratigraphy estimated based on Borehole 2, which is estimated to be in the northbound lanes of the current Highway 400, at about Station 15+585 (approximately 25 m north of the proposed cantilever sign location).

6.5.1 Standard Caisson Foundation Design in Soil

The standard ground mounted overhead VMS and single cantilever sign foundation designs presented in MTO's *Sign Support Manual* have been developed based on the minimum soil conditions given in Section 8.5.4 (*Foundations*) and Section 3.5.4 (*Foundations*) of the *Sign Support Manual*, respectively, and are summarized below.

- | **Case 1 (Non-Cohesive Soils):** Sand with a friction angle of 28° surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30° surrounding the lower third of the portion of the caisson below the design frost depth.
- | **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and "soft" clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

For standard caisson foundation designs, the caissons depths are as follows:

- | Ground mounted overhead VMS supports: As illustrated on Standard Drawing SS118-6, caissons shall extend 6.5 m below the design frost penetration depth of 1.5 m resulting in a total caisson length of 8.0 m.
- | Ground mounted single cantilever sign supports: As indicated on Standard Drawing SS118-3, caissons shall extend to depths ranging from 5 m to 6.5 m below the design frost penetration depth of 1.5 m, resulting in a total caisson length of 6.5 m to 8.0 m, depending on the class of sign.

The standard foundation design provided in MTO's *Sign Support Manual* does not apply to sites where extensive poor fill materials or materials looser or softer than those of Case 1 or Case 2 are present. For such subsurface conditions, a site-specific design is required (See Section 6.5.2).

6.5.2 Site-Specific Caisson Foundation Design in Soil

A site-specific caisson foundation design may be carried out by the structural engineer to optimize the standard foundation design using the geotechnical design parameters given in Table 1 following the text of this report. Where both undrained shear strength and effective stress parameters are provided, the structural assessment should be completed for both cohesive and non-cohesive soil cases, and the more conservative approach adopted. In the design of cantilever, trichord and monotube sign foundations, the passive resistance within the

upper 1.5 m below ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this unfactored lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit State (ULS).

It is anticipated that the VMS and cantilever sign supports will be constructed in areas of relatively flat ground. In cases where the sign foundations are located on the highway embankment side slope or within approximately two caisson foundation diameters of the crest of the slope in the direction of loading, there will be unbalanced earth pressures around the foundation due to its being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth pressure coefficient (K_p 2:1), calculated in accordance with Figure C6.18 of the Canadian Highway Bridge Design Code and its Commentary (CHBDC (2019)), to be used in the foundation design is also included in Table 1, attached.

6.5.3 Summary

Based on the borehole information, the subsurface conditions at the proposed VMS and cantilever locations have been compared to the standard design requirements and it has been assessed that the foundations for the VMS and cantilever signs shall be designed using a site-specific design as per Section 6.5.2 above.

6.6 Corrosion Assessment and Protection

The results of analytical testing on a soil samples from select sign locations are summarized in Section 4.3 and the analytical laboratory test report is included in Appendix E.

The analytical test results were compared to CSA A23.1 Table 3 (*Additional requirements for concrete subjected to sulphate attack*) to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentrations measured in the tested samples are less than 0.002%, which is below the Moderate degree of exposure (i.e., below the Class S3 exposure limits), and the degree of sulphate attack is considered “Negligible” according to Table 7.2 in MTO’s *Gravity Pipe Design Guidelines* (2014). Therefore, based on the soil sample tested, when the designer is selecting the exposure class for the concrete structure, the effects of sulphates from within the site soils in contact with any portion of the proposed structure constructed below the ground surface may not need to be considered.

According to the MTO Gravity Pipe Design Guidelines (2014), the pH is not considered detrimental to steel durability as it is less than a pH of 8.5.

The resistivity analytical test results of the soil samples were also compared to the MTO *Gravity Pipe Design Guidelines* (2014) to assess the relative level of corrosion potential on buried steel in contact with soil. The resistivity measured in the tested soil samples (ranging between 490 ohm-cm and 6,300 ohm-cm) indicates that the soil corrosiveness is “very low” ($6,000 > R > 10,000$ ohm-cm) to “severe” ($R < 2,000$ ohm-cm), as per Table 3.2 of the *Gravity Pipe Design Guidelines* (MTO, 2014), and some level of corrosion protection should be applied to the foundation elements / materials. Based on the results of the samples tested and given that the structure will be exposed to de-icing salt, consideration should be given by the designer to designing for a “C” type exposure class as defined by CSA A23.1 Table 1.

Ultimately, it is the structural designer’s decision to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) are followed.

6.7 Construction Considerations

6.7.1 Control of Soil and Groundwater

Foundations for the CCTV poles and VMS supports should be constructed consistent with OPSS 903 (Deep Foundations) and OPSS 915 (Sign Support Structures), respectively.

The water-bearing non-cohesive soils at this site should be expected to run or flow into the caisson holes during or after drilling of the caisson foundations for the VMS supports. Therefore, appropriate equipment and procedures will be required to minimize ground loss during drilling and concrete placement. This could include the use of temporary caisson liners, and/or the use of drilling mud. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of this condition; such an NSSP is provided in Appendix F.

6.7.2 Obstructions

Cobbles and/or boulders should be anticipated when advancing through till deposits. It is recommended that a paragraph be added into the NSSP described in Section 6.7.1 be included in the Contract Documents to warn the Contractor of the potential presence of cobbles and/or boulders within the till deposit, an example of the NSSP is provided in Appendix F.

6.7.3 CCTV Poles

We understand the CCTV poles will be “direct buried”. According to SP682S30, the concrete poles will be inserted directly into a steel lined auger hole and the annulus surrounding the concrete poles will be filled with grout / concrete to form the foundation that is to be in intimate contact with the surrounding soils.

6.7.4 Piezometer Decommissioning

The piezometers installed in Boreholes CCTV-4 and CCTV-5 should be decommissioned during construction and a Non-Standard Special Provision (NSSP) should be added to the Contract Documents; an NSSP for this purpose is attached in Appendix F.

7.0 CLOSURE

This Foundation Design Report was prepared by Anastasia Poliacik, P.Eng., a geotechnical engineer with Golder. Mr. William Cavers, P.Eng., an MTO Foundations Designated Contact and Associate of Golder, conducted an independent technical and quality control review of the report.

Signature Page

Golder Associates Ltd.



Anastasia Poliacik, P.Eng.
Geotechnical Engineer



William Cavers, P.Eng.
MTO Foundations Designated Contact, Senior Geotechnical Engineer

AMP/WC/ljv

Golder and the G logo are trademarks of Golder Associates Corporation

<https://golderassociates.sharepoint.com/sites/21998g/deliverables/wo15-hwy400wideninglloydton/4.cctvandvms/5.final/1786658-wo15-fidr-rev0-2021'11'25-cctvsigns.docx>

REFERENCES

Canadian Standards Association (CSA), 2006. *Canadian Highway Bridge Design Code and Commentary on CAN/CSA S6 06*. CSA Special Publication, S6.1 06.

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

CSA Group. 2014. A23.1-14/A23.2-14 - Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.

ASTM International:

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

Ontario Provisional Standard Drawings:

OPSD 3090.101 Foundation, Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications:

OPSS.PROV 915 Construction Specification for Sign Support Structures

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

Ministry of Transportation, Ontario

Gravity Pipe Design Guideline. Drainage and Hydrology Design and Contract Standards Office, 2014.

Sign Support Manual. Provincial Highways Management Division, Highway Standards Branch, Bridge Office. February 2019.

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR CCTV POLES AND VARIABLE MESSAGE SIGN FOUNDATIONS

| Sign ID (Location) | Reference Borehole | Ground Surface Elevation at Reference Borehole (m) | Approximate Finished Ground Surface Elevation at Sign Location (m) | Standard or Site-Specific Foundation Design | Stratum | Elevation in Reference Borehole (m) | Design Groundwater Elevation (m) | Design Parameters ^{2, 3} | | | | | | | |
|-----------------------------|-----------------------|---|--|--|---|---|--|-----------------------------------|----|------------------------|----------------------------|---------------------------|----------------|-------------------|--|
| | | | | | | | | S _u (kPa) | Φ' | γ (kN/m ³) | γ' (kN/m ³) | n _h (kPa/m) | K _p | K _{p2:1} | |
| CCTV No. 1 (Sta. 13+870) | C27-3 to C27-5 | 306.3 to 307.9 | 307.3 | Site Specific | Sand to silty sand fill | 307.3 - 306.7 | 304.5 | - | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Firm to very stiff clayey silt | 306.7 - 303.1 | | 100 | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Soft silty clay | 303.1 - 302.0 | | 20 | 27 | 20 | 10 | - | 2.66 | 0.90 | |
| | | | | | Stiff clayey silt till | 302.0 - 299.5 | | 100 | 30 | 21 | 11 | - | 3.00 | 1.12 | |
| | | | | | Loose silt | 299.5 - 298.9 | | - | 30 | 20 | 10 | 2000 | 3.00 | 1.12 | |
| | | | | | Very stiff clayey silt | 298.9 - 297.4 | | 100 | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Compact silt | 297.4 - 296.3 | | - | 32 | 20 | 10 | 6000 | 3.25 | 1.23 | |
| CCTV No. 2 (Sta. 14+953) | CCTV-2 | 305.6 | 306.0 | Site Specific | New fill | 306.0 - 305.0 | 295.2 | - | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Firm clayey silt fill | 305.0 - 303.8 | | 40 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | | | | | Loose organic silt | 303.8 - 303.4 | | - | 27 | 18 | 8 | - | 2.66 | 0.90 | |
| | | | | | Stiff to very stiff clayey silt-silt till | 303.4 - 295.2 | | 100 | 30 | 21 | 11 | - | 3.00 | 1.12 | |
| CCTV No. 3 (Sta. 16+964) | DC-11, DC-13 | 355.0, 358.9 | 351.0 | Site Specific | Firm to very stiff clayey silt to clayey silt with sand till | 351.0 - 346.8 | 343.0 | 100 | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Compact to very dense sand | 346.8 - 343.0 | | - | 34 | 21 | 11 | 10000 | 3.54 | 1.34 | |
| CCTV No. 4 (Sta. 18+217) | CCTV-4 | 317.4 | 317.5 | Site Specific | Loose to compact silty sand to sandy silt | 317.5 - 313.3 | 311.5 | - | 30 | 20 | 10 | 4000 | 3.00 | 1.12 | |
| | | | | | Very stiff clayey silt-silt | 313.3 - 312.2 | | 125 | 31 | 20 | 10 | - | 3.12 | 1.18 | |
| | | | | | Compact silt | 312.2 - 306.5 | | - | 32 | 20 | 10 | 6000 | 3.25 | 1.23 | |
| CCTV No. 5 (Sta. 19+250) | CCTV-5 | 317.3 | 318.8 | Site Specific | New fill | 318.8 - 317.2 | 311.9 | - | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Firm clayey silt | 317.2 - 316.6 | | 40 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | | | | | Stiff silt of slight plasticity | 316.3 - 315.1 | | 100 | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Compact silt | 315.1 - 306.0 | | - | 32 | 20 | 10 | 6000 | 3.25 | 1.23 | |
| VMS No. 1 (Sta. 25+800) | VMS-1 | 220.0 (West) | 220.0 | Site Specific | Loose to compact silty sand fill | 220.0 - 218.2 | 219.0 | - | 30 | 20 | 10 | 4000 | 3.00 | 1.12 | |
| | | | | | Very loose to loose peat | 218.2 - 216.6 | | - | 27 | 16 | 6 | - | 2.66 | 0.90 | |
| | | | | | Soft to stiff clayey silt-silt to clayey silt | 216.6 - 209.6 | | 30 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | VMS-2 | 220.0 (East) | 220.0 | | Stiff to very stiff clayey silt-silt fill | 220.0 - 217.8 | | 100 | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Very loose to loose sand to silty sand | 217.8 - 216.3 | | - | 29 | 20 | 10 | 1000 | 2.88 | 1.06 | |
| | | | | | Firm clayey silt | 216.3 - 215.5 | | 30 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | | | | | Compact silt | 215.5 - 214.4 | | - | 32 | 20 | 10 | 4000 | 3.25 | 1.23 | |
| | | | | | Firm clayey silt | 214.4 - 209.8 | | 30 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | | | | | Compact sandy silt | 209.8 - 208.7 | | - | 32 | 20 | 10 | 5000 | 3.25 | 1.23 | |
| Cantilever Sign No. 1 | 2 | 220.0 | 220.0 | Site Specific | Very dense silty sand fill | 220.0 - 219.2 | 218.0 | - | 30 | 20 | 10 | - | 3.00 | 1.12 | |
| | | | | | Firm silty clay fill | 219.2 - 218.0 | | 50 | 28 | 20 | 10 | - | 2.77 | 0.99 | |
| | | | | | Firm Peat | 218.0 - 216.0 | | 20 | 27 | 10 | 1 | - | 2.66 | 0.90 | |
| | | | | | Soft silty clay | 216.0 - 212.0 | | 20 | 28 | 19 | 9 | - | 2.77 | 0.99 | |

NOTES:

1. Although Su, φ' and Kp parameters are given for the full depth of the soil, the passive resistance in the upper 1.5 m should be neglected in the design to account for frost action.
2. Design parameters:

S_u

= undrained shear strength (kPa);

φ'

= effective friction angle (degrees);

γ

= bulk unit weight (kN/m3);

γ'

= effective unit weight below the groundwater level (kN/m3);

n_h

= constant of horizontal subgrade reaction (kPa/m);

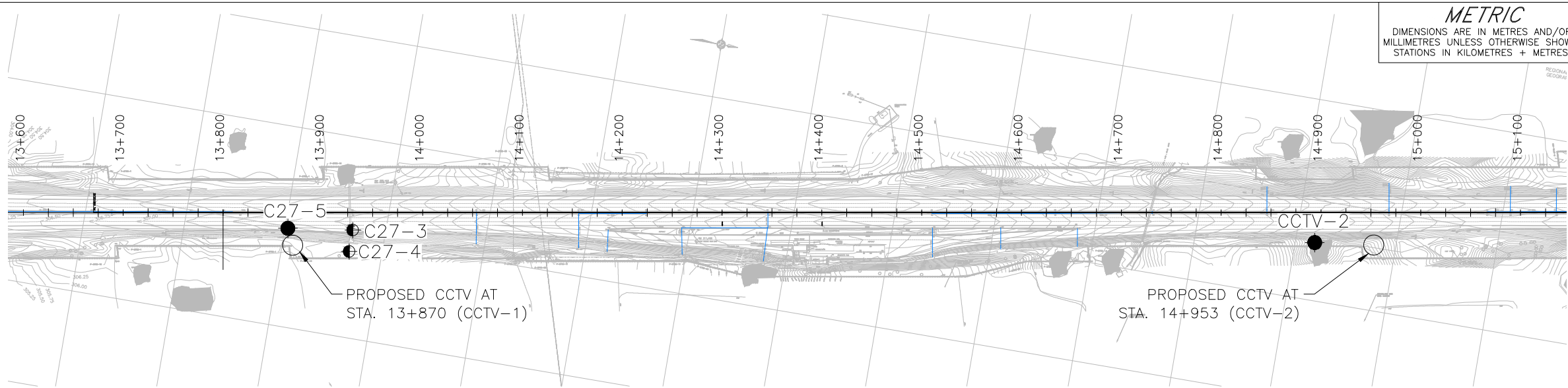
K_p

= passive earth pressure coefficient; and

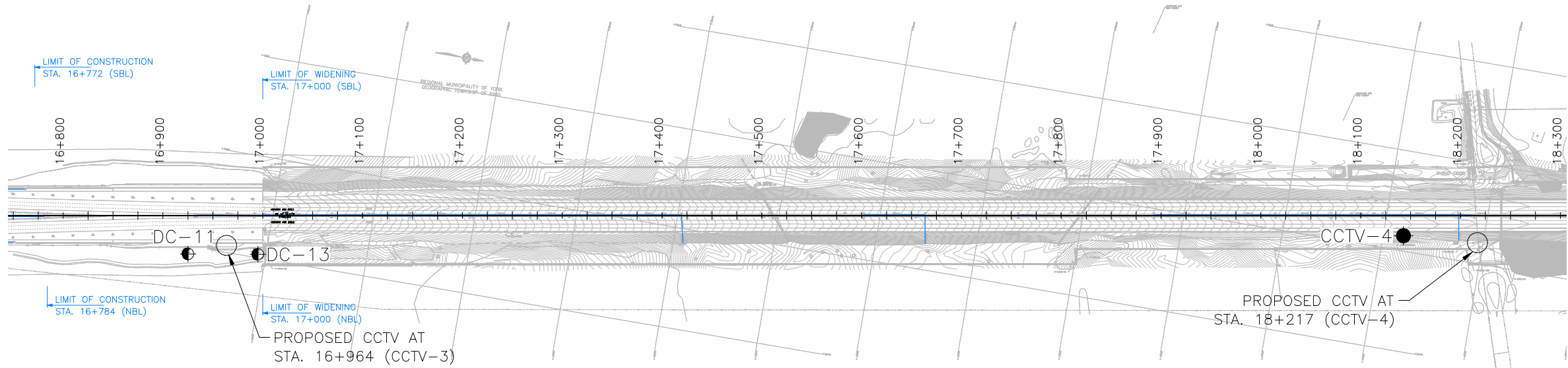
K_{p2:1}

= passive earth pressure coefficient adjusted to account for 2H:1V sloping ground within two caisson diameters of the foundation element.

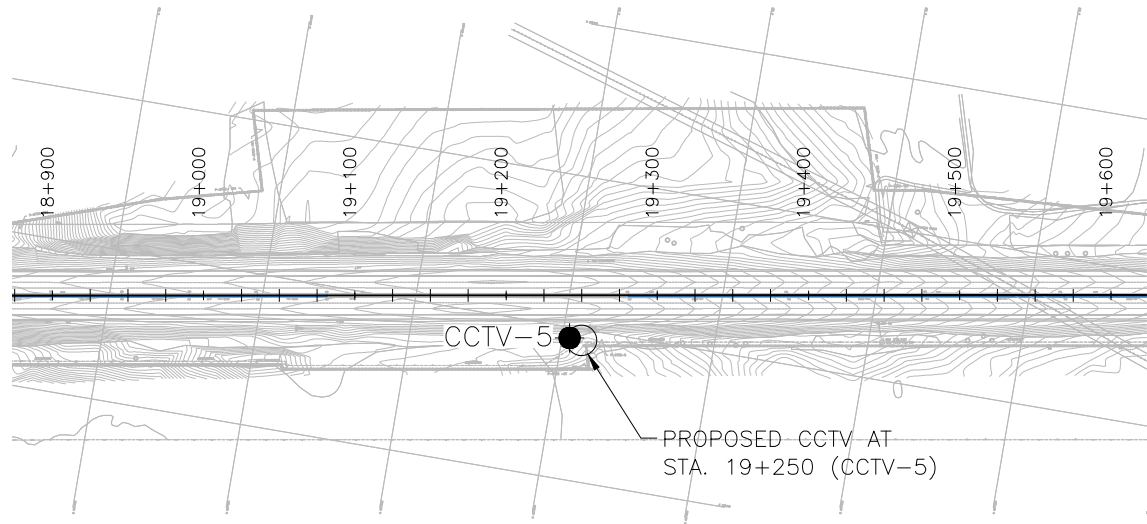
3. Where both undrained shear strength and effective friction angle parameters are provided for cohesive materials, the structural assessment should be completed for both undrained and drained conditions, and the selected design should be based on the more conservative approach.



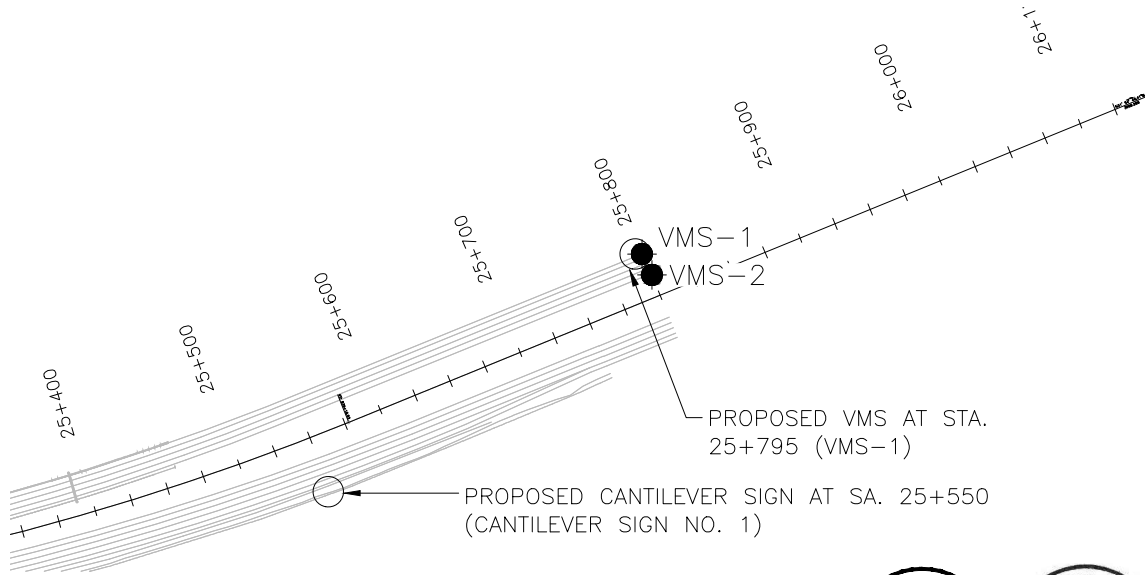
PLAN 1 – STATION 13+864 AND 14+894



PLAN 2 – STATION 16+954 AND 18+144



PLAN 3 – STATION 19+244



PLAN 4 – STATION 25+800



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

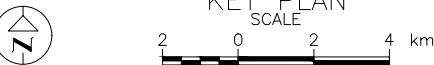
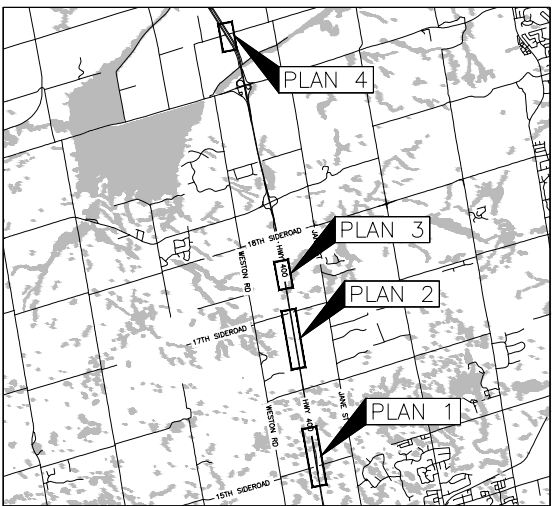
CONT No.
WP No.

CCTV POLES AND VMS SUPPORT

BOREHOLE LOCATIONS



SHEET



LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation (GEOCRE 30M13-214 and 30M13-217)

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 10)

| No. | ELEVATION | NORTHING | EASTING |
|--------|-----------|-----------|----------|
| C27-3 | 307.9 | 4866367.3 | 299192.6 |
| C27-4 | 306.3 | 4866367.2 | 299214.3 |
| C27-5 | 307.6 | 4866302.8 | 299201.7 |
| CCTV-2 | 305.6 | 4867319.3 | 299042.3 |
| CCTV-4 | 317.8 | 4870520.2 | 298484.7 |
| CCTV-5 | 317.3 | 4871604.9 | 298307.0 |
| DC-11 | 358.9 | 4869323.0 | 298708.0 |
| DC-13 | 355.0 | 4869392.1 | 298696.6 |
| VMS-1 | 220.0 | 4877942.1 | 296758.1 |
| VMS-2 | 220.0 | 4877951.0 | 296770.6 |

NOTES

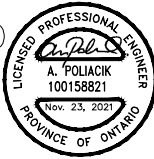
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

REFERENCE

Base plan provided in digital format by MH, drawing file no. X117116615Base (1).dwg, received June 15, 2021.
Topography plan provided in digital format by MH, drawing file no. X117116615Contours.dwg, received June 2, 2021.
CCTV poles plan provided in digital format by IBI Group, drawing file no. ATMS_121579_Hwy400_Aurora.dwg, received July 7, 2021.

Latitude: 43.963872 Longitude: -79.575919

| | | | |
|-----------------------|----------|----------------------------------|----------|
| NO. | DATE | BY | REVISION |
| Geocres No. 30M13-236 | | | |
| HWY. 400 | | PROJECT NO. 1786658 (W015) DIST. | |
| SUBM'D. AP | CHKD. AP | DATE: 11/23/2021 | SITE: |
| DRAWN: DD | CHKD. WC | APPD. WC | DWG. 1 |



APPENDIX A

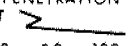
**Borehole Records – Previous Investigations
(GEOCRES 31D00-298)**



RECORD OF BOREHOLE No 1

METRIC

W P 7-82-01 LOCATION Sta. 10 + 301.3 N.B. Chainage o/s 2.2 m Rt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 15 CHECKED BY CP

| 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 221.3 | N.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 21 cm Asphalt | | | | | | | | | | | | | | | | GR SA SI CL |
| | Brown Fill | | 1 | SS | 79 | | 220 | | | | | | | | | | 40 45 (15) |
| | Gravelly Sand to Silty Sand | | 2 | SS | 35 | | | | | | | | | | | | 6 42 44 8 |
| 218.9 | Wood | | 3 | SS | 47 | | | | | | | | | | | | |
| 2.4 | Black Fine Fibrous Peat with wood fragments Soft | | 4 | SS | PH | | 218 | | | | | | | W = 266 % | | | 0 _m = 79% |
| | | | 5 | TW | PH | | | | | | | | | W = 387 % | | 9.8 | e ₀ = 5.91 C _c = 3.66 |
| 216.6 | | | 6 | TW | PH | | | | | | | | | W = 267 % | | 11.2 | |
| 4.7 | | | 7 | TW | PH | | 216 | | | | | | | | | 17.4 | 0 4 68 28 |
| | Grey Interbedded Silty Clays and Silts of Slight plasticity Firm to V. Stiff | | 8 | SS | 21 | | | | | | | | | | | | 0 16 79 5 |
| | | | 9 | SS | 10 | | 214 | | | | | | | | | | |
| 213.2 | | | 10 | SS | 6 | | | | | | | | | | | | |
| 8.1 | End of Borehole | | | | | | | | | | | | | | | | |

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 7-82-01 LOCATION Sta. 10 + 684.8 N.E. Chainage o/s 2.3 m Rt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 15 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 220.6 | N.B.I. Paved Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 28 cm Asphalt | | | | | | | | | | | | | | | | |
| | Fill Sand with Silt and Gravel | | 1 | SS | 59 | | 220 | | | | | | | | | | 25 50 (25) |
| | | | 2 | SS | 11 | | | | | | | | | | | | |
| | Brown Silty Clay | | 3 | SS | 7 | | 218 | | | | | | | | | | |
| | Grey Some Sand | | | | | | | | | | | | | | | | |
| 217.3 | | | 4 | SS | 7 | | | | | | | | | | | | 0 19 60 21 Om = 56% |
| 3.3 | Black Fine Fibrous Peat Occ. wood fragments Firm | | 5 | SS | 7 | | | | | | | | | | | | Om = 87% |
| 215.9 | | | | | | | 216 | | | | | | | | | | |
| 4.7 | Grey Silty Clay with Silt and Sand Seams | | 6 | TW | PH | | | | | | | | | | | | 0 3 69 28 e _o = 1.04 C _c = 0.269 P _c = 65 kPa |
| 214.5 | Stiff to V. Stiff | | 7 | SS | 25 | | | | | | | | | | | | |
| 6.1 | End of Borehole | | | | | | | | | | | | | | | | |

+³, x⁵: Numbers refer to Sensitivity

20
15
10

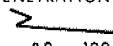
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3

METRIC

W P 7-82-01 LOCATION Sta. 11 + 163.2 N.B. Chainage o/s 1.8 m Rt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 15 CHECKED BY SP

| 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 220.0 | N.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| | 13 cm Asphalt | | | | | | | | | | | | | | | | |
| 0.0 | Fill Sand with Silt and Gravel | | 1 | SS | 7 | | | | | | | | | | | | |
| 218.5 | | | | | | | | | | | | | | | | | |
| 1.5 | Black Fine Fibrous Peat Occ. Silty Clay and Silty Sand Layers Firm | | 2 | SS | 9 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | PH | | | | | | | | | | | | |
| | | | 4 | SS | 5 | | | | | | | | | | | | |
| 216.3 | | | | | | | | | | | | | | | | | |
| 3.7 | Grey Silty Clays of low to Intermediate Plasticity Firm to V. Stiff | | 5 | TW | PH | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 6 | TW | PH | | | | | | | | | | | | |
| | | | 7 | SS | 28 | | | | | | | | | | | | |
| 214.2 | | | | | | | | | | | | | | | | | |
| 5.8 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 4

METRIC

W P 7-82-01 LOCATION Sta. 11 + 905.8 N.B. Chainage o/s 1.4 m Rt. E.P. Driving Lane ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TJK
DATUM Geodetic DATE 82 11 16 CHECKED BY CF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 221.3 | N.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 25 cm Asphalt | | | | | | | | | | | | | | | | |
| | Fill Silty Sand to Gravelly Sand | | 1 | SS | 73 | | 220 | | | | | | | | | | 18 40 35 7 |
| | Brown | | 2 | SS | 55 | | | | | | | | | | | | |
| | Grey Silty Clay with Sand | | 3 | SS | 19 | | | | | | | | | | | | |
| 218.2 | | | 4 | SS | 13 | | 218 | | | | | | | W = 70 % | | | Om = 28% |
| 3.1 | Black Fine Fibrous Peat Firm to Stiff | | 5 | TW | PH | | | | | | | | | W = 310 % | | 10.2 | Om = 85% e _o = 6.43 C _c = 3.64 |
| 216.4 | | | 6 | TW | PH | | | | | | | | | | | | |
| 4.9 | | | 7 | TW | PH | | 216 | | 3 | | | | | | | 19.3 | 0 2 81 17 e _o = 0.808 C _c = 0.179 |
| | Grey Silty Clay of low to Intermediate Plasticity Occ. Silt and Fine Sand Seams Firm to V. Stiff | | 8 | TW | PH | | 214 | | 5 | | | | | | | 20.6 | |
| 213.2 | | | 9 | SS | 36 | | | | | | | | | | | | |
| 8.1 | End of Borehole | | | | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 5

METRIC

W P 7-82-01 LOCATION Sta. 11 + 904.4 S.B. Chainage o/s 1.4 m Lt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 16 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 221.4 | S.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 21 cm Asphalt | | | | | | | | | | | | | | | | |
| | Fill Silty Sand to Gravelly Sand | | 1 | SS | 41 | | 220 | | | | | | | | | | |
| | Brown Grey | | 2 | SS | 24 | | | | | | | | | | | | |
| 218.8 | Silty Clay some Sand | | 3 | SS | 8 | | | | | | | | | | | | |
| 2.6 | | | 4 | TW | PH | | 218 | | | | | | | | | 10.4 | Om = 76% e _o = 4.35 C _c = 2.62 |
| | Black Fine Fibrous Peat Non-woody Firm | | 5 | SS | PH | | | | | | | | | | | | Om = 73% |
| 216.8 | | | 6 | TW | PH | | | | | | | | | | | 19.2 | 0 3 76 21 |
| 4.6 | Grey Silty Clays of low to Intermediate Plasticity Occ. Silty Sand Layers Firm to V. Stiff | | 7 | SS | 43 | | 216 | | | | | | | | | | 0 70 25 5 |
| 214.9 | End of Borehole | | | | | | | | | | | | | | | | |
| 6.5 | | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

METRIC

W P 7-82-01 LOCATION Sta. 11 + 460.7 S.B. Chainage o/s 1.7 m Lt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 17 CHECKED BY *SP.*

| 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 220.1 | S.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| | 16 cm Asphalt | | | | | | | | | | | | | | | | |
| 0.0 | Fill Sand | | 1 | SS | 30 | | | | | | | | | | | | 7 87 (6) |
| | Brown Grey | | 2 | SS | 13 | | | | | | | | | | | | |
| | Silty Clay some Sand | | 3 | SS | 20 | | | | | | | | | | | | |
| 216.9 | | | 4 | SS | 3 | | | | | | | | | | | | |
| 3.2 | Black Fine Fibrous Peat Firm | | 5 | TW | PH | | | | | | | | | | | | |
| | | | 6 | TW | PH | | | | | | | | | | | | |
| 215.3 | | | 7 | TW | PH | | | | | | | | | | | | |
| 4.8 | Grey Silty Clays of low to Intermediate Plasticity Firm to V. Stiff | | 8 | SS | 8 | | | | | | | | | | | | |
| | | | 9 | SS | 12 | | | | | | | | | | | | |
| 212.0 | | | 10 | SS | 22 | | | | | | | | | | | | |
| 8.1 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

W P 7-82-01 LOCATION Sta. 10 + 310.5 S.B. Chainage o/s 2.0 m Lt. E.P. Driving ORIGINATED BY AR
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
 DATUM Geodetic DATE 82 11 17 CHECKED BY EP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 220.7 | S.B.L. Paved Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 9 cm Asphalt | | | | | | | | | | | | | | | | |
| | Brown Fill | | 1 | SS | 23 | | 220 | | | | | | | | | | |
| 219.3 | Sand Some Silt | | | | | | | | | | | | | | | | |
| 1.4 | | | 2 | SS | 7 | | | | | | | | | | | | |
| | Black Fine Fibrous Peat with wood fragments Firm | | 3 | TW | PH | | | | | | | | | | | | |
| | | | 4 | TW | PH | | 218 | | | | | | | | | | |
| | | | 5 | TW | PH | | | | | | | | | | | | |
| 216.6 | | | | | | | | | | | | | | | | | |
| 4.1 | Grey Silty Clay Stiff | | 6 | TW | PH | | 216 | | | | | | | | | | |
| 216.0 | | | | | | | | | | | | | | | | | |
| 4.7 | | | 7 | SS | 24 | | | | | | | | | | | | |
| | Grey Sandy Silt to Silt Compact | | 8 | SS | 20 | | | | | | | | | | | | |
| 214.1 | | | | | | | | | | | | | | | | | |
| 6.6 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 9

METRIC

W P 7-82-01 LOCATION Sta. 10 + 301.0 N.B. Chainage o/s 11.5 m Lt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 18 CHECKED BY ep

| 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 220.9 | N.B.L. Median Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 16 cm Asphalt | | | | | | | | | | | | | | | | |
| | Gravelly Sand | | 1 | SS | 100 | 10 cm | 220 | | | | | | | | | | |
| | Boulder | | | | | | | | | | | | | | | | |
| | Silty Clay with Sand | | 2 | SS | 85 | | | | | | | | | | | | |
| | Fill | | | | | | | | | | | | | | | | |
| | Silty Sand to Sandy Silt | | 3 | SS | 21 | | 218 | | | | | | | | | | 4 53 38 5 |
| | Traces of Clay | | 4 | SS | 6 | | | | | | | | | | | | 3 41 49 7 |
| 217.2 | | | | | | | | | | | | | | | | | |
| 3.7 | | | 5 | SS | 2 | | | | | | | | | | | | |
| | Grey Silty Clay with interbedded Sandy Silt Layers | | 6 | SS | 10 | | 216 | | | | | | | | | | |
| | Soft to Very Stiff | | 7 | SS | 17 | | | | | | | | | | | | |
| 214.3 | | | 8 | SS | 22 | | | | | | | | | | | | 0 18 67 15 |
| 6.6 | End of Borehole | | | | | | | | | | | | | | | | |

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10

METRIC

W P 7-82-01 LOCATION Sta. 11 + 905.5 N.B. Chainage o/s 15.4 m Lt. E.P. Driving ORIGINATED BY AR
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
 DATUM Geodetic DATE 82 11 18 CHECKED BY EP

| 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 Y | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 221.6 | N.B.L. Median Shoulder | | | | | | | | | | | | | | | | |
| 0.0 | 26 cm Asphalt | | | | | | | | | | | | | | | | |
| | Gravelly Sand | | 1 | SS | 28 | | | | | | | | | | | | |
| | Fill | | 2 | SS | 63 | | 220 | | | | | | | | | | |
| | Silty Clay and Sand Trace Gravel | | 3 | SS | 40 | | | | | | | | | | | | |
| | Brown Grey | | 4 | SS | 40 | | 218 | | | | | | | | | | 2 37 41 20 |
| | Fine Sand some Silt | | 5 | SS | 9 | | | | | | | | | | | | |
| 216.6 | | | 6 | SS | 3 | | | | | | | | | | | | 1 83 12 4 |
| 5.0 | | | 7 | SS | 6 | | 216 | | | | | | | | | | |
| | Grey Silty Clays of low to Intermediate Plasticity Soft to Firm | | 8 | TW | PH | | | | | | | | | | | | e ₀ = 0.96 C _c = 0.22 |
| | | | 9 | SS | 10 | | | | | | | | | | | | |
| 213.5 | | | 10 | SS | 36 | | 214 | | | | | | | | | | |
| | Sand | | | | | | | | | | | | | | | | |
| 8.1 | End of Borehole | | | | | | | | | | | | | | | | |



RECORD OF BOREHOLE No 11

METRIC

W P 7-82-01 LOCATION Sta. 10 + 301.8 N.B. Chainage o/s 10.4 m Rt. E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 19 CHECKED BY EP

| 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 | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 219.5 | Ground Surface | | | | | | | | | | | | | | | | |
| 0.0 | Brown to Black Fine Fibrous Peat with occasional wood fragments Soft to Firm | | 1 | SS | 5 | | | | | | | | | | | | |
| | | | 2 | TW | PH | | | | | | | | | | | | |
| | | | 3 | TW | PH | | | | | | | | | | | | |
| | | | 4 | SS | PH | | | | | | | | | | | | |
| 216.3 3.2 | Grey Silty Clay with interbedded Sandy Silt and Silt Layers Stiff to V. Stiff | | 5 | SS | 17 | | | | | | | | | | | | |
| | | | 6 | SS | 13 | | | | | | | | | | | | |
| | | | 7 | SS | 14 | | | | | | | | | | | | |
| 213.7 5.8 | End of Borehole | | | | | | | | | | | | | | | | |

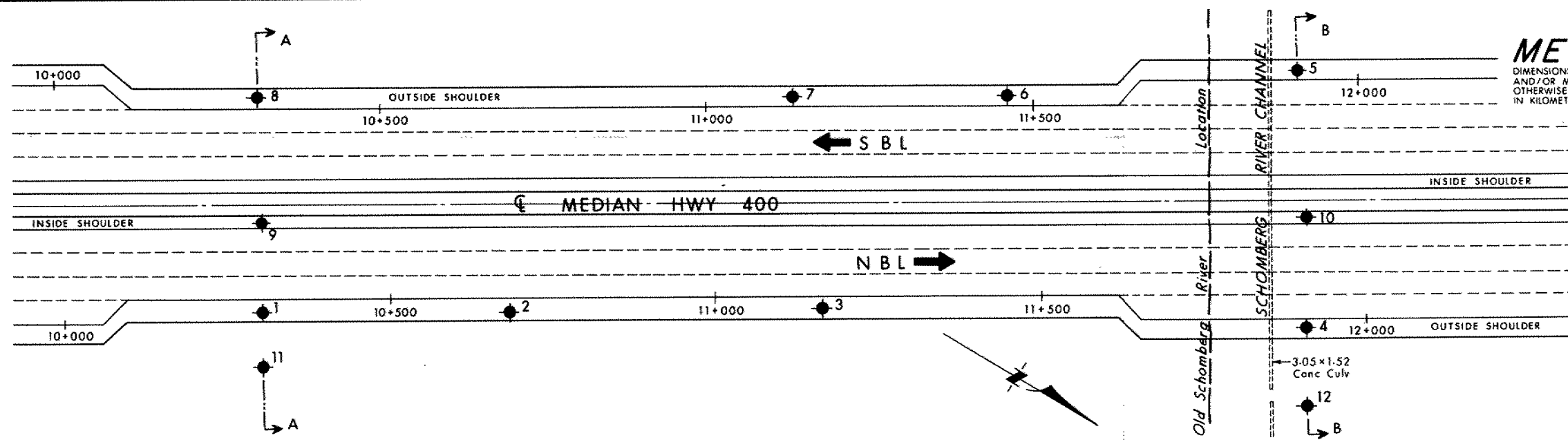


RECORD OF BOREHOLE No 12

METRIC

W P 7-82-01 LOCATION Sta. 11 + 905.8 N.B. Chainage o/s 13.4 m Rt.E.P. Driving ORIGINATED BY AR
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger Lane COMPILED BY TJK
DATUM Geodetic DATE 82 11 19 CHECKED BY EP

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| 218.4 | Ground Level | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | GR SA SI CL | | | |
| 0.0 | Black Fine Fibrous Peat Occ. wood fragments Soft to Firm | | | | | | 218 | | | | | | | | | | O _m = 85% e _o = 8.43 C _c = 7.84 | | | |
| | | | 1 | TW | PH | | | | | | | | | | | | | 10.3 | | |
| | | | | | | | | | | | | | | | | | | | | |
| 216.7 | | | 2 | TW | PH | | | | | | | | | | | | | 18.9 | | |
| | | | | | | | | | | | | | | | | | | | | |
| 1.7 | Organics | | | | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 4 | | | 216 | | | | | | | | | | | | |
| | Grey Silty Clays of low to Intermediate Plasticity with interbedded Sandy Silt and Silt Layers Soft to V. Stiff | | | | | | | | | | | | | | | 0 6 74 20 e _o = 0.82 C _c = 0.132 | | | | |
| | | 4 | TW | PH | | | | | | | | | | | | | 20.1 | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | 5 | SS | 13 | | 214 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | 6 | SS | 18 | | | | | | | | | | | | | 0 60 35 5 | | | |
| | | | | | | | | | | | | | | | | | | | | |
| 212.6 | | | 7 | SS | 25 | | | | | | | | | | | | | | | |
| 5.8 | End of Borehole | | | | | | | | | | | | | | | | | | | |



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

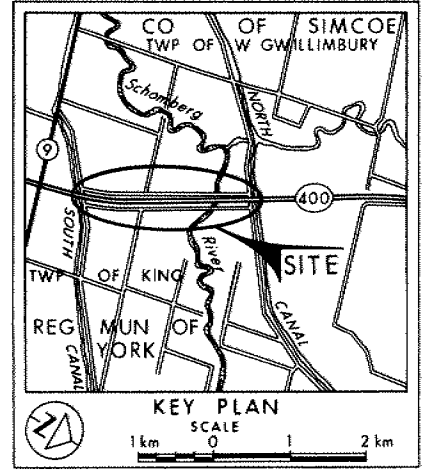
CONT No
WP No 7-82-01

HWY 400 OVER HOLLAND MARSH

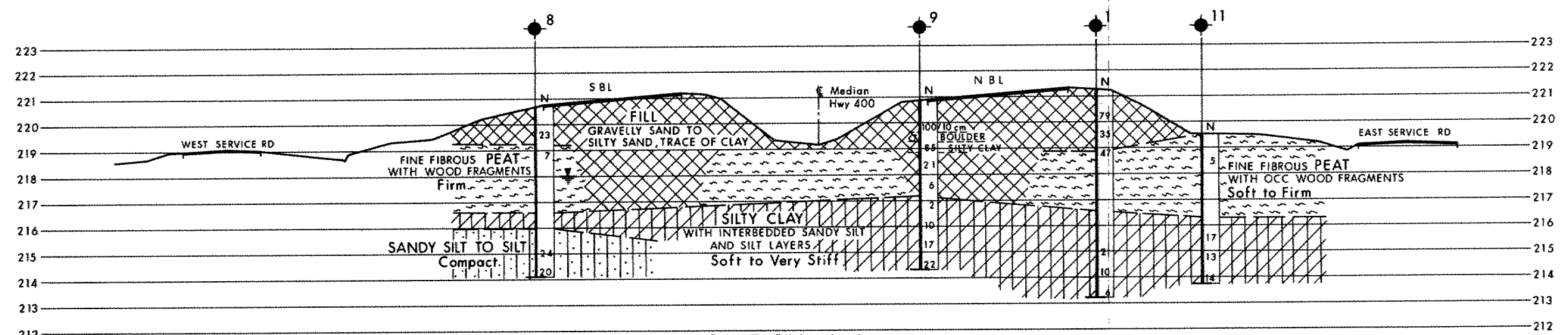
BORE HOLE LOCATIONS & SOIL STRATA



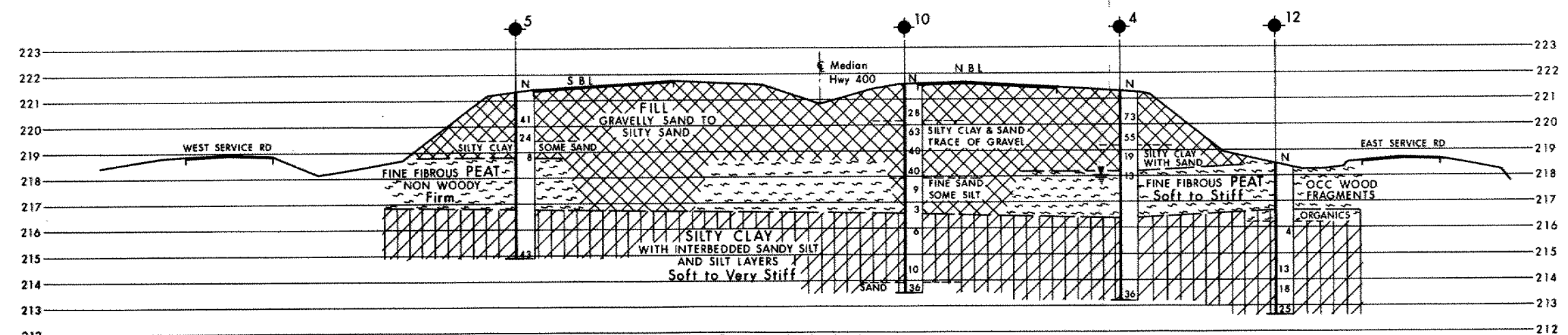
SHEET



NOTE
For Profiles Refer to
Dwg No 78201-B



SECTION A-A
SCALE
HOR 4m 2 0 4m
VERT 2m 1 0 2m



SECTION B-B
SCALE
HOR 4m 2 0 4m
VERT 2m 1 0 2m

- LEGEND**
- Bore Hole
 - ⊕ Dynamic Cone Penetration Test (Cone)
 - ⊙ Bore Hole & Cone
 - N Blows/0.3m (Std Pen Test, 475 J/blow)
 - CONE Blows/0.3m (60° Cone, 475 J/blow)
 - W.L. at time of investigation

| No | ELEVATION | NORTH BOUND STATION | LANE E P OFFSET |
|----------------------|-----------|---------------------|-----------------|
| 1 | 221.3 | 10+301.3 | 2.2m Rt |
| 2 | 220.6 | 10+684.8 | 2.3m Rt |
| 3 | 220.0 | 11+163.2 | 1.8m Rt |
| 4 | 221.3 | 11+905.8 | 1.4m Rt |
| 9 | 220.9 | 10+301.0 | 11.5m Lt |
| 10 | 221.6 | 11+905.5 | 15.4m Lt |
| 11 | 219.5 | 10+301.8 | 10.4m Rt |
| 12 | 218.4 | 11+905.8 | 13.4m Rt |
| SOUTH BOUND LANE E P | | | |
| No | ELEVATION | STATION | OFFSET |
| 5 | 221.4 | 11+904.4 | 1.4m Lt |
| 6 | 220.1 | 11+460.7 | 1.7m Lt |
| 7 | 220.1 | 11+133.9 | 1.6m Lt |
| 8 | 220.7 | 10+310.5 | 2.0m Lt |

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

| REV. | DATE | BY | DESCRIPTION |
|--------------------|------------|------|-------------|
| 1 | 1983 01 24 | J.K. | APPROVED |
| Geocres No 31D-298 | | | |
| HWY No 400 | | | DIST 6 |
| SUBMITTAL CHECKED | | | SITE N/A |
| DRAWN BY CHECKED | | | DWG 78201-A |



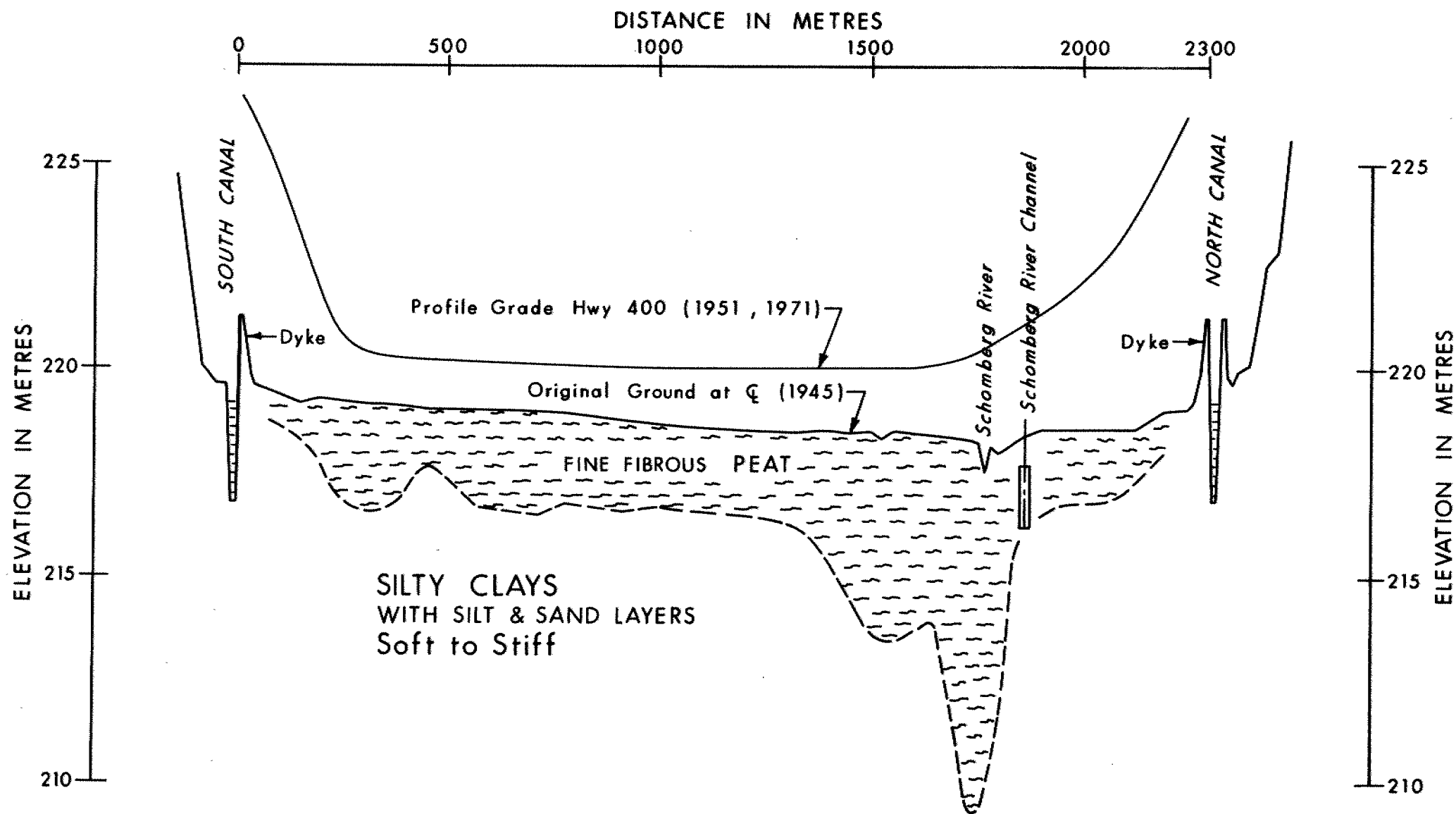


Fig 6 : Hwy 400 Profile Showing Peat Depths (1945 Soundings)

APPENDIX B

**Borehole Records – Previous Investigations
(GEOCRES 30M13-214 / 30M13-217)**

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>i.e.</i> , SAND and gravel) |
| > 20 to 35 | Primary soil name prefixed with "gravelly, sandy" as applicable |
| > 10 to 20 | some (<i>i.e.</i> , some sand) |
| ≤ 10 | trace (<i>i.e.</i> , 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 cm² 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, G _s) |
| 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) |
| Y | unit weight |

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

COARSE-GRAINED SOILS

Compactness¹

| 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 |

- 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 grain size. 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.
- 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 |

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- 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. |

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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 $= (w_L - w_P)$ |
| 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 |
| $C_{a(e)}$ | secondary compression index |
| C_a | rate of secondary compression |
| $C_{a(e)}$ | 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 $= \sigma'_p / \sigma'_{vo}$ |

(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 $= \tan \delta$ |
| 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 |

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

Notes: 1
2

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

| | | | | | | | |
|-----------------------------|--|--|--|---------------------------|--|---------------|--|
| PROJECT 09-1111-0018 | | RECORD OF BOREHOLE No C27-3 | | SHEET 1 OF 2 | | METRIC | |
| G.W.P. 2835-02-00 | | LOCATION N 4866367.3 ; E 299192.6 | | ORIGINATED BY TT | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE D-90 Truck Mount, 108 mm Inside Diameter Hollow Stem Augers | | COMPILED BY SKB/HS | | | |
| DATUM Geodetic | | DATE November 7, 2010 | | CHECKED BY SMM | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|----|---|--------------------------------|----------------|--------------------------------------|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | 20 | 40 | 60 | 80 | 100 | ● QUICK TRIAXIAL × REMOULDED | W _P | | | W |
| 307.9 | GROUND SURFACE | | | | | | | | | | | | | | | | | |
| 0.9 | ASPHALT | | | | | | | | | | | | | | | | | |
| 307.0 | Silty sand, trace gravel, trace clay (FILL) | | 1A | SS | 13 | | | | | | | | | | | | | |
| 0.9 | Compact Brown Moist | | 1B | | | | | | | | | | | | | | | |
| | Clayey silt, trace to some sand, trace gravel, trace organics and rootlets to a depth of 1.4 m. (FILL) | | 2 | SS | 19 | | | | | | | | | | | | | |
| | Stiff to very stiff | | | | | | | | | | | | | | | | | |
| | Brown to grey below 4.5 m | | | | | | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | | |
| | Sand and silt zones between depths of 2.3 m and 3.7 m. | | 3 | SS | 13 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 17 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 26 | | | | | | | | | | | | | |
| 303.4 | | | | | | | | | | | | | | | | | | |
| 4.5 | CLAYEY SILT, trace to some sand, trace gravel, sand pockets (TILL) | | 6 | SS | 20 | | | | | | | | | | | | | |
| | Very stiff | | | | | | | | | | | | | | | | | |
| | Brown | | | | | | | | | | | | | | | | | |
| | Wet | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 23 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| 300.1 | CLAYEY SILT, trace sand | | 8A | | | | | | | | | | | | | | | |
| 7.8 | Very stiff to hard | | 8B | SS | 52 | | | | | | | | | | | | | |
| | Grey | | | | | | | | | | | | | | | | | |
| | Moist to wet below 10.2 m. | | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 37 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | Brown between depths of 10.2 m and 11.7 m. | | 10 | SS | 32 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 11 | SS | 16 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | </ | | | |

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 11/30/15 SIB

| PROJECT 09-1111-0018 | | RECORD OF BOREHOLE No C27-3 | | | | SHEET 2 OF 2 | | METRIC | | | | | | | | | |
|----------------------|---|---|--------|------|----------------------------|--------------------|--|--------------------|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---|--|--|
| G.W.P. 2835-02-00 | | LOCATION N 4866367.3 ; E 299192.6 | | | | ORIGINATED BY TT | | | | | | | | | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE D-90 Truck Mount, 108 mm Inside Diameter Hollow Stem Augers | | | | COMPILED BY SKB/HS | | | | | | | | | | | |
| DATUM Geodetic | | DATE November 7, 2010 | | | | CHECKED BY SMM | | | | | | | | | | | |
| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | | | | | |
| | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | <div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div> | | | | | | | | | | |
| | END OF BOREHOLE NOTES: 1. Borehole caved at a depth of 10.5 m (Elev. 297.4 m) upon completion of drilling. 2. Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 11/30/15 SIB

| | | | | | | | |
|----------------------|--|---|--|----------------------|--|---------------|--|
| PROJECT 09-1111-0018 | | RECORD OF BOREHOLE No C27-4 | | SHEET 1 OF 1 | | METRIC | |
| G.W.P. 2835-02-00 | | LOCATION N 4866367.2 ; E 299214.3 | | ORIGINATED BY TWB/CS | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE D-50 Track Mount, 108 mm Inside Diameter Hollow Stem Augers | | COMPILED BY SKB/HS | | | |
| DATUM Geodetic | | DATE October 13 and 14, 2010 | | CHECKED BY SMM | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT CONTENT LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|---|----|-----|--------------------------------------|---|-------------------|---|----------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | WATER CONTENT (%) | | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | W _p | W | W _L |
| 306.3 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | 1A | SS | 3 | | | | | | | | | | | | |
| 306.0 | | | 1B | | | | | | | | | | | | | | |
| 0.3 | CLAYEY SILT, some sand, trace gravel, trace organics and rootlets, zones of oxidation staining | | 2A | SS | 13 | | | | | | | | | | | | |
| 305.1 | Soft to stiff | | 2B | | | | | | | | | | | | | | |
| 1.2 | Brown to grey | | | | | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| | SILT and SAND, trace clay, trace gravel, trace organics | | 3 | SS | 10 | | | | | | | | | | | | |
| 304.0 | Compact | | | | | | | | | | | | | | | | |
| | Brown | | | | | | | | | | | | | | | | |
| | Wet | | | | | | | | | | | | | | | | |
| 304.0 | Augers grinding between 1.8 m and 2.1 m depth. | | 4 | SS | 9 | | | | | | | | | | | | |
| | CLAYEY SILT, trace sand, trace gravel | | | | | | | | | | | | | | | | |
| | Firm to stiff | | 5 | SS | 7 | | | | | | | | | | | | |
| | Grey | | | | | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| 302.6 | | | 6 | SS | 19 | | | | | | | | | | | | |
| 3.7 | CLAYEY SILT, some sand, trace gravel, trace organics, zones of oxidation (TILL) | | 7 | SS | 18 | | | | | | | | | | | | |
| | Very stiff to hard | | | | | | | | | | | | | | | | |
| | Brown to grey below 7.9 m | | | | | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 34 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

| | | | | | |
|---------|-----------------|------------------------------------|---|---------------|---------------|
| PROJECT | 09-1111-0018 | RECORD OF BOREHOLE No DC-11 | | SHEET 1 OF 2 | METRIC |
| W.P. | 2835-02-00 | LOCATION | N 4869323.0 ;E 298708.0 | ORIGINATED BY | AM |
| DIST | Central HWY 400 | BOREHOLE TYPE | D-50 Track Mount, 108 mm Outside Diameter Solid Stem Augers | COMPILED BY | MAS |
| DATUM | Geodetic | DATE | December 21, 2010 | CHECKED BY | SMM |

[illegible]

Continued Next Page

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 12/4/15 SIB

| PROJECT 09-1111-0018 | | RECORD OF BOREHOLE No DC-11 | | | | SHEET 2 OF 2 | | METRIC | | | | | | | | | | |
|----------------------|--|---|--------|------|----------------------------|------------------|--|--------------------|--|--|--|--|-------------------|---|---|--|--|--|
| W.P. 2835-02-00 | | LOCATION N 4869323.0 ; E 298708.0 | | | | ORIGINATED BY AM | | | | | | | | | | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE D-50 Track Mount, 108 mm Outside Diameter Solid Stem Augers | | | | COMPILED BY MAS | | | | | | | | | | | | |
| DATUM Geodetic | | DATE December 21, 2010 | | | | CHECKED BY SMM | | | | | | | | | | | | |
| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | WATER CONTENT (%) | | | | | |
| | --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | <div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div> | | | | | <div style="display: flex; justify-content: space-between;"> W_p W W_L </div> | | | | | | |
| 343.0 | SAND, some silt Compact to very dense Brown Moist | 14 | SS | 74 | | 343 | | | | | | | | ○ | | | | |
| 15.9 | END OF BOREHOLE NOTE: 1. Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 12/4/15 SIB

| PROJECT 09-1111-0018 | | RECORD OF BOREHOLE No DC-13 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | | | |
|----------------------|---|---|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| W.P. 2835-02-00 | | LOCATION N 4869392.1 ; E 298696.6 | | | | ORIGINATED BY AM | | | | | | | | | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE D-50 Track Mount, 108 mm Outside Diameter Solid Stem Augers | | | | COMPILED BY MAS | | | | | | | | | | | |
| DATUM Geodetic | | DATE December 21, 2010 | | | | CHECKED BY SMM | | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 355.0 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL | | | | | | | | | | | | | | | | |
| 0.2 | Silty SAND, trace gravel, containing rootlets, slightly organic Very loose to loose Brown Moist | | 1 | SS | 3 | | | | | | | | | | | | |
| | | | 2 | SS | 6 | | | | | | | | | | | | |
| 353.5 | | | | | | | | | | | | | | | | | |
| 1.5 | CLAYEY SILT, some sand to sandy, trace to some gravel (TILL) Firm to very stiff Brown Moist | | 3 | SS | 5 | | | | | | | | | | | | |
| | | | 4 | SS | 12 | | | | | | | | | | | | |
| | | | 5 | SS | 25 | | | | | | | | | | | | |
| | | | 6 | SS | 28 | | | | | | | | | | | | |
| | | | 7 | SS | 50 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | Augers grinding at a depth of 5.5 m | | 8 | SS | 24 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 30 | | | | | | | | | | | | |
| 346.8 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| 8.2 | NOTE: 1. Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | |

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 12/4/15 SIB

APPENDIX C

Borehole Records – Current 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>i.e.</i> , SAND and gravel) |
| > 20 to 35 | Primary soil name prefixed with "gravelly, sandy" as applicable |
| > 10 to 20 | some (<i>i.e.</i> , some sand) |
| ≤ 10 | trace (<i>i.e.</i> , 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 cm² 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, G _s) |
| 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) |
| Y | unit weight |

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

COARSE-GRAINED SOILS

Compactness¹

| 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 |

- 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 grain size. 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.
- 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 |

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- 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. |

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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 $= (w_L - w_P)$ |
| 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 |
| $C_{a(e)}$ | secondary compression index |
| C_a | rate of secondary compression |
| $C_{a(e)}$ | 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 $= \sigma'_p / \sigma'_{vo}$ |

(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 $= \tan \delta$ |
| 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 |

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

Notes: 1
2

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

| PROJECT | | 1786658 (W015) | | RECORD OF BOREHOLE No C27-5 | | SHEET 1 OF 1 | | METRIC | | | | | | | | | | | | | |
|---------------|---|---------------------------|---------|-----------------------------|------------|---|-----------------|---|--|--|--|---|---------------------------------|--|-------------|---|-------------|---------------------------------------|--|--|--|
| G.W.P. | | 2835-02-00 | | LOCATION | | N 4866302.8; E 299201.7 MTM NAD 83 ZONE 10 (LAT. 43.936692; LONG. -79.569735) | | ORIGINATED BY | | | | | | | | | | | | | |
| DIST | | Central HWY 400 | | BOREHOLE TYPE | | Power Auger; 203 mm O.D. Hollow Stem Augers | | COMPILED BY | | | | | | | | | | | | | |
| DATUM | | CGVD28 / HT2 0 (Geodetic) | | DATE | | November 9, 2020 | | CHECKED BY | | | | | | | | | | | | | |
| | | | | | | | | AMP | | | | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT | | | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | ELEVATION SCALE | SHEAR STRENGTH kPa | | | | | W _p W W _L | | | γ | GR SA SI CL | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED | | | | | WATER CONTENT (%) | | | | | | | | |
| 307.6 | GROUND SURFACE | | | | | | | 20 40 60 80 100 | | | | | | | | | | | | | |
| 0.0 | ASPHALT (150 mm) | | | | | | | | | | | | | | | | | | | | |
| 0.2 | SAND (SP) to SILTY SAND (SM), trace gravel to gravelly (FILL) | | | | | | | | | | | | | | | | | | | | |
| 306.7 | Brown Moist | | | | | | | | | | | | | | | | | | | | |
| 0.9 | CLAYEY SILT (CL), some sand, trace gravel | | 1A | SS | 13 | | | | | | | | | | | | | | | | |
| | Stiff to very stiff | | 1B | | | | | | | | | | | | | | | | | | |
| | Brown Moist | | 2 | SS | 8 | | | | | | | | | | | | | | | | |
| | | | 3 | SS | 16 | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 17 | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 19 | | | | | | | | | | | | | | | | |
| 303.1 | SILTY CLAY (CI), trace sand | | | | | | | | | | | | | | | | | | | | |
| 4.5 | Soft Brown Moist | | 6 | SS | 3 | | | | | | | | | | | | | | | | |
| 302.0 | CLAYEY SILT (CL), some sand, trace gravel (TILL) | | | | | | | | | | | | | | | | | | | | |
| 5.6 | Stiff Brown Moist | | 7 | SS | 14 | | | | | | | | | | | | | | | | |
| | - 50 mm sand seam at 6.6 m depth | | | | | | | | | | | | | | | | | | | | |
| 299.5 | SILT (ML), trace clay | | 8A | SS | 8 | | | | | | | | | | | | | | | | |
| 8.1 | Brown Moist | | 8B | | | | | | | | | | | | | | | | | | |
| 298.9 | CLAYEY SILT (CL), trace sand | | | | | | | | | | | | | | | | | | | | |
| 8.7 | Very stiff Brown Moist | | 9 | SS | 16 | | | | | | | | | | | | | | | | |
| 297.4 | SILT (ML), trace clay | | | | | | | | | | | | | | | | | | | | |
| 10.2 | Compact Brown Wet | | | | | | | | | | | | | | | | | | | | |
| 296.3 | | | 10 | SS | 27 | | | | | | | | | | | | | | | | |
| 11.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | |
| | NOTE: | | | | | | | | | | | | | | | | | | | | |
| | 1. Borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | | | | | |

| PROJECT | | RECORD OF BOREHOLE | | | | No CCTV-2 | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|----------------------|---|--|---------|------|------------|-------------------------|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| W.P. 2835-02-00 | | LOCATION N 4867319.3; E 299042.3 MTM NAD 83 ZONE 10 (LAT. 43.945840; LONG. -79.571732) | | | | ORIGINATED BY LM | | | | | | | | | | | |
| DIST Central HWY 400 | | BOREHOLE TYPE Power Auger, 203 mm O.D. Hollow Stem Augers | | | | COMPILED BY CC | | | | | | | | | | | |
| DATUM HT2 0 | | DATE November 27, 2020 | | | | CHECKED BY AMP | | | | | | | | | | | |
| 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 | | | | | | | | | |
| 305.6 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL (600 mm) | | 1 | SS | 2 | | | | | | | | | | | | |
| 305.0 | | | 2 | SS | 6 | | | | | | | | | | | | |
| 0.6 | CLAYEY SILT (CL), trace sand, containing organics, oxidation staining (FILL) Firm Grey Moist | | | | | | | | | | | | | | | | |
| 303.8 | | | 3A | SS | 6 | | | | | | | | | | | | |
| 303.4 | ORGANIC SILT (OL) Dark brown and grey mottling Moist | | 3B | | | | | | | | | | | | | | |
| 2.2 | | | | | | | | | | | | | | | | | |
| | CLAYEY SILT-SILT (CL-ML), some sand to sandy, trace gravel (TILL) Stiff Grey Moist | | 4 | SS | 15 | | | | | | | | | | | | |
| | | | 5 | SS | 12 | | | | | | | | | | | | |
| 301.9 | | | | | | | | | | | | | | | | | |
| | Sandy SILT (ML) Brown Moist | | 6A | SS | 21 | | | | | | | | | | | | |
| 301.5 | | | 6B | | | | | | | | | | | | | | |
| 4.1 | | | | | | | | | | | | | | | | | |
| | CLAYEY SILT-SILT (CL-ML), some sand to sandy, trace gravel (TILL) Very stiff Grey Moist | | 7 | SS | 17 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 18 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 9 | SS | 21 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 20 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 11 | SS | 23 | | | | | | | | | | | | |
| 295.2 | | | | | | | | | | | | | | | | | |
| 10.4 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| | NOTE: 1. Water was not encountered in borehole during drilling. | | | | | | | | | | | | | | | | |

| PROJECT | | 1786658 (W015) | | RECORD OF BOREHOLE No CCTV-4 | | SHEET 1 OF 1 | | METRIC | | | | | | | | | | | | | | | | | |
|---|-----------|---|------------|------------------------------|------|---|--|---------------|-----------------|--|--|--|--|--|---|--|--|-------------|--|--|---------------------------------------|--|--|--|--|
| W.P. | | 2835-02-00 | | LOCATION | | N 4870520.2; E 298484.7 MTM NAD 83 ZONE 10 (LAT. 43.974646; LONG. -79.578717) | | ORIGINATED BY | | | | | | | | | | | | | | | | | |
| DIST | | Central HWY 400 | | BOREHOLE TYPE | | Power Auger; 203 mm O.D. Hollow Stem Augers | | COMPILED BY | | | | | | | | | | | | | | | | | |
| DATUM | | HT2 0 | | DATE | | November 13, 2020 | | CHECKED BY | | | | | | | | | | | | | | | | | |
| | | | | | | | | AMP | | | | | | | | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | | | ELEVATION SCALE | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT | | | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
| ELEV | DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | | | | | | | | | | | | | | |
| 317.8 | 0.0 | GROUND SURFACE | | | | | | | | | | | | | | | | | | | | | | | |
| | 0.2 | TOPSOIL (150 mm) | | 1A | SS | 6 | | | | | | | | | | | | | | | | | | | |
| | 0.7 | SILTY SAND (SM), some gravel, trace clay | | 1B | SS | | | | | | | | | | | | | | | | | | | | |
| 317.1 | 0.7 | Loose Brown Moist | | 2 | SS | 14 | | | | | | | | | | | | | | | | | | | |
| | | Sandy SILT (ML), trace clay | | | | | | | | | | | | | | | | | | | | | | | |
| | | Compact Brown Moist | | 3 | SS | 19 | | | | | | | | | | | | | | | | | | | |
| | | | | 4 | SS | 23 | | | | | | | | | | | | | | | | | | | |
| | | | | 5 | SS | 21 | | | | | | | | | | | | | | | | | | | |
| | | | | 6 | SS | 20 | | | | | | | | | | | | | | | | | | | |
| 313.3 | 4.5 | CLAYEY SILT-SILT (CL-ML), some sand | | 7 | SS | 18 | | | | | | | | | | | | | | | | | | | |
| | | Very stiff Brown Wet | | | | | | | | | | | | | | | | | | | | | | | |
| 312.2 | 5.6 | SILT (ML), trace to some sand, trace clay | | 8 | SS | 19 | | | | | | | | | | | | | | | | | | | |
| | | Compact Brown Wet | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 9 | SS | 28 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 10 | SS | 22 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | 11 | SS | 26 | | | | | | | | | | | | | | | | | | | |
| 306.5 | 11.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | | | | | | |
| NOTES: | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. Borehole caved to a depth of 8.4 m (Elev. 309.4 m) upon completion of drilling and removal of augers. | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Water measured in open borehole at a depth of 6.5 m (Elev. 311.2 m) upon completion of drilling and removal of augers. | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Water measured in piezometer as follows: | | | | | | | | | | | | | | | | | | | | | | | | | |
| Date | Depth (m) | Elev. (m) | | | | | | | | | | | | | | | | | | | | | | | |
| 04-Dec-20 | 6.3 | 311.5 | | | | | | | | | | | | | | | | | | | | | | | |
| 10-Feb-21 | 6.3 | 311.5 | | | | | | | | | | | | | | | | | | | | | | | |

| PROJECT | | 1786658 (W015) | | RECORD OF BOREHOLE No CCTV-5 | | SHEET 1 OF 1 | | METRIC | | | | | | | | | | | | |
|---|-------|---|------------|------------------------------|------|---|-------------------------|-----------------|---|--|--|-------------------|--|--|---------------------------------------|--|--|-------------|--|--|
| W.P. | | 2835-02-00 | | LOCATION | | N 4871604.9; E 298307.0 MTM NAD 83 ZONE 10 (LAT. 43.984408; LONG. -79.580944) | | ORIGINATED BY | | | | | | | | | | | | |
| DIST | | Central HWY 400 | | BOREHOLE TYPE | | Power Auger; 203 mm O.D. Hollow Stem Augers | | COMPILED BY | | | | | | | | | | | | |
| DATUM | | HT2 0 | | DATE | | November 10, 2020 | | CHECKED BY | | | | | | | | | | | | |
| | | | | | | | | AMP | | | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT | | | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | |
| ELEV | DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH kPa | | | WATER CONTENT (%) | | | γ | | | GR SA SI CL | | |
| 317.3 | 0.0 | GROUND SURFACE | | 1A | SS | 7 | | 317 | 20 40 60 80 100 | | | 10 20 30 | | | kN/m³ | | | | | |
| 316.6 | 0.7 | TOPSOIL (100 mm) CLAYEY SILT (CL), trace gravel, trace sand, containing organics Firm Brown Moist | | 1B | SS | 7 | | 317 | 20 40 60 80 100 | | | 10 20 30 | | | OC=3.0% | | | | | |
| | | SILT of slight plasticity (ML), trace gravel, some sand Stiff to very stiff Brown Moist | | 2 | SS | 13 | | 316 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| | | | | 3 | SS | 16 | | 315 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| 315.1 | 2.2 | SILT (ML), trace sand to sandy, trace gravel Compact to very dense Brown Moist | | 4 | SS | 49 | | 315 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| | | | | 5 | SS | 55 | | 314 | 20 40 60 80 100 | | | 10 20 30 | | | 2 3 91 4 | | | | | |
| | | - Sandy below 4.5 m depth | | 6 | SS | 56 | | 313 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| | | | | 7 | SS | 16 | | 312 | 20 40 60 80 100 | | | 10 20 30 | | | 0 34 66 0 | | | | | |
| | | | | 8 | SS | 52 | | 311 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| | | | | 9 | SS | 57 | | 310 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| | | - Wet below 9.1 m depth | | 10 | SS | 82 | | 308 | 20 40 60 80 100 | | | 10 20 30 | | | 0 23 77 0 | | | | | |
| | | | | 11 | SS | 39 | | 307 | 20 40 60 80 100 | | | 10 20 30 | | | | | | | | |
| 306.0 | 11.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | | | |
| NOTES: 1. Borehole caved to a depth of 8.2 m (Elev. 309.1 m) upon completion of drilling and removal of augers. 2. Water measured in open borehole at a depth of 5.6 m (Elev. 311.7 m) upon completion and removal of augers. 3. Water measured in piezometer as follows: <div style="display: flex; justify-content: space-between;"> <div>Date</div> <div>Depth (m)</div> <div>Elev. (m)</div> </div> <div style="display: flex; justify-content: space-between;"> <div>03-Dec-20</div> <div>5.4</div> <div>311.9</div> </div> <div style="display: flex; justify-content: space-between;"> <div>10-Feb-21</div> <div>5.4</div> <div>311.9</div> </div> | | | | | | | | | | | | | | | | | | | | |

GTA-MTO 001 S:\CLIENTS\MTOWHY_400_KING_TO_LLOYDTOWN\02_DATA\GINT\HWY_400_KING_TO_LLOYDTOWN\GPJ GAL-GTA.GDT 4/8/21

| PROJECT | | 1786658 (W015) | | RECORD OF BOREHOLE No VMS-1 | | SHEET 1 OF 1 | | METRIC | | | | | |
|---|---|-----------------|---------|-----------------------------|------------|---|-----------------|--|--|---|--|----------------------|---------------------------------------|
| W.P. | | 2835-02-00 | | LOCATION | | N 4877942.1; E 296758.1 MTM NAD 83 ZONE 10 (LAT. 44.041432; LONG. -79.600349) | | ORIGINATED BY | | | | | |
| DIST | | Central HWY 400 | | BOREHOLE TYPE | | Power Auger; 203 mm O.D. Hollow Stem Augers | | COMPILED BY | | | | | |
| DATUM | | HT2 0 | | DATE | | November 27, 2020 | | CHECKED BY | | | | | |
| | | | | | | | | AMP | | | | | |
| 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 | | | |
| 220.0 | GROUND SURFACE | | | | | | | | | | | | |
| 0.0 | ASPHALT (150 mm) | | | | | | | | | | | | |
| 0.2 | SILTY SAND (SW), trace gravel (FILL) Loose to compact Brown to grey Moist | | 1 | SS | 17 | | | | | | | | |
| | | | 2 | SS | 10 | | | | | | | | |
| 218.2 | | | 3A | SS | 6 | | | | | | | | |
| 1.8 | PEAT (PT) Very loose to loose Dark brown to black Moist | | 3B | | | | | | | | | | |
| | | | 4 | SS | 4 | | | | | | | | |
| 216.6 | | | 5A | SS | 3 | | | | | | | | |
| 3.5 | CLAYEY SILT-SILT to CLAYEY SILT (CL), trace sand, containing organics to a depth of 4.3 m Soft to stiff Grey Moist | | 5B | | | | | | | | | | |
| | | | 6 | SS | 5 | | | | | | | | |
| | | | 7 | SS | 9 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 8 | SS | 5 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 9 | SS | 2 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 10 | SS | 5 | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | 11 | SS | 10 | | | | | | | | |
| 209.6 | | | | | | | | | | | | | |
| 10.4 | END OF BOREHOLE | | | | | | | | | | | | |
| NOTES: | | | | | | | | | | | | | |
| 1. Borehole open upon completion of drilling and removal of augers. | | | | | | | | | | | | | |
| 2. Water measured in open borehole at a depth of 1.0 m (Elev. 219.0 m) upon completion of drilling and removal of augers. | | | | | | | | | | | | | |



GTA-MTO 001 S:\CLIENTS\IMTO\HWY 400 KING TO LLOYDTOWN\02 DATA\GINT\HWY 400 KING TO LLOYDTOWN.GPJ GAL-GTA.GDT 4/8/21

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

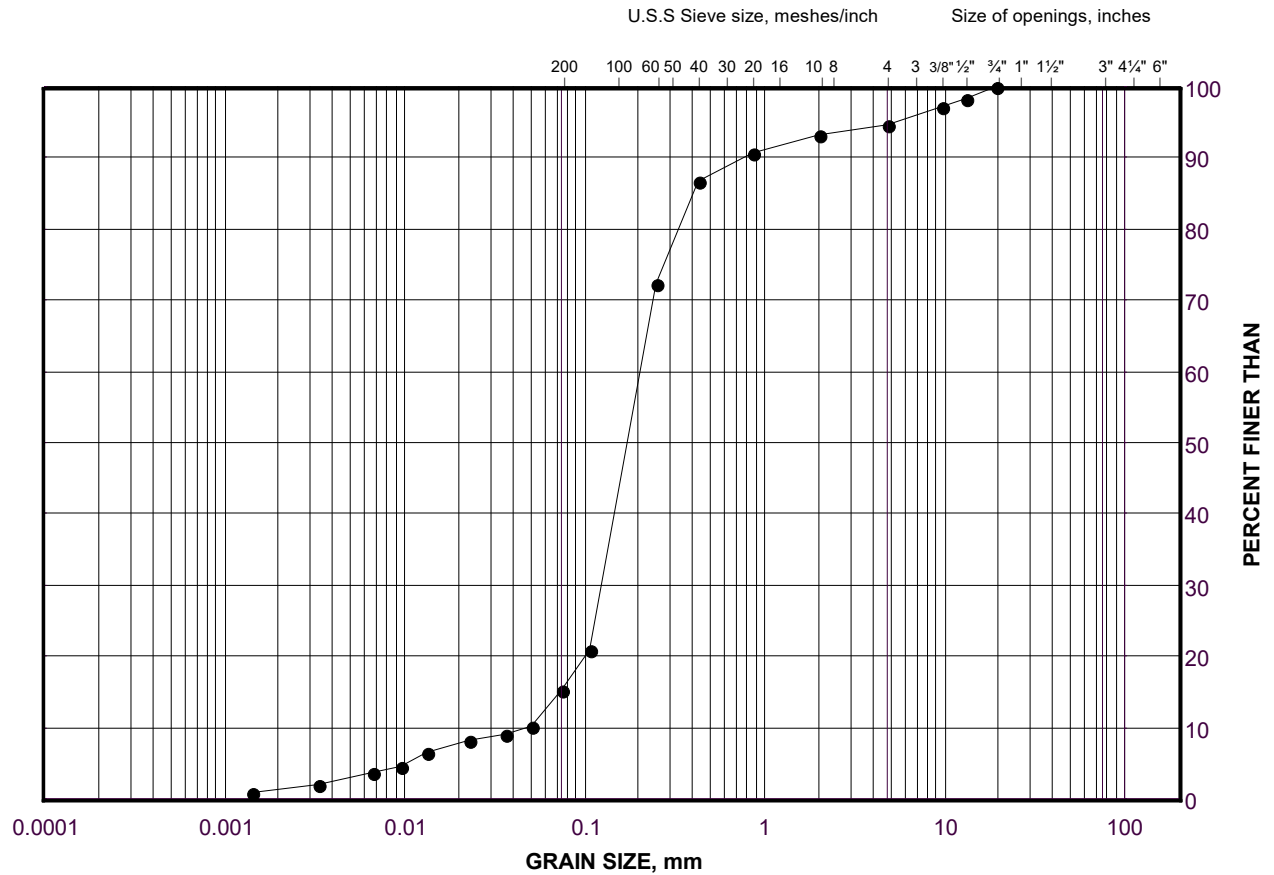
APPENDIX D

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) (FILL)

FIGURE D-1



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

LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| • | VMS-1 | SS2 | 218.6 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

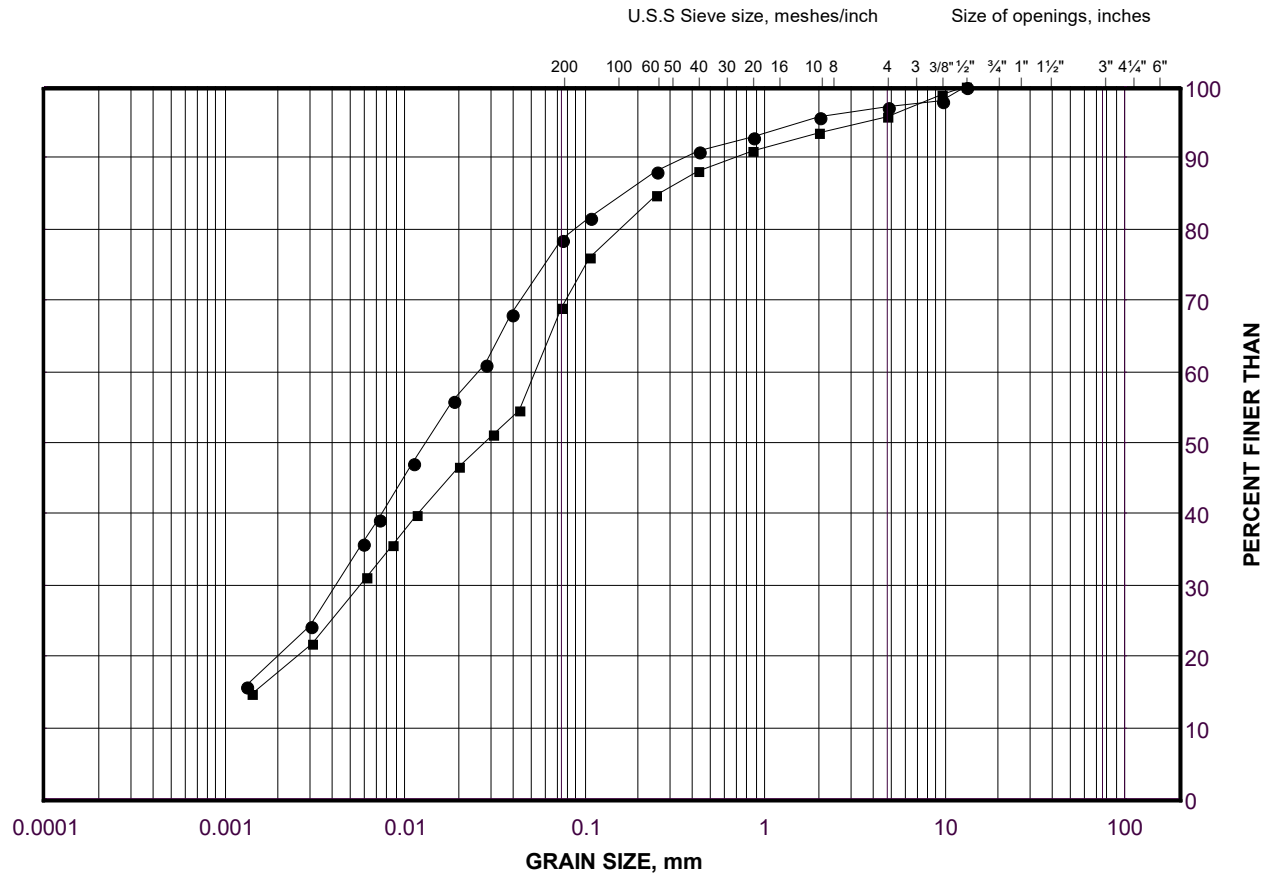
Golder Associates

Date: 29-Mar-21

GRAIN SIZE DISTRIBUTION

CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (FILL)

FIGURE D-2



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

LEGEND

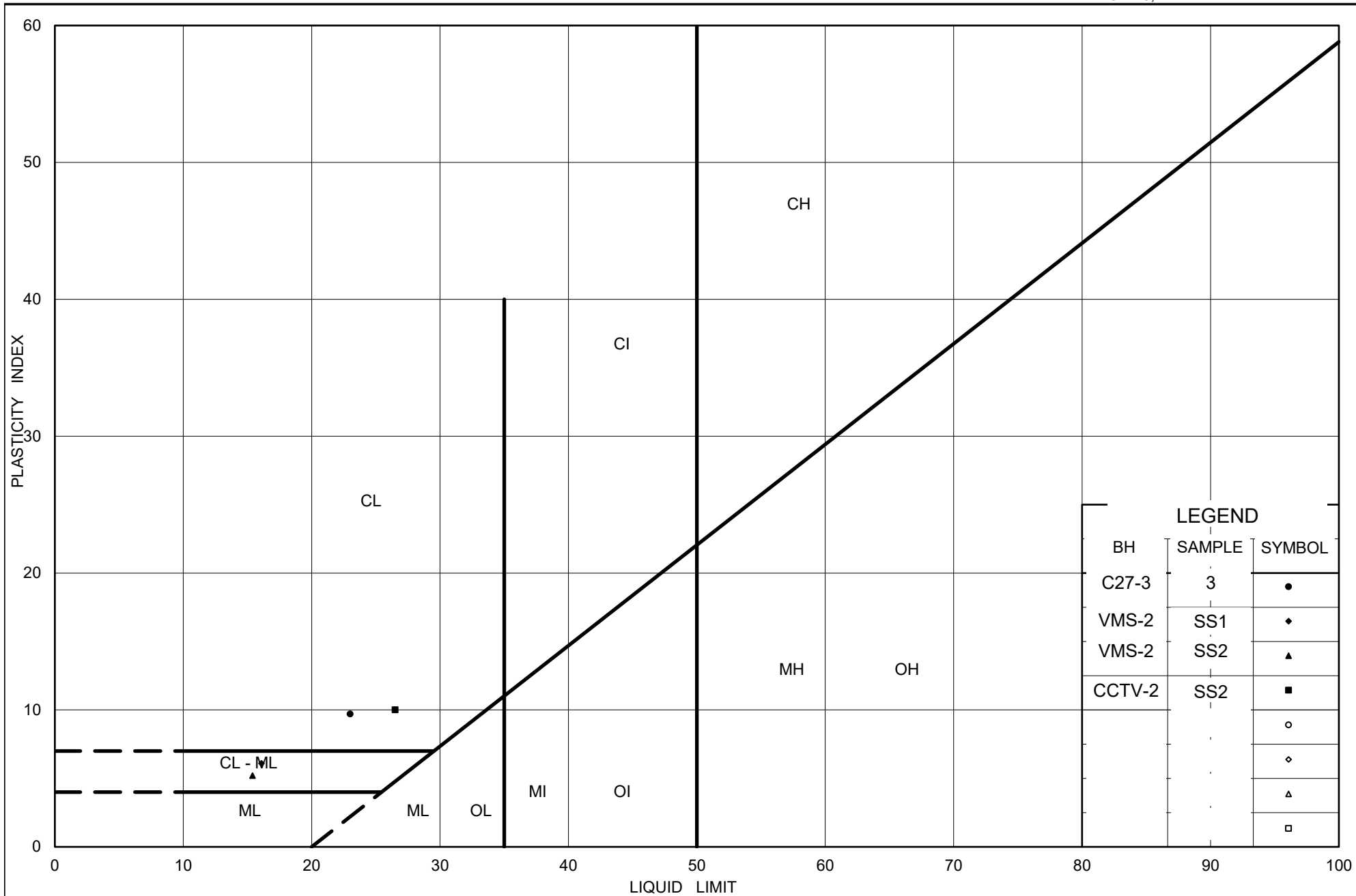
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C27-3 | 3 | 305.4 |
| ■ | VMS-2 | SS2 | 317.8 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

Golder Associates

Date: 29-Mar-21



Ministry of Transportation

Ontario

PLASTICITY CHART CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (FILL)

Figure No. D-3

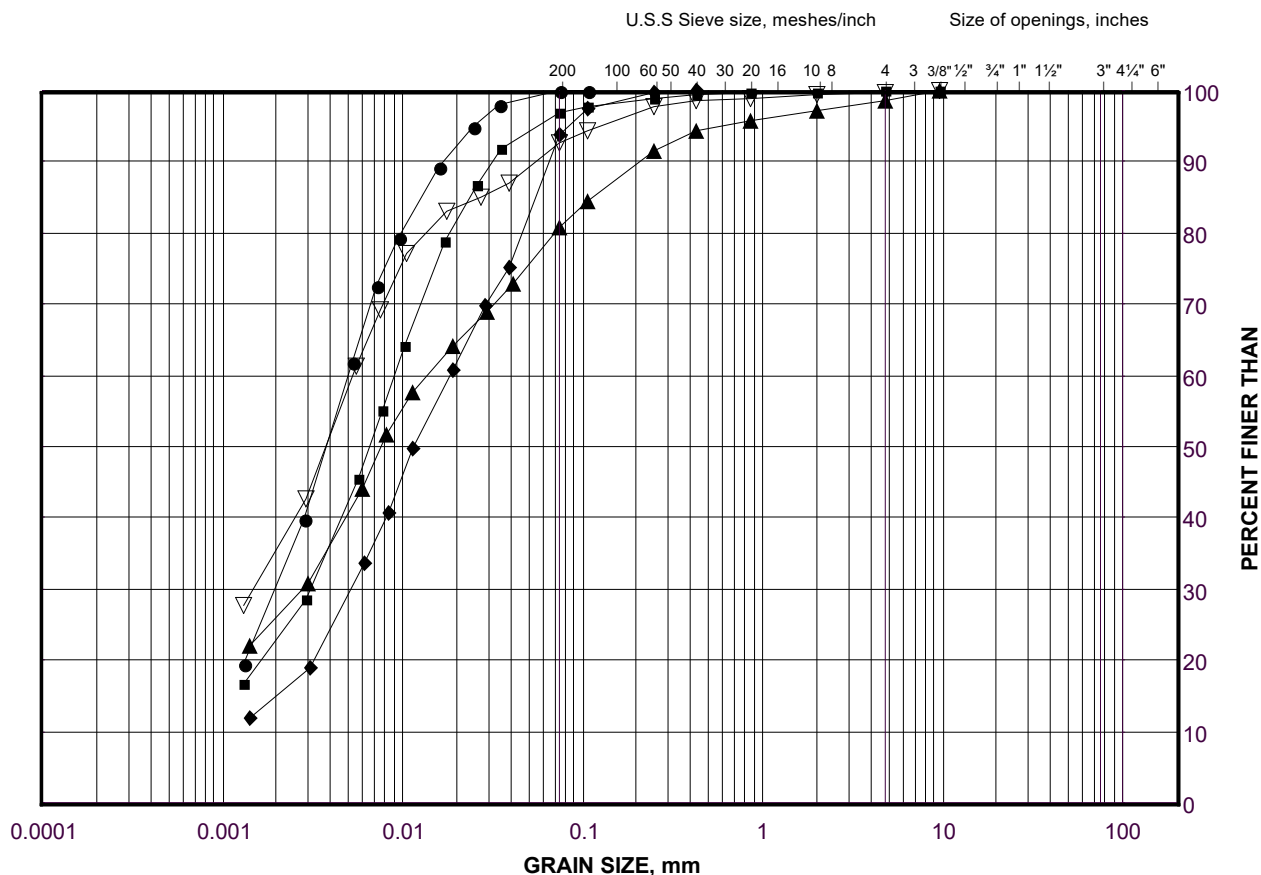
Project No. 1786658 - 09-1111-0018

Checked By: AMP

GRAIN SIZE DISTRIBUTION

CLAYEY SILT-SILT (CL-ML) to SILTY CLAY (CI)

FIGURE D-4



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

LEGEND

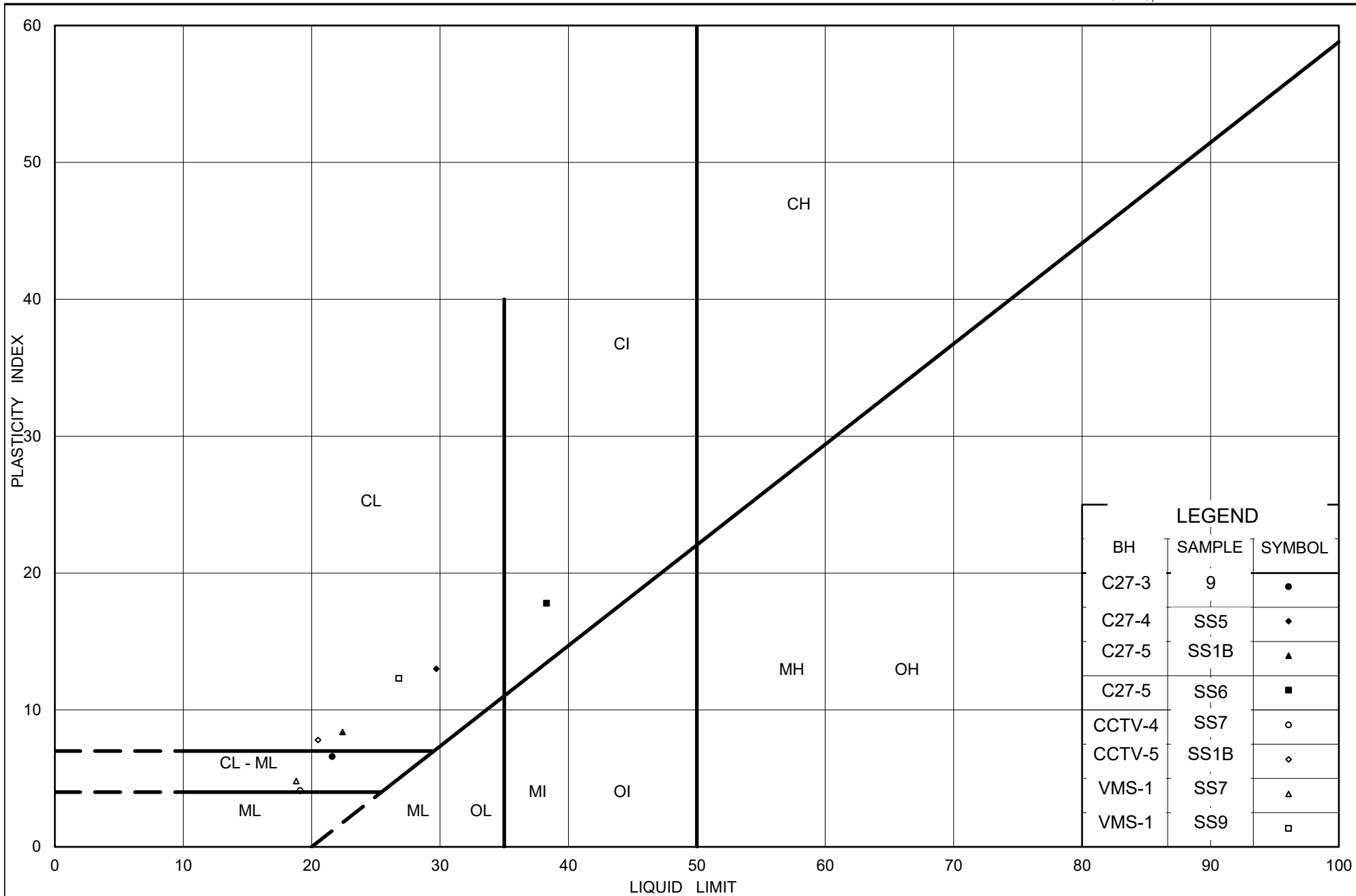
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C27-3 | 11 | 295.5 |
| ■ | C27-3 | 9 | 298.5 |
| ◆ | VMS-1 | SS11 | 209.6 |
| ▲ | C27-5 | SS1B | 306.0 |
| ▽ | C27-5 | SS6 | 302.4 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

Golder Associates

Date: 29-Mar-21



Ministry of Transportation

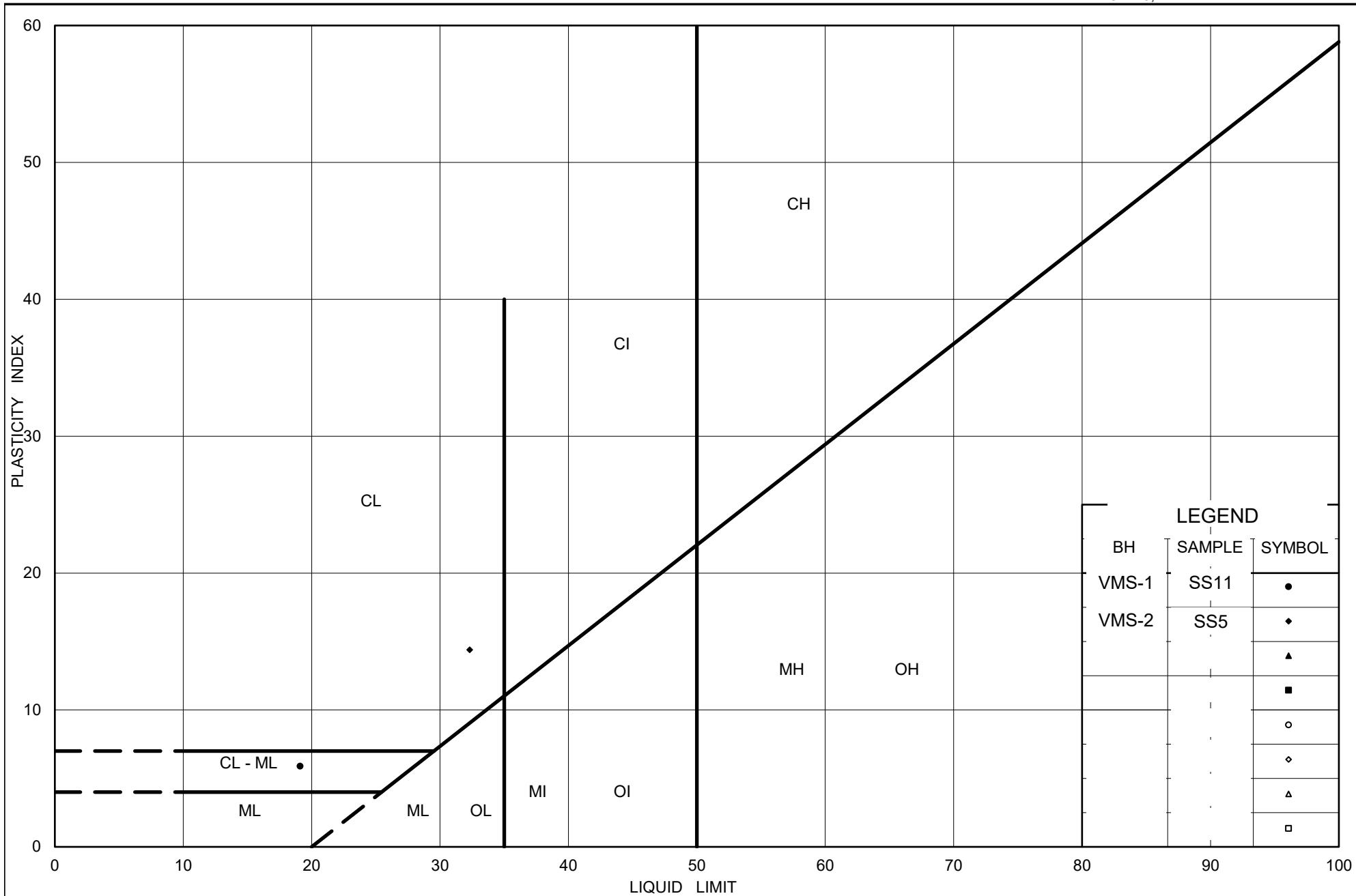
Ontario

PLASTICITY CHART CLAYEY SILT-SILT (CL-ML) to SILTY CLAY (CI)

Figure No. D-5A

Project No. 1786658 - 09-1111-0018

Checked By: AMP



Ministry of Transportation

Ontario

PLASTICITY CHART CLAYEY SILT-SILT (CL-ML) to SILTY CLAY (CI)

Figure No. D-5B

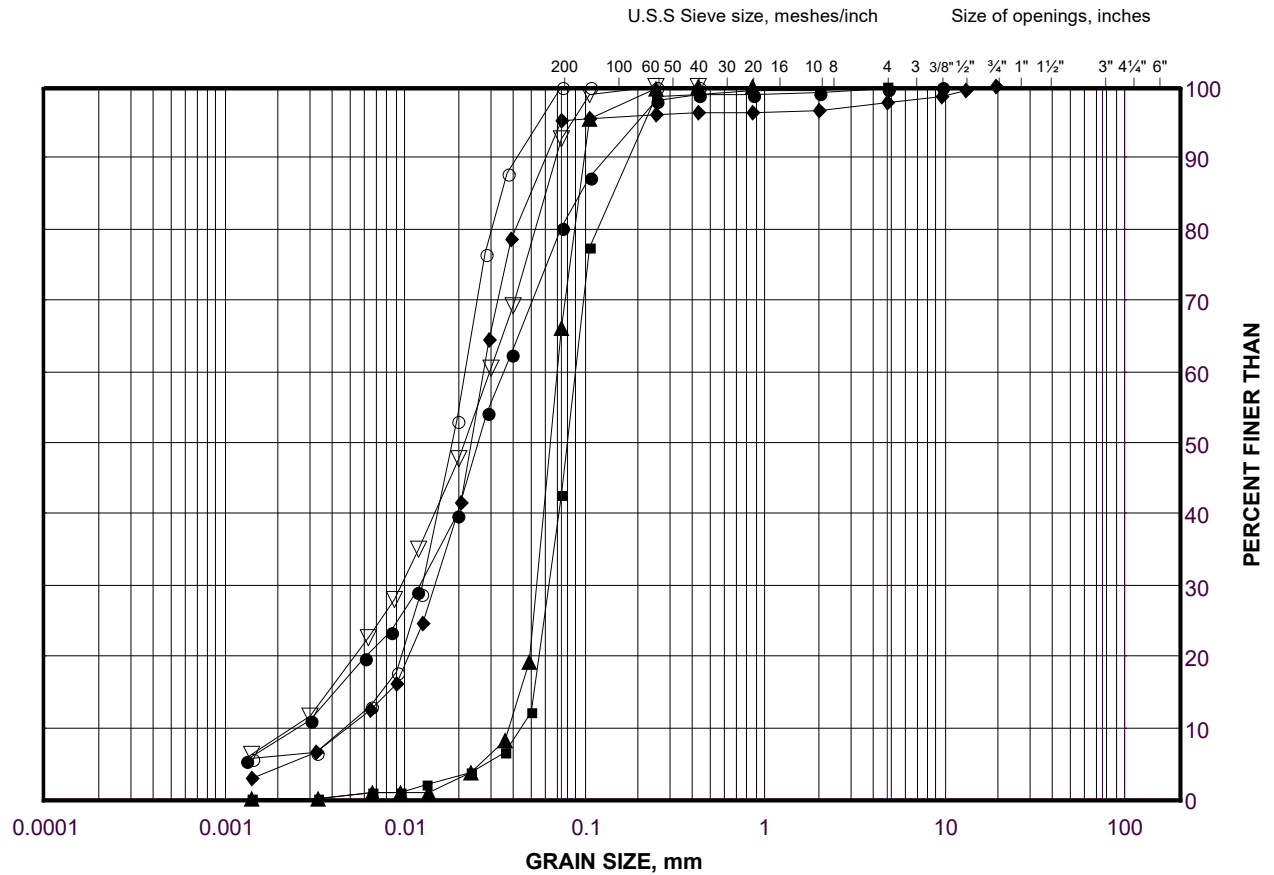
Project No. 1786658 - 09-1111-0018

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILT (ML) of slight Plasticity to SAND (SP)

FIGURE D-6A



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

LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | DC-11 | 8 | 352.5 |
| ■ | CCTV-5 | SS10 | 307.5 |
| ◆ | CCTV-5 | SS5 | 313.6 |
| ▲ | CCTV-5 | SS7 | 312.0 |
| ▽ | CCTV-4 | SS8 | 311.0 |
| ○ | C27-5 | SS8B | 299.3 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

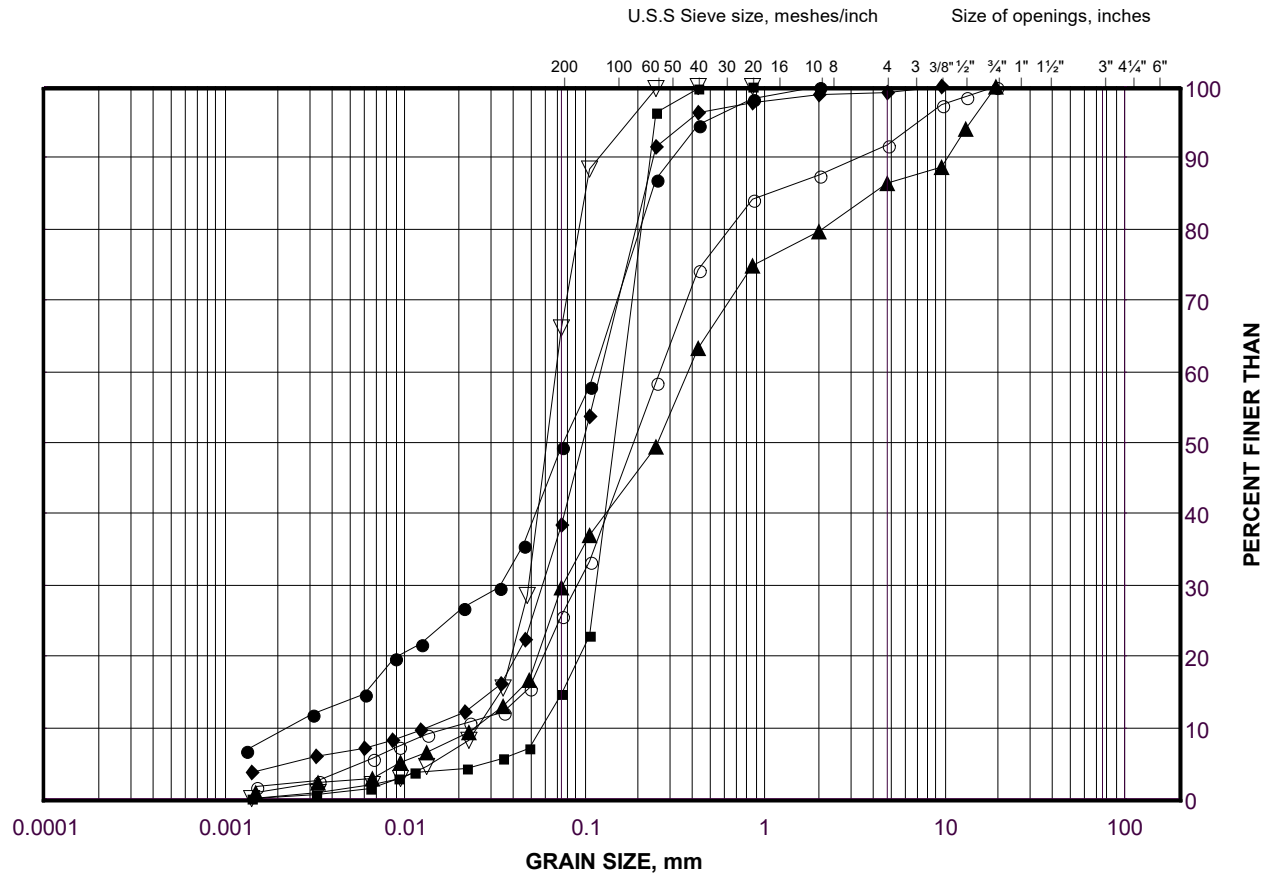
Golder Associates

Date: 29-Mar-21

GRAIN SIZE DISTRIBUTION

SILT (ML) of Slight Plasticity to SAND (SP)

FIGURE D-6B



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

LEGEND

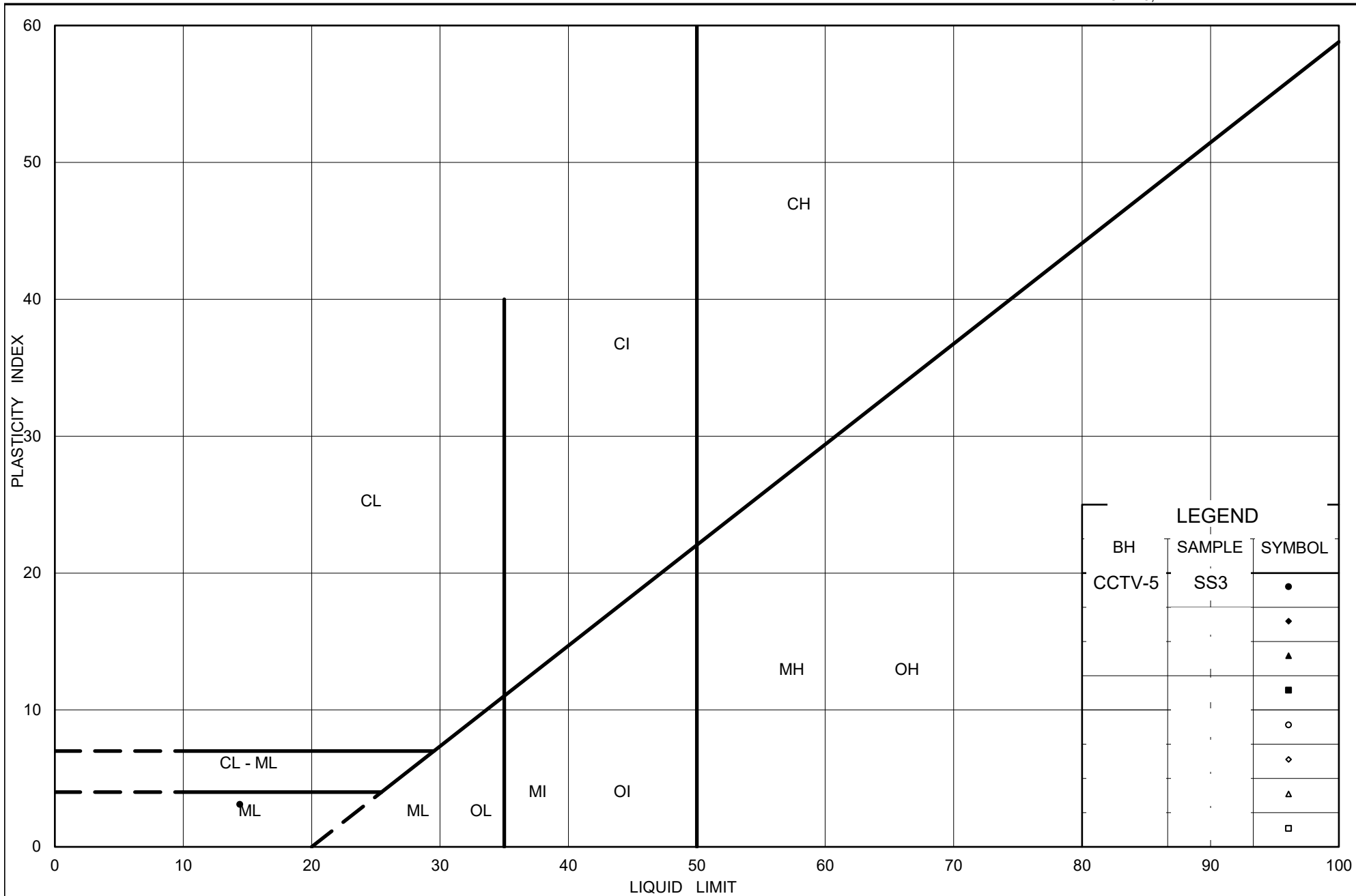
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | C27-4 | 10 | 296.9 |
| ■ | DC-11 | 12 | 346.4 |
| ◆ | C27-4 | 3 | 304.5 |
| ▲ | CCTV-4 | SS1B | 317.1 |
| ▽ | CCTV-4 | SS4 | 314.8 |
| ○ | VMS-2 | SS4 | 216.3 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

Golder Associates

Date: 29-Mar-21



Ministry of Transportation

Ontario

PLASTICITY CHART **SILT (ML) of slight plasticity**

Figure No. D-7

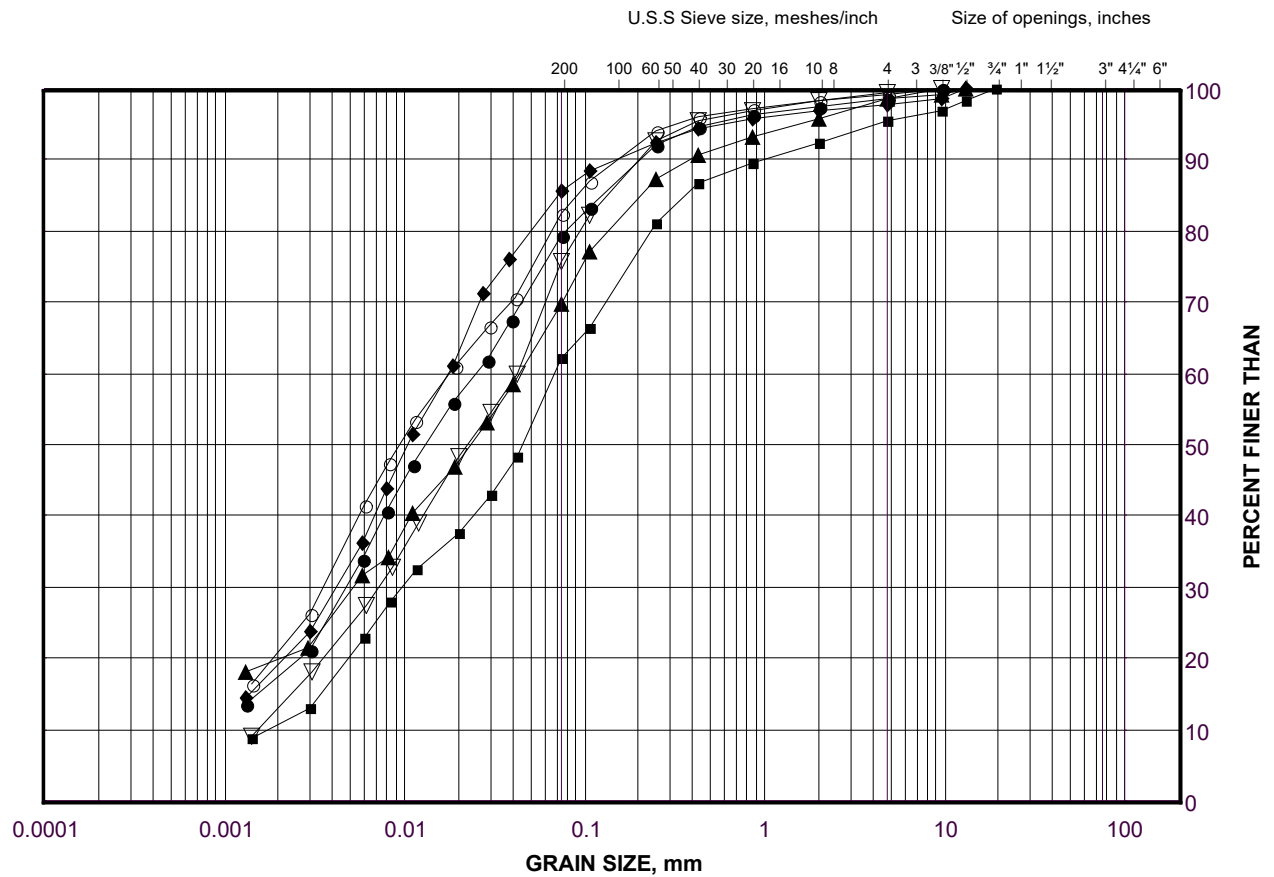
Project No. 1786658 - 09-1111-0018

Checked By: AMP

GRAIN SIZE DISTRIBUTION

CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (TILL)

FIGURE D-8



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

LEGEND

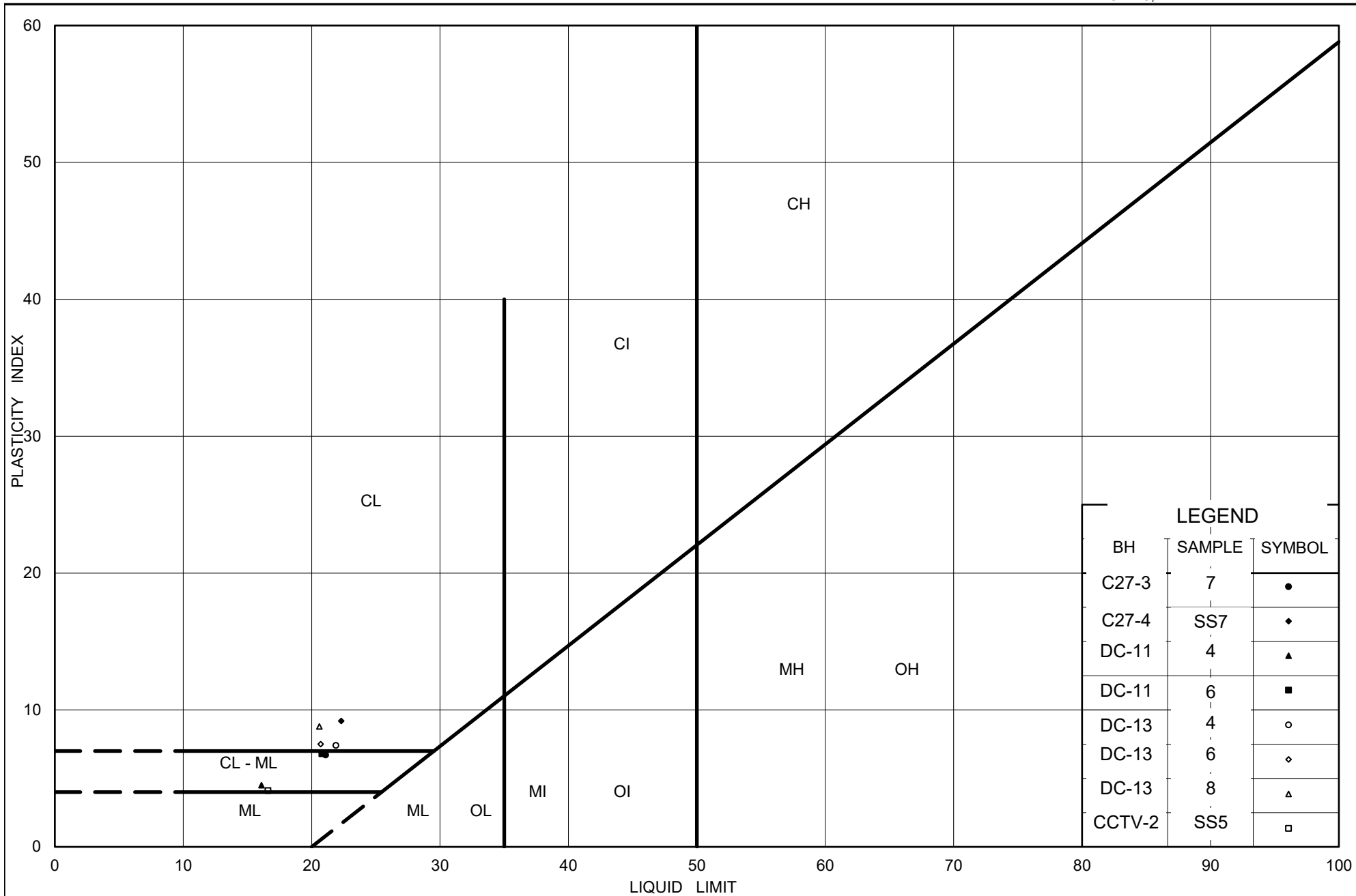
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | DC-13 | 4 | 352.4 |
| ■ | DC-11 | 4 | 356.3 |
| ◆ | C27-3 | 7 | 301.5 |
| ▲ | DC-13 | 8 | 348.6 |
| ▽ | CCTV-2 | SS5 | 301.9 |
| ○ | CCTV-2 | SS7 | 300.3 |

Project Number: 1786658,09-1111-0018

Checked By: AMP

Golder Associates

Date: 29-Mar-21



Ministry of Transportation

Ontario

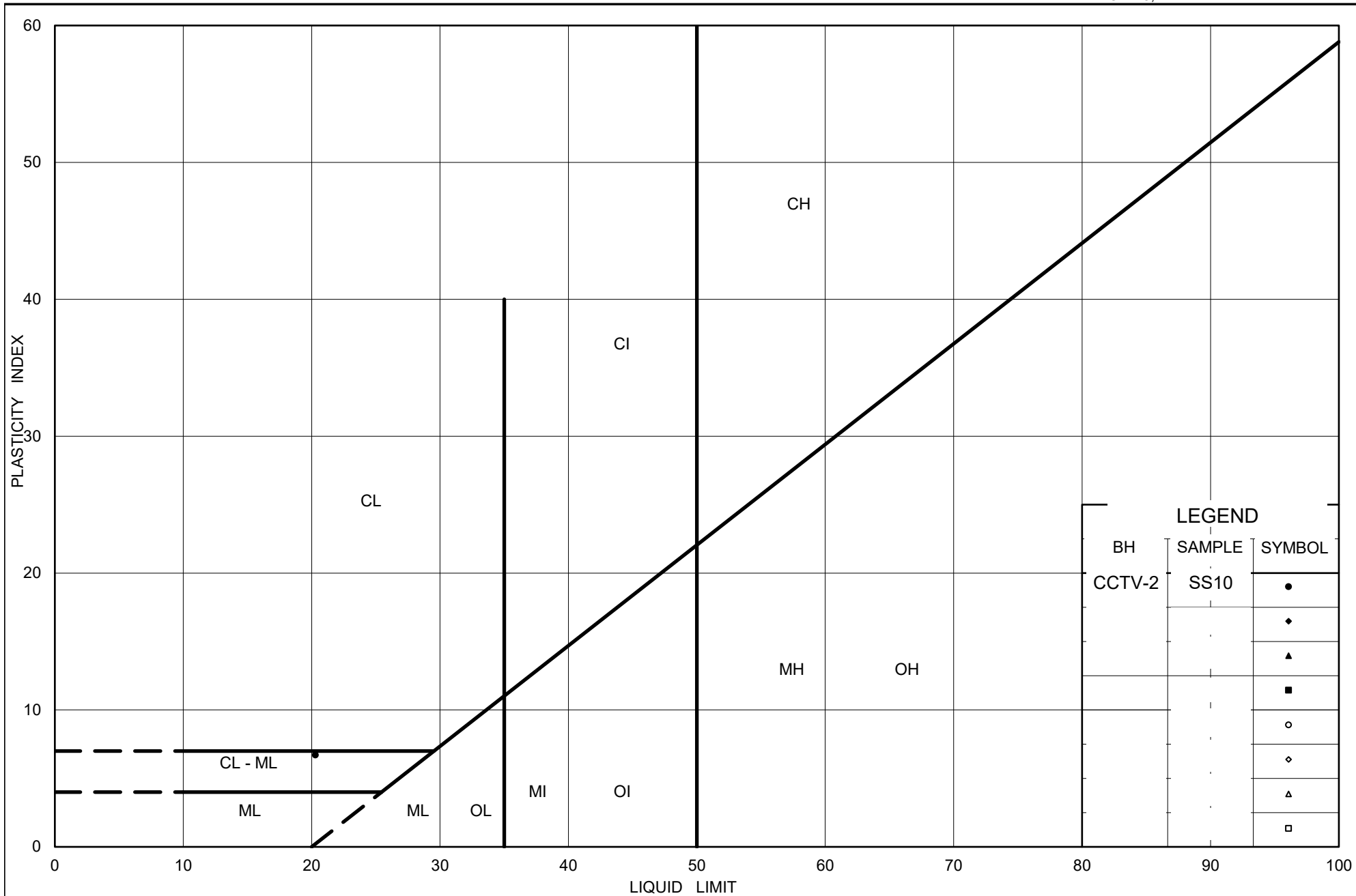
PLASTICITY CHART

CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (TILL)

Figure No. D-9A

Project No. 1786658 - 09-1111-0018

Checked By: AMP



Ministry of Transportation

Ontario

PLASTICITY CHART CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL) (TILL)

Figure No. D-9B

Project No. 1786658 - 09-1111-0018

Checked By: AMP

APPENDIX E

Analytical Laboratory Test Results



Your Project #: 1786658 WO 15
Your C.O.C. #: 805726-01-01, 794544-05-01

Attention: Carter Comish

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/01/28
Report #: R6497732
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: C0X1766

Received: 2020/12/11, 18:34

Sample Matrix: Soil
Samples Received: 4

| Analyses | Quantity | Date | Date | Laboratory Method | Analytical Method |
|------------------------------|----------|------------|------------|-------------------|-------------------|
| | | Extracted | Analyzed | | |
| Chloride (20:1 extract) | 3 | 2020/12/16 | 2020/12/17 | CAM SOP-00463 | SM 23 4500-Cl E m |
| Chloride (20:1 extract) | 1 | 2020/12/17 | 2020/12/18 | CAM SOP-00463 | SM 23 4500-Cl E m |
| Conductivity | 4 | 2020/12/17 | 2020/12/17 | CAM SOP-00414 | OMOE E3530 v1 m |
| pH CaCl ₂ EXTRACT | 4 | 2020/12/16 | 2020/12/16 | CAM SOP-00413 | EPA 9045 D m |
| Resistivity of Soil | 4 | 2020/12/14 | 2020/12/17 | CAM SOP-00414 | SM 23 2510 m |
| Sulphate (20:1 Extract) | 3 | 2020/12/16 | 2020/12/17 | CAM SOP-00464 | EPA 375.4 m |
| Sulphate (20:1 Extract) | 1 | 2020/12/17 | 2020/12/18 | CAM SOP-00464 | EPA 375.4 m |

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.



Your Project #: 1786658 WO 15
Your C.O.C. #: 805726-01-01, 794544-05-01

Attention: Carter Comish

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/01/28
Report #: R6497732
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: C0X1766

Received: 2020/12/11, 18:34

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: emese.gitej@bureauveritas.com

Phone# (905)817-5829

=====

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



BUREAU
VERITAS

BV Labs Job #: COX1766
Report Date: 2021/01/28

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: CC

SOIL CORROSIVITY PACKAGE (SOIL)

| | | | | | | | | | |
|----------------------|--------------|--------------------|-----------------|-------------------|------------|-----------------|---------------------------|------------|-----------------|
| BV Labs ID | | OKC178 | | OKC179 | | | OKC179 | | |
| Sampling Date | | 2020/11/27 | | 2020/11/13 | | | 2020/11/13 | | |
| COC Number | | 805726-01-01 | | 805726-01-01 | | | 805726-01-01 | | |
| | UNITS | CCTV-2 SA3B | QC Batch | CCTV-4 SA4 | RDL | QC Batch | CCTV-4 SA4 Lab-Dup | RDL | QC Batch |

Calculated Parameters

| | | | | | | | | | |
|-------------|--------|-----|---------|------|--|---------|--|--|--|
| Resistivity | ohm-cm | 780 | 7108299 | 6300 | | 7108299 | | | |
|-------------|--------|-----|---------|------|--|---------|--|--|--|

Inorganics

| | | | | | | | | | |
|-------------------------------|---------|------|---------|------|----|---------|-----|----|---------|
| Soluble (20:1) Chloride (Cl-) | ug/g | 560 | 7112592 | 44 | 20 | 7114805 | | | |
| Conductivity | umho/cm | 1280 | 7114634 | 158 | 2 | 7114634 | | | |
| Available (CaCl2) pH | pH | 7.28 | 7112629 | 7.90 | | 7112629 | | | |
| Soluble (20:1) Sulphate (SO4) | ug/g | <20 | 7112601 | <20 | 20 | 7114979 | <20 | 20 | 7114979 |

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

| | | | | | | | | | |
|----------------------|--------------|-------------------|------------|-----------------|------------|-----------------|-------------------------|------------|-----------------|
| BV Labs ID | | OKC180 | | OKC182 | | | OKC182 | | |
| Sampling Date | | 2020/11/10 | | 2020/11/09 | | | 2020/11/09 | | |
| COC Number | | 805726-01-01 | | 805726-01-01 | | | 805726-01-01 | | |
| | UNITS | CCTV-5 SA3 | RDL | 27-5 SA2 | RDL | QC Batch | 27-5 SA2 Lab-Dup | RDL | QC Batch |

Calculated Parameters

| | | | | | | | | | |
|-------------|--------|------|--|-----|--|---------|--|--|--|
| Resistivity | ohm-cm | 5200 | | 490 | | 7108299 | | | |
|-------------|--------|------|--|-----|--|---------|--|--|--|

Inorganics

| | | | | | | | | | |
|-------------------------------|---------|----------|-----|------|----|---------|-----|----|---------|
| Soluble (20:1) Chloride (Cl-) | ug/g | <200 (1) | 200 | 920 | 20 | 7112592 | | | |
| Conductivity | umho/cm | 193 | 2 | 2050 | 2 | 7114634 | | | |
| Available (CaCl2) pH | pH | 7.83 | | 7.75 | | 7112629 | | | |
| Soluble (20:1) Sulphate (SO4) | ug/g | <20 | 20 | <20 | 20 | 7112601 | <20 | 20 | 7112601 |

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

(1) Detection Limit was raised due to matrix interferences.



BUREAU
VERITAS

BV Labs Job #: COX1766
Report Date: 2021/01/28

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: CC

TEST SUMMARY

BV Labs ID: OKC178
Sample ID: CCTV-2 SA3B
Matrix: Soil

Collected: 2020/11/27
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|------------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 7112592 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |
| Conductivity | AT | 7114634 | 2020/12/17 | 2020/12/17 | Tarunpreet Kaur |
| pH CaCl ₂ EXTRACT | AT | 7112629 | 2020/12/16 | 2020/12/16 | Neil Dassanayake |
| Resistivity of Soil | | 7108299 | 2020/12/17 | 2020/12/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 7112601 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |

BV Labs ID: OKC179
Sample ID: CCTV-4 SA4
Matrix: Soil

Collected: 2020/11/13
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|------------------------------|-----------------|---------|------------|---------------|-------------------|
| Chloride (20:1 extract) | KONE/EC | 7114805 | 2020/12/17 | 2020/12/18 | Alina Dobreanu |
| Conductivity | AT | 7114634 | 2020/12/17 | 2020/12/17 | Tarunpreet Kaur |
| pH CaCl ₂ EXTRACT | AT | 7112629 | 2020/12/16 | 2020/12/16 | Neil Dassanayake |
| Resistivity of Soil | | 7108299 | 2020/12/17 | 2020/12/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 7114979 | 2020/12/17 | 2020/12/18 | Alina Dobreanu |

BV Labs ID: OKC179 Dup
Sample ID: CCTV-4 SA4
Matrix: Soil

Collected: 2020/11/13
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|----------------|
| Sulphate (20:1 Extract) | KONE/EC | 7114979 | 2020/12/17 | 2020/12/18 | Alina Dobreanu |

BV Labs ID: OKC180
Sample ID: CCTV-5 SA3
Matrix: Soil

Collected: 2020/11/10
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|------------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 7112592 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |
| Conductivity | AT | 7114634 | 2020/12/17 | 2020/12/17 | Tarunpreet Kaur |
| pH CaCl ₂ EXTRACT | AT | 7112629 | 2020/12/16 | 2020/12/16 | Neil Dassanayake |
| Resistivity of Soil | | 7108299 | 2020/12/17 | 2020/12/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 7112601 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |

BV Labs ID: OKC182
Sample ID: 27-5 SA2
Matrix: Soil

Collected: 2020/11/09
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|------------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 7112592 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |
| Conductivity | AT | 7114634 | 2020/12/17 | 2020/12/17 | Tarunpreet Kaur |
| pH CaCl ₂ EXTRACT | AT | 7112629 | 2020/12/16 | 2020/12/16 | Neil Dassanayake |
| Resistivity of Soil | | 7108299 | 2020/12/17 | 2020/12/17 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 7112601 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |



BUREAU
VERITAS

BV Labs Job #: COX1766
Report Date: 2021/01/28

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: CC

TEST SUMMARY

BV Labs ID: OKC182 Dup
Sample ID: 27-5 SA2
Matrix: Soil

Collected: 2020/11/09
Shipped:
Received: 2020/12/11

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Sulphate (20:1 Extract) | KONE/EC | 7112601 | 2020/12/16 | 2020/12/17 | Deonarine Ramnarine |



BUREAU
VERITAS

BV Labs Job #: COX1766
Report Date: 2021/01/28

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: CC

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

| | |
|-----------|-------|
| Package 1 | 5.7°C |
|-----------|-------|

Revised report (2021/01/28): Split report as per client request.

Results relate only to the items tested.



BUREAU
VERITAS

BV Labs Job #: COX1766

Report Date: 2021/01/28

QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 1786658 WO 15

Sampler Initials: CC

| QC Batch | Parameter | Date | Matrix Spike | | SPIKED BLANK | | Method Blank | | RPD | |
|----------|-------------------------------|------------|--------------|-----------|--------------|-----------|--------------|---------|-----------|-----------|
| | | | % Recovery | QC Limits | % Recovery | QC Limits | Value | UNITS | Value (%) | QC Limits |
| 7112592 | Soluble (20:1) Chloride (Cl-) | 2020/12/17 | NC | 70 - 130 | 99 | 70 - 130 | <20 | ug/g | 9.5 | 35 |
| 7112601 | Soluble (20:1) Sulphate (SO4) | 2020/12/17 | 94 | 70 - 130 | 102 | 70 - 130 | <20 | ug/g | NC | 35 |
| 7112629 | Available (CaCl2) pH | 2020/12/16 | | | 100 | 97 - 103 | | | 0.080 | N/A |
| 7114634 | Conductivity | 2020/12/17 | | | 102 | 90 - 110 | <2 | umho/cm | 1.6 | 10 |
| 7114805 | Soluble (20:1) Chloride (Cl-) | 2020/12/18 | 118 | 70 - 130 | 103 | 70 - 130 | <20 | ug/g | NC | 35 |
| 7114979 | Soluble (20:1) Sulphate (SO4) | 2020/12/18 | 115 | 70 - 130 | 106 | 70 - 130 | <20 | ug/g | NC | 35 |

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).



BUREAU
VERITAS

BV Labs Job #: COX1766
Report Date: 2021/01/28

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: CC

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



CHAIN OF CUSTODY RECORD

Page of

| | | | | | | | | | | | | | | | | | |
|---|--|--|---------------------------------------|--|--|---|--|--|---|--|---|---|--|--|--|--|--|
| INVOICE TO: | | | REPORT TO: | | | PROJECT INFORMATION: | | | Laboratory Use Only: | | | | | | | | |
| Company Name: #1326 Golder Associates Ltd | | | Company Name: Golder Associates | | | Quotation #: B80683 | | | BV Labs Job #: | | Bottle Order #: | | | | | | |
| Attention: Accounts Payable | | | Attention: Darcy Hansen Carter Conish | | | P.O. #: | | | | |  | | | | | | |
| Address: 6925 Century Ave Suite 100 | | | Address: cconish@golder.com | | | Project: 1786658 WO 15 | | | COC #: | | Project Manager: | | | | | | |
| Mississauga ON L5N 7K2 | | | | | | Project Name: | | |  | | Ema Gitej | | | | | | |
| Tel: (905) 567-4444 Fax: (905) 567-6561 | | | Tel: (905) 567-4444 Ext: 2064 Fax: | | | Site #: | | | C#805726-01-01 | | | | | | | | |
| Email: CanadaAccountsPayableInvoices@golder.com | | | Email: Darcy.Hansen@golder.com | | | Sampled By: | | | | | | | | | | | |
| MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY | | | | | | ANALYSIS REQUESTED (PLEASE BE SPECIFIC) | | | | | | Turnaround Time (TAT) Required: | | | | | |
| Regulation 153 (2011) | | | | | | Other Regulations | | | | | | Special Instructions | | | | | |
| <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input checked="" type="checkbox"/> Medium/Fine | | | | | | <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw | | | | | | O. Reg 347 Schedule 4 | | | | | |
| <input type="checkbox"/> Table 2 <input checked="" type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse | | | | | | <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw | | | | | | | | | | | |
| <input checked="" type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC | | | | | | <input type="checkbox"/> MISA <input type="checkbox"/> Municipality | | | | | | | | | | | |
| <input type="checkbox"/> Table | | | | | | <input type="checkbox"/> PWQO <input type="checkbox"/> Reg 406 Table | | | | | | | | | | | |
| Include Criteria on Certificate of Analysis (Y/N)? <input checked="" type="checkbox"/> | | | | | | Field Filtered (please circle): | | | | | | Corrosivity req (Cl, SO4, pH, EC/Resistivity) | | | | | |
| Sample Barcode Label | | | | | | Sample (Location) Identification | | | | | | Date Sampled | | | | | |
| 1 RW-1 SA3 | | | | | | 2020 | | | | | | AM Soil | | | | | |
| 2 TISB-1 SA3 | | | | | | 2020 | | | | | | | | | | | |
| 3 CCTV-2 SA3B | | | | | | 2020 | | | | | | | | | | | |
| 4 CCTV-4 SA4 | | | | | | 2020 | | | | | | | | | | | |
| 5 CCTV-5 SA3 | | | | | | 2020 | | | | | | | | | | | |
| 6 26-6 SA4B | | | | | | 2020 | | | | | | | | | | | |
| 7 27-5 SA2 | | | | | | 2020 | | | | | | | | | | | |
| 8 28-6 SA#6 | | | | | | 2020 | | | | | | | | | | | |
| 9 29-5 SA12 | | | | | | 2020 | | | | | | | | | | | |
| 10 33-5 SA8 | | | | | | 2020 | | | | | | | | | | | |
| * RELINQUISHED BY: (Signature/Print) | | | | | | Date: (YY/MM/DD) | | | | | | Time | | | | | |
| Carter Conish | | | | | | 20/12/11 | | | | | | 6pm | | | | | |
| RECEIVED BY: (Signature/Print) | | | | | | Date: (YY/MM/DD) | | | | | | Time | | | | | |
| P/ALEXANDER FORR | | | | | | 20/12/11 | | | | | | 18:29 | | | | | |
| # jars used and not submitted | | | | | | Laboratory Use Only | | | | | | Time Sensitive | | | | | |
| | | | | | | Temperature (°C) on Recept | | | | | | Custody Seal | | | | | |
| | | | | | | 47.6 °C | | | | | | Present | | | | | |
| | | | | | | | | | | | | Intact | | | | | |
| | | | | | | | | | | | | Yes | | | | | |
| | | | | | | | | | | | | No | | | | | |
| | | | | | | | | | | | | White: BV Labs | | | | | |
| | | | | | | | | | | | | Yellow: Client | | | | | |
| | | | | | | | | | | | | SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS | | | | | |
| | | | | | | | | | | | | | | | | | |



Bureau Veritas Laboratories
6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

CHAIN OF CUSTODY RECORD

Page of

| INVOICE TO: | | REPORT TO: | | PROJECT INFORMATION: | | Laboratory Use Only: | |
|---|--|--|----------------|---|------------------|--|-------------------------------|
| Company Name: <u>1326</u> <u>#2292</u> Golder Associates Ltd | Company Name: <u>Kimberley Rose</u> <u>aka Carter Comish</u> | Quotation #: <u>B80683</u> | BV Labs Job #: | | Bottle Order #: | | |
| Attention: <u>Accounts Payable</u> | Attention: <u>Kimberley Rose</u> | P.O. #: | 794544 | | | | |
| Address: <u>100 Scotia Ct</u> <u>6725 Century Ave #100</u> | Address: <u>ccomish@golder.com</u> | Project: <u>1895923.4000</u> <u>178658 WWS</u> | COC #: | | Project Manager: | | |
| Whitby ON L1N 8Y6 M.S. NO. L5N 7K2 | Tel: <u>(905) 723-5491 Ext 6644</u> Fax: <u>(905) 723-2182</u> | Project Name: | | | Erna Gitej | | |
| Tel: <u>(905) 723-2727</u> | Email: <u>Kimberley_Rose@golder.com</u> | Site #: | C#794544-05-01 | | | | |
| Email: <u>CanadaAccountsPayableInvoices@golder.com</u> | | Sampled By: | | | | | |
| MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY | | | | ANALYSIS REQUESTED (PLEASE BE SPECIFIC) | | Turnaround Time (TAT) Required: | |
| Regulation 153 (2011) <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input checked="" type="checkbox"/> Medium/Fine <input type="checkbox"/> Table 2 <input checked="" type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input checked="" type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> Table <input type="checkbox"/> Other | | | | Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Municipality <input type="checkbox"/> PWQO <input type="checkbox"/> Reg 406 Table <input checked="" type="checkbox"/> Other | | Special Instructions <u>O. Reg 347</u> <u>Schedule 4</u> | |
| Include Criteria on Certificate of Analysis (Y/N)? <u>P</u> | | | | Field Filtered (please circle): Metals / Hg / Cr VI <u>Geog 153 VOCS by HS & F & H (5ml)</u> <u>Reg 153 PPHs</u> <u>Reg 153 Metals & Inorganics - PPH</u> <u>corrosivity pH</u> <u>short term</u> | | Regular (Standard) TAT: (will be applied if Rush TAT is not specified): Standard TAT = 5-7 Working days for most tests. Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details. Job Specific Rush TAT (if applies to entire submission) Date Required: _____ Time Required: _____ Rush Confirmation Number: _____ (call lab for #) | |
| Sample Barcode Label | Sample (Location) Identification | Date Sampled | Time Sampled | Matrix | | # of Bottles | Comments |
| 1 <u>34-5 SA 6</u> | | <u>Nov 12 2020</u> | | | | | |
| 2 <u>35-4 SA 6</u> | | <u>Nov 12 2020</u> | | | | | |
| 3 <u>36-5 SA 9</u> | | <u>Nov 2 2020</u> | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| * RELINQUISHED BY: (Signature/Print) | | Date: (YY/MM/DD) | Time | RECEIVED BY: (Signature/Print) | Date: (YY/MM/DD) | Time | # jars used and not submitted |
| <u>Kimberley Rose</u> | | <u>20/11/12</u> | <u>6p</u> | <u>Kimberley Rose</u> | <u>20/12/11</u> | <u>18:34</u> | |
| Laboratory Use Only | | | | Laboratory Use Only | | | |
| Time Sensitive | | Temperature (°C) on Receipt | Custody Seal | Yes | | No | |
| | | <u>4/7/6</u> | Present | <input checked="" type="checkbox"/> | | <input type="checkbox"/> | |
| | | | Intact | <input checked="" type="checkbox"/> | | <input type="checkbox"/> | |
| * UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BV LABS' STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVLABS.COM/TERMS-AND-CONDITIONS. | | | | SAMPLER MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS | | | |
| * IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS. | | | | White: BV Labs Yellow: Client | | | |
| ** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVLABS.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS. | | | | | | | |

Bureau Veritas Canada (2019) Inc.



Your Project #: 1786658 WO 15
Your C.O.C. #: N/A

Attention: Carter Comish

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/02/26
Report #: R6534377
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: C144289

Received: 2021/02/18, 16:20

Sample Matrix: Soil
Samples Received: 1

| Analyses | Quantity | Date | Date | Laboratory Method | Analytical Method |
|-------------------------|----------|------------|------------|-------------------|-------------------|
| | | Extracted | Analyzed | | |
| Chloride (20:1 extract) | 1 | 2021/02/22 | 2021/02/22 | CAM SOP-00463 | SM 23 4500-Cl E m |
| Conductivity | 1 | 2021/02/23 | 2021/02/23 | CAM SOP-00414 | OMOE E3530 v1 m |
| pH CaCl2 EXTRACT | 1 | 2021/02/23 | 2021/02/23 | CAM SOP-00413 | EPA 9045 D m |
| Resistivity of Soil | 1 | 2021/02/18 | 2021/02/23 | CAM SOP-00414 | SM 23 2510 m |
| Sulphate (20:1 Extract) | 1 | 2021/02/22 | 2021/02/22 | CAM SOP-00464 | EPA 375.4 m |

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.



Your Project #: 1786658 WO 15
Your C.O.C. #: N/A

Attention: Carter Comish

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/02/26
Report #: R6534377
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: C144289

Received: 2021/02/18, 16:20

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: emese.gitej@bureauveritas.com

Phone# (905)817-5829

=====

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



BUREAU
VERITAS

BV Labs Job #: C144289
Report Date: 2021/02/26

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: SK

SOIL CORROSIVITY PACKAGE (SOIL)

| | | | | |
|----------------------------------|--------------|--|------------|-----------------|
| BV Labs ID | | OWL365 | | |
| Sampling Date | | 2021/02/18 | | |
| COC Number | | N/A | | |
| | UNITS | W015-VMS-2-SA3-7'6" -9'6" | RDL | QC Batch |
| Calculated Parameters | | | | |
| Resistivity | ohm-cm | 980 | | 7206658 |
| Inorganics | | | | |
| Soluble (20:1) Chloride (Cl-) | ug/g | 470 | 20 | 7211038 |
| Conductivity | umho/cm | 1020 | 2 | 7212717 |
| Available (CaCl2) pH | pH | 7.94 | | 7212923 |
| Soluble (20:1) Sulphate (SO4) | ug/g | <20 | 20 | 7211042 |
| RDL = Reportable Detection Limit | | | | |
| QC Batch = Quality Control Batch | | | | |



BUREAU
VERITAS

BV Labs Job #: C144289
Report Date: 2021/02/26

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: SK

TEST SUMMARY

BV Labs ID: OWL365
Sample ID: W015-VMS-2-SA3-7'6"-9'6"
Matrix: Soil

Collected: 2021/02/18
Shipped:
Received: 2021/02/18

| Test Description | Instrumentation | Batch | Extracted | Date Analyzed | Analyst |
|-------------------------|-----------------|---------|------------|---------------|---------------------|
| Chloride (20:1 extract) | KONE/EC | 7211038 | 2021/02/22 | 2021/02/22 | Deonarine Ramnarine |
| Conductivity | AT | 7212717 | 2021/02/23 | 2021/02/23 | Tarunpreet Kaur |
| pH CaCl2 EXTRACT | AT | 7212923 | 2021/02/23 | 2021/02/23 | Neil Dassanayake |
| Resistivity of Soil | | 7206658 | 2021/02/23 | 2021/02/23 | Automated Statchk |
| Sulphate (20:1 Extract) | KONE/EC | 7211042 | 2021/02/22 | 2021/02/22 | Avneet Kour Sudan |



BUREAU
VERITAS

BV Labs Job #: C144289
Report Date: 2021/02/26

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: SK

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

| | |
|-----------|-------|
| Package 1 | 3.7°C |
|-----------|-------|

Revised Report [2021/02/26]: Split report as per client request.

Results relate only to the items tested.



BUREAU
VERITAS

BV Labs Job #: C144289

Report Date: 2021/02/26

QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 1786658 WO 15

Sampler Initials: SK

| QC Batch | Parameter | Date | Matrix Spike | | SPIKED BLANK | | Method Blank | | RPD | |
|----------|--|------------|--------------|-----------|--------------|-----------|--------------|---------|-----------|-----------|
| | | | % Recovery | QC Limits | % Recovery | QC Limits | Value | UNITS | Value (%) | QC Limits |
| 7211038 | Soluble (20:1) Chloride (Cl ⁻) | 2021/02/22 | NC | 70 - 130 | 101 | 70 - 130 | <20 | ug/g | 11 | 35 |
| 7211042 | Soluble (20:1) Sulphate (SO ₄) | 2021/02/22 | NC | 70 - 130 | 109 | 70 - 130 | <20 | ug/g | NC | 35 |
| 7212717 | Conductivity | 2021/02/23 | | | 103 | 90 - 110 | <2 | umho/cm | 1.6 | 10 |
| 7212923 | Available (CaCl ₂) pH | 2021/02/23 | | | 101 | 97 - 103 | | | 0.89 | N/A |

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).



BUREAU
VERITAS

BV Labs Job #: C144289
Report Date: 2021/02/26

Golder Associates Ltd
Client Project #: 1786658 WO 15
Sampler Initials: SK

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Anastassia Hamanov, Scientific Specialist

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



6740 Campbell Road, Mississauga, Ontario L5N 2L8
 Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
 CAM FCD-01191/6

WORK ORDER

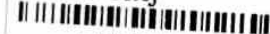
CHAIN OF CUSTODY RECORD

Page 1 of 1

| Invoice Information | | Report Information (if differs from invoice) | | Project Information (where applicable) | | Turnaround Time (TAT) Required | | | | | | | |
|--|---------------------------|--|--------------------------------|--|--|--|--------------|------|-----------------------------|----------------------|---|-------------------|-----------------------|
| Company Name: <u>Golden Associates Ltd</u> | | Company Name: <u>Golden Associates Ltd</u> | | Quotation #: _____ | | <input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses | | | | | | | |
| Contact Name: <u>Accounts Payable</u> | | Contact Name: <u>Carter Comish</u> | | P.O. #/ AFE#: _____ | | PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS | | | | | | | |
| Address: <u>6925 Century Ave, Suite #100</u> | | Address: _____ | | Project #: <u>1786658</u> | | Rush TAT (Surcharges will be applied) | | | | | | | |
| <u>Mississauga, ON, L5N 7K2</u> | | _____ | | Site Location: _____ | | <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days | | | | | | | |
| Phone: <u>905 567 4444</u> Fax: _____ | | Phone: <u>905 567 4444 x220</u> Fax: _____ | | Site #: _____ | | Date Required: _____ | | | | | | | |
| Email: <u>Canada.accounts.payable@golden.com</u> | | Email: <u>Carter-Comish@golden.com</u> | | Site Location Province: _____ | | Rush Confirmation #: _____ | | | | | | | |
| MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS LABORATORIES' DRINKING WATER CHAIN OF CUSTODY | | | | | | | | | | | | | |
| Regulation 153 <input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Lomm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table _____ FOR RSC (PLEASE CIRCLE) Y / N | | Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWUJ <input type="checkbox"/> Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____ | | Analysis Requested # OF CONTAINERS SUBMITTED FIELD FILTERED (CIRCLE) Metals / Hg / CrVI BTEX/ PHC F1 PHCs P2 - F4 VOCs REG 153 METALS & INORGANICS REG 153 ICPMS METALS REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B) <u>Conductivity Pkg.</u> | | LABORATORY USE ONLY CUSTODY SEAL Y / N Present Intact COOLER TEMPERATURES <u>9/4/13</u> COOLING MEDIA PRESENT: (Y) / N COMMENTS | | | | | | | |
| Include Criteria on Certificate of Analysis: Y / N | | | | | | | | | | | | | |
| SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS | | | | | | | | | | | | | |
| SAMPLE IDENTIFICATION | DATE SAMPLED (YYYY/MM/DD) | TIME SAMPLED (HH:MM) | MATRIX | # OF CONTAINERS SUBMITTED | FIELD FILTERED (CIRCLE) Metals / Hg / CrVI | BTEX/ PHC F1 | PHCs P2 - F4 | VOCs | REG 153 METALS & INORGANICS | REG 153 ICPMS METALS | REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B) | Conductivity Pkg. | HOLD - DO NOT ANALYZE |
| 1 <u>W039-NW-1-SS3-5'-7'</u> | <u>2021/02/18</u> | <u>PM</u> | <u>SOIL</u> | <u>1</u> | | | | | | | | <u>X</u> | |
| 2 <u>W015-VMS-2-SAB-7'6"-9'6"</u> | <u>"</u> | <u>"</u> | <u>"</u> | <u>1</u> | | | | | | | | <u>X</u> | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |
| RELINQUISHED BY: (Signature/Print) | DATE: (YYYY/MM/DD) | TIME: (HH:MM) | RECEIVED BY: (Signature/Print) | | DATE: (YYYY/MM/DD) | TIME: (HH:MM) | | | | | | | |
| <u>Shantanu Kaur / SK</u> | <u>2021/02/18</u> | <u>3:30 PM</u> | <u>[Signature]</u> | | <u>2021/02/18</u> | <u>16:20</u> | | | | | | | |

18-Feb-21 16:20

Ema Gitej



C144289

ATM

ENV-1290

APPENDIX F

Non-Standard Special Provisions

**CONTROL OF OVERBURDEN SOILS DURING EXCAVATION FOR CLOSED CIRCUIT TELEVISION
POLE FOUNDATIONS AND VARIABLE MESSAGE SIGN SUPPORTS - Item No.**

Non-Standard Special Provision

The Contractor shall construct pole foundations and sign supports in conformance with the design and at the locations indicated in the Contract Documents.

The Contractor shall construct the pole foundations and sign supports against undisturbed bases and sides of excavations. The bases of caisson excavations shall be cleaned of loosened and/or softened materials prior to pouring concrete for the foundation. The construction methods and techniques shall be the responsibility of the Contractor. Consideration shall be given to using temporary liners or tremie concreting techniques where conditions warrant.

The Contractor is advised that excavations will be advanced through granular fill materials (where present), various interlayers of granular and native material through/into cohesive soils which may contain lenses or layers of potentially saturated cohesionless soils. The granular soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment shall be implemented to eliminate ground loss during drilling, caisson installation and concrete placement.

The contractor is also advised that the soils throughout the project area are glacially-derived and contain cobbles and boulders. Appropriate equipment and procedures shall be implemented for construction of foundations to penetrate obstructions (cobbles and boulders), and into the very stiff to hard till deposit, to depths/elevations specified in the contract.

Basis of Payment

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

DECOMMISSIONING OF PIEZOMETERS - Item No.

Non-Standard Special Provision

1.0 SCOPE

This special provision covers the requirements for the decommissioning of the piezometers located in the vicinity of the proposed stormwater management ponds.

Standpipe piezometers were installed in Boreholes CCTV-4 and CCTV-5. The piezometers have been left in place to allow for monitoring of groundwater levels up to the time of construction. The piezometer locations (relative to MTM NAD 83 Zone 10 and in latitude and longitude), piezometer diameters, borehole diameter, and piezometer depth are summarized below.

| Standpipe Piezometer Identification | Approximate Location | | PVC Pipe and Screen diameter / Borehole diameter | Depth (Below Ground Surface) to Tip of Screen |
|-------------------------------------|----------------------------|----------------------------|--|---|
| | Northing (m) (Latitude, °) | Easting (m) (Longitude, °) | | |
| CCTV-4 | 4,870,520.2 (43.974646) | 298,484.7 (-79.578717) | 50 mm / 203 mm | 8.4 m |
| CCTV-5 | 4,871,604.9 (43.984408) | 298,307.0 (-79.580944) | 50 mm / 203 mm | 7.6 m |

2.0 REFERENCES – Not Used

3.0 DEFINITIONS – Not Used

4.0 DESIGN AND SUBMISSION REQUIREMENTS – Not Used

5.0 MATERIALS – Not Used

6.0 EQUIPMENT – Not Used

7.0 CONSTRUCTION

As part of the construction activities the contractor shall properly decommission the standpipe piezometers prior to the start of the construction works. The abandonment method for standpipe piezometers must satisfy the minimum requirements of Ontario Regulation 903 Wells, as amended under the Ontario Water Resources Act. In addition, the contractor shall provide a written record of the decommissioning procedure to the Contract Administrator. The record shall include plugging material used, depth of plugging material and limit of the PVC standpipe/screen removal.

8.0 QUALITY ASSURANCE – Not Used

9.0 MEASUREMENT FOR PAYMENT – Not Used

10.0 BASIS OF PAYMENT

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



golder.com